MARINE ENGINEERING—INDEX TO VOL. I.

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NOTE.—The figures following the name of the month refer to page numbers. Illustrated articles are marked with an asterisk (*) following the title.

MARINE ENGINEERING.

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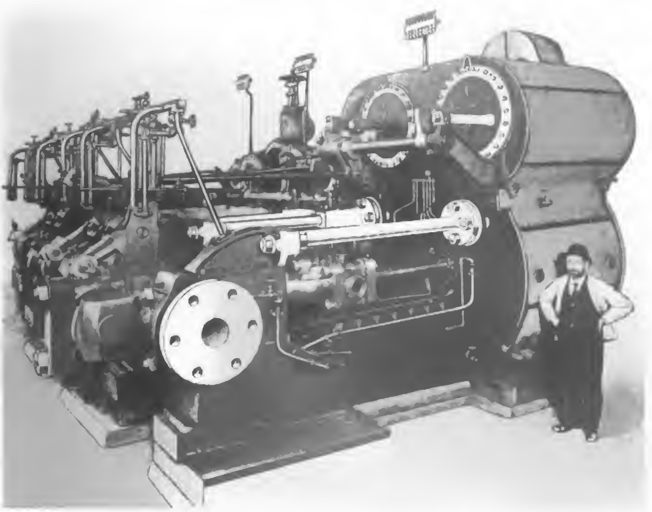
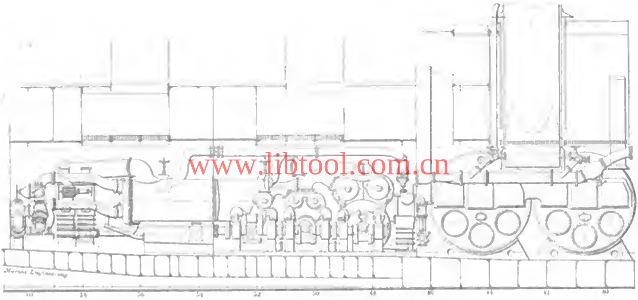
NEW HORIZONTAL ENGINES FOR U. S. CRUISER CHICAGO.

U. S. S. Chicago, which is in dry dock, in the Brooklyn Navy Yard, will soon be fitted with the new machinery which has been completed in the yard shops. This unarmored cruiser, which was one of the original White Squadron, is of 4,500 tons displacement. When launched in 1884 she made 15 knots with 5,083.7 horse power on her trial trip. The navy authorities decided to make very radical changes in the Chicago by putting in more powerful engines, replacing the heavy square rig by a fore and aft spread of canvas and increasing the offensive powers of the vessel. The engines taken out were of a peculiar compound beam type, and it was decided to replace these with horizontal direct-acting triple-expansion engines. These are expected to develop 9,000 horse-power under forced draught, sufficient, it is estimated, to give the Chicago a maximum speed of 18½ knots an hour. The designs for the engines and boilers were prepared by the Bureau of Steam Engineering under the direction of Engineer-in-Chief, George W. Melville, U. S. N.



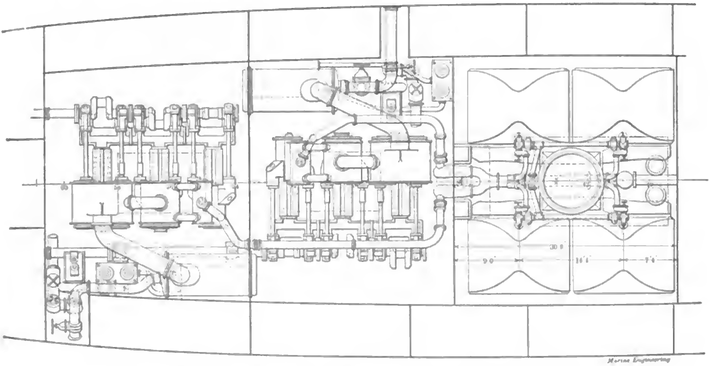
PORT ENGINE U. S. S. CHICAGO IN NAVY YARD SHOPS.

With the change of engines, a new set of boilers was a necessity and after deliberation the



GENERAL ARRANGEMENT OF MACHINERY, U. S. S. CHICAGO—ELEVATION.

bureau adopted a combination of the cylindrical and sectional types. Consequently the Chicago is to have four Scotch boilers, which have also been built in the Brooklyn yard, and six Babcock & Wilcox water tube boilers supplied by the patentees. The type of engines used was necessary to get the machinery below the water line, as the Chicago has no side armor. There is a protective deck over the machinery spaces 1½ in. thick which has been extended right fore and aft. This is pierced for gratings below the engine room skylights. In the accompanying drawings the general arrangement of the new machinery will be seen in part. The portion not shown is forward of the Scotch boilers, and includes the blower space and further forward, the room for the water tube boilers. The engines and boilers occupy 140 ft. of the length of the vessel. Measuring from forward aft the B. & W. boilers occupy 42 ft., the blower room 12 ft. 4 in., the Scotch boilers, 30 ft. 8 in. and the engine room, 55 ft. The extreme height of the machinery spaces is 20 ft., from inner floor of the double bottom to the protective deck overhead. The machinery space does not extend the full width across the ship as a belt of coal 7 ft. thick



GENERAL ARRANGEMENT OF MACHINERY, U. S. S. CHICAGO—PLAN.

is carried along the sides the full height of the machinery.

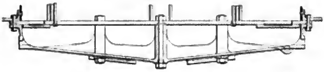
The engines as will be seen from the engraving, are of very handsome design, symmetrical, compact and yet with all parts easy of access. Their construction has been carried out with skill and thoroughness. With the single exception of the crank shafts, which were delivered at the Navy Yard in the rough, every pound of the material was produced in the various shops. A description of one engine will apply to both as they are the same in all essentials, differing only in such details as are made necessary by their respective positions to port and starboard. The port engine is shown in the cut. This has three cylinders, 33½ in., 50½ in., and 76 in. dia., and 40 in. stroke. Steam will be supplied at 180 pounds pressure and when going full speed the engine will make 135 revolutions. The main bed plate is made up of box sections, three of which carry the main bearings while three distance pieces bear the slides on top, and are bolted to projections cast on the front ends of the cylinders.

The cylinders are also of cast iron, jacketed, 1½ in. thick in the body, and fitted with liners of hard cast iron 1¼ in. thick. The pistons are of cast steel, dished, of very light weight, and each is fitted with two cast iron rings ⅝ in. on the faces, and ¾ in. deep, set out with elliptical springs. Piston valves are fitted to each cylinder; one 18 in. dia. to the H. P.; two 18 in. dia. to the I. P. and two of 30 in. dia. to the L. P. cylinders. The valve seatings are fitted with hard cast iron liners and the valve bodies and rings are of composition metal. The valve spindles run free through the inboard ends of the valves, a feather preventing any twisting motion. The outboard ends are secured by a taper and fitted with tail rods. These work through bushings in the covers and as the valve spindles also work in bushings, in the front ends, all weight is taken off the stuffing boxes. Any bushing can be removed and replaced with little loss of time. The stuffing boxes throughout are of the Watson patents. The valve rods of the H. P. and I. P. cylinders are 3 in. dia. those of the L. P. 3½ in. dia. The piston rods are of mild steel 7 in. dia. fitting in the cross heads in a taper 11½ in. long. The cross heads are made of cast steel with slippers of manganese bronze, babbitted, 24 in. long and 18 in. wide. Cast iron is used for the guides which are kept cool by water jackets. The connecting rods are 7 ft. 2 in., centers 7⅜ in. dia. at the throat. and 8 in. at the large end, and they are bored with a 4½ in. hole reduced to 2 in. near the forks. The cross head journals measure 8 in. dia. and 8¼ in. long, while the crank pins are 14¼ in. dia. and 16 in. long. The big ends are of composition, babbitted and held together by bolts, 2 to each rod, 4¼ in. dia.

Open-hearth steel is the material used in the crank shaft, which is 22 ft. 0¾ in. long, 14 in. dia. in the body and 14 in. by 16½ in. in the main bearings, with an 8 in. hole through the bearings and pins. It is made in three sections, bolted together with couplings 2 ft. 4 in. dia. and 3¼ in. thick, each pair connected with six 3 in. bolts. Each section weighs 2½ tons. The cranks are set at angles of 120 deg. The crank webs are 17 in. wide and 9½ in. thick, with the corners rounded off. The valve gear is of the well-known Marshall patent, which necessitates the use of only one eccentric for each cylinder. The cylinders are isolated one from the other so that free passage between is permitted for oiling and examinations. Between the L. P. and I. P. cylinders the steam reversing engine is bolted to the L.P. cylinder. The starting platform, which has heretofore been fitted over the motion in engines of this type, is placed on a level with the bed plate. The levers are attached to a plate secured to the tie rod on the H.P. end of the engine. This brings the starting gear for both engines close together and admits of ready observation as the direction in which each engine is turning. It will be noticed that the engines overlap, the keel being in the same vertical plane with the front ends of the cylinders. The main stop valve of the engine, which is seen directly over the H.P. valve chest, acts also as the throttle valve. It is a Hornblower double beat balanced valve. The main steam pipe is 12 in. dia., of cast steel, and the exhaust 27 in. dia. The mains connecting the I.P. and L.P. receivers are of copper. The rocking shaft which communicates the motion of the eccentric rods to the valve spindles of the L.P. cylinder is 5½ in. dia., carried by cast iron brackets bolted and stayed to the cylinder head. That for the I. P. cylinder is 4½ in. dia., carried in bearings secured to squares on the inboard ends of the tie rods. Over portion of this length of shaft a sleeve is fitted 8 in. dia., which carries the levers of the reversing gear. The eccentric rod for the H.P. cylinder is joined direct with a forked end to the valve spindle, without the intervention of any levers or guides. The tie rods are 6 in number of 5 in. dia. flanged at the ends and held fast by heavy turned bolts and nuts.

It will be noticed the engines are inclined slightly downwards, the center line making an angle of less than 4 deg. with the horizontal. The shafts are parallel with each other and with the base line. Lubrication is secured by a gravity system and a convenient arrangement of water pipes is carried over the crank shaft. Turning gear is fitted between the engine and tail shaft. The thrust shafts are of open hearth steel, 24 ft. long and 13¼ in. dia. There are 13 collars on each shaft, 17½ in. dia., and 1⅝ in. thick. The tunnel shafting is 14½ in. dia. and the propeller shafts are 15 in. Over all the starboard shafting is 138 ft. 8 in. long. Manganese bronze is used for the propellers which are 13 ft. dia. and 14 ft. pitch, three bladed and a modified Griffiths' in design.

Machine steel is used for the shells of the condensers which are cylindrical 5 ft. 8½ in. dia. and 11 ft. 6 in. between tube sheets. Each contains 3,399 Muntz metal tubes ⅝ in. O. D. of 18 B. W. G. fitting into stuffing boxes at the ends and giving a total of 6,380 sq. ft. cooling surface. The tube sheets are 1 in. thick. Each tube is a snug fit through the inner side of the sheet for a distance of 3-16 in. From there to the outside of the sheet, the tube holes are ⅞ in. dia. screwed and fitted with ferrules ⅝ in. deep which leaves a space for packing with corset lacing. No inside stays are used, the tube sheets being braced to the condenser heads at each end in the manner shown in the cut. The section shows the strengthening webs which connect the bolt sleeves. There are five 1¼ in. tie bolts in each head, one in the center, and the others equally spaced around. The outer flanges of shell and covers are held together at each end by ¾ in. bolts.



CONDENSER HEAD AND TUBE SHEET.

Independent vertical duplex direct-acting air pumps built by Marshal T. Davidson are used. The steam cylinders are 12 in. dia., and the pump chambers 25 by 18 in. The circulating pumps and engines were built in the yard shops. The engines are compound, with cylinders 6½ and 9¾ in. by 8 in. stroke. The centrifugal pumps which they drive have fliers 36 in. dia. and 2¼ in. width of face. The suction and discharge openings are 15½ in.

As the Chicago will be worked under forced draught on the closed stokehold system when running at the higher speeds, blowers are fitted in the space between the two boiler rooms. There are 4 fans each 66 in. dia. with 12 in. blades. The blower engines are double, with cylinders 5 by 5 in. and cranks set at right angles. The blowers are arranged in pairs, two on each side of the keel line, the engine shaft of each extending inboard and connecting with couplings so that if necessary the port engines could drive all four blowers, and vice versa. The boilers include four single ended Scotch type 13 ft. 9 in. dia. by 10 ft. 3 in. long with 273 sq. ft. grate and 8,552 sq. ft. heating surface, and six Babcock & Wilcox water tube boilers containing 360 sq. ft. grate, and 18,000 sq. ft. heating surface. This gives a total available grate surface of 633 sq. ft. and 26,552 of heating surface. It is estimated that the Scotch boilers will drive the ship 13 knots and with the water-tube boilers added, 18.5 knots can be had. The bunker capacity is 918 tons.

The construction and erection of this machinery, in the yard shops, has been carried out under the direction of Chief Engineer Edward Farmer, U. S. N., and his staff.

NOTES ON LIQUID LUBRICANTS.

BY HENRY E. CUTTS, A. M.

In order to work an engine economically it is necessary to prevent, as far as possible, any waste of power. A very important factor in the total of waste is the amount of energy lost in overcoming the friction of the moving parts. More attention is now given to the elimination of this source of loss than in time past, but even now lubrication is not accorded the place it should hold in the economy of the engine room.

The friction of solid bodies sliding on each other is very considerable, varying with the material, and the pressure applied to the parts in contact. The friction of liquids moving on each other is much less than that of solids, as solid surfaces are of an entirely different character. The molecular structure of a solid is fixed, while the molecules of a liquid move readily, changing their relative positions with ease, the speed varying in different portions, increasing and diminishing in zones parallel to the direction of motion. For example, in a liquid medium between two solid surfaces, one in motion and the other at rest, that part next the moving surface moves with the same speed as the moving surface, while the speed of the liquid gradually diminishes until that portion of the liquid next the surface at rest is also at rest. For this reason a liquid acts as a lubricant between the bearing surface of an engine. In order that the friction of the liquid itself be as small as possible, there should be only a mere film between the bearing surfaces, yet, sufficient to prevent them touching at any point. It thus becomes necessary that the liquid used as a lubricant be of such body that a thin homogeneous layer will be, at all times, interposed between all points of the bearing surfaces.

Theoretically, friction is equally small in liquids as compared with solids, but practically, of all liquids, oil is found to be the best adapted for lubricating purposes from its possession of an innate property known as greasiness. In earlier days of engineering knowledge animal and vegetable oils were used for lubrication of lighter bearings, while for large masses and heavy pressures, greases, which liquefy at temperatures above the normal, were necessary. In latter times, however, hydrocarbon, that is, mineral oils or compounds, containing a large percentage of mineral oils have been largely substituted, mainly because they are freer from objectionable qualities.

When mineral oils came into use as lubricants the specific gravity, showing the weight of an oil, was supposed to give a good indication of its quality. It was soon found, however, that mixtures of light and heavy hydrocarbon oils could be manufactured, which would have the same specific gravity as homogeneous oils of good lubricating power, but would be far inferior to them in this essential. Consequently it became necessary to apply other tests to the hydrocarbon oils. Of these the most important is the test to ascertain the viscosity or fluidity at the ordinary temperatures of use. With animal or vegetable oils this test is not of so great importance, as the viscosity varies but little in different samples of the same kind of oil. Lard oil has a certain viscosity, as also have sperm, rape, castor, etc., and their viscosities diminish but little with the rise of temperature. So an engineer had to but order a certain kind of oil and be sure of its possessing the same lubricating power as the oil he was then using. With the advent of mineral oils it became necessary for him to know the viscosity of the oil which he found satisfactory in use, so that in ordering fresh supplies he would be sure to get oil of the same lubricating power. The fact that he purchased mineral oil was not of itself sufficient to indicate its lubricating quality. Neglect of this precaution invariably resulted in trouble in the engine room.

There is, however, a great variation of viscosity in mineral oils at different temperatures, so that an oil of the proper body at, say, the temperature of the shaft bearings would be entirely too light at the temperature of the cylinders. This makes imperative a knowledge of the viscosity at several temperatures in order to get effective lubrication. For the measurement of viscosity there are many devices, unfortunately too many, and there is consequently no fixed scale of viscosity. Oils can be compared only by testing with the same kind of instrument and the comparison based on some oil of constant viscosity, as a sperm oil. In the majority of the viscosimeters used for this test a given volume of oil is allowed to run through a small orifice and the time occupied in its passage noted; for it has been proven that the friction in a liquid flowing through a small tube is of the same character as when the same liquid is interposed between moving surfaces. The accompanying table shows the variation in viscosities of different oils at different temperatures, and particularly the great decrease in the viscosity of mineral oils as the temperature rises.

VISCOSIMETER TESTS.

Kind of Oil.	Time of flow at Temp. F.		
	70 deg.	100 deg.	212 deg.
Sperm	88 sec.	66 sec.	42 sec.
Lard Oil	130 "	89 "	58 sec.
Engine Oil (Mineral) Sp.Gr. 0.911	284 sec.	90 sec.	45 sec.
Engine Oil (Mineral) Sp.Gr. 0.920	495 sec.	113 sec.	49 sec.
Cylinder Oil (Mineral) Sp.Gr. 0.887		800 sec.	78 sec.
CylinderOil (Mineral) Sp. Gr. 0.890		1500 sec.	94 sec.

Although the lubricating power of an oil is of prime importance, it is not the only property to be considered. Many oils of good lubricating power are not the best oils to use in the engine room. An oil should not have too low a flashing point, which is the temperature at which the vapor given off would catch fire. A low flashing point is not only an indication of possible danger in using the oil, but shows an admixture of light hydrocarbons, the presence of which is due to improper manufacture, or to their addition to lighten a too thick or viscous oil. If an oil is to be used in exposed places, or in a cold climate, it should not, on the other hand, solidify at too high a temperature. Again, care must be taken in the selection of an oil so that it will not gum nor decompose at the temperature at which it is to be used. Gumming is due, in some oils, to the nature of the oil itself, vegetable oils, for instance, slowly absorb oxygen from the air and form a sticky layer where applied, which, with one or two exceptions, prevents their use as lubricants for machinery. In other oils, gumming is due to matter left in the oil when it is marketed, the refining process being imperfectly carried out. Or again, it may be caused by the addition of foreign matter to give weight or body to the oil. As to decomposition, or turning rancid, animal oils undergo this chemical change through the application of heat, the action of the air, or of steam, or too long keeping even under ordinary conditions. The change converts the lubricant into a mixture of glycerine and free fatty acids, which latter are corrosive in their action, and by constant application to the metals in contact dissolve portions, causing what is known as pitting. As mineral oils do not contain any fatty acids and do not decompose under service conditions, they act less on metals than any other liquid lubricant. This property, among others, has so well come to be recognized, that in many steamship lines only hydrocarbon oils are permitted as lubricants. These, however, are in very many cases, and especially so in the brands sold for cylinder use exclusively, composed of mineral oil, with a slight admixture of animal oil, so the presence of free fatty acids has to be considered in their use.

The selection of oils is a difficult matter, as many of the more delicate tests cannot be effectively made without experience and the use of proper apparatus. Laboratory tests, while absolutely essential, are not conclusive, for it is the behavior of an oil, under service conditions, that must always govern its use as a lubricant. Starting with a poor oil, efficient lubrication manifestly cannot be accomplished, while given an oil, good as far as the scientist can determine, the practical conditions under which it is applied may render it of little value.

The British Navy estimates for 1897-98 show a decrease on the previous year's expenditure, for shipbuilding and engineering of warships, for the item of shipbuilding and engineering of warships, of $2,500,000. The total estimates for the fiscal year which begins April 1 are $109.190,000, or slightly more than was expended last year.

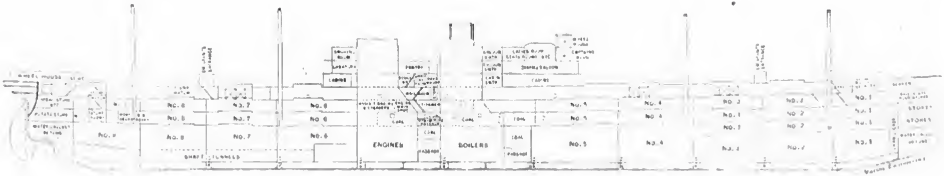
LARGEST FREIGHT CARRIER AFLOAT.

When the Hamburg-American twin-screw freight and passenger ship Pennsylvania, left the port of New York on her first eastward voyage, February 18, she carried away a miscellaneous cargo of 11,999 long tons dead weight. Her mean draught with this load in the cargo space, with 1,450 tons of coal and all stores aboard, was 31½ ft. The dimensions of this marine monster are: Length, 560 ft.; beam, 62 ft., and depth, from keel to awning deck, 42 feet.

The Pennsylvania is a good example of an increasing type of ocean vessel which is designed to be a profitable freight carrier, and yet afford such comforts and conveniences for passengers, as will attract many ocean travelers. To these considerations, and that of making a tremendously strong and seaworthy vessel, everything else has been subordinated. For this reason the general exterior of the ship could not be called handsome; nor in the interior is there any attempt at unnecessary, though possibly artistic, decoration which is to be found on most of the big liners. A good idea of the general appearance of the Pennsylvania, as she sits in the water, can be had from the accompanying photograph which was made upon her arrival in port. The proportions between the longitudinal and the vertical lines are not perfect, however, as she was in ballast when the view was taken. When loaded the great length is more apparent. The contour of the hull is graceful, but the straight pole masts and funnel give the boat an awkward appearance.

AWNING DECK S. S. PENNSYLVANIA LOOKING AFT FROM SALOON DECK.

Reference to the sectional diagram will show the interior arrangements. There are eight decks in all, though only four run the entire length of the hull. There is a double cellular bottom extending the length of the keel, the distance between the floors being 4 ft. This is used for water ballast, the total amount which can be carried being 1,896 tons. The decks are; lower deck, between deck, main deck, upper deck, and awning deck, in the hull, and in the superstructure, or bridge, amidships saloon deck, promenade deck and boat deck. The awning deck runs flush from stem to stern, and is used for working the vessel. The lower deck extends aft from the stem 148 ft. The hull is divided into 12 water-tight compartments by transverse bulkheads, which extend to the upper deck, and without openings; so that in case of collision or accident the safety of the vessel would not depend upon the possible working of automatic apparatus, or the promptness of the crew in closing doors. There are nine holds, and as many hatches, while for the speedy handling of cargo, there are twelve ordinary winches, and eight revolving steam cranes, each of 3 tons capacity. The general plan of this hoisting gear can be readily seen from the view showing the awning deck aft of the superstructure. The cargo capacity, exclusive of the trunk hatches and store rooms, is 720,630 cubic feet. The last named spaces give additional 5,800 and 24,060 cubic ft.



LONGITUDINAL SECTION STEAMSHIP PENNSYLVANIA.

respectively, and to this can be added the capacity of the shelter deck, giving a total of all cargo and store room of 211,702 tons of 40 cubic feet. There is also accommodation for 450 horses.

The pole masts are used for lookout, signal, and derrick purposes only, entire dependance being placed on the machinery for propulsion. They do not extend below the between decks. They are fitted in pairs, which helps to give the vessel an odd appearance. The distance between each pair is 88 ft., and between the main and mizzen masts 243 ft. Exceptionally heavy anchor gear and steam windlass is fitted forward in the usual liner style, while aft a steering engine of the builder's patent, controls the rudder by a balanced tiller. The superstructure extends a distance of 158 ft. amidships, its center line transversely being 16 ft. aft of the center line of the hull. The boat deck is 24 ft. above the awning deck, and on the awning deck the greater number of first-class state rooms are fitted. Here, also, are the cabins of the executive officers, and various work rooms of the steward's department. The dining saloon occupies the forward part of the structure on the promenade deck, and aft there is a lavatory, pantry and other like accommodations. The dining

HAMBURG-AMERICAN LINE STEAMSHIP PENNSYLVANIA.

room skylight is carried above the boat deck. On this deck the smoking and ladies' rooms are well furnished and equipped. In the forward end, the captain's room gives a commanding view clear ahead. Above this is the wheel house, the top of which is 80 ft. above the keel. It is surmounted by a sort of flying bridge. On the saloon and promenade decks there is a wide, clear space around the cabins from which passengers can get an unobstructed view toward every point of the compass. The navigating officer's bridge is carried across the forward end of the boat deck, and in addition to the usual signal apparatus, is fitted with telegraphs communicating with the executive officers' stations fore and aft on the awning deck. There is accommodation on the upper and main decks for steerage passengers, the vessel altogether having room for 200 first cabin, 150 intermediate, and 1,000 steerage passengers.

STARTING PLATFORM, STARBOARD ENGINE.

The machinery is situated amidships, the forward end of the boiler room being about 30 ft. forward of the center of the ship. The coal is carried forward and aft of the boiler room and alongside the engine room in the lower 'tween deck spaces. The bunker capacity is 1,412 tons. The engine room is 38 ft. long, and the width of the ship, 62 ft., while the distance from the starting platform to the top of the skylight is a clear rise of 74 ft. The main engines are quadruple expansion with four cylinders and four balanced cranks built under the patents of Herr Otto Schlick. His investigations of the causes and prevention of vibration in steam vessels are well known, and these engines are a demonstration of his ideas. The cylinders are 23-in., 33-in., 48-in., and 69-in. dia., and are grouped in pairs at the ends of the crank shafts. The stroke is 54-in. and the engines at full speed make only 75 revolutions per minute. The disposition of the cranks can be readily seen in the accompanying diagram. The sequence of the cylinders looking aft is high pressure, low pressure, second intermediate and first intermediate, thus getting the larger reciprocating parts between those of smaller dimensions. The distance between the piston centers of each pair is 6 ft. 5 in., while the distance apart in the middle is 12 ft. This makes an unusually roomy engine, as may be noticed from the position of the frames and fittings, in the cut. The first three cylinders have piston valves, and the low pressure a slide valve. The valve chests of the L.P. and second I.P. cylinders face each other, and those of the H.P. and first I.P. are on the ends, so that all the valves can be readily got at for inspection or repair. They are worked by the ordinary Stephenson link. In details of design the engines conform to the best modern marine practice. The frames are of the box pattern, and the crank shaft is built up and is 14¾ in. dia. in the journals, and 14½ in. in the pins. The air and bilge pumps form part of the back frames and are worked by levers off the low pressure cross-head. In the center of the crank shaft the turning gear is fitted, and by a simple adjustment of the worm wheels, it is operated by the reversing engine, when the vessel is in port. The condensers are of compact build, and contain 7,280 sq. ft. of cooling surface.

In keeping with the usual practice of the builders, the shafts are carried inboard, and consequently they converge toward the stern to the extent of 4 ft. 6 in. The forward ends of the crank shafts are 17½ ft. apart, while the propeller centers are 13 ft. apart. In length the shafts are of unusual dimensions, being 227 ft. over all. The tunnel shafts are 13¾ in. dia. and the propeller shafts 14½ in. The shafting is hollow, not to reduce weight, however, as the holes are of small diameter for purposes of inspection of the material only. The propellers are three-

FIREROOM ATHWARTSHIPS.

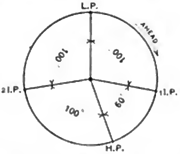
bladed 16 ft. dia., and 21 ft. pitch, each weighing 9½ tons. The port propeller is forward of the starboard 5 ft., and the blades overlap slightly.

Steam is generated at a pressure of 210 pounds to the sq. in. in three double-ended Scotch boilers, 13 ft. 8 in. dia. and 20 ft. 6 in. long and two single-ended boilers of corresponding size. They are fitted athwartships and are worked under natural draught. There are twenty-four furnaces, with a grate area ot 433 sq. ft., and the five boilers contain 15,025 sq. ft. of heating surface. The dia. of the funnel is 12 ft. and its top is 98 ft. above the grate bars. See's ash ejectors and also hoists are conveniently fitted.

Steamship.		Length ft.	Beam ft.	Depth ft.	Mean Drgt. ft.	Load dis. tons	Cargo tons	Bunker cap tons	I. H. P.	Steam P. lbs.	Speed knots	Pass. accom.
Great Eastern, Launched	1858	680	82.6	58.	30	27,384	6,000	10,000	actual 7,652	25.	13	4,000
Pennsylvania, "	1896	560	62.	42.	31½	23,400	12,000	1,450	est 5,500	210	14½	1,820

COMPARATIVE TABLE DIMENSIONS, ETC., GREAT EASTERN AND PENNSYLVANIA.

The auxiliary apparatus includes centrifugal circulating pumps, two Weir's boiler feed pumps, one of which is sufficient to maintain the water levels, also a Morrison's evaporator of twenty-five-ton capacity connected with the L.P. receiver and the main condenser. There is also an auxiliary condenser and a pair of powerful 6 in. duplex pumps with connections to all points, so that they can be used for ballast or other purposes. Attached to the forward bulkhead, over the passage leading to the boiler room, is a Weir's feed water heater, which receives the exhaust from the auxiliary engines, and is designed to raise the temperature of the feed to boiling point. In the recess between the thrust bearings, at a slightly lower level than the engine room floor, the electric light plant is fitted. There are three Allen's direct-driven dynamos, two of which are in regular use when the vessel is at sea, and the third in reserve. They run at 275 rev. per minute, each generator supplying current to 300 lamps of 16 candle power. There is also a compact Hall refrigerating machine here which maintains a low temperature in the provision rooms aft. There are in all 45 engines on board, containing 85 steam cylinders.



DISPOSITION OF CRANKS STARBOARD ENGINE LOOKING FORWARD.

The Pennsylvania was built and engined in the yard of Harland & Wolff, in Belfast, Ireland. She has been constructed in accordance with the rules of the Germanischer Lloyd, and the British Board of Trade. On September 10 last she was launched, and the machinery subsequently put aboard under the supervision of Herr John Korte, who represented the owners and who is now Chief Engineer of the Pennsylvania. She had proved herself a good sea boat when she reached New York on her first voyage, direct from the builder's yard. Though she was running light and the weather on the Atlantic was boisterous, she was very steady and maintained an average of 14½ knots an hour. This voyage, however, was not of much engineering value in ascertaining economies or degree of vibration which had been most carefully considered by the designer, for the vessel had no cargo aboard. The coal used, too, was the best Welsh steaming variety, and there was no difficulty whatever in keeping up the maximum pressure. In claiming for the Pennsylvania great stability, it is pointed out that she was launched and fitted out without a ton of water ballast aboard. In fact, her tanks were not filled until the trial trip. In the matter of heating, lighting, ventilation, toilet arrangements, etc., the ship is unusually well planned and equipped. Even the stokers and coal-passers enjoy the luxury of shower baths for their exclusive use. The equipment in the way of boats and navigating apparatus is also very complete.

The Pennsylvania will run regularly in the Hamburg-New York route, making the trip across in about eleven days. As this is the greatest freight carrier afloat, it is of interest to compare her dimensions with those of the Great Eastern, the leviathan whose gigantic appearance, as she entered New York harbor, nearly forty years ago, is well remembered by many.

In reporting to the Secretary of War upon the necessity for a deeper entrance to New York harbor, Col. G. L. Gillespie, of the Engineer corps, urges the construction of a 35-ft. channel at low water. The present channel has a depth of 30 ft. at mean low water, but the continual increase in the draught of ocean-going vessels has caused a pressing demand for further dredging. On the first voyage of the Pennsylvania she drew 31½ ft. The widening of the channel is also necessary on account of the increased lengths of the newer vessels. The estimates for the work of deepening the channel to 35 ft. and increasing the width are: 1,000 ft., $1,740,000; 1,500 ft., $2,772,000; 2,000 ft., $4,180,000

HIGH STEAM PRESSURES ON SEA GOING SHIPS AND IN GENERAL.—I.

BY DR. R. H. THURSTON.

Continuous rise of steam-pressure has been a notable feature of progress in the marine department of steam engineering from its earliest days. This fact is in itself sufficient proof that this is at least one of the most important, if not the most essential, element of advance; and it requires no knowledge of the science of thermodynamics to convince one familiar with the practical side of this movement that increasing steam-pressure means improving economy, up to some limit as yet unknown. That there is such a limit is sufficiently obvious from the fact that, throughout this history of the marine engine, gains have been continually less and less rapid, proportionally to the rise of pressure. It may also be inferred from the general principle that the nearer the engineer approaches the perfection of his ideal, the more difficult does it invariably become to effect additional gains, and, the narrower the margin between the fact of the moment and the "theoretical" limit, the slower the progress made in effacing that margin. Thus we have, in the following data, illustrations of the method and rate of progress of the marine engine since the beginning of the century, the date of its practical origin.[1]

Until the introduction of the compound marine engine, the advance in pressures and expansion was slow; but from 1850 the progress is seen to have been not only rapid, but quite as remarkably and continuously accelerated in its rate of gain.[2] At the present time the indications seem to be that, for some cause, probably connected with the difficulties in securing satisfactory boiler construction, this rate of acceleration is beginning to fall off. The maximum pressures rise from fifty pounds a generation ago to 125 pounds in 1880, to 200 pounds in 1890, to 250 in 1895, and are likely to be about 300 pounds in 1900. The change now taking place, in the transfer of the work of steam-making from the shell-boiler to the water tube boiler, seems likely soon to result in the removal of many obstacles, and it is very possible, that in the near future it will be found easy to control and utilize pressures of 500 and of 1,000 pounds per square inch. In fact, the employment of 1,000, 1,500, and, as is said, 2,000 pounds pressure by Jacob Perkins sixty years ago and of 800 and of 1,000 pounds by Dr. Alban, a half century ago, may be taken as ample evidence of the practicability of employing such tensions of steam if found desirable.[3] The two real questions are: Will it pay the boilermaker to supply boilers for these pressures? and will it pay the engineer or steam-user to adopt them in ordinary practice? These are questions to be settled by experiment and experience. A triple-expansion engine, with ratios of expansion in each cylinder of about 3½, will work steam of 500 pounds, and at 4 to 4½ expansions will take care of steam at 1,000 pounds. A quadruple-expansion engine will similarly handle 500 and 1,000 pounds with ratios of 2 and 2½.

With this steady rise of steam-pressures has been observed as constant increase in the value of the ratio of expansion adopted in the most successful practice. One of the most interesting, instructive, and remarkable facts in the history of the marine engine, as of other types, is the singular moderation of builders in following the principle enunciated by Watt in his patent of 1782, that of economical expansion of steam. Purely thermodynamic and purely mechanical theory dictated a ratio nearly equal to the quotient of back-pressure divided by initial pressure; but, even after the introduction of the multiple-cylinder engine, doing away, largely, with the difficulties arising from irregular impulse and consequent variable motion of the crank, all designers and builders recognized the existence of a limit far inside this of the ideal case. But it was only after the nature, extent, and effects of the internal wastes by "cylinder condensation" had been clearly shown, by Clark, Hirn, and Isherwood and their successors, that the real meaning of the known ineffectiveness of expansion beyond a very restricted limit became familiar to the profession of engineering.

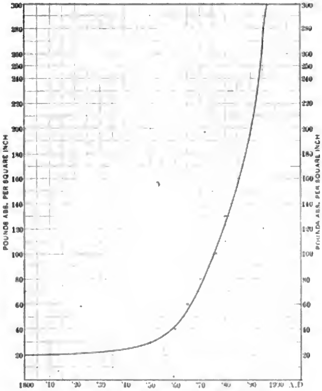


FIG. 1.—RISE IN STEAM PRESSURES. 1800-1900.

Marine Engineering

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[1] Vide History of the Growth of the Steam-Engine; 4th ed., 1897, pp. 482, et seq.; and Manual of the Steam-Engine, ed. of 1896, Vol. I, pp. 76, et seq.

[2] *Trans.* A. S. M. E.; Vol. xv., 1893; lxxii., p. 354.

[3] "History of the Growth of the Steam Engine," pp. 323-327. Vide also Stewart and Galloway's Histories, and Pole's translation of Alban.

Steam in the engine, when subject to the influences characteristic of the ordinary steam-engine construction, behaves very differently from its assumed method of action in the ideal case.

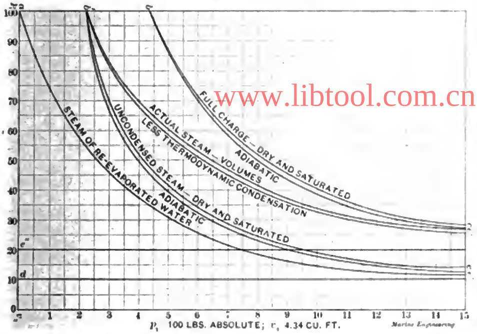


FIG. 2.—1 LB. STEAM IN THE STEAM ENGINE.—RANKINE CYCLE.

This fact may be perhaps best shown, in a general way, by the accompanying diagram of the action of one pound of steam entering the engine at 100 pounds absolute pressure, and in the dry and saturated condition. Its volume, at entrance, is 4.34 cubic feet and its temperature 327.6° F. If expanded from its initial and minimum volume and retained, meantime, dry and saturated, its successive volumes, at successive pressures and temperatures, will be given by the steam-tables, and its expansion-line will be *b c*; while the adiabatic will be slightly lower, and as on the diagram, *b c'*; the difference being due to the progressive condensation of the steam expanding and doing work, to thermodynamic condensation.

In the actual engine, however, the steam entering is partly condensed; and, often, in the simple engine with high ratios of expansion one-half may be found, as in the diagram, to be thus reduced to the liquid state. The remaining steam, if expanded as assumed for the full charge, in the preceding case, would give the curve of constant weight, *b' e*, or, if adiabatically expanded, the line *b' e'*; thermodynamic condensation producing loss of pressure continuously. But this does not occur. The water of condensation at entrance commences re-evaporating from the moment of closing of the cut-off valve, and this produces wet steam continuously; the mixture of this liquid and its vapor thus producing a volume continuously increasing, as along the line *ae*, of the diagram. It often happens that practically all of the water of "cylinder condensation" is thus re-evaporated before the end of the stroke of the piston is reached. In such case, the addition of the steam thus produced to that left uncondensed, at the moment of cut-off, gives the line *b' c*, if thermodynamic condensation is not taken into account. Such condensation does, however, occur in every case, and whatever the circumstances under which heat-exchanges take place, and to the amount of, approximately, a percentage measured by the ratio of expansion, as shown by the line *b' c'*; though in the case here illustrated, perhaps entirely obscured in its effects by the heat-interchanges observed between the fluid and the metal of the cylinder-wall or the water accompanying the steam when not initially dry.

The ideal engine-diagram differs thus from the real, in often a very remarkable and striking manner, and the corresponding differences of work performed per unit weight of working fluid are similarly disclosed by comparison of the areas, enclosed between these expansion-lines and the base-line, *e e''* or *e' d*, usual fair terminal pressure lines, respectively for non-condensing and for condensing engines of good performance. It is this internal form of heat-waste that has constituted the main obstacle to advance in the improvement of the economical action of the steam engine, and which has impeded approximation to its thermodynamic perfection.

A contract has been let by the Spanish Government for a floating dock to be moored at the port of Olongapo in the Philippine Islands. The dock will be the largest of its kind and will measure 450 ft. in length, 117 ft. in width over pontoons and 38 ft. 6 in. in depth. The dock when in position will rest on six pontoons, each about 14 ft. deep. These will be of iron while the sides of the dock will be of steel. The pontoons will be so arranged that should any one be damaged it can easily be removed and floated onto the dock for repairs. Powerful pumping engines will be fitted so that a vessel weighing 12,000 tons can be lifted in about two hours. The maximum length of vessel which the dock will accommodate will be 500 ft. The dock will be built in sections, so that it can be readily shipped to its destination from the yard of the contractors, Robert Stephenson & Co., at Newcastle-on-Tyne, England.

ELECTRICITY ON S. S. LA GRANDE DUCHESSE.

Electricity is such a necessity aboard ship that now every steam vessel, for whatever purpose designed, is fitted with, at least, an electric lighting plant. From a beginning made in the lighting of engine rooms and cabins, the applications of electrical energy have been extended to a great variety of practical uses. As complete an installation as can be found in a merchant vessel is that which the new Plant liner, La Grande Duchesse, is equipped. In this steamship electricity is used for seven separate and distinct purposes.


STARBOARD SIDE OF DYNAMO ROOM.

The plant is located in a separate compartment aft of the engine room, between the thrust bearings. Entrance is had from the engine room through two water-tight doors, opposite to which in the after bulkhead are corresponding doors leading into the shaft tunnels. In the center of the compartment on either side of the keel-line the duplicate generators and engines are placed in a fore and aft position. They are of the 20 K.W. direct-connected General Electric marine type. These engines have high-pressure cylinders 7 by 7 in. and cranks set opposite. Steam from the main boilers is reduced at the engines to 140 pounds, which gives 550revolutions a minute. The generators are connected into a marbelized slate switchboard bolted to a frame about 12 in. from the engine room bulkhead. This is a little over 5 ft. square, in one piece, is 2 in. thick and weighs 1,200 lbs. The fittings which are shown in the accompanying cut include two main dynamo switches, fifteen feeder switches, one motor switch, one three-point volt-meter switch, one volt-meter, and three ammeters. Two of these are for the generators and one for the search-light circuit. There is also on the board one ground detector and two Carpenter enamel field rheostats. For purposes of observation, two single incandescent light brackets illuminate the instruments. Overhead in the center line of the board the rheostat for the projector is bolted to the deck beams. Of the sixteen circuits controlled by the board switches, ten go to as many distributing points for general lighting on the two-wire 110-volt system, using Edison lamps. These distributing boards are located at convenient points on the various decks. The boards are made of blue Vermont marble and are enclosed in cabinets made of wood to correspond with the surrounding joiner work. The wiring from these centers, which is arranged so as to have not more than eight lights on each circuit, is run in hardwood moldings. The staterooms have one light each with the lamp switch at the head of the berth. The other feeders from the switchboard are used; one for the search light; three for the cargo circuits; one for the running lights, and one for the two 12 K.W. motors operating the coal-trimming apparatus. The ship has a total of 700 incandescent lights and one arc light. The arc light is fitted with a 12-in. projector in position on the foremast just above the pilot house.

Inside the pilot house there is a variety of electrical apparatus. Instead of having the wheel connected directly with a steering engine under the wheel house, the steering engine is placed aft in the tiller room and operated by a telemotor controlled from the pilot house. A brass column in front of the steersman carries a wheel of the usual pattern, and an indicator on top shows the exact angle to which the engine should bring the rudder when the wheel is turned. The connection between the controller and telemotor is made with a 26 conductor. This does away with the noise and inconvenience of rods or chains and keeps the mechanical steering gear in compact form in the rudder room. The telemotor instantaneously following the motion of the hand wheel regulates, through suitable gear, the admission of steam to the proper ends of the steering engine cylinders. To the left of the steersman, on the wall of the house, there is an electrical rudder indicator which is wired to a sliding contact on the rudder quadrant, so the exact position of the rudder can be read by a glance at the dial. Incandescent lamps fixed in sockets on the sides and roof of the house, corresponding


GENERAL VIEW OF SWITCH BOARD.

with the positions of the running lights, are so wired that should any of the running lights go out, the corresponding lamp would be switched in, and a buzzer at the same instant sound a warning. There is also an annunciator in the house connected with the thermostats at fourteen different points in the cargo spaces, forming a very complete automatic fire alarm system. More novel and useful perhaps is a complete telephone exchange with a central station and 150 instruments, giving instant communication between all parts of the ship. The exchange, a view of which is given, is situated on the starboard side of the main deck cabins, where an operator is always on duty. In each executive officer's cabin and in each state room a compact instrument of the Bell long-distance pattern is fitted to the side. In the state rooms the telephone is placed close to the head of the berth, and the passenger, if in his berth, can call "central" by a push button, and unhook the receiver without rising. Five connections can be made at one time through "central." The necessary current is obtained from storage batteries, taking current at 8 volts from a rotary transformer, shown in the cut, which is connected with the lighting circuit.


TELEPHONE EXCHANGE ON MAIN DECK.

There is also a novelty aboard in the electrically driven coal trimming apparatus. The bunkers are fitted athwarthship fore and aft of the boiler room. Two gratings are fitted in the 'tween deck on each side of each bunker close to the loading ports in the sides. There are, consequently, eight openings into the bunkers through which coal can be loaded, each 20 by 27 in. fitted with three crossbars about 7 in. apart. This is sufficient to prevent the passage of too large lumps of coal into the conveyors underneath. These run across the top of the bunkers parallel to the bulkheads and each other. In each conveyor an endless sprocket chain carries scrapers 16 in. wide, 18 in. deep and 30 in. apart. In the under sides of the conveyors there are a series of slides, each of which is opened and shut by a rack and pinion worked by a hand wheel below. The driving shafts of the conveyors are on the starboard side and are carried through the bulkheads into the boiler room. There are two 12 K. W. motors connected to the shaft ends by reducing gears in the ratio of twenty to one. The motors are overhead in the boiler room close to the bulkheads. With the gears they are enclosed in dust-proof casings, which are provided with doors. The coal is brought alongside in barges and dumped into chutes in the usual way, which discharge over the bunker gratings. The direction in which the motors run is governed, of course, by the side of the vessel in which coal is being loaded, and using each series of conveyors oppositely, coaling could proceed from both sides at once. A handy switch permits of instant reversal of motion. Since the vessel commenced running, this apparatus has worked perfectly. One man only is necessary to operate the slides in the conveyors so that the coal shall be evenly distributed over the bunkers. When the bunkers are nearly full, it is necessary to put four or five men to work for about an hour to level off the various mounds which have been formed under the conveyors. The full capacity of the automatic trimmers has never been tested as the maximum rate of loading is regulated by the speed at which the buckets can be filled in the barges alongside. This is far below the capacity of the conveyors. Loading from one side alone the average rate for the 500 tons taken aboard, is about one ton a minute.

The greater part of the electrical equipment of the liner was manufactured by the General Electric Co. in its Schenectady shops. The electrical steering apparatus was supplied by the Williamson Brothers, of Philadelphia, and the telephones by the Bell Co. All this apparatus was fitted aboard in the builder's yard at Newport News, under the supervision of C. H. Richardson, superintendent of the electrical department of the Newport News Shipbuilding and Dry Dock Co.


TELEMOTOR ATTACHED TO STEERING ENGINE.

ORIGIN AND DEVELOPMENT OF THE FERRYBOAT.—I.

BY A. E. STEVENS.

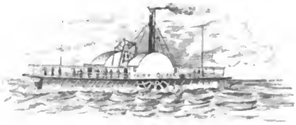
There is no other city of the commercial importance of New York so bounded by navigable streams. From their physical characteristics, civil engineering was not able to supply crossings in the way of bridges or tunnels until long after the demands of travel had necessitated some more modern means of transit than the rowboat, or the periauger of our forefathers. The successful application of steam in navigation took place in that harbor in which nature had made the greatest local demands for such an improvement; and it is to the combination of such demand and the ability to meet it, accidental or otherwise, that New York owes the honor of being the birthplace of marine engineering. Though the birthplace of the science has lost the position of leadership in marine practice, there can be no question but that in the specialty of ferryboats New York still remains pre-eminent. A glance at the amount of ferry business done on the North and East Rivers and across the waters of the Upper Bay, suggests the causes of this result. It is estimated that every year the ferries between New York and New Jersey alone carry a total of passengers somewhat greater than the total population of the United States. The yearly ferry business of the harbor is probably not less than 200,000,000 passengers, and 6,000,000 teams. All of this is carried with remarkable safety, and upon vessels which are as a class far superior to any engaged in similar traffic on any other waters. New York, therefore, is the best place in which to study the question of ferryboats.

TEAM BOAT OF EARLY TIMES.

Many of the older ferries antedated the era of steam, and are still operated over the same routes on which the periauger and rowboat carried the colonial farmers of New Jersey and Long Island to their markets on Manhattan Island. Following these, soon came the team boat, or horse boat, in which the muscular power of horses and mules was used for the propulsion of the vessel. They were either double hulled vessels, with a radial paddle wheel between the hulls, or of the scow type, with wheels on each side, as shown in the illustration.

In 1812, two steam boats, designed by Robert Fulton, were placed in use upon the Paulus Hook ferry, from the foot of Cortlandt street, and one by Colonel John Stevens upon the Hoboken Ferry, from the foot of Barclay street in New York. The latter boat, the little Juliana, was afterwards withdrawn from the service, and, as then announced, in favor of the "more convenient" horse boat. It is almost certain, however, that this retrograde step was taken because of the monopoly enjoyed by Messrs. Fulton and Livingston for the navigation of the waters of the State of New York with steam. Fulton's boats had twin hulls, and measured about eighty feet in length. Several of this type were also built for use on the East River, but they did not prove successful. In 1822-1823, the Hoboken Ferry returned to steam propulsion; and the boats then adopted may be regarded as the direct forerunners of the vast majority of American ferryboats. Little information survives as to the build of the Hoboken and Pioneer, the boats with which the service was begun. Their immediate successor, the Fairy Queen, which went into the service in 1828, has had her memory preserved in the sketch which is here reproduced. Her cost was $16,874.50. These boats had their cabins below deck, and the teams stood on the open deck. They could carry comfortably not more than one hundred persons and six to eight teams. A drinking bar was a feature, and in summer an awning, shown in the illustration of the Fairy Queen, was spread over the deck. The steering was by a tiller, which was shifted from end to end. The pilots stood forward and passed the word aft to the helmsman. The engines of these boats were sufficient to give them, for their day, a very high speed. They did not differ from the beam engines of to-day in any of the essentials of design. The wooden side-wheels of that day have survived in some of the modern boats.

By small changes the beam engine boat of to-day, as illustrated by the Montclair, has been evolved. In other directions, scattered attempts to introduce the inclined, instead of the beam engine, and discussion of the advisability of other types, were about the only symptoms of advance, until the construction of the Robert Garrett and Erastus Wiman for the Staten Island ferries. In these, a compound inclined engine and feathering side wheels were introduced in place of the beam engine. The vessels themselves were large and powerful, but their type has never been



ORIGINAL TYPE BEAM ENGINE FERRY.

reproduced. Compound engines had also been tried on the Fishkill, in a curious combination of a steeple compound with Corliss valve gear, driving the ordinary beam. The boat was built for the ferry between Newburg and Fishkill in 1884. This type also has never been reproduced. Special conditions and needs in different places, led to widely different types in the ferryboat by the natural process of evolution, but on routes where conditions have remained unchanged early forms survive.

For example the heavy ice on the Straits of Mackinaw has produced such ice fighters as the St. Ignace and St. Marie, while though the horse boat has passed away, the rope ferry survives as a costless form of motive power, and the row or sail boat is still among the successful ferries of the day. In addition to changes in form, due to physical characteristics of the route and the amount of travel over them, different classes of travel have produced different types of boats; as for instance, the powerful ferry steamers plying between Detroit and Windsor, and San Francisco and Oakland. In the former, like most examples of naval architecture on the lakes, an originality and desire for improvement is displayed characteristic of their western origin. Designed to ferry trains of cars, they are, of course, of quite a different type from the ordinary passenger ferryboat. Their most marked difference lies in their motive power, which consists of horizontal engines running at high speed and placed below deck, driving the sidewheels through pinions and gears. The wheels are capable of working independently, and give the boats great maneuvering power, but the rattle of the gear would be inadmissable in ordinary passenger service. A similar service is performed in New York harbor from Mott Haven to the New Jersey shore, on the ferryboats Maryland and Express.

MODERN SINGLE DECK FERRYBOAT.

Probably the earliest demonstration of the practicability of screw propulsion was made in a small model (now preserved in the Smithsonian Institution in Washington) which in 1804 and 1805 was tried by Colonel John Stevens, of Hoboken. While the boat was simply an experiment in steam propulsion, she demonstrated, at that time, the practicability of the use of screws. It is curious that many of the experiments were made between Barclay street, New York, and the ferry landing at Hoboken, although the boat could in no sense be called a ferryboat. Screw propulsion at that time was abandoned because the route to Albany, which early New York designers had in view, did not allow sufficient draft to accommodate the diameter of the propellers which experiment showed to be necessary with the slow engine speed of the time.

In the fifties, Colonel Stevens' sons designed, and actually contracted for the construction of a screw ferryboat, whose mutilated model is still in the possession of the writer. For some reason, however, the vessel was never built, and the subject remained in abeyance until in 1867 Livingston Brady, of New York, patented a system of screw propulsion for ferryboats. Two vessels were subsequently built for use on the Mississippi River. While accounts agree that they were otherwise satisfactory, the wash caused by the race from their propellers proved so destructive to levees that their use had to be abandoned. These vessels were afterwards used as agitating dredges in the Mississippi passes.

There is now building in Belfast for the White Star Line an addition to its transatlantic fleet which in size and power considerably exceeds any vessel afloat or building. This new liner is to be called the Oceanic, a name which was very worthily borne by one of the first steamships of the company, now withdrawn from service. The Oceanic will be 685 ft. between perpendiculars, 704 ft. over all and between 17,000 and 18,000 tons gross register. She will be fitted with twin screws, and will, in general, follow the lines and equipment of the present Majestic and Teutonic. It had been known for a long time that the company had in contemplation the construction of a monster passenger boat and the lack of detail caused many exaggerations to be circulated about the speed which she would have. Even 27 knots was said to be within the limit. The Oceanic will probably be fitted with more powerful engines than any other liner in existence, but according to the most authentic reports, the question of speed will be subordinated to the comfort and convenience of passengers, of all classes. The Oceanic will be fitted as a mercantile armed cruiser.

Traffic returns of the Manchester Ship Canal for 1896 give a total tonnage of 1,509,659 tons, a substantial increase over the previous years. The total for 1895 was 1,087,443 tons and for 1894, 682,600 tons.

INCREASING SIZE OF LAKE STEAMERS.

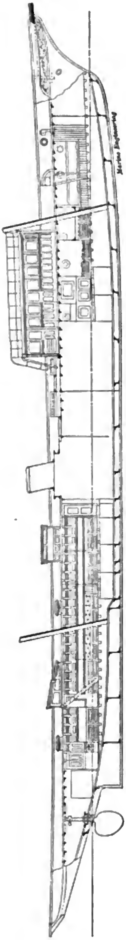
Marine architects find the increasing size of the steamships which ply on the Great Lakes a subject of perennial interest. In the early days of steam navigation a vessel of 780 tons was called "big." Half a century was required for the limit in size to climb to 2,500 tons. In 1891, 300 ft. keel, 40 ft. beam and 24 ft. in depth were the dimensions of the largest vessels. Since that time the increase in size has been remarkably rapid. The length of keel has been increased from 300 ft. to 400; the breadth of beam from 40 ft. to 48; the depth from 24 ft. to 28; the tonnage from 2,500 to 4,500. Even this by no means sets the bounds for the shipbuilders. No less an authority than W. I. Babcock of the Chicago Shipbuilding Company predicts that vessels 500 ft. long with a capacity of 6,000 tons will soon be built, and this, too, regardless of any prospective increase in the depth of water in harbors and channels. Mr. Babcock thinks shipbuilders will be content to stop at the 6,000 ton limit for some time to come, even with the twenty foot waterway to the sea. Just to show what the navigators of the Great Lakes have to contend with a few figures taken from government reports on the depth of water at some of the principal harbors may be of interest.

The entrance channel to Chicago harbor has been dredged to a depth of 20 ft. though at the entrance to the river the depth is but 18 ft. Over the La Salle street tunnel, a short distance from the mouth of the Chicago river, there is but 16 ft. of water. Only a small part of the river has over 15 ft. of water. At Duluth a depth of 13 ft. is maintained at the canal entrance. In the greater portion of the harbor basin the depth is 16 ft. At St. Joseph and Benton harbor the available depth in harbor and canal is 12 ft. At Buffalo vessels drawing 23 ft. can enter the outer harbor. Buffalo river and Blackwell canal allow a draught of 16 ft. At Calumet (South Chicago) 12 miles from Chicago, a depth of 16 ft. is maintained. The Illinois Steel Company's basin has a depth of 19 ft. At Cleveland the depth in various parts of the harbor ranges from 17 to 20 ft. At Erie the depth is 18 ft. at mean lake level or not less than 16½ ft. at low water. At Grand Haven, the principal harbor of refuge on the east coast of Lake Michigan, the depth is 18 ft. At Manitowoc 15½ ft. At Milwaukee the channel between piers at the entrance to the river affords a depth of 19 ft. The average depth of water in the river is 16 ft. The Sault Ste. Marie canal has a depth of 21.5 ft. The Detroit river has a number of shoal spots where there is but 17 ft. of water. The work of dredging a 21 ft. channel through the river will soon be completed. Before the close of the present season an 18 ft. waterway between Duluth, Chicago and Buffalo will be completed.

There has been a vast amount of talk about the Chicago drainage canal having a disastrous effect in lowering the lake levels. The consensus of opinion among the best engineers is that they do not know anything about it and that they will not know until the channel is in use. They are inclined to believe that the lowering in level will be too slight to be of any consequence. Judging by the vast amount of money recently invested in vessels of large size no apprehension that the lakes will be drained by the channel exists. Statistics show more vessels of large size on the Great Lakes than on the Atlantic coast. Of the 3,333 vessels of all kinds aggregating 1,324,068 gross tons, on the lakes, 383 are of 1,000 tons or over, while on the Atlantic coast out of the 16,786 vessels of all kinds aggregating 2,667,314 tons, but 247 are of 1,000 tons or over. Bringing the comparison right up to date it is found that the lake shipyards are still gaining on the Atlantic coast builders; for in the three months ending with the year 1896 three new steel vessels were registered on the lakes with an aggregate gross tonnage of 13,890.30, against four steel steamers on the Atlantic coast with an aggregate gross tonnage of 9,442.76. More steel vessels were built on the Great Lakes last year than in all the rest of the country together. Vesselmen agree that the larger boats are to be the controlling factor in lake navigation in future. One-third of the general traffic in coal, grain and iron ore this season will be done in modern vessels constructed to utilize the increased depth of water. By the opening of navigation there will be 20 ft. of water to all the elevators in South Chicago. Even cities as small as Manitowoc are endeavoring to secure a greater depth of water in their harbors in order to retain their share of lake commerce. Chicago business men fear the larger vessels may cease frequenting their harbor and transfer their business to South Chicago, hence the movement to have the tunnels under the river lowered has a great deal of energy behind it.

Experimental tests with the sand blast in cleaning ships' bottoms are being made at the navy yard in Brooklyn, N. Y. The preliminary test was upon the hull of U. S. S. Atlanta. This was entirely satisfactory. With a pressure not to exceed 15 pounds, the blast swept away all incrustations with great rapidity. The nozzle, attached to a length of flexible pipe, was readily moved along the skin, leaving the plates clean and highly burnished. The apparatus is very compact. A small compressor supplies the blast, which is conveyed in iron pipes along the dock coping. At convenient intervals there are connections to which the piping leading down into the dock can be attached. Sharp sand is admitted to an attachment at the nozzle of the hose. The time occupied by this process compared with the ordinary method of scraping is said to be five times as fast. The process has been in use in foreign navies for some time.

STEAM YACHT FOR HARRISON B. MOORE.



LONGITUDINAL SECTION STEAM YACHT MARIETTA.

There was launched at the yard of the John N. Robins Co. at Erie Basin, Brooklyn, N. Y., March 27, a steel steam yacht for Harrison B. Moore, which will probably prove to be one of the fastest pleasure crafts in Eastern waters. The designer, Mr. Henry J. Gielow, has aimed to produce a vessel in which the interior accommodations would be ample, and a high rate of speed for cruising could be economically maintained.

Particular care has been taken in the selection of material and construction to produce a thoroughly staunch, seaworthy and yet speedy craft. The hull is of mild steel, having a tensile strength of from 55,000 to 60,000 lbs. per sq. in. and an elongation of not less than 25 per cent. in 8 in. The dimensions are: Length, 172 ft. 6 in., over all; 140 ft., load water line; beam, 18 ft.; depth 10 ft. The mean draught with full equipment and stores aboard is 7 ft. 9 in. Carrying out the idea of safety, a double bottom has been built amidship which will be utilized for fresh water tanks, or for water ballast in a seaway. There are four steel water tight bulkheads, so placed that the yacht would float even with two compartments filled. The lines are very graceful, tapering sharply forward, and there is a handsome clipper bow and considerable overhang at the stern. There are two masts and one funnel, with a considerable rake, making altogether a very smart looking vessel. The deck is flush from stem to taffrail, and none of the deck fittings will show above the bulwarks except the deck house. This is 26 ft. long and rises 5 ft. 8 in. above the deck. The roof is level and is reached from below by a ladder with brass rail, which also runs around the top of the house. This makes a very convenient platform for observation in fine weather. In the forward end of this house the social hall is situated, and back of this is the butler's pantry, fitted with a dumb waiter connecting with the galley below. In the after end the captain's state room is furnished in comfortable style, and has in it a chart rack and desk. The crew's quarters are forward on the main deck. They are very roomy and conveniently fitted up. Aft of this is the ward room and officer's rooms and then the galley. Next come the engine and boiler rooms taking up 33 ft. along the keel line and the width of the hull. An air space about a foot wide aft of the engine room bulkhead, prevents the radiation of any heat from the machinery spaces into the state rooms. The saloon is 15 by 17 ft. fitted with two sideboards and four sofas, these arranged so that they can be readily converted into berths and by means of curtains the saloon can be divided into four separate compartments. There are five staterooms, four forward of the saloon, and one aft which takes up the entire width of the vessel. There are also two wing berths in the after end of the saloon. Every room has both hot and cold running water. Polished mahogany is used for the interior joiner work and the decoration is in white and gold. Lighting throughout will be by electricity, the plant consisting of a generator and a storage battery.

The propelling engine is of the four cylinder triple expansion type, with cylinders 14 in., 21½ in., and two 24 in. dia. by 18 in. stroke. The bedplate is of steel, and all the moving parts are of steel as light as is consistent with strength and durability, the bearings and pins having extra large wearing surfaces. Piston valves are used throughout. The estimated I. H. P. is 1,000 at 300 revolutions and a boiler pressure of 250 lbs. Copper is used for the condenser shell for lightness. This has eight hundred ⅝ in. tubes. A rotary engine operates the circulating pump. Steam is generated in two Roberts water tube boilers, placed side by side aft of the engines, the line shaft running between. The rough dimensions of the boilers are width, 6 ft. 3 in.; length 9 ft. 9 in. and height 6 ft. 8 in. The grate area is 80 sq. ft. and the heating surface is 2,640 sq. ft. Forced draught on the closed fire room system is produced by a blower coupled to a twin cylinder high speed engine. The yacht will be known as the "Marietta," and will be commissioned about May 30 next.

NEW DOCK AT N. Y. NAVY YARD COMPLETED.

New Timber Dry Dock No. 3 in the Navy Yard at Brooklyn, N. Y., was tested March 17 by the docking of the Monitor "Puritan," 6,000 tons. This is the largest dock on the eastern seaboard, and in general dimensions the biggest anywhere on the coasts. Its construction was attended by many difficulties, natural and otherwise, not the least of which was the fact that the dock site is a quicksand. After the excavation had been made sheet piling, 8 in. thick, was driven around the space which was to form the bottom of the dock, also transversely under the floor, and also following the outer line of the cross cap system. Rough timber piles were freely used in getting a foundation, and under the floors concrete was laid, 4 ft. thick. Concrete was also extensively used in the abutments. The floor is built up of 12 by 12 in. longitudinal stringers secured to the tops of the foundation piles, upon which are secured 14 by 16 in. transverse floor timbers, spaced 4 ft. centers. Upon these timbers there is bolted the 3 in. working floor. The side or altar system is of 5½ by 15 in. braces in pairs, embracing the pile heads in the side structure. The braces are notched to receive the 8 by 13 in. longitudinal timbers which form the altars or steps. These afford convenient ingress and egress to the dock at all points. A system of transverse cross caps secured to piles and to the tops of the altar braces, forms the stiffening construction outside the lines of coping and surrounds the entire dock. There are several transverse lines of sheet piling in the abutments as stopwaters. The sides are strengthened by tie rods, secured to anchor piles outside the cross cap system. Yellow pine is the timber used throughout, with the exception of the oak which occurs in the abutments. The whole structure is bolted and secured in a substantial manner. The necessity for this is apparent, when, for instance, it is remembered that the pressure against the edges of the caisson, when the dock is dry, is 28,000 pounds to the square foot. The dock is emptied by the centrifugal pumps which were put in for Dock No. 2. Connection is made with the new dock by two 42 in. pipes. The pumps have a capacity of 85,000 gals. a minute. There is also fitted for Dock No. 3 an independent drainage pump with a capacity of 7,000 gals. a minute. Tests made by the Government showed the leakage into the dock was very slight. A test of 49 hours showed less than a foot of water on the floor, which would give a rate of inflow of 6,800 gallons an hour. The total capacity of the dock at M.H.W. when filled is 15,605,000 gallons. Dock No. 3 is distant 150 ft. from the Simpson timber dock, officially known as No. 2, and is parallel with it. It will easily accommodate the largest ships in the navy and is long enough to hold two vessels, such as a battleship and a monitor, at the same time. The accompanying drawing shows graphically the comparative size over all of Caissons of six U. S. Dry Docks, including those of the three largest, viz.: Brooklyn dock, No. 3; Port Orchard dock in Puget Sound, and Port Royal dock, South Carolina; all of recent construction. The dimensions of these docks are given in the accompanying table.

DOCK.	Length on Coping Head to outer gate.	Length on floor Head to outer gate sill.	Width of Entrance at Coping.	Width of Entrance at Bottom.	Depth over sill M.H.W.
No. 3 Brooklyn	668' 3"	624' 11"	105' 2⅞"	71' 7¼"	29' 0"
No. 2 Brooklyn	500' 0"	459' 10"	85' 0"	52' 10½"	25' 6"
Port Orchard	650' 0"	618' 6"	92' 7⅞"	Inverted arch	30' 0"
Port Royal	405' 0"	459' 0"	97' 0"	66' 0"	26 0"

DIMENSIONS OF DRY DOCKS IN U. S. NAVY YARDS.

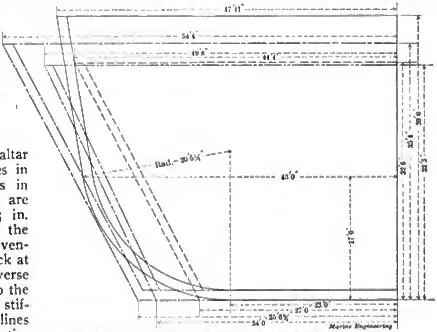


DIAGRAM SHOWING COMPARATIVE SIZE OF CAISSONS, U.S. DRY DOCKS.

NO. 3. BROOKLYN. SHOWN THUS: —— — —— —
NO. 2. " AND DOCKS AT LEAGUE ISLAND–NORFOLK. " " — — — — —
PORT ORCHARD, DOCK, PUGET SOUND. " " ————————
PORT ROYAL, S. C. " " —— — ——

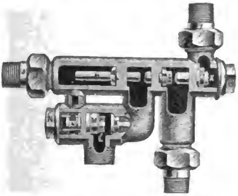
The Brooklyn dock is by far the most important. Though it has a foot less water over the sill than the Port Orchard dock the depth is sufficient to take in, under normal conditions, the largest ships in the navy now built or likely to be for a considerable time. Its strategic position as well as its situation on the eastern seaboard in easily navigable waters, and its close proximity to the splendid resources of the New York Navy Yard have all to be considered.

The plans for the dock were prepared by the Bureau of Yards and Docks of the Navy Department, now under the direction of Commodore Edmund O. Matthews, U. S. N. It was completed by T. and A. Walsh, contractors, of New York, the work being in charge of Engineer C. M. Bird, of Wilmington, Del., who has had much practical experience in the construction of government dry docks.

NEW APPARATUS.

A New Injector for Marine Use.

Among marine engineers the Penberthy Automatic Injector has obtained a wide reputation for its remarkable efficiency. The working range of this injector, however, has hitherto been limited to steam pressures of from 20 lbs. to 23 lbs. low up to 145 lbs. to 155 lbs. high, with an ability to handle hot water at 120 to 125 deg. at 60 lbs. to 80 lbs. steam pressure, and at 125 lbs. steam pressure, water at 95 to 100 deg. While these results have been satisfactory, the Penberthy Injector Company, Detroit, Mich., has realized for some time an increasing demand among marine engineers for an automatic injector which would work on higher steam pressures. It has made large numbers of the regular Penberthy Injector with special jets to work at 200 lbs., but in such cases the lowest pressure has been raised to 50 lbs. or 60 lbs. To get over this difficulty the company carried out a series of experiments which have resulted in the manufacture of the new Penberthy Special Injector. This has a working range of from 15 lbs. to 250 lbs. high steam pressure and will at the same time handle hot water at 140 to 145 deg. on 65 lbs. to 80 lbs. steam, 135 to 140 deg. at 100 lbs. steam, and 119 to 122 deg. at 150 lbs. steam.



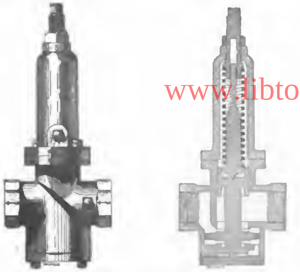
PENBERTHY SPECIAL INJECTOR.

The reasons for the effectiveness of the new injector are thus explained by the company: In all automatic injectors heretofore made the vacuum valve, or overflow valve, K, will fall away from its seat the moment the vacuum at the points of the jets, G and H, is lost, which takes place as the temperature of the water increases at this point. With this injector, it will be noticed when the valves, L and K, are seated the end of the valve, L, comes against the end of the overflow valve, K, and the full boiler pressure being against the opposite end of the valve, L, the valve, K, is held firmly to its seat; thus accomplishing automatically that which in positive injectors requires two or three valves to be operated by the engineer. Again referring to the cut, the chamber in which the delivery jet, H, is located, is termed the pressure chamber, and in no other injector made is there an outlet from this chamber, except into the boiler. In the Penberthy Special there is an outlet around the valve, L, to the overflow. Therefore, in starting this injector, the only pressure to be overcome is the atmospheric pressure, the water passing through the jet, H, into the pressure chamber, and then out around the valve, L. This gradually closes as the current to the boiler is established, and the valve is thereafter held to its seat by the full pressure in the pressure chamber, referred to, which also acts through this valve upon the valve, K, as mentioned.

The Penberthy Injector Company fully guarantees this injector to do all that is claimed for it as above, and desires that every marine engineer should familiarize himself with the new method of construction and new principles involved. The company will send a full descriptive circular to any marine engineer on application.

Brass Reducing Valve.

A new reducing valve, put on the market by the Viaduct Brass Works, is shown in the cuts. This valve is designed to reduce and maintain whatever steam it may be adjusted to, regardless of the initial pressure, so long as this pressure does not fall below that to which the valve was adjusted. The valve consists of a valve cylinder with annular ports, and a piston valve fitted into it, which is so arranged as to open and close these ports, also leaving a confined space between the end of the cylinder and the lower end of the valve to receive the reduced pressure to operate it. By referring to the sectional view, it will be noticed that the high pressure enters through the induction pipe into the valve cylinder between the two pistons; and, the pistons being of the same diameter, it is powerless to move the valve until it passes through the annular ports to the outer chamber or low pressure side, and as soon as the low pressure that the valve is adjusted to is obtained, it will, by means of the small port leading from the low pressure side, communicating with the confined space below the valve at the end of the cylinder, operate on the end of the piston valve, forcing it shut against the means for forcing it open. As soon as the pressure weakens, it also weakens on the end of the piston valve, and the means for forcing the valve open will force it down and let in more supply to maintain the adjusted pressure. This valve is manufactured by the Viaduct Brass Works, 35 West Center street, Cleveland, O.


EXTERIOR AND SECTION OF VALVE.

High Speed Vertical Engine.

The Shepherd vertical automatic engine, which is illustrated herewith, is designed especially for direct connection. The simplicity of design, the high speed at which it is capable of being run, the liberal wearing surfaces allowed, and the very small space a given power occupies, make it particularly useful for driving direct-connected generators for lighting, or for pumps, blowers, etc., on steamships, yachts, and ferry-boats. The engine is very clean and neat in operation; not a drop of oil is thrown about on the engine room floor or walls.

The bed and frames are of cast iron, well ribbed and braced, and contain within themselves the cross-head guides and the main bearings, thus making it impossible for the main working parts to get out of line except by wear, and adjustment for correcting this is provided. The back frame contains the guides and the rocker-arm bracket, and supports the cylinder should the front frame be removed. The cylinder and steam chest are cast together. The cylinder and barrel and both top and bottom heads are jacketed with an air space or non-conducting material. The valve is double ported for both steam and exhaust, and is self adjusting for steam tightness, automatically following up all wear. It is also collapsible and acts as a relief valve in case of water in the cylinder. The governor is of the Shepherd type, which gives remarkable results in the way of close regulation, and combines simplicity, freedom from dirt (no oil being used about it in any way), and noise or pounding even after long use. The crank shaft is a solid steel forging, counterbalanced. The crank pin and main bearings are of very liberal proportions, and are automatically oiled by ring or chain oilers, which keep a continuous stream of oil running over them all the time. The piston rod, connecting rod, valve and eccentric rods, pins, bolts, are also steel forgings, accurately machined. The cross-head is of phosphor bronze or cast steel.

These engines are made in simple and compound types, the latter, both cross and tandem style, either for belted or direct connection, by the Davis-Farrar Co., of Erie, Pa., from the designs and under the personal supervision of Wm. G. Shepherd, the Vice-President and Manager.


SHEPHERD AUTOMATIC ENGINE.

The Davis-Farrar Co., and its Manager, have both had an extended experience in the design and construction of steam engines for marine uses.

Ornamental Radiators for Steamships.

Improvements in the heating of staterooms and saloons of steamships has kept pace with the development in other conveniences. The coal stove of early days gave place to the steam coil of unsightly pipe. This was so out of keeping with the artistic interiors of modern boats that, while it was a practical success, it is being rapidly displaced by the neatly designed and compact radiator. The Fowler & Wolfe Manufacturing

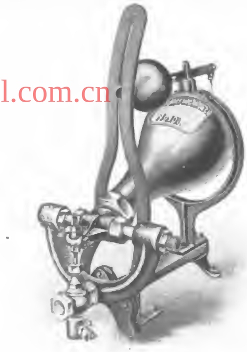
Company, 391 Bourse Building, Philadelphia, Pa., has given much attention to what it terms ornamental wall and steamship radiators, and has recently completed installations on the steamships La Grande Duchesse and Creole and also on the pilot boat Sommers N. Smith.

The radiators are manufactured by the company in sections of two sizes, viz.: Standard size, 12½ in. wide and 24 in. long, containing 7 sq. ft. of surface; and a smaller section, 12½ in. wide and 17 in. long, containing 5 sq. ft. of surface. Both extend out from the wall 3½ in., leaving ample air space behind. The larger section is sufficient to heat large outside staterooms, and the smaller size, inside rooms. For the saloons, cabins and larger rooms, these sections may be combined in a variety of forms and in any sizes required. The various forms and combinations of sections are fully shown in the new catalogue of the company. The radiators are made to withstand a pressure of 200 pounds to the square inch and more if required. They may, therefore, be safely used under high pressure direct from the boilers, if by accident the pressure reducer should fail to act. The company has orders in hand now for sets for four American steamships and for foreign vessels.

CABIN INTERIOR SHOWING RADIATOR.

Bundy Trap for Marine Uses.

The wants of marine engineers, for simple and durable devices, are taken into account in the design of the Bundy Steam Trap. The illustration here shows a trap specially designed for use aboard ship. It operates through the weight of the water which flows into the pear-shaped bowl. As the large Bundy Traps hold from 40 to 60 gallons of water, this weight is considerable. By reference to the cut, it will be observed an arm is used to guide the lever while the ship is rolling, and another part is used over the fulcrum of the lever to keep it in place. There is but one motion of the ship that can affect the working of the trap and that has been fully overcome, the manufacturers claim, by this device.



EXTERIOR VIEW BUNDY TRAP.

The Trap is made in two classes, viz.: The Return Trap and the Tank Trap. The Return Trap will return condensation to the boiler, or feed a boiler like a steam pump from a feed water heater. The Tank Trap will discharge the water into a tank or overboard. When the water has sufficiently filled the bowl it settles in the frame and discharges After emptying, the ball weight on the lever raises the bowl. There are no interior working parts or any contracted opening, the full size being carried all the way through the trap. The Bundy Trap will raise water two feet for every pound of steam pressure carried. The manufacturers have issued a very complete prospectus of this apparatus, which can be had on application to the A. A. Griffing Iron Co., 61 Centre street, New York.

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Letters and other mail matter can be sent to our care and will be forwarded or held until called for, as desired.

Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

Marine Engineering is the product of whatever carefulness and judgment the publishers possess, modified only by the difficulties incident to the construction of a technical journal. They believe there is a fairway for a publication that is designed to be accurate, absolutely impartial, and altogether devoted to American shipbuilding and engineering. The record of the trial trip is apparent. When the machinery shall have been in operation long enough to properly adjust the bearings better performance will be possible.

Several wealthy Americans have within a comparatively short time placed orders abroad for steam yachts, which in the aggregate will amount to a very considerable sum. Why they deliberately passed over the talent of American naval architects, and the skill of American shipbuilders, not taking any account of a proper patriotism, is a question which no persons but themselves could intelligently answer. That good boats can be built abroad none but an ignoramus would deny. That as good and better boats are built on this side of the Atlantic has often been shown. Wherefore the choice of these yachtsmen? It is not alone the monetary loss of the yachts to the home yards that hurts, but the very serious display of want of confidence in American genius. What will the foreigner, who is in need of ships, think of their actions? They are men of influence, and as yachtsmen, are supposedly familiar with the capabilities of American builders. It is pleasant to contrast with this the discrimination shown by Mr. Harrison B. Moore, the launch of whose yacht, Marietta, is recorded in this issue. Twice before has a yacht of the same name been built for him in an American yard. May he live to build and enjoy as many more. The new yacht is as fine a boat as any that ever made the trip between the Cloch and Cumbrae lights. Success to Marietta, the third.

In a recent editorial the New York Sun cited the number of mishaps to vessels of the British Navy, in one week, to show that "accidents are not peculiar to American ships." A comparison would not be entirely fair, taking into consideration the respective sizes of the navies. So far, however, as the engineering departments of our warships are concerned the officers would not fear a comparison made on strictly equal terms. Having in mind the shorthandedness of the engine-room staffs on the vessels of the American Navy, the only peculiarity is that accidents are not much more frequent. An investigation of the records of other navies would show that accidents are not rare in any. The liability to breakdown or mishap is inherent in all mechanical contrivances. When an accident happens the dryland sailor usually exaggerates its importance. It is the unfamiliar danger which is the more fearful. This citizen who, on a railroad train, hears with indifference that a hot box compels a wait, or that the locomotive has failed, gets nervous and apprehensive on an ocean steamship, even if the engines are only stopped. If he owns a bicycle which, when he is riding, develops about one-eighth of a horse-power, he can from his experience with repair bills appreciate how much greater is the probability of accident in apparatus which develops, perhaps, 10,000 horse-power, even allowing for the larger factor of safety in the latter.

Elsewhere in this issue will be found an account of a quick repair which was effected by the engine-room staff of the S. S. La Grand Duchesse. It is true the weather was good at the time and the element of risk did not enter into the matter at all. Nevertheless, it afforded a good opportunity for sizing up the inventiveness of the staff and the ability to put ideas into prompt execution. American ingenuity can always be relied upon in an emergency. In receiving proper credit for his ability in emergencies, the engineer is at a disadvantage as compared with his brethren of the navigating department. The one is buried in the obscure depths of the engine-room, while the other is on deck, conspicuously in evidence in times of sudden peril or distress. There is, perhaps, only one time during the life of a steamship when the engineer receives his dues—that is the trial trip. Attention is then attracted to the management of the engine-room, especially when the builder receives a handsome bonus for speed. The substitution, however, of bare poles, in the modern steamship, for the heavy rig of former days, must direct the attention of the thoughtful to the reliance which has come to be placed on those down below. There is as much necessity for courage and knowledge on the starting platform as there is on the flying bridge. A competent engine-room staff is an added insurance of safety, which the passenger may well consider, and for which the shipper has no extra rate of premium to pay.

Secretary John D. Long, of the Navy Department, has taken a very proper stand in refusing to permit any unfairness toward the employes in the Navy Yards, for the benefit of political mechanics, who expected to get easy jobs under the new administration. It needed the exercise of good judgment and courage to give this reply to the influential congressional delegations, from the districts in which the various yards are situated. There was no halfheartedness either about the answer of the Secretary of the Navy, which reads:

> "It is the intention of the Department to enforce fairly and justly the regulations as promulgated; and to disarm unjust criticism it is necessary that the attention of each officer at the yards be called to do what is expected of him, to the certainty of punishment if any person intrusted with the enforcement of the labor regulations violates them, or fails, through carelessness and negligence, to perform the duties expected and required of him."

The "machine" experts will consequently not have the privilege of doing scamped work at the taxpayers' expense. If there is any work in which the moral obligation to be thorough is more binding than another, that work is the construction of ships of war. The very honor of the nation may depend upon the skill and care with which some minor part of the mechanism of a war vessel is constructed. Merit alone should rule in the selection of employes.

THE ENGINEER, BY AN ENGINEER.

At the recent anniversary dinner of the Stevens Institute of Hoboken, N. J., Engineer-in-Chief George W. Melville, U. S. N., responding to a toast, made several statements which, though they refer primarily to the Naval Service, can with much profit be considered by members of the Merchant Marine. For the benefit of such the following extracts are here published:

* * *

It has been a crime of the engineering profession that it has been too indifferent in securing due credit and honor for its professional achievements. The technical expert and scientist has been too backward in claiming the substantial rewards of his labor, and this lack of business efficiency has always stood in the way of his official, financial and social advancement. The legal and medical fraternity have each established a code of ethics which secures to its members and to the profession the reward of individual labor. But the engineer has too long been content to build the foundation, and even the structure of great inventions, and then permit others to claim the rewards which should accompany his work.

* * *

The triumph of the engineer over prejudice and tradition has been comparatively rapid, for it required but fifty years to make steam the principal motive power on board warships. Official recognition has not yet been given to the work of the engineer, and particularly in naval matters has the engineer been unjustly treated. The attempt to deprive him of a just share of the rewards and emoluments of the naval service has impaired the efficiency of the organization, and has caused bitter internal strife, which is to-day our great naval weakness, and whose continuance invites disaster in time of battle.

* * *

There came with the naval engineer the civilizing influences of the song of steam, and with each successive advance in the installation of a higher type of engine and steam generator, there has been a progressive improvement in the character and intelligence of the crew. And, therefore, with much joy not only the engineer but the world can say: Gone are the days when the captain of a warship was an absolute despot, and when naval crews were composed of desperate men, who, in the opinion of the sailor officers, could only be made amenable to discipline by being flogged into shape.

* * *

Our naval commanders of the past century bequeathed to this nation predominance on the ocean, a predominance which was lost in the transition from the sail to the steam age. This inheritance will yet be reclaimed, but it will be secured as much by the work of the engineer as by that of the sailor. And if the national government will permit the scientific colleges to send forth the elect of their graduates to compete for commissions in the naval service, then it may be that the genius of the engineer graduates of such institutions as yours, will bring about the restoration of that command of the sea which our people have too long been dispossessed of.

CORRESPONDENCE.

[*We do not assume responsibility for the opinions expressed by correspondents.*]

Deposit in Cylinders Causes Trouble.

The engineers of our line have had a good deal of trouble with cylinder oils. We use a very good brand, and while the engine is running there is no apparent difficulty. At the end of a voyage, however, it is a common experience on removing the covers to find the rings stuck fast in the pistons and valves by a deposit, a lump of which I send you with this. When the deposit is soft it is easy enough to remove, but if the cylinder has not been opened for some time it is troublesome to clean. The stuff gets as hard as a piece of iron. We sometimes get great quantities of it from one engine. The tops of the pistons will have big patches of the stuff, thick enough to fill up the clearance, and it will be flattened by contact with the inside of the cover. The rings are stuck so tight often that they have no elasticity at all. It not only bothers us in this way, but we have to open up the engine just for the purpose of removing this stuff. There is a difference of opinion as to what the stuff is composed of. Some of the engineers think it is formed by organic matter in the oil, which is carbonized by the heat of the steam, but others believe it is a sort of clay which is put in the oil to give it body. I would like to know if our experience is peculiar, or if any other engineers have had the same bother and if they know what the deposit really is.

TRANSATLANTIC.

[The substance accompanying this letter was of the consistency of putty and dark in color. We have submitted it for analysis.—Ed.]

Wants Pointers About Water-tube Boilers.

Will some of your readers who have had practical experience in the management of water-tube boilers give me a few pointers. I am an engineer employed by a company whose older vessels are fitted with Scotch boilers. In one of the newer boats water-tube boilers have been put in, and I expect soon to be transferred to her. I have read a good deal about the water-tube boiler, including the discussions between the advocates of the shell boiler and the newer steam generator. What I am after is not theoretical suppositions, but facts concerning the everyday use of the boilers. How to work them, and not whether they are the best adapted to the service, is what I want to know. I have been told that these boilers require a good deal of care and watching, that the firing has to be done differently from the old method, and that the feed needs close attention. Can dependence be placed on automatic apparatus for this purpose? Many others, I am sure, would appreciate a few pointers, for considering how many of the new ships have water-tube boilers, any engineer is liable to have to handle them.

WATER-TUBE.

Oil in Feed Water.

I should like to obtain information from your seagoing correspondents as to how they can use, continuously, the water from their surface condensers without injury to the boilers, from oil. Several large stationary plants have been installed with surface condensers, with a view of saving the city water bills, but I have known of several instances where the oil, fed to the boilers with the returning water, has caused burnt tubes in water tube boilers or bags in shells, and they are now throwing the condensed steam from the condenser away and buying a continuous supply of water from the city mains. It is certain that the water is used over and over on shipboard. How do they manage it?

RALPH.

Failure of Condenser Tubes.

There is nothing it seems to me, in the economy of the engine room, so little understood as the subject of condenser tubes. While there has been steady progress in boiler construction, steam expansion, and auxiliary apparatus, there is retrogression, even more rapid, in the condenser. This is assuming that other companies have the same experiences as ours, and as far as I know they have. In my own experience condenser tubes have always given trouble, but have especially since the use of steam pressures of 100 pounds and upwards. Now as to the details. There is no uniformity in the wearing qualities of tubes even under the same conditions. Some will not stand one voyage across the Atlantic, while others, of the same make and material, will last six months and even years. The corrosion and failure of the tubes is invariably on the sea water side. Thus it cannot be charged up to the oil which may pass over with the exhaust steam. The point where the tubes suffer most is at the ends where the salt water enters the condenser. I have tried tubes of various alloys, tinned and otherwise, and from as many different makers, and yet the general result is the same in all cases. There does not seem to be any change in the rate of decay, whether the condenser shell is made of brass or iron. The use of zinc plates in the water chamber does not prevent corrosion, though probably it may prolong the lives of the tubes. The destructive action on the plates is indeed very marked. In condensers of large capacity I have frequently found a zinc plate 9 in. by 6 in. by ⅝ in. completely oxidized within two weeks, and when removed so brittle that it would crumble to pieces in the hands. What connection there is between high pressure steam and this remarkable shortening of the life of a tube I cannot understand, unless it be that manufacturers now-a-days do not make as good a tube as in the early times of low pressures. I would like to hear from others as to their experiences and have the benefit of their ideas.

A. C. B.

Here is a Poser.

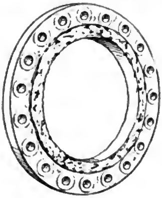
In case a vessel develops leaks in her condenser which are not serious enough to necessitate stopping th engine and opening the condenser, to plug tubes, etc., the feed water will have a quantity of salt water added to it. Suppose this quantity leaking in, in a given time, to be, say 5 per cent. of the amount of water fed to the boilers in that time. The two methods to dispose of this excess of feed water are: 1st. Put the whole quantity in the boilers and blow down occasionally, thereby reducing the density each time—but the density is gradually rising. 2nd. Allow the excess to escape from the hotwell, thereby causing the density in the boilers to rise gradually also. In both cases the supposition is that the density does not go dangerously high before the end of the voyage. I would like to hear from seagoing engineers, which of these two methods, in their opinion, is preferable, and which will deposit the most salt in the boilers.

E.

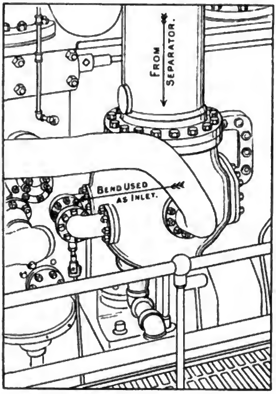
MISHAPS AND REPAIRS.

Steam Supply Improvised.

An occurrence in the engine room of the Plant liner La Grande Duchesse on a recent trip is of special interest as showing the promptness and skill with which a readjustment of conditions was effected. This splendid vessel had left Savannah in the afternoon, and was speeding northward to New York at about 17 knots an hour at the time. The boilers were giving steam at 225 pounds freely and the engines working smoothly, without the least indication of anything wrong. About 10.30 o'clock at night, the engineer on watch was on the starting platform when a sharp report overhead, accompanied by a rush of steam at the tremendous working pressure and the slowing down of the port engine, indicated that something had given out. He immediately closed the throttle of the engine and investigated. From the neighborhood of the separator, which was fitted in the main steam pipe just inside the forward engine room bulkhead, close to the bend leading down to the H. P. valve casing, steam was rushing upwards in great volumes. As the skylights were open, the engine room did not fill up with vapor, and as none of the staff was on the upper platform there were no casualties to consider. Chief Engineer Thomas Devlin was in his cabin when the explosion occurred. He was in the engine room an instant later, and told off a gang of men to close the main stop valve at the boilers. He also gave orders to ease the fires, and turned out the entire engine room staff for emergency duty. When the steam was off the engine, the asbestos covering was quickly torn away and the real damage ascertained. The outlet neck of the cast iron separator had split all around, except for a distance of about 8 in. at the bottom. At the top the (2) portions of the pipe had pulled apart ⅛ in. The steam main is 14 in. dia. An inspection of the accompanying illustration will show just where the break occurred, close to the after flange of the separator. The fracture was regular, its circumference being almost equi-distant from the flange face at every point. The thickness of metal was 1¼ in. of good grain, and apparently free from blow holes or defects. The separator itself was 26 in. long, having flanges with male and female faces 1 in. wide, fitting corresponding ends in the cast steel steam mains. The flanges were 24 in. dia., held together with 19, 1 in. bolts with a single thickness of packing surrounding the surface ends. Chief Engineer Devlin immediately decided to leave the break as it was and, if possible, make a steam connection with the engine so that the boat would not have to proceed with one propeller only. He selected the bypass on the throttle valve as the point for the new connection. The bypass is made up of three sections, as shown in the cut, two of which were removed, leaving only the bend next to the cylinder. This gave a 2 in. inlet to the H. P. valve chest below the throttle vale. The supply was got by disconnecting the drain pipe from the bottom of the starboard engine separator, which was also 2 in. dia. A search was made for connecting pipe, as there was none available in store, and a length of brass pipe was taken from the fresh water filling pipes. With spare elbows, the connection was quickly fitted. The connecting pipe was stretched between the engines, passing under the upper platform of the port engine, a distance of about 14 ft. Steam was then turned on both engines, all the boilers being kept going, with fires eased, so that steam would be plentiful and no possibility of trouble from priming. The port engine gave 84 revolutions, the starboard engine making the regular 120 revolutions. It was just three hours after the explosion when both engines were going again. In this condition the liner went ahead at a speed of 14 knots, and steered very handily. With one engine only the speed would have fallen to 11½ knots, and steering would have been difficult. As most of the passengers were asleep when the break occurred, and the repairs were so speedily executed, no one probably knew that anything had happened, nor was any trouble apparent when the liner entered this port and docked. The delay in arrival did not exceed 5 hours.



BROKEN FLANGE.

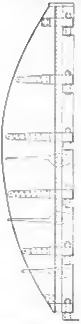


THROTTLE VALVE PORT ENGINE.

Replacing a Rudder and Rudder Post.

The S. S. Borderer while on a passage to Boston in February was unfortunate enough to lose her rudder and rudder post, during a heavy gale. Attempts to rig a jury rudder were unsatisfactory, so when a fishing schooner was spoken, a bargain was made with her captain to tow astern of the Borderer and act as a rudder for the steamer. This scheme worked well, and in due time, they reached Boston Harbor. After unloading, the steamer went into dry dock at East Boston, and a survey was made. It was then found that the rudder post had broken square off at the 20 ft. mark on the post and close to the stern post at the bottom. The rudder was broken off about 8 ft down from the head. It was decided to make temporary repairs to the rudder post and fit a new permanent rudder.

The design of the rudder is shown in the outline drawing. It consisted of a round iron rudder stock 28 ft. long, with a flange coupling on the top end. The size of the stock varied from 9⅝ in. dia. at the top end to 7 in. at the bottom. On to this stock was shrunk and keyed six wrought iron braces, with the alternate brace arms on the opposite sides of the rudder plate. The rudder plate was 1⅛ in. steel, 28 ft. long by 4 ft. 10 in. wide, notched over the brace hubs and fitting into a keyway 1½ in. deep, the whole length of the rudder stock. The pintle pins 4¾ in. dia. were forced into the braces with a taper fit, and secured by a 4 in. nut. After being riveted, all joints about the plate were carefully caulked. This rudder complete weighed seven tons. In making the repairs to the rudder post, the ends were squared, butted, and fastened by cover pieces 2½ in. thick by 5 ft. long. These covering slabs were fastened with driven 1¼ in. turned rivets in reamed holes. At the bottom end it was necessary to use filling pieces 1¾ in. thick under the slabs to make the work flush with the garboard doubling plate. There was used at the bottom end in addition to the 1¼ in. rivets three 1¾ in. dia. turned rivets driven through slabs, filling pieces and the solid stub of the keel.


RUDDER DESIGN.


REPAIRS COMPLETED.

The rudder post had four lugs for pintle pins, and was planed, drilled, and bored for pintle pins, by templet in the shop so that when put in place it fitted perfectly with everything in line. Not a file or chisel was used on any part after leaving the shop. The post was 20 ft. long, vertically, extended 8 ft. forward to the stub of keel, and weighed five tons.

Bids for the work were asked for and the contract was awarded to The Lockwood Manufacturing Company, of East Boston, to be finished in fifteen working days. The work was done in the most satisfactory manner in the short space of twelve working days. Forgings for the job were furnished by the Boston Forge Co., of East Boston.

EDUCATIONAL.

THE INDICATOR APPLIED TO THE MARINE ENGINE.—I.

BY HENRY L. EBSEN.

THERE is probably no instrument used by engineers which has been written about as extensively as the indicator, and yet so important is the subject of its application and uses, that he would be a confident engineer who would say he possessed an entire knowledge of it, in all phases and aspects. There is to be had in the application of the indicator to marine engines a variety of results, greater and more significant than any which can be obtained from its application to land engines. It will be the purpose of this article to note some of the results, as well as to give information about the correct manipulation of the indicator, for the guidance of those who have not made the subject a special study.

Let us first consider the instrument as a means of measuring power. Ordinarily it is desirable to know the power developed in a steamship to be able to make comparisons with the water and coal consumption. In vessels that are in regular service it is almost an impossibility to give accurate figures of these comparisons, for the reason that a part of the coal burned goes toward driving the auxiliary plant, consisting of electric, ventilating, refrigerating, steering, pumping, evaporating, heating and cooking outfits. The exhaust of some of these auxiliaries is led to the receiver of the low pressure cylinder of the main engine, of others to the feed heater, and yet others to the main condenser or hotwell. As the power of the auxiliaries is a very variable quantity matters could not so be arranged, that, say, one boiler would take care of the auxiliaries and the other boilers be connected with the main engine and feed and circulating pumps, or, in other words, to separate the auxiliary plant from the propelling plant. Therefore, it is customary to quote the efficiency of the entire plant by comparing the total coal consumption with the horsepower of the main engine. As the auxiliary system of the large fast passenger ships contains a great number of engines which are not economical in the use of steam, and the loss of heat due to condensation in the net work of the pipes is considerable, the figure of the efficiency of the entire plant is often a disappointment if the above facts are not properly appreciated. Furthermore, it does not allow of close comparison between different types of vessels, as for instance between a freighter, with only a few auxiliaries, and a fast passenger vessel; even if both have the same style of modern economical main engines.

Another use of the indicator is to enable the engineer to regulate the distribution of power in the different cylinders of the main engine. All main engines have a linking-up device on the valve gear of each cylinder, independent of the reversing gear. In order to give a uniform rotative effort to the shaft, it is necessary that the total power of the engine be divided evenly on the different cranks. Take for instance a triple expansion engine, properly designed, running with links full out and the power evenly distributed. If it should become necessary, on account of cleaning fires, or poor coal, to reduce the quantity of steam to the engine in order to keep up the boiler pressure, the high pressure cylinder would be linked up first, decreasing its cut off, reducing the total amount of steam passing through the engines, and correspondingly reduce the total horsepower. Under these changed conditions, the high pressure cylinder would have a greater power than either the intermediate or low pressure. It thus becomes necessary that these be linked up likewise until the powers are again even. If the low pressure cylinder drives the pumps, it is allowed a corresponding excess of power. In cases where the crosshead, crankpin, or other working parts of one cylinder are at any time giving trouble, it is a very simple matter to reduce the strain on them by reducing the power of the cylinder, giving part of it to the next, or distributing it among the other cylinders, and at the same time not materially reducing the total power. But the valves of the last cylinders usually have a longer travel than those of the first cylinders, so the linking-up process cannot be adjusted proportionately offhand, but must be studied with the help of the indicator. This becomes very apparent in quadruple expansion engines.

Again, in twin screw vessels, it is essential that the powers of the two engines be equal, so that each will give the same amount of thrust. If one engine develops more power than the other, when sailing a straight course, the rudder must be put over several degrees, and this drag impedes the speed. The two engines, one right handed and the other left handed, will occasionally show a difference of power, sometimes even when running at the same number of revolutions, and to bring them even by linking-up slightly on the one developing the most power, the indicator is indispensable.

Motor Boats at the Sportsmen's Exposition.

At the recent Sportsmen's Exposition at Madison Square Garden there was an unusually interesting series of exhibits of motor boats. In most of these the propelling power was obtained by the use of naphtha or other similar liquid.

The Gas Engine and Power Company, Morris Heights, N. Y., exhibited an open launch, 25 ft. long, fitted with a four H. P. engine, built for use on Lake Minnetonka. The frame was oak with cedar planking and the upper works were finished in oak and mahogany, highly polished, which, with the brass railing, gave the boat a very elegant appearance. An 18 ft. cedar, clinker built, yacht tender, built for Major C. F. Ulrich, was also shown. This was a very serviceable looking boat. On a draught of 20 in. it was designed to make nearly 7 miles an hour. A triple expansion steam engine, built in the company's shops, called out much favorable comment from those interested. It had cylinders 7 in., 11¼ in. and 17½ in. by 10 in. stroke. At 160 pounds' pressure and 140 revolutions, the engine indicated 150 H. P. One noticeable feature of the design was the small amount of cast iron used. The frames even were steel columns, stoutly braced, giving a very rigid and easily examined engine.

A vapor engine of the Marine Vapor Engine Company, Jersey City, N. J., was shown in operation at its stand, a portion of the valve casing being cut away so that the motion of the parts could be easily followed. Alcohol is used as the motive power in this engine. The alcohol is vaporized in a retort, which is heated by a kerosene flame, and the vapor is used expansively in the cylinder. Owing to the absence of shock from the explosion of inflammable gases, which are utilized in other motors, a great steadiness is claimed in running. The vapor after passing through the cylinder is condensed and returned to the alcohol tank. At this stand several motor boats were displayed. The largest, a 25 ft. cabin boat, built of oak and cedar with mahogany finish. It was fitted with a 5 H. P. engine and guaranteed to go 9 miles an hour. A large tank for kerosene was fitted forward, and the interior cabin arrangements were arranged for extended cruises.

A 50 horse-power Globe gas engine was shown at the stand of the Pennsylvania Iron Works Company, Philadelphia, Pa. This, considering the power developed, occupies a very small floor space; vastly less than a steam engine and boiler could be got into. A 6 H. P. motor with shaft and propeller attached was also exhibited, in motion. An 18 ft. cedar boat, built by the O. Sheldon Company, of Boston, who supply the hulls in which Globe engines are fitted, was a good example of a handy, durable craft.

A very fine cruising boat with cabin was in view at the stand of the Daimler Motor Company, Steinway, Long Island. The dimensions of this boat were: Length, 33 ft.; beam, 8 ft., and draught of water, 8½ ft. It was fitted with a 7 H. P. motor of the Daimler type, sufficiently powerful to give the boat a speed of 9 miles an hour. The storage tank was of 150 gal. capacity. The boat was beautifully finished in oak and mahogany. The cabin was richly upholstered. In the forward end a binnacle and wheel were fitted while aft of the cabin proper there was a most convenient pantry and storeroom. The engine took up a very small space in the stern, leaving ample seating room under the awning.

The exhibit of the New York Launch and Engine Company, Morris Heights, N. Y., included a 21 ft. naphtha launch, in which was fitted a 40 gal. fuel tank, so that long cruises could be conveniently made. The Otto Gas Engine Company exhibited at this stand a 25 H. P. engine of its well-known marine pattern, a very compact and strongly built machine.

A portable boat motor, which can be attached to any row or sail boat up to 18 ft. in length was shown at the stand of the American Motor Company, Havemeyer Building, New York. This is fitted with a reversible propeller, the propeller also being used as a rudder. The weight of the apparatus is 70 pounds and a speed of 6 to 8 miles per hour is guaranteed.

The Manhattan Manufacturing Company, 120 Liberty street, New York, exhibited one of its small marine type engines, with shaft and reversible propeller connected. This engine is enclosed in a metal case of small dimensions, the working parts running in oil, and as it is fitted with ball-bearing thrust bearings, a great reduction in friction is said to result.

The exposition was well attended throughout and the launch builders' stands were among those most frequented by visitors.

The total of domestic exports from the United States for the month of January, 1897, was $92,472,312, as against $85,543,304 for the same month in 1896. Of agricultural products the exports were to the value of $66,694,508, and of manufactured products, $20,622,850. The greatest gains occurred in the exports to Great Britain, Germany, Belgium and China. Exports to South American countries show a decline in the same time of about $500,000. Of the exports for the month, goods valued at only $6,193,914 were carried in American ships, while $82,061,257 worth went in foreign vessels. Of imports $7,398,823 worth came in American vessels and $41,617,167 in foreign ships.

The Clyde Line steamship Saginaw went ashore at Long Beach on March 24. There was a heavy rain and mist at the time. She carried mixed cargo and only one passenger, who was brought ashore by the life-saving crew. Several mishaps to sailing craft occurred the same day.

HOME AND FOREIGN EXCHANGES.

Traffic in New York Harbor.

Reviewing the traffic conditions in New York harbor during the year 1896, Seaboard, in a recent issue, published a valuable article, with handsome illustrations, from which the following extracts are taken:

During the year 1896, 99,223 cabin passengers and 252,350 steerage passengers landed in New York, all coming from foreign countries. They were brought in on 822 trips made by vessels of 21 lines, and 30 trips by miscellaneous steamers. The North German Lloyd Steamship Company brought 38,034 steerage passengers from Bremen and 16,146 from Mediterranean ports; the Hamburg-American Line brought 32,280 steerage passengers from Hamburg, and 3,581 from Mediterranean ports; the White Star Line landed 21,220 steerage passengers; the Cunard, 20,000; the Anchor Line, 18,839 from the Mediterranean ports, and 6,448 from Glasgow; the French line, 17,371 and the American Line, 12,830. Of cabin passengers the American Line brought 16,859; Cunard, 17,999; Hamburg-American, 12,173 from Hamburg and 438 from Mediterranean ports; North German Lloyd, 10,921 from Bremen and 2,634 from Mediterranean ports, and the White Star Line, 11,607.

The ocean steamship lines which enter the port of New York are among the largest and most important on the globe. The finest ships the world has ever produced are to be seen leaving and entering the harbor every day. Such great ocean steamers as the Campania and Lucania, of the world renowned Cunard Line; the St. Louis and St. Paul, Paris and New York, of the American Line; the City of Rome, of the Anchor Line; the Pennsylvania, Furst Bismarck, Augusta Victoria, Normannia and Columbia, of the Hamburg-American Line; La Touraine, La Bourgogne and La Normandie, of the French Line; the Spree and Havel, of the North German Lloyd; the Friesland, Westernland, Noordland and Kensington, of the Red Star Line, all magnificent passenger ships, with their many consorts, are to be seen almost constantly passing through the harbor, either starting on their voyage or reaching the port after a trip from the other side of the world. These boats are used chiefly to carry passengers, while the bulk of the freighting business is carried on in steamers especially fitted for this work. The biggest cargo-carrying vessels that ever floated are to be seen in the port at all times, among which the great White Star freighters, those of the German lines, and the hosts of "tramps" or roving steamers, moving about the harbor, combine, with the local traffic, to make it life and animation, and present to the eye a constant succession of marine pictures.

Of course the leading transatlantic steamships surpass all others running from the port, in point of size, but there are a large number of splendid vessels, and these constructed in American shipyards, which ply to various ports along the coasts and to the West Indies, to Mexico, Central and South America, and for comfort they are ofttimes in advance of the more pretentious "Royal Mail" steamers. Take, for example, the La Grande Duchesse, owned by the Plant System. Here is a vessel which in some ways is unequalled by any in the world. While not as big as the foremost steamships running across the Atlantic Ocean, yet she is a stronger craft, has more modern improvements, and is, taken all in all, a superior boat to many of them. The new Creole, 3,800 tons, of the Cromwell Line, running to New Orleans, is another fine specimen of the shipbuilders' art. The John Englis, a coasting steamer which lately went into commission, is probably the best boat of her class in the world, while the numerous fine steamers of the Old Dominion, Savannah, Clyde, Mallory, Morgan, Ward, Red D, and other lines, are as perfect and finely equipped as they are typically American.

Leaving the port of New York every evening summer and winter, bound for various points within 200 miles, is a fleet of inland steamboats which cannot be matched in any other part of the world. These great vessels, daily freighted with a thousand or more passengers, and a large cargo, steam away at the rate of twenty miles an hour, reaching their destination in the early hours of the morning, and running with the regularity of a railroad train. Such vessels as the Priscilla, Puritan, Plymouth, Pilgrim, Adirondack, Drew, Dean Richmond, City of Lowell, City of Worcester, Connecticut, Richard Peck, etc., could only be duplicated by the expenditure of from $800,000 to $1,500,000.

In the harbor of New York there are nearly fifty ferry lines, 150 steamers being actively engaged every day in transporting passengers and vehicles to different points along the shores. No freight is carried by these boats, except what may happen to be loaded on to trucks, etc. For the purpose of transporting heavy freight, etc., from one point to another, hundreds of steam lighters, canal boats, barges, etc., are constantly engaged. The vessels which have no steam of their own are towed about the harbor by the 500 tugboats which are owned by the various transportation companies and others. In Brooklyn, on the East River, is located the United States Navy yard, the most important in the country. Here naval vessels are built and repaired, and employment given to 2,000 men at all times. The dry dock is one of the best in the country, and cost $2,000,000.

During 1896 a total of 4,460 vessels arrived at New York from foreign ports. They were divided up as follows: Steamers, 2,948; ships, 176; barks, 345; brigs, 99; schooners, 892. From all coastwise ports there were 10,229 arrivals in the harbor. These consisted of 1,787 steamers; 13 ships; 52 barks; 24 brigs and 8,353 schooners. New York exported 18,476,263 bushels of wheat, 19,100,190 bushels of corn, 15,880,150 bushels of oats during the year 1896. The coal mining industry of the port amounts to $82,000,000, the steamship lines using 1,425,000 tons annually. The amount of freight transferred at the port of New York annually is estimated at 80,000,000 tons. For the six months ending January 1 the receipts for customs at the port of New York were $45,425,927.64, while the January, 1897, receipts were $7,705,400.36. The total exports for the seven months ending January 31, 1897, were $268,275,831, the imports for the same time being $304,247,879.

A New Mail Steamship Record.

The following paragraph from the Yachtsman is of particular interest, not only as recording a phenomenal service speed for a passenger steamer, but because it is over this route that the American mail, which crosses the Atlantic via Queenstown, is carried.

Much interest centered at Kingstown, last week, in the first trial trip of the first of the four new Irish Channel mail screw-steamers. The new vessels are named after the four Irish provinces, as in the case of the old paddle-steamers which have been on the station for over 36 years. The first vessel finished is the Ulster. The day was, in most respects, an ideal one for a trial, water just smooth, with the faintest roll off the Race. At Holyhead breakwater Ulster gave Ireland, the crack of the old paddle fleet, a short start, but soon overhauled and passed her. When "full speed ahead" was rung down to the engine room, it soon became very evident that the passage would be "a record." The Kish lightship was left to starboard in 2h.4m.30s., and the Burford buoys

8m. 30s. later. Then she began to slow down for Kingstown harbor, and the piers were entered at 4 p. m. The across-channel passage, from breakwater to breakwater, was accomplished in 2h. 26m., the mean speed being 23.4 knots per hour. Ulster, therefore, holds the record as the fastest mail-steamer afloat. She is a distinct departure from the old across-channel type of paddle-steamers, and, indeed, is not unlike a diminutive Atlantic liner, with an uninterrupted promenade deck along each side from her foremast aft, and a small hurricane deck over the forecastle. She promises to be a good sea-boat, and there are hopes of her making a still better record when her officers get to know her ways. The three other vessels, Munster, Leinster, and Connaught, are to be on the station by April 1. All three have been built by Messrs. Laird, of Birkenhead, who were also the constructors of their old paddle-wheel namesakes.

Floating Pneumatic Grain Elevator.

A floating pneumatic grain elevator has been put in service, recently, at the port of Limerick, Ireland, which possesses many interesting features. This vessel, the Garryowen, as described by The Engineer (London), is 170 ft. long and 16 ft. 6 in. deep, with propelling engines of 240 horse power and a speed of nine knots.

The machinery mainly consists of two high-pressure steel boilers, constructed to the requirements of the Board of Trade, each 10 ft. 6 in. dia. by 11 ft. long, and having two furnaces 3 ft. 2 in. dia., fitted with Adamson rings and provided with separate combustion chambers. The working pressure is 120 lb. per square inch. The pneumatic engine is of the horizontal type, and its bed-plate is formed by steel girders 56 ft. long, forming part of the frame of the vessel, and greatly adding to its strength. The engine is of the ordinary compound type, having a high-pressure cylinder 22 in. dia., and fitted with an expansion valve and a center-weight high-speed governor. The low-pressure cylinder is 42 in. dia., and there are two pneumatic cylinders to each side of the engine of 38 in. dia., and having their pistons fitted on to prolongations of the piston-rods of the steam pistons. The stroke is 48 in., and at forty-two revolutions 440 indicated horse power is given out.

The work required from the pneumatic engine may be divided into two distinct parts, a suction action through one set of pipes to lift the grain out of the ship and deposit it in the receiving tanks, and on the return stroke of the piston to compress the air and force the grain out of the lower set of delivery tanks, and then convey it through the shore mains and deliver it into any required compartment in the warehouses. In the former case the air is drawn off from the upper part of the receiving tanks, and the grain falls by gravity into the discharging boxes, and thence into hoppers. Below these hoppers are placed one-ton automatic self-registering weighing machines. The discharging boxes consist of two compartments having ports on the top, alternately opening to the receiving tank, and rocking to and fro on a shaft, so that one side is being filled with grain while the opposite compartment is being emptied. Inclined shoots are provided between the weighing machines and the pressure tanks, and doors are also provided to regulate the speed of the delivery to the pressure tanks to suit the inflow of grain into the receiving tanks. When once adjusted to suit any kind of grain, wheat, maize, etc., which may be required to be operated upon, the whole of this portion of the plant works automatically and without attention.

Auxiliary air chambers are placed on deck to serve as dust collectors between the suction-receiving tanks and the pneumatic engine. These chambers are of large capacity, and are provided with internal pipes and cones, so that any dust which may be held in suspension by the air after leaving the first receiver is projected by its velocity beyond the cones on entering the enlarged space, and cannot again mix with the air, and the dust so collected can, by an arrangement of air locks, be returned to the grain, so that the cargo shall not suffer any loss of weight, but the quantity of such dust to be dealt with is comparatively small.

The usual engine-room staff, together with a captain, mate, and four deckhands, who also couple up the pipes, are required to work the elevator, and a man, or intelligent lad, is required to attend to each pipe in the holds of the ship, to lower and move them about as may be required. The cost of working, including coal, etc., may be approximately taken at 3d per ton with bulk cargoes, but may be somewhat less or more, according to the circumstances of each case.

American Coal Ousting British.

The constantly increasing export of American coal has aroused the British miners and shippers to a little alarm for their markets. The following shows the distribution of the exports of United States coal during the three years stated:

Exported to.	1893. Tons.	1894. Tons.	1895. Tons.
Bermuda	3,157	2,823	5,047
Canada:			
Nova Scotia, etc.	89,586	97,869	104,680
Quebec, Ontario, etc	1,907,723	2,704,562	2,941,542
British Columbia	3,074	500	1,977
Newfoundland	3,203	2,366	5,551
West Indies:			
British	14,399	23,443	22,503
Danish	37,006	41,461	30,420
Dutch	1,713	1,673	2,247
French	33,017	38,861	43,203
Hayti	525	1,031	1,108
San Domingo	2,468	3,773	4,337
Cuba	333,914	331,902	418,700
Porto Rico	18,309	15,301	30,266
Other Countries	398,773	349,624	250,120
Total	2,846,667	3,615,191	3,870,701

Here we see, says London Fairplay, the exports increased by upward of one-third within three years, and notwithstanding serious interruptions at the mines. Beyond doubt the competition of the United States with British coal in the not very dim and distant future in markets which it has not yet reached must be prepared for. Sellers of best Cardiff are foolish to turn up their noses at the possibilities of Pocahontas.—The Marine Journal.

The annual report of the Commissioner of Patents, John S. Seymour, for the year ending Dec. 31, 1896, made to Congress, contains many interesting details. It shows that the total number of applications for patents, for inventions, was 42,077. The total number of patents issued to citizens of the United States was 21,285, and to citizens of foreign countries 2,027. New York heads the list of States with 3,882 patents, while Nevada stands at the bottom with nine. Connecticut leads in the proportion of patents issued to inhabitants, the total number of patents being 983, or one to every 759 persons in the State. Among the European countries England is first with 617 patents, Germany a close second with 543, and France coming next with 194. Canada came in the list with 244 patents granted. The total expenditures of the office were $1,113,413.71. The receipts over expenditures were $210,646.12, and the total balance to the credit of the office, in the United States Treasury, amounted to $4,718,639.47. The income was greater than any previous year, except 1890.

CONSTRUCTION NOTES.

Moran Bros.' Company, of Seattle, Wash., have work well advanced on Torpedo boat No. 8. This is one of the 170 ft. boats, with a breadth of 17 ft. and of 182 tons gross. They are also building two steel stern-wheel steamers, of light draught, for service on the Yukon River, Alaska. There has just been completed at this yard the new revenue cutter, "Golden Gate," for San Francisco harbor. This measures 110 ft. long, 20 ft. 6 in. beam, and 12 ft. 0½ in. deep. The engines are of 525 I. H. P.

Bath Iron Works, Limited, Bath, Me., reports great activity in the yard. The gunboats, Newport and Vicksburg, are nearly finished, and both will soon be sent on the builders' trial trip. There are two lightships on the stocks. The frames are up and part of the plating in place. These vessels will be ready for launching in about six weeks. Work has also been begun on a lighthouse tender, and preparations are being made for the construction of the torpedo boats for the government. The outlook for the season is very bright.

The Wolff and Zwicker Iron Works, Portland, Ore., are building lightship No. 70, for the Government. She is of composite build; the main framing, the reverse frames, floors and keelsons are of steel. She will also have one bilge strake of steel, and will be steel plated from the water line up. Below the water line she will be planked with 4 in. Bergen fir, with 2 in. oak sheathing and will be copper plated. The dimensions are: Length, over all, 123 feet; breadth, moulded, 28 ft. 6 in., with a mean load draught of 13 ft. The gross tonnage is 589.5 tons. She will have lower, main and spar decks, and three transverse bulkheads, up to the main deck. She will be fitted with two light masts. Interior finish will be in Oregon white pine and yellow fir, and there will be accommodation for ten persons in five staterooms. The propelling machinery consists of one single condensing engine 20 by 22 in., which at 100 pounds pressure and 150 revolutions will give 350 horse power. The main boiler is of the tank type, 12 ft. diam. and 11½ ft. long. The usual auxiliaries are fitted. There is also a steam hoist, and special steam and fog signal apparatus, as well as an electric light plant.

F. W. Wheeler and Co., West Bay City, Mich., have nearly finished a 2,500 ton steamship, designed to carry wood pulp. The dimensions are: Length over all, 281 ft.; breadth, 42 ft.; depth, moulded, 19 ft. The hull is of steel; the bottom sheathed with oak to the upper turn of the bilge. There are four bulkheads, three of which are watertight, and one screen bulkhead fitted with two doors in the lower hold. There is only one deck, with topgallant and forecastle deck, and full poop. The deck is fitted with seven hatches, in each of which a pulp wood conveyor, built by the M. Garland Co., of Bay City, is fitted. Four of these discharge over the starboard rail, and three over the port. The vessel will have a speed of twelve miles an hour. The engines for the single screw are triple-expansion, with cylinders 17 in., 28 in., and 47 in. dia. by 36 in. stroke. They will develop 1,000 H. P. at 100 revolutions. Steam will be supplied at 175 lbs. pressure by two Scotch boilers, 11 ft. by 12 ft., each fitted with two Adamson ring furnaces with separate combustion chambers, working under natural draught. The deck appliances include a Williamson steam and hand steering gear, a windlass with capstan connected, by the American Windlass Company, and an independent steam capstan aft, of the same pattern.

The Cleveland Ship Building Co., Cleveland, O., is building steamer No. 27, for the Wilson Transit Co. She will be 400 ft. long between perpendiculars; 420 ft. long, over all; 48 ft. beam, and 28 ft. deep. The construction is on what is known as the channel bar system, of the Carnegie Steel Company's open hearth steel plates and shapes throughout. She will have a water-bottom 5 ft. deep, capable of carrying about 2,000 tons of ballast. There will be twelve hatches in the spar deck; the usual style of barge cabins, made of wood throughout, with interior finish in quarter sawed oak. The rig will consist of three pole masts. Steam steering gear, steam windlass and capstan forward, steam capstan aft, two steam capstans amidships, and one of the builder's steam hoisting engines amidship will be fitted. The propelling machinery will consist of a triple-expansion engine with cylinders 23 in., 38 in. and 63 in. dia., and 40 in. stroke, turning a propeller 13 ft. dia. and 17 ft. pitch. There will be three Scotch boilers, each 12 ft. dia. and 13 ft. long, having a working pressure of 175 lbs. to the sq. in. It is estimated this power will easily drive the vessel twelve miles an hour, loaded. No. 27 is designed to carry 4,000 gross tons of ore on 14½ ft. mean draught, or about 6,000 gross tons on 16½ ft. It is the intention to have her ready for sea on the opening of navigation. The owners and builders expect to have one of the best ships that has ever been turned out on the lakes.

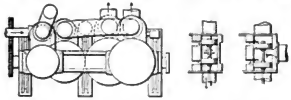
The Neafie and Levy Ship and Engine Co., Philadelphia, have under construction a steam pilot boat for the Pennsylvania and Delaware Pilots. This vessel is of open hearth steel, 148 ft. 8 in. long over all, 25 ft. beam, and 14 ft. 6 in. deep amidships. She has four watertight bulkheads, two ballast tanks, one galley tank, and one large tank for feed water. On the upper deck there is a forward house fitted with seats, lockers and tables, as a deck cabin. There is also a raised pilot house of wood, and a large cabin aft for the captain, finished in hardwood. The crew's quarters forward are finished in pine, and arranged for twelve men. The after cabin will accommodate twenty men. It is finished in white pine, enameled and gilded, with mahogany trimmings. All the furniture is of very artistic design, and the plumbing and sanitary appliances fitted, are equal to those on any yacht. The propelling machinery consists of a compound engine with 20 in. and 40 in. cylinders by 28 in. stroke. The air, feed and bilge pumps are driven by the main engine. The shafting is extra heavy, 9 in. dia. at the thrust, which is of the builders' improved horse shoe type, adjustable by wedge blocks. The engine has been designed with a view to durability and economy, all bearings being large, and in view of the expected power, all pipes, valves, etc., have been made large and free. A large wrecking and fire pump is installed in the engine room recess with suctions and fire deliveries on deck. The donkey feed pump and circulating pump are independent. Steam is supplied by a Scotch boiler 13 ft. dia. by 14 ft. long, with about 2,300 sq. ft. heating surface. It is built to pass U. S. inspection for 125 lbs. steam. There is also an evaporator and distiller in the engine room, and a donkey pump in the fire room. A complete electric installation is fitted, with 10,000 c. p. search light, a signal lamp, and incandescent lamps in the various quarters. The dynamo is multipolar, direct coupled to a twin-cylinder engine. Steam windlass and steam steering gear are also provided. The boat will have two masts, and will appear a very neat craft in the water.

Recent press dispatches from San Francisco reported that S. Anano, president of the Toyo Kisun Kabushiki, or Oriental Steamship Company of Japan, had arrived to establish a line of steamships between China, Japan, and this coast, with a terminus at this port. He had ordered three modern steamships for the line, each to be capable of carrying 600 passengers, besides having a dead weight capacity of 5,000 tons for freight. Mr. Anano said that if there is business enough he will maintain a weekly service.

SELECTED PATENTS.

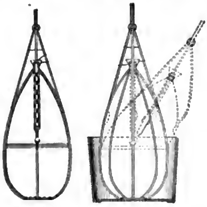
578,697—Steam-engine. *Nathaniel G. Herreshoff, Bristol, R. I., assignor to the Herreshoff Manufacturing Company. Filed Dec. 2, 1895.*

In an engine with two or more pairs of cylinders and cranks, having one cylinder of each pair above and partially overlapping its mate, the lower cylinder of the two pairs being in direct contact with each other and having the several valve-chambers out of the plane of the axes, the combination therewith of the frame connecting the upper cylinders, constituting with the cylinders a rigid supporting-girder performing the functions of a bed-plate, and the lower frames connecting such girder with the shaft-bearings, the last-mentioned frames being arranged so far out of the line of the cylinders as to allow the removal of the heads and pistons from the lower ends of the lower cylinders after detaching the slides without disturbing the frames. 2. In a compound engine with the cylinder and cranks in pairs, the double-piston valves (see cut) working in the valve-chests (see cut) arranged as described the valve-chest for the high-pressure cylinders receiving steam between the pistons and exhausting at the ends, and the valve-chests for the low-pressure cylinders each receiving its weaker steam at the ends and exhausting from the space between the valve-pistons. 3. An engine having two pairs of cylinders, with double-piston valves for each, the valve for a cylinder of one pair having the steam-inlet pipe opening into the space between pistons and its exhaust connected with the space between pistons of the valve belonging to the second cylinder of the same pair, and the exhaust of the second valve being connected with the end spaces of the valves of both cylinders of the second pair.



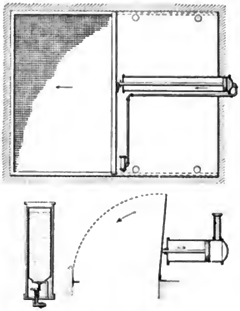
578,568—Oil-distributor for calming waves. *Daniel Knowles, Norfolk, Va. Filed July 3, 1896.*

In an oil-distributor, the combination of a bag having an internal spreader or brace near its lower end, and a filling tube having one end communicating with the mouth of the bag and its other end loosely connected with the said brace. 2. The combination of a bag, and means for holding the end portion of the bag opposite to the mouth vertical, while the mouth and portion of the bag adjacent may be inclined to the vertical. 3. The combination of a bag, a stationary rod arranged within and connected to the bottom of the bag, a perforated filling-tube having one end in line with the mouth of the bag and its other end loosely connected with the stationary rod, and a cap for closing the outer end of the tube. 4. The combination of a bag, a bottom plate for the plate, a rod extending upward from the plate, a ring or hoop arranged above the bottom plate and connected with the rod, a filling-tube loosely connected with the rod and extending to the mouth of the bag, and a cap for closing the outer end of the tube. 5. The combination of a bag, a stationary rod arranged within the lower portion of the bag and having a socket formed in its upper end, a filling-tube extending inward from the mouth of the bag and having at its inner end a ball fitting in the socket in the rod, and a cap for closing the outer end of the filling-tube. 6. The combination of a bag, a filling-tube connected with and extending inwardly from the mouth of the bag, and means connecting the tube with the bottom of the bag. 7. The combination of a bag, a filling-tube connected with both the top and bottom of the bag, and a cap for closing the outer end of the tube. 8. The combination of a bag, a bottom plate arranged within the bag, a brace extending continuously from such bottom plate to the mouth of the bag, the portion of such brace adjacent to the mouth of the bag being tubular to serve as a filling-tube, and a cap for closing the outer end of the tube, substantially as set forth.



578,028—Apparatus for automatically closing bulkhead doors. *Alexander von der Ropp, Berlin, Germany. Filed June 12, 1896.*

In combination with the movable door, a piston connected therewith, a cylinder for the piston, a breakable vessel containing an expansible fluid, a chamber containing said vessel and communicating with the cylinder, and means for breaking the said vessel and releasing the expansible fluid to operate the piston and the door. 2. In combination with the movable door, a cylinder, a piston therein for operating the door, and a fragile receptacle containing a fluid adapted to expand when released therefrom, said receptacle being arranged to be broken to discharge its fluid into the cylinder.



577,750—Propulsion of vessels by reciprocating paddles. *John L. Helmolt, New York, N. Y. Filed June 2, 1896.*

577,421—Reciprocating propeller for vessels. *Harmon Compton, Dunmore, Pa. Filed July 23, 1896.*

577,797—Hand steering gear. *William Tuttle, Natchez, Miss. Filed July 7, 1896.*

ADMIRALTY LAW.

U. S. SUPREME COURT.

Maritime Lien Disallowed.

William H. Ziegler sought to enforce a lien upon the steamship Valencia, for coal which he had supplied to the New York Steamship Company, upon their order, while they had the vessel under charter. The coal was not delivered by the order or consent of the master, and all bills were sent to the company's office in New York. Mr. Ziegler was not aware that the vessel was under charter, resting satisfied with the knowledge that the company was directing its operations, nor did he pursue any inquiry in this regard. There was no agreement that the credit of the vessel would be pledged for the coal. The District Court sustained the libelants' claim and an appeal was taken. The Supreme Court was finally asked to decide, whether, upon the facts, the libelants obtained a maritime lien on the steamship for the coal, which had not been paid for. The court answered in the negative, holding that one furnishing supplies on the order of another having control and possession of a vessel, under circumstances which put him on inquiry as to the existence and terms of a charter party, can acquire no lien contrary to the provisions of the charter party.

Opinion by Mr. Justice Harlan. Attorneys F. R. Coudert and Joseph Kling for appellants. Attorneys W. W. Goodrich and J. A. Deady for appellees.

Naval Sea Duty Defined.

Lieutenant Barnette, U. S. N., secured judgment against the United States in the Court of Claims, for $780.25, the difference between shore pay, which the government had allowed, and sea pay, during a term of service on the naval school ship St. Mary's, in the port of New York. This service was performed under an order of the Secretary of the Navy, assigning the officer to "short duty," on the ship. The government appealed, and the court of last resort decided in favor of the officer.

The Supreme Court, after noting the differences between the pay for "sea duty," "shore duty," and "waiting orders," held that to constitute sea service three things only are necessary. The service must be performed "at sea," "under the orders of a department," and "in vessels employed by authority of the law." On the first point the court held, that under the statute, a vessel is at sea even though used as a training or receiving ship, at anchor or alongside a wharf, and not in condition to be taken out to sea. The appellee lived on the vessel, wore his uniform, and was subject to the regulations governing vessels at sea; consequently the designation, of the Secretary of the Navy, of the duty as "shore duty," was immaterial. As to the second point, the appellee had acted exclusively under the orders of the commander of the vessel, a naval officer also, and though the ship had been placed at the disposal of the Board of Education of New York, the possession, control, discipline, and authority were all retained by the federal government. As to the last point, even the court below had found, as a fact, that the St. Mary's was a "sailing vessel owned and employed by the United States." Under these circumstances, the appellee was entitled to sea pay, even though he had received during the period of service compensation from the State of New York, as nautical instructor.

Opinion by Mr. Justice Gray. Assistant Attorney General Dodge and George H. Cochran for the United States. Attorneys John S. Blair and Charles Abert for appellee.

U. S. DISTRICT COURT.

Personal Injury Case.

Laurence P. Butler was awarded $1,200 compensation, with interest and costs, in a suit for damages for personal injuries, against the steamer City of Kingston. The steamer plies between Seattle and Port Townsend, carrying passengers. While making a trip, the libelant stepped on an iron lid in the deck, which covered a chute to the coal bunkers. The lid tipped and the passenger fell partially into the chute, and was badly hurt. Coal had been passed through the opening a short time previously, and when the lid was replaced it was not inspected by any of the executive officers. The court held that under the law the owner should have taken proper care that all openings in the decks, upon which passengers were allowed to walk, were securely closed or guarded. And where an injury to a passenger was occasioned by the giving way of any cover, it was incumbent upon the owner to show affirmatively that there was no fault or negligence on the part of the officers or crew.

Judge Hanford, District Court, D. Washington, N. D. Attorneys, R. W. Jennings and W. H. Gorham for libelant. James M. Ashton for claimant.

Compensation For Salvage Services Refused.

The barges Pohatcong and Mayaug, while going up the East River, New York harbor, in tow of the tug Scranton, grounded on Man-of-War rock, south of Blackwell's Island. The Scranton steamed off for help, and meanwhile the tug Ramsey came up and offered to pull the Pohatcong off. The master refused this aid, explaining that his tug had gone for assistance. The tug Ramsey lay nearby a long while. Finally her master made fast a line to the Pohatcong and hauled her off the rocks, and towed her to the flats near Twenty-sixth street, where she anchored, with little damage done The owners of the Ramsey sought to recover compensation for their salvage services. The court dismissed the libel upon legal grounds. The captain of the barge testified that he had refused the aid of the tug because of general instructions he had received from the superintendent of his line. The court held that the situation was one fairly within the scope of the master's (Pohatcong) judgment, under his general instructions not to receive outside help in such cases, and that compensation for the salvage service, though of some value, must be refused.

Judge Brown, District Court, S. D. New York. Attorneys Carpenter and Peck for libelants. Hamilton Odell for claimants.

Tug Responsible For Safety of Tow.

The responsibility of a tug for the safe mooring of her tow was considered in this suit, in which the owners of the scow Aurora recovered damages from the tug Governor. The tug was towing the scow to sea in New York harbor, and was obliged to put back on the approach of a southeast gale. She moored the tow along the bulkhead forming the outside of the Atlantic Basin, which was safe from a southeasterly gale, but unsafe in high westerly winds. During the night the wind shifted to the westward, and the scow was damaged by pounding. The court held that the tug was in fault either for not taking the tow inside the basin, or else for not maintaining a sufficient watch during the night, with help at hand sufficient to remove the tow in time to prevent damage, upon any change of wind to the westward, which was a change to be reasonably anticipated.

Judge Brown, District Court, S. D. New York. Attorneys Goodrich, Deady & Goodrich, for libelant. Attorneys Macklin, Cushman & Adams, for claimant.

Salvage as Distinguished from Towage.

An award of $1,500 was made by Judge Seaman to the North Michigan Transportation Company, owners of the steamship Charlevoix, for salvage service in towing into port the disabled freighter Waverley, on Lake Michigan. The Waverley, which had 47,000 bushels of corn aboard and two schooners in tow, was on a voyage from Chicago to Buffalo, when her machinery broke down. The schooners continued under sail and the disabled steamer blew signals of distress. The steamer Charlevoix, with passengers and miscellaneous cargo, bound to Chicago, answered, and was asked for assistance, the question of compensation being left open. The weather at the time was threatening with "a lump of a sea." This necessitated careful maneuvering and occasioned to the steamer towing "more risk than would be incurred in her regular voyage." The court held that the extent of the risk, which was assumed by the salvor, was not to be gauged by the results alone, and the fact that the towing line was speedily taken, and no mishap occurred, was entitled to no consideration only so far as it tended to show the state of the wind and sea. The value of the Waverley and cargo was put, by stipulation, at $67,000, and the Charlevoix and cargo at $75,000. The owners of the former had tended $500, but the court held that the purposes of the rule of salvage which grants compensation in the nature of a reward would not be fulfilled by narrowing the allowance so closely to the rate of mere towage. The court accordingly gave a decree for $1,500 and costs.

Judge Seaman, District Court, E. D. Wisconsin. Attorneys Markham, Nickerson & Harper, for libelant. Attorneys Schuyler & Kremer for claimant.

NEW PUBLICATIONS.

THE MECHANICAL ENGINEERING OF POWER PLANTS. By Frederick Remsen Hutton, E. M., Ph.D., Professor of Mechanical Engineering in the School of Engineering of Columbia University, New York. John Wiley & Sons. 1st Edition, pp. 726. Illustrated. Price, $5.

Every ambitious engineer wants to know the why and wherefore of all things connected with the generation and use of steam for the production of power. He desires to find an answer to the inquiries of his mind, in concise form, and unmixed with abstruse reasonings or difficult calculations, which more often than not obscure the practical facts which are sought. It is the purpose of this book to so inform the student; to put before him plainly, cause and effect of the various apparatus and agents involved. The general character of the work prevents any especial attention being given to appliances in use aboard ship, but the underlying principles are identical in steam machinery whether ashore or afloat. It widens the horizon of the engineer to become familiar with the advancement in steam generation and engine building in general. There is quantity and variety enough of illustration to make the text easily comprehensible.

Catalogues.

The 1897 catalogue of the Jos. Dixon Crucible Co., regarding graphite for lubricants, is now ready for distribution. It contains much information, practical and scientific, and is written especially for working engineers. Copies can be had upon application to the company.

"A Reminder" is a very convenient memorandum book in diary form, sent to all applicants by C. A. Daniel, 323 Market street, Philadelphia, Pa. It contains a great deal of valuable information of various kinds in addition to a daily diary, and is an exceedingly convenient book.

The subject of refrigeration on steamships has received much attention from the A. Gray Kilbourn Construction Co., Drexel Building, Philadelphia. Over 100 ocean lines have Kilbourn machines in use. Mr. Kilbourn has just produced a machine of small capacity, from 200 pounds a day upwards. This machine is especially designed for yachts and coasting steamer purposes, and is illustrated and described in a folder now issued by this company. Copies of this circular can be had by application to the company.

An eight-page folder 6 by 9 inches in size is being sent out by the Davis-Farrar Company, Erie, Pa., illustrating the Sheperd automatic engines. Four illustrations are given of the single expansion engine. The various features of these engines are briefly mentioned as well as the sizes made. This company is now at work on a large and more complete catalogue, which will describe fully all of the engines made, including compound, triple and quadruple expansion. Copies of the folders can be had upon application to the company.

A catalogue and price list of steam users' supplies has just been published by the Sims Company, Limited, Erie, Pa. A variety of devices are fully illustrated and described, including feed water filters, low water alarms, injectors, oil and grease cups, packing, water gauges, etc. The fact that Mr. Sims, president and general manager of this company, is an engineer of many years' experience, will be sufficient reason for every marine engineer who is interested in keeping posted on such matters to get a copy of this catalogue and read it carefully.

A convenient little catalogue is being distributed by the Standard Gauge Manufacturing Company, 602 The Cuyahoga, Cleveland, O., illustrating and describing the safety water columns manufactured by this company. These columns contain one float, one valve, and a single lever. The working of the column is thoroughly illustrated and described, and full information is given, such, for instance, as the most satisfactory way in which to attach the column to a boiler. This company is just arranging to push the sale of its columns in the marine field, and a reference to this catalogue will show the various advantages it possesses.

The recent demand for compact water tube boilers for use on steam launches and elsewhere where space must be economized has lead to the introduction of a large number of such boilers. One of the latest is the Buckley patent safety water-tube boiler, manufactured by the Rochester Machine Tool Works, Rochester, N. Y. These boilers are arranged to carry high pressures up to 250 or 300 pounds. Any one interested in the subject of boilers, and especially small boilers for boats and launches, should send for a circular issued by this company, which describes the boiler quite fully and illustrates also the Acme marine or yacht engine manufactured by this company.

The demand for a feed water heater and purifier that would be suited to the needs and requirements of vessels on the Great Lakes led Robert Leavmonth, chief engineer of the Anchor Line steamers, Buffalo, N. Y., to invent such a heater himself. His heater and purifier has now been in use for some years on many of the largest steamers on the lakes. Among the newest steamers to adopt them are the Crescent City, the Empire City, and the new boats of the Republic Line. Mr. Leavmonth is a practical engineer of many years' experience and will send a catalogue and other descriptions of his heater and purifier to all who are interested in the subject and will write for them.

A compound marine engine of approved design is illustrated and described in an eight-page folder which is being distributed by the Shipman Engine Manufacturing Company, Rochester, N. Y. The engines manufactured by this company have been well known for years and comprise all sizes from one horse-power upwards. The smaller sizes have been known for some years, and have a reputation that does not need further comment, but the compound is the latest development and several have already been put into use in various parts of the country. The largest one yet made has cylinders 6 by 12 by 8 in., occupies a floor space of 64 by 24 in., is 54 inches high and weighs 1,650 pounds.

The Worthington water tube boiler is one of the latest to be put upon the market. It is manufactured by the New York Safety Steam Power Company, 30 Cortlandt street, New York. The company is one long established in the steam engine business, and for many years it has been doing a considerable amount of marine work, especially in the way of furnishing engines. The need for an efficient water tube boiler to withstand high pressures and yet be compact and thoroughly practical, has led to the introduction of this boiler. The catalogue published by the company is very thoroughly and finely illustrated and goes into the details necessary to give a good understanding of what this boiler is. Every man interested in the subject of boilers would do well to send to the company for one of these catalogues.

In connection with a fine catalogue describing and thoroughly illustrating a complete line of diving apparatus and submarine armor, Andrew J. Morse & Sons, 140 Congress street, Boston, Mass., are sending out a description of the Morse improved telephone for divers. This telephone contains many improvements over the one formerly used, as it now comprises a hand telephone for use above water, and dry battery in a leather case with shoulder strap, a receiver and transmitter inside of the helmet for the use of the diver, and an electric cable in the center of a specially made line. The helmets are furnished with the transmitter and receiver in positions properly connected and ready for use at any time. The catalogue also contains a description of the Morse improved three cylinder air pump, which will furnish ample amount of air for divers to any depth that a diver can descend.

No neater brochure has ever been issued than the one now being sent out by the Vacuum Oil Company, Rochester, N. Y. It is entitled "From the Mail," and consists of a series of letters from a great variety of people speaking in the highest terms of the lubricating quality of the oils manufactured by this company. The illustrations are beautifully made and the printing and entire matter are of the very choicest work. Among the communications is one telling of the use of Vacuum oil upon the steamboats of the Newport & Wickford Company, and another from the William Cramp Ship and Engine Building Company, stating that Vacuum oils are used in the yards of this company as well as on all new vessels on their trial trips. Every user of lubricating oils should send to the Vacuum Oil Company for one of these publications, both for the beauty of the work, and for the valuable information contained. One can be had by mentioning Marine Engineering.

BUSINESS NOTES.

THE SPRINGFIELD ELEVATOR AND PUMP CO., Springfield, Mass., is now manufacturing the line of pumps so long and well known as the product of the Valley Pump Co., Easthampton, Mass. All sizes and kinds of pumps are made for marine uses, and many of them will be found in operation on the Mississippi River, as well as on Long Island Sound and on the sea coast.

THE SHIPMAN ENGINE CO., 200 Summer street, Boston, Mass., has been particularly busy this season in launch work. This company supplies various styles of marine engines from one h. p. upwards. All the necessary appliances are also supplied, including various types of propellers, wheels, steering gear, whistles and everything else that goes to make a steam launch comfortable and safe.

THE SCOTT ELECTRIC LAMP CO., 136 Liberty street, New York, finds that it pays to make a specialty. The search lights and lamps manufactured by this company are used on Government boats, river and lake steamers and along the coast. Some of the best known yachts in the country are also equipped with "Huntington" lamps. This company supplies all the requirements for search lights.

THE BOSSERT ELECTRIC CONSTRUCTION COMPANY, Utica, N. Y., through its New York manager, William Taylor, 106 Mail and Express Building, is having a good sale for fuse mains and other electrical devices for use on vessels which have electric plants. As these devices are adapted especially to this kind of work and have proved efficient, Mr. Taylor is rushing their sale in an energetic manner.

THE VIADUCT BRASS CO., Cleveland, O., is putting out a full line of brass goods for steam users' purposes. The latest is a reducing valve, which is being used on the lakes with marked success. This valve is fully described in these pages elsewhere. A catalogue descriptive of all the manufactures of this company has just been published and can be had upon application to the company, by mentioning Marine Engineering.

THE MARINE APPLIANCE CO., 36 Oliver street, Boston, Mass., is filling many orders for its new navy closet. These closets are designed to be safe against any sea pressure, and yet are in keeping with the latest sanitary requirements. They can be used either above or below the water line, and are made in various sizes and of various designs to suit all the conditions and requirements, from small yachts to large steamships.

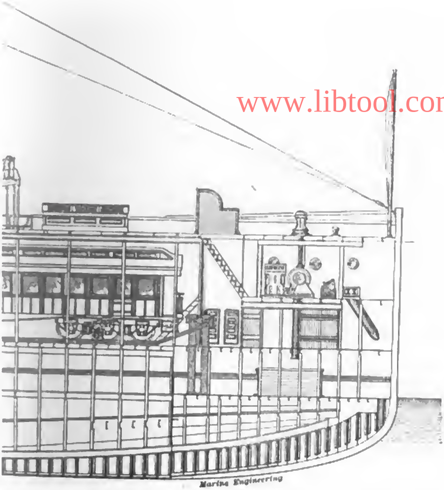
THE CRANDALL PACKING CO., 136 Liberty street, New York, and Palmyra, N. Y., reports a large increase in orders for its various special packings during the past three months. Its expansion ring, sectional ring, and coil packings are treated by a patented cold oil process which thoroughly lubricates, yet leaves the finished product firm and elastic. This company furnishes packings to many of the principal steamship lines in the United States.

THE VANDERMAN PLUMBING AND HEATING CO., Willimantic, Conn., is finding a good demand for two specialties, which are of great use to marine engineers. One is the Vanderman chest, which is made of steel, in many large sizes. This chest is very strong and durable, and is particularly arranged for the tools that an engineer must have handy. The other specialty is a combination pipe vise, the value of which can be readily seen by referring to the illustration in the advertisement in our advertising columns.

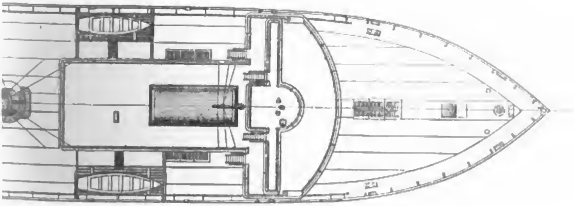
THE A. GRAY KILBOURN CONSTRUCTION CO., Drexel Building, Philadelphia, Pa., is just putting on the market a novelty. It is the Duff Hand Drill, which is a surprisingly convenient tool. It is made with ball bearings, and can be operated with any ordinary bit brace in almost any position and under all conceivable conditions. The drill is designed to bore holes of any size up to, and including, one inch. Marine engineers have found them particularly valuable, because they adapt themselves to so many conditions and are so compact.

THE INTERIOR CONDUIT & INSULATION CO., 527 West 34th street, New York, makes a very large line of exhaust fans and blowers. These ventilators are operated in all ways, and especially by means of a Lundell electric motor. This company also presents a large line of blowers for use where fans are not ample or satisfactory. The ventilation of a ship below decks is very important and any one wishing to secure information on the subject would do well to make inquiries of the Interior Conduit & Insulation Co.

THE BELKNAP MOTOR CO., Portland, Me., is installing electric plants on the steamers Cumberland and State of Maine of the International Line. Both boats are being equipped with direct-coupled multipolar dynamos of 18 k.w. capacity, or sufficient to supply 300 incandescent lamps and a 10,000 c.p. search light. This company has already installed duplicate plants on the St. Croix of the International Line. This completes the equipment of light plants on the steamers coming into Portland, seven plants being furnished by this company, including the Bay State, Portland, Cottage City, Manhattan, and St. Croix and the above named. A New York Safety Steam Power Co. engine direct coupled with a Belknap multipolar dynamo is used on the Cumberland, and an Ideal engine made by the Harrisburgh Foundry & Machine Co. on the State of Maine.



Marine Engineering



MARINE ENGINEERING.

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U. S. SEA-GOING BATTLESHIP IOWA, BUILT BY W. CRAMP & SONS.

U. S. BATTLESHIP IOWA, IN DOCK AT NAVY YARD, N. Y.

The finest war vessel in the American Navy and as fine a ship as ever flew a naval flag is shown in the illustration of U. S. seagoing battleship Iowa, on this page. The fourth battleship of the new navy, the Iowa, embodies many novel features and improvements over the design of those previously built—the Indiana, Massachusetts, and the Oregon. The appropriation by Congress for the construction was approved July 19, 1892, and the work was awarded William Cramp & Sons, of Philadelphia, on February 11, 1893, at the contract price of $3,010,000. On August 5, following, her keel was laid; on March 26, 1896, she was launched, and on April 7, 1897, she went on her trial trip off the Massachusetts coast. The general dimensions which are here given are supplemented by a list of similar dimensions of the battleship Indiana, which shows wherein the Iowa excels the earlier battleships:

IN DRY-DOCK, SHOWING RAM.

Dimensions.	Iowa.	Indiana.
Length on load water line	360 ft.	348 ft.
Breadth of beam, extreme.........	72 ft. 2½ in.	69 ft. 3 in.
Displacement in tons, normal draught............................	11,410	10,288
Mean draught at normal displacement	24 ft.	24 ft.
Freeboard forward	19 ft.	11 ft. 7½ in.
Normal coal supply................	625 tons.	400 tons.
Total coal capacity	1,780 tons.	1,640 tons.
Maximum indicated horse-power.	11,000	9,000
Speed in knots, contract.	16	15
Complement of officers and crew.	486	460

The Iowa is built of mild steel, with a double bottom, and water-tight bulkheads extending up to a height of 10 ft. above the load water line. The defensive powers of the vessel are provided for by a belt of 14 in. steel armor 7½ ft. wide, extending along the water line region a distance of 185 ft. 6 in. amidships. This is 3 ft. above and 4½ ft. below the water line. The forward and after ends of the belt turn inboard and run diagonally across the ship, with a thickness of 12 in. Within the bounds of this plating and on the level with its upper edge a flat protective deck of 2¾ in. steel is in place. Inside this protected portion of the hull are carried the propelling machinery and the magazines. The inboard ends of the side armor form the foundations for the barbette turrets. Protection for the unarmored ends is secured by an extension of the midship protective deck, fore and aft, to the stem and stern. These decks, which are 3 in. thick, start from the lower edges of the diagonal armor and extend the width of the ship. The forward deck terminates back of the ram, giving a very useful stiffening here. From the upper edge of the 14 in. armor belt there rises 4 in. of hardened steel, for a distance of 90 ft. amidships, backed by a belt of coal several feet in thickness. Forward and abaft the casement armor, from the protective deck to the main deck, the skin is backed by a wide cofferdam filled with cellulose, and minutely subdivided. This is expected to keep out any appreciable quantity of water should the sides be pierced in action.

The formation of the sides amidships, where they curve inboard, secures the necessary freeboard without the added weight consequent were the lines carried up with the water line fulness. The weight of material saved here was utilized in carrying the sides higher forward. Thus an easier curve of stability, roomier quarters for the crew, greater sweep of the guns in the broadside sponsons, and the probability of increased efficiency of the great guns, in almost any fighting condition of the sea, was secured.

The main battery consists of four 12 in. and eight 8 in. breech loaders. These are mounted in pairs, the former in two Hichborn barbette turrets, of the balanced type. The 12 in. guns can fire through an arc of 270 deg. Their turrets are 15 in. thick, while the barbettes, which extend down to the protective deck, are 17 in. thick. The advantage of the balanced turrets in wide angle fire is apparent. In the Indiana, for example, the main battery is fitted in unbalanced turrets, and when trained in a broadside direction produces a considerable heeling effect. The 8 in. rifles are mounted on the upper deck in four barbette turrets, of the ordinary type, 8 in. thick. They fire through an arc of 160 deg.

IN DRY-DOCK, SHOWING PROPELLERS.

The secondary battery is composed of six 4 in. rapid fire rifles, four of which are mounted on the main deck in armored sponsons, and sheltered by thick splinter bulkheads of steel, and two are mounted aft on the bridge deck, sheltered by fixed shields. Twenty 6-pounder, four 1-pounder, and four Gatling guns constitute an auxiliary force, and are mounted on the main deck, on the upper deck, and bridges, and in the tops of the military mast. The ship is also fitted with five torpedo tubes, one in the stern and two in each broadside.

As the Iowa is fitted with twin screws, the propelling machinery consists of two sets of triple expansion engines, fitted in separate water-tight compartments. The cylinders are 39 in., 55 in. and 85 in. dia. by 48 in. stroke. Steam boiler pressure of 160 pounds is generated in three double-ended boilers, 16 ft. 9 in. dia., one 20 ft. long, and two 19 ft. long; and two single-ended, 16 ft. 9 in. dia. and 9 ft. 10½ in. long. These are fitted in four water-tight compartments. Forced draught is used at the higher speeds. On the trial trip the Iowa, on a mean draught of 24 ft., showed a mean speed of a fraction less than 17 knots, the engine making between 110 and 112 revolutions. At full speed the ship has a radius of endurance of 5 days, in which 2,213 miles could be run. At the cruising speed of 10 knots, the bunker capacity would carry her 8,022 miles.

Nearly a hundred auxiliary engines are used to operate the hydraulic, electric and other apparatus for turning the turrets, working and loading the guns, lifting and lowering the boats, raising the anchors, controlling the rudder, bringing up the ammunition from the magazines, providing fresh water, lighting the ship, making ice, preserving the fresh food, and thoroughly ventilating the ship by powerful blowers. In the construction the use of wood has been dispensed with whereever possible, and that which is absolutely necessary has been subject to an electrical fire proofing process. In the matter of fittings, to secure comfort for the officers and crew, this ship does not differ materially from the coast line battleships, save in one particular, and that an important one, the additional accommodation for the crew afforded by the forecastle deck. This is a very valuable feature, particularly in tropical climates or when the ship's company may be augmented by the presence of prisoners or rescued seamen.

The total number of ships under construction for the British Navy for the year 1897-98, commencing April 1, is 108. This includes fourteen battleships, eight first-class cruisers, nine second-class cruisers, ten third-class cruisers, two sloops, four twin-screw gunboats, fifty-two torpedo-boat destroyers, eight light-draught steamers and one Royal yacht. The total displacement tonnage is 38,000 tons and the aggregate horse-power about 800,000 indicated.

The French Government has let contracts for three torpedo boats, each to have a speed of 24 knots, and to cost $63,380.

HINTS ON ELEMENTARY STABILITY, WITH REMARKS ON WATER BALLAST.*

BY CAPT. A. S. THOMSON, LIEUT. R. N. R.

Actual statical stability, is defined as the moment of force of which a floating body endeavors to regain a position of stable equilibrium after having been deflected from it. The center of buoyancy may be considered the point of support for a floating body, and so long as this point is above the center of gravity a vessel will have stability at all angles of inclination; moreover, this stability, as in the case of a body having rigid support, is quite independent of form. In the case of a solidly supported body, the vertical through the center of gravity must not fall outside the base, whilst for the floating vessel it must not fall outside the point to which the center of buoyancy moves out as the vessel heels. Thus the distance to which the center of buoyancy moves out on either side of the center of gravity, for a single angle of heel, may be compared to the length of rigid base of a body having solid support, outside which supporting base the vertical through the center of gravity may not fall if stability is to be retained.

In order to illustrate the transverse stability, it is convenient to take a section of a vessel in a plane at right angles to the keel. Such a section can be drawn to represent, both in form and area, the resultant value of a number of similar sections taken at equal intervals throughout the length of the ship. A simple plan to find the required approximate area is to take the transverse sectional area of the actual ship at the widest part, and multiply it into the known co-efficient of fineness, the form of the required section being readily found by referring to the half-body plan. Keeping in mind that, in a transverse plane, every longitudinal axis appears at a point, and every longitudinal plane as a line, the transverse stability of the section may be taken as fairly representing that of the entire vessel. The line, vertical in the upright position, dividing the section into two equal and symmetrical parts, we shall now call the middle line.

The apparent weight of the ship as a whole may be considered to act downwards through the center of gravity, whilst an equal and opposite force reacts upwards through the center of buoyancy. For a vessel to float freely at rest in any given position, these two points must be in the same vertical line. When they are not so situated, the equal and opposite forces acting through them form a couple, and the vessel, if left to herself, rotates till the couple disappears and equilibrium is restored. The center of buoyancy moves out from the middle line as the vessel inclines, its position depending solely on the form of the displacement, and being quite unaffected by mere change of volume of displacement. The center

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* From a paper read before the Shipmasters' Society, London, on March 25, 1897.

of gravity tends to move vertically, such motion being necessary to maintain the volume of displacement constant at all angles of inclination.

The center of gravity tending to move only vertically, it is usual to consider it as the point about which the transverse section may be supposed to rotate. The measure of stability for any given angle of heel is the righting moment of buoyancy which then obtains. This righting moment, generally expressed in foot tons, is equal to the weight of water displaced by the ship multiplied into the horizontal distance in feet between the verticals through the centers of gravity and buoyancy respectively.

As a vessel heels a wedge-shaped portion of the hull becomes immersed, whilst a more or less similar wedge, having precisely equal volume, rises out of the water on the opposite side, the total displacement of course remaining the same as before the inclination took place. As long as similarity in the form of the in-and-out wedges is retained, the center of buoyancy moves out along the arc of a circle, the center of which is the metacenter, the moment of buoyancy increasing as the side of the angle of heel. In the majority of cases this condition only holds good for small inclinations of about 10 degrees, for, as the inclination continues, want of parallelism in the vessel's sides above and below the water line generally causes increasing dissimilarity of the in-and-out triangles. The center of buoyancy now commences to have a curve of varying radius, the centers of which are called prometacenters. These points are located by the intersection of successive verticals through the center of buoyancy at different angles of heel. The metacenter, as its name is supposed to imply, is the limit of height to which the center of gravity may be raised without destroying stability for small inclinations. Good breadth of beam combined with small displacement gives maximum metacentric height for a given position of center of gravity, and consequently greatest initial stability. Unless, however, the center of gravity is low relatively to the metacenter, the stability will be of small amount. Under all circumstances lowering the center of gravity increases stability, so that even a deep narrow ship with weights kept low down in the hull, will have great stability at large angles of inclination. A vessel with good initial stability is said to be stiff, and one deficient in this respect tender, yet at large angles of inclination, the tender vessel may have greater stability than the wider and shallower craft.

A ship when oscillating behaves as a pendulum and also as a balance wheel of a watch, but principally as the latter. Inasmuch as the center of gravity tends to move vertically the ship behaves as a pendulum; inasmuch as the whole mass of the ship tends to rotate about an axis more or less coincident with the center of gravity, she behaves as a balance wheel. The period of a compound pendulum depends on the length alone of the equivalent simple pendulum, but the period of a balance wheel depends on its moment of inertia and the strength of the controlling spring. The height of the center of buoyancy above the keel is readily found for any vessel when upright by referring to the displacement scale—note, the mean draught, taking the corresponding displacement from the scale—then the draught which gives half this displacement is the height of the center of buoyancy above the keel. The position thus determined should coincide with the center of area of any transverse section which may be intended as a guide to the stability of the same vessel. Should the points not coincide, the under-water part of the section should be altered until coincidence results.

The metacentric height, a distance between metacenter and center of gravity in the upright position, may be determined by a very simple experiment. The position of one of the limiting points being known, that of the other follows. The ship, being perfectly upright and floating quite freely, is slightly listed, usually by moving a known weight across the deck. The displacement must be accurately known, and the angle of inclination carefully measured by means of a long plumb line, or when this is not possible, by the use of a delicate clinometer. What has now taken place is this: the center of gravity and center of buoyancy have both moved towards the side to which the ship inclines, and the vertical through both points makes a known angle with the middle line at the metacenter. The direction in which the center of gravity has moved coincides with the direction in which the known weight was moved, and the distance through which it has moved is of course the product of the known weight into the distance moved, divided by the total sectional displacement.

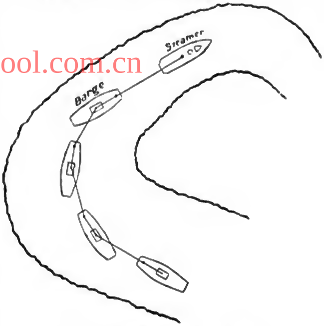
A vessel when oscillating behaves in many respects like the balance wheel of a watch. For simplicity, we will take a section of a ship so loaded that the center of gravity is in the plane of flotation, and this being so we may assume the ship to oscillate about her center of gravity. Now, if the ship under these circumstances has a period, that period cannot be due to pendulum action, for the center of gravity does not raise or fall to any appreciable extent. If the vessel is inclined and then allowed to oscillate freely, the moment of buoyancy will act as the spring of a balance wheel, causing the ship to regain an upright position, at which instant the force of the spring will be zero. Inertia will then continue the swing past the upright or central position till the moment of inertia is overcome by that of buoyancy or the compression of the spring, when the swing will be repeated in the opposite direction. Now, the moment of buoyancy in different vessels for a given inclination and length of righting arm varies as the weight of the vessel, but the moment of inertia in different vessels varies as the product of the mass of the ship into the square of the radius of gyration, or distance of the center of gyration from the center of gravity. Weight for weight, then, the larger a ship the longer the period; and size for size, the longer the radius of gyration, the longer the period. It cannot be too strongly insisted on, that some degree of reserve or excess stability is necessary for the safety of a vessel in a sea-way; at the same time, we must be on our guard against exaggerated theories which seem to require the length of righting lever practically doubled in order to guard against disaster under not unusual conditions.

With regard to the carriage of water ballast, nearly all steam vessels and some of the more modern sailing ships are fitted to carry water ballast either in shallow double bottoms more or less continuous over a great portion of the length of the vessel, or in deeper tanks of lesser longitudinal extent. In nearly every case, however, the capacity of these tanks is small compared with the tonnage of the vessel, water ballast being intended originally partly for trimming purposes and partly to enable the ship to stand upright when empty, or, again, in the case of steamers, to retain stability, which is affected by consumption of fuel. Ships are nowadays frequently sent to sea, even to cross the Atlantic in winter months, depending almost entirely on water ballast. In many instances the quantity of water carried is scarcely sufficient to ensure seaworthiness, and, even when this is not the case, it only too often proves a source of danger and discomfort through being carried so low down in the vessel. Notwithstanding that the ship is like a cork on the water, with propeller half immersed, and scarcely able to face a heavy head sea, the metacenter height may be considerable enough to give rise to violent lurching, or abnormally heavy rolling in certain conditions of wind and sea. Water being the most economical and convenient form of ballast, the remedy seems to be in the devising of some simple and not too costly arrangement whereby ships may carry a much greater quantity of water, distributed in a manner better adapted to the requirements of stability and easy motion in a sea-way. Captain Froud suggests the simple plan for sailing vessels of dividing the main hold into two or more compartments by means or transverse bulkheads, and filling them completely with water up to the level of the steel upper deck. For steamships it would seem that deep wing tanks, which might also be used as bunkers for coal in addition to the ordinary double-bottom tanks, would best suit the necessities of the case.

CALIFORNIAN METHOD OF TOWING ON SACRAMENTO RIVER.

Californian Method of Towing Barges.

The sketches here presented show the method of towing on the Sacramento and San Joaquin Rivers in California. The towboat is fitted with a tow post which is almost as high as the stack. From this the line, which is invariably of wire rope, is carried to the first barge and secured to the forward bitts in the usual way. Each barge is fitted with a towing frame of five vertical posts connected by a steel bar. This extends the entire length fore and aft, and is carried over the pilot house. When more than one barge is being towed the line is carried from the centre tow post on each barge to the bitts on the barge astern. The object of this system is to operate the towboat and barges independently, so as to speedily navigate the winding and shallow streams, and to dodge snags, sand bars, cobblestone bars, and shoal places. The barges used in the river above Sacramento have a capacity of 330 tons of grain, which they carry on a draught of 22 to 24 in. The barges used below Sacramento are of larger capacity, carrying 800 tons. Besides grain, the traffic on the Sacramento River in these vessels, consists largely of lumber, bricks, fruits, and vegetables. In the crooked portions of the river a speed of about 10 miles an hour is maintained, but in open water this is considerably increased. The principal route on the Sacramento River is from San Francisco to Red Bluff in Tehama County, a distance of 275 miles. Most freight is taken to the coast from Sacramento City.



TOWING BARGES AROUND BEND.

LARGEST SEA-GOING FERRY IN EXISTENCE.

The steel twin screw car ferry, Pere Marquette, recently built by Messrs. F. W. Wheeler & Co., of West Bay City, Michigan, for the Flint and Pere Marquette Railroad Company, to be used in the transportation of freight or passenger cars across Lake Michigan, is by far the largest and most complete vessel of its class in the world, and marks an era in car ferry construction. This vessel is 350 ft. in length, over all; 338 ft. between perpendiculars; with a beam of 56 ft., and depth from keel to upper deck of 36 ft. 3 in. The moulded depth to main deck is 19 ft. 6 in. There are four tracks with a capacity of 30 freight cars, and when fully loaded the ferry has a displacement of 4,050 tons, on a 12 ft. 3 in. draft of water.

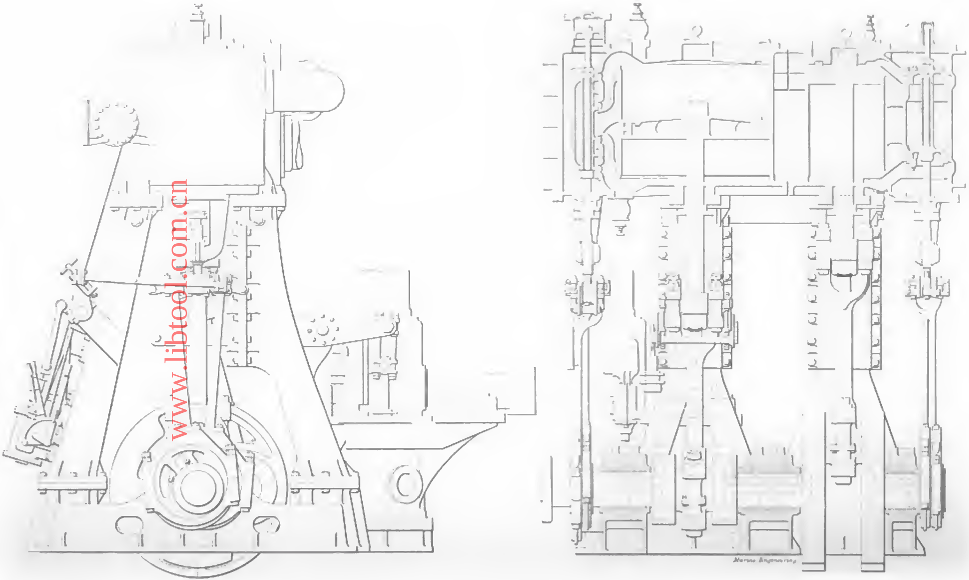
PERE MARQUETTE ON THE STOCKS.

Being intended for both summer and winter service, with the certainty of encountering very heavy ice, and severe gales from four to five months in the year, the first consideration was great strength combined with the most approved shape of hull, to resist the tremendous crushing strains which would undoubtedly at times be brought to bear. In view of this the framing from below the turn of the bilge to the upper deck is of channel section 12 in. deep and weighs 25 lbs. per ft. These frames are spaced 24 in. apart, with every alternate frame stopping at the under side of the main deck stringer plate. The keel is of the flat plate type, and is 48 in. in width, and weighs 32½ lbs. per sq. ft. To this is connected by heavy angles the vertical, center-plate keelson, 42 in. wide, and 25 lbs. per sq. ft. in weight. The floor plates are 30 in. deep at the center by 20 lbs., and are connected to the center girder by double angles. A foundation plate is securely riveted to the top of the floors and connected to the center girder by 12 in. channels, on top of which is a rider plate the width of the two flanges of the channels and the thickness of the center keelson plate. The frames connecting the floor plates to the shell plating are of angle steel, and extend from the center of the ship to the lower turn of the bilge, there butting against the channel side frames. The side frames extend far enough below the bilge to make a strong connection with the floors.

On each side of the center girder, and spaced about 6 ft. 9 in. apart, are 2 continuous keelsons, consisting of intercostal plates, flanged to the shell plating and extending above the top of the floors, sufficient to be riveted between double bulb angles on the one nearest to the center, and double channels on the other. Everything pertaining to the bottom construction of the vessel in the engine and boiler spaces is made extra heavy. At the lower turn of the bilge, and connected to the reverse bars on top of the floors is a heavy keelson formed of double 9 in. channels, riveted back to back. The bilge keelson consists of intercostal plates flanged to the shell and riveted between double bulb angles, which are securely connected to the main frames. The shell plating from keel to bilge is 25½ lbs. per sq. ft. in weight. Above the bilge there are 2 water-line strakes, and the main sheer strake, which is doubed, all of 30 lbs. per sq. ft. The shell plating between the main and upper decks is 10 lbs. and 12½ lbs., the upper deck sheer strake being 15 lbs. For about 35 ft. abaft the stem, and from the keel to about 3 ft. above the water line, the shell plating is double. Inside the vessel at this point is a network of heavy diagonal braces, keelsons, beams and brackets.

A special feature in the Pere Marquette is that the propellor shafts are entirely enclosed within the hull, the vessels framing being so shaped as to form a sleeve for the shafting. At the extreme ends of these tubes, or sleeves, heavy cast steel brackets are fitted, moulded to the shape of the vessel. These brackets are riveted together at the center of ship, an intercostal plate extending between frames, being first fitted between them. At the water line there is worked a continuous plate stringer 49 in. wide. securely connected to the shell and main frames with heavy angles. This stringer is bracketed above and below to the main frames with large plate brackets. Channel beams 12 in. deep, spaced

READY FOR LAUNCHING.



TWIN-SCREW COMPOUND ENGINES FOR SEA-GOING FERRYBOAT PERE MARQUETTE.

CONSTRUCTED BY F. W. WHEELER & CO., WEST BAY CITY, MICH., U. S. A.

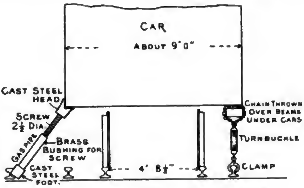
every 8 ft. apart are fitted in conjunction with stringer plate, all efficiently connected and bracketed. Midway between these beams and the main deck is another stringer, similar in all respects to the bilge keelson. The main deck beams are spaced every 24 in. apart, and are of 9 in. channel section connected to the frames with very large brackets. On top of these beams there is worked the main deck stringer and deck plating, the stringer plate being 66 in. wide and 30 lbs. per sq. ft. in weight; the rest of the plating is 17½ lbs. The main deck beams are supported by 3 rows of stanchions, of I section, spaced every 4 ft. to which are riveted continuous 12 in. channels these being also riveted to the lower flange of the beams. The upper deck beams are of bulb angles 6 in. deep, and spaced every 4 ft., supported by I stanchions, and continuous fore and aft channels. The center row of stanchions are spaced every 8 ft. and the outside rows every 12 ft. This deck is also entirely plated with steel 10 lbs. per sq. ft. in weight, except the stringer plate which is 17½ lbs.

The cabins are located on the upper deck. They are contained in two separate houses, one forward of the smokestacks and one aft, as shown in the plans. On top of the forward cabin is the pilot house, in which is placed both steam and hand steering gear. The steering engine is by Williamson Bros., of Philadelphia. The forward cabin contains the captain and mates rooms, the passenger saloon, 36 ft. by 10 ft., with 10 state rooms; the smoking room, 10 ft, 6 in. by 8 ft., with lavatory opening from the saloon; also accommodations for the chief engineer and purser, and toilet rooms for the passengers. The outside dimensions for this cabin are: 73 ft. 6 in. long and 24 ft. wide. The after-cabin, which is 49 ft. long by 24 ft. wide, contains the dining saloon, 16 ft. 6 in. by 11 ft.; the officers mess, and crews mess, with pantry and kitchen in connection. The assistant engineers, stewards, watchmen, and wheelsmen are quartered in this house. The main saloon and dining room are of pine, paneled and finished in white and gold, with hand-carved festoons worked on the panels. All the other rooms are of pine, ceiled and paneled, and finished plain white. At the extreme forward end of the vessel, on the main or car deck, are the sailors' quarters, all neatly finished. Above this crew space is a partial deck on which is located a steam windlass, mooring bitts, chocks, fairleaders, etc. The windlass is of the American Ship Windlass Company's build. On the main deck there are four steam gypseys; two on each side, also by the same company. The firemen's quarters are forward of the boilers, below the main deck, and very comfortable and well ventilated.

The propelling power of the Pere Marquette consists of two sets of fore and aft compound engines of the inverted direct connected type. The cylinders are 27 and 56 in. dia. by 36 in. stroke, and are entirely below the main deck. Piston valves are used on the high pressure cylinders, and double ported slide valves on the low pressure cylinders; all worked by double bar Stephenson link motion. The crankshaft is 13 in. dia. built up with crank arms 8 in. and 9 in. thick. The lineshaft is in five pieces 12½ in. dia. with forged coupling flanges. The propeller shaft is 13 in. dia. The propellers are 12 ft. in dia. by 14 ft. pitch, made of cast steel, and very heavy, for use in the ice. The airpumps are worked from the low pressure crossheads and are of 27 in. dia. by 18 in. stroke. Steam is supplied by four single-ended return tube boilers 15 ft. 3 in. dia. by 12 ft. long working under a steam pressure of 135 lbs. per sq. in. There are four furnaces to each boiler with grates 5 ft. 6 in. long. The total grate surface of the four boilers is 280 sq. feet, and heating surface 11,568 sq. ft. The tubes are 3¼in. dia. and 8 ft. 11⅝ in. long, and there are 330 to each boiler. The boilers were built by Wickes Brothers, of Saginaw, Mich.

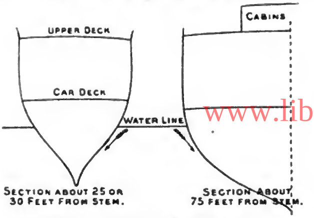
The auxiliary apparatus includes a feed heater, 25 in. dia. and 8 ft. long, with 80 1½ in. tubes. Two duplex feed pumps, 10 in. by 6 in. by 10 in., made by Deane Bros., of Indianapolis. Bilge pumps 7 in. by 10¼ in. by 10 in., and fire and sanitary pumps by the same makers. There is an extensive electric lighting installation aboard. This consists of three complete sets of engines and dynamos of the vertical direct connected type. The two larger are of 15 K. W. and the smaller 4 K. W. capacity, supplying 10 arc lamps, 332 16 c. p. incandescent lamps and one search-light of 2,000 c. p. The machines are connected to the switch board, so that the three may be operated together but, ordinarily two machines only are used, one of the larger being kept in reserve. The lights are distributed between the car spaces on the main deck, the forward and after cabins, and the hold.

The Pere Marquette carries four life boats, and two life rafts, the life boats being carried abreast of the deck house, and resting on skids built of steel angles. The davits are hinged at the bottom and arranged to fall outboard, instead of swinging in the usual style. The two pole spars and two smoke stacks give the vessel a very fine appearance, and all throughout she reflects great credit on her designer and on her builders.



METHOD OF SECURING CARS ON FERRY.

Since the Pere Marquette was put in commission she has given entire satisfaction to the owners and exceeded the most sanguine expectations, Carrying a full load, in open water, she has easily attained a speed of 16 miles, exceeding the guarantee by 3½ miles. Though the past winter on the lakes has been unusually mild, the ferry has had several rather severe tests. In February last she made her first trip, with 30 loaded freight cars aboard, in the teeth of a severe gale, other boats of the company having to turn back. She behaved admirably and the cars remained steadily in place as though they formed part of her construction. The method of holding the cars is shown very clearly in the accompanying rough sketch. Since that trip she has on occasions crushed her way, uninterruptedly, through solid ice 14 in. thick, at a speed of 10 miles an hour. The ferry has been designed very carefully with a view to successfully ramming the ice. The lines are very fine forward, and the boat under steam cuts her way very cleanly through the ice field, much of the shattered ice passing down under the boat. This can be better understood by examination of the rough sections here shown. During a hard winter, the ice on the route is frequently 2 to 3 ft. thick, and after severe gales the ice is piled up, or windrowed, to the extent of 8 or 10 ft. This of course is not solid ice. When the ferry is making her dock she has to go in stern first, and in winter there is usually great quantities of slush ice in the slip. On such occasions the propellors are used to wash it away.



DIRECTION TAKEN BY SHATTERED ICE.

The Flint and Pere Marquette R. R., which owns this fine vessel, runs through Michigan, from Toledo, Detroit, Flint, Saginaw, Bay City, and up through the northern portion of the lower peninsular to Ludington. From here it operates a line of passenger, mail, and freight steamers across Lake Michigan to Milwaukee, Chicago and Manitowoc. The Pere Marquette runs in the route between Ludington and Manitowoc, a distance of about 60 miles. The object of the company in building this vessel was to transport passengers and freight across the lake, without in the latter case breaking bulk. The Pere Marquette, which was designed by naval architect, Robert Logan, of Cleveland, has been such a success that the company will build a fleet of this exact type.

HIGH STEAM PRESSURES ON SEA-GOING SHIPS AND IN GENERAL.—2.

BY DR. R. H. THURSTON.

In large degree the gain of the century now marking the growth of the modern steam-engine out of the germ developed into modern form by Watt, when improving the invention of Newcomen, has come, especially in the earlier days of that progress, through devices which effected the reduction of this waste. Watt made the first step when he attempted to put in practice his well-stated principle—"keep the engine as hot as the steam which enters it"—and applied the steam-jacket with that end in view. The results of increased speeds of piston have been marked, in this direction, and these gains, reinforced by those due to increased steam-pressures and the otherwise unattainable elevation of the economical ratio of expansion, have led to such gains as are exhibited in the accompanying diagram, reduced from the records of the steam pumping engine.[4]

In the old Savery engine of two centuries ago, and until the engine of Newcomen became successful in displacing it, the wastes in this direction were nearly all, the utilized part but a minute fraction, of the steam supplied. At the commencement of the present century the work of Newcomen, of Smeaton, and of Watt had effected a grand beginning in the extinguishment of the internal wastes and, since the middle of the century, the progress made has been quite rapid and extensive. At the commencement of this period, as shown on the curve in diagram No. 3, the wastes, at about 1750, were 95 per cent of all steam, heat and fuel; by the beginning of the nineteenth century, Watt had brought them down to 30 per cent, and they have since steadily fallen until, to-day, in the best engines constructed, they are as low as 20 per cent, and, with superheating, considerably less. Meantime, the duty of the engine, as measured by the number of foot-pounds of work performed by 100 pounds of fuel, of best

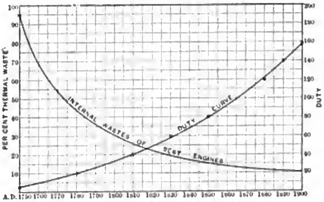


Fig. 3.—Progress in Steam Engine Efficiency.

Marine Engineering

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[4] *Trans.* A. S. M. E.; Vol. xviii; No DCCXVII.; p. 6.

quality, has risen from the five or six millions of the last century, to twenty in Watt's engines, to eighty millions at the middle of the century, and to about one hundred and fifty millions at the present time. And still the good work progresses and we should see one hundred and sixty millions reached by A. D. 1900.

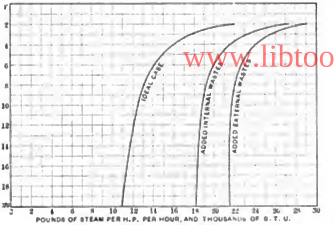

FIG 4.—MARINE ENGINE ECONOMICS.

Marine Engineering

The best work yet performed on land is about ten pounds of steam per horse-power and per hour, corresponding to about one pound of best fuel, as a minimum. The figure varies greatly, however, with pressure-variations, and the best work at one hundred to one hundred and twenty-five pounds pressure is between twelve and eleven pounds. The lower figure, above, has been approximated by best engines at 175 pounds or more, or with considerable superheating and in large engines. The diagram, No. 4 shows the more common figures for a triple-expansion marine engine in which something is necessarily sacrificed to insure that compactness, lightness and general effectiveness that is inconsistent with a design looking to maximum possible efficiency. The lower curve shows how the ideal engine, the purely thermodynamic machine, would vary in its consumption of steam, allowing about 2.3 pounds for perfect efficiency, unity, when steam is carried at 165 pounds and back-pressure stands at 4 pounds. The minimum here computed, at a ratio of expansion of twenty, is eleven pounds; but the line is still drooping, and, with reduced back-pressures and high expansions, a considerably higher figure might be found. When, however, the internal wastes are added, as shown on the next curve above, the minimum consumption of steam becomes 18 pounds, and the trend of the line shows that it is not far from its minimum in this particular case. When the friction wastes are now added, as shown on the upper curve, the minimum becomes above 21 pounds, and, even with the best possible boiler performance, the consumption of fuel could be brought no lower than about two pounds per horse-power per hour. The usual consumption of an engine of this type under the assumed conditions, is about two and a half pounds of fuel. With more liberal allowance of boiler-power, with dryer steam, with higher speed of piston, and especially with condensers producing a good vacuum, these figures may be brought down to 16 pounds of steam, and under two pounds of fuel, without difficulty, and such figures have been often now attained. The diagram, however, may be taken as a fairly representative one.

The future of the marine engine, if we may judge by the trend of our curves, is by no means likely to exhibit an early suspension of the progress already observed. The curves are all still extending in the direction of improved efficiency and increased utilization of heat, stored in steam, by thermodynamic conversion in the standard forms of marine engine. The now evidently fast-coming revolution in boiler-construction, the introduction of the water-tube boiler, is important as removing some serious obstacles to further increase of steam-pressures, and the only question in the mind of the designing engineer is now how far will it pay to go in the attempt to secure additional progress in this department of economics. But gain is certain to be less and less, proportionally, as pressures rise and as expansion is correspondingly increased, and we cannot, at best, secure more than a gain of 50 per cent. in steam and fuel, in increasing pressures, from the one hundred pounds usual, only lately, to ten times that figure. The gain is probably logarithmic, thus[5]:

Pressures.	100	200	300	500	1000
Expansions...........	15	30	45	75	150
Steam used per I. H.P.	13-15	11-13	10-11	9-10	8-9

and the best of designers and constructors cannot hope to do better than is indicated above, under ordinarily favorable conditions, if we may judge the future by the past. The limit, wherever it may be found, will undoubtedly be a commercial one, and will be reached at some point far inside of that set by purely thermodynamic considerations. That we shall pass the limit at 250 pounds per square inch is, probably, not at all to be expected; that it will be found as high as 1,000 pounds seems to the writer, at present, at least, exceedingly doubtful; that 500 pounds may prove commercially available would seem not impossible. Experience, to date, indicates, in the opinion of the writer, that when they are employed, the engineer will be able to utilize as nearly the full thermodynamic value of the coming high pressures as he has, in the past, realized that of the lower pressures now being constantly more and more exceeded.[6]

That continuous rise in steam-pressures may be expected for some time—for a long time, probably—and ultimately to the limit set to its control by the strength of our materials, none can doubt. But at what point that limit will be set

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[5] [6] Ibidem.

by inability of our, as steadily improving, materials of construction to resist the combined effects of high pressure and high temperature, no one can say. Nor can we say how far we shall be able, at as yet unattained pressures in the marine or other steam engines to approximate the ideal case by reduction of the wastes of the real engine. Assuming, however, that we may anticipate at least as much success in this direction, at high pressures, in the future, as at the present comparatively low figures, the accompanying sketch will indicate what may be hoped for, and it may aid in determining whether it will finally pay to struggle for the higher thermodynamic result. In the figure, let the curve at the left represent the performance of the ideal, perfect engine—diagram No. 5—perfect in the sense of exhibiting no extra-thermodynamic losses. Let the curve at the right similarly exhibit the costs of power in a real engine of such proportions that the heat, steam, and fuel supplied will be subject to a loss of one-half by extra-thermodynamic action. Experience, so far as it at present guides us, appears to indicate that we may expect to find it practicable to keep down this waste at high pressures to the extent that it is now held down, under usual conditions, in the simple engine. Should it prove practicable, also, throughout so wide a range of pressures, to reduce it by compounding or otherwise, to one-half the amount assumed as a minimum for the simple engine at such pressures, the curve *C* results; and if, by adding a third cylinder, in series, reduction to one-third may be hoped for, the curve *D* exhibits the presumable costs of power, in pounds of steam per horse-power per hour, or, if the feed-water is suitably heated by waste heat in the flues or from the exhaust, in, it may be assumed, thousands of *B. T. U.*, or, again, in tenths of a pound of good fuel consumed in good boilers. In the same way, the quadruple-expansion engine, with its added cylinder intercepting the otherwise wasted leakage and cylinder-condensation of its predecessors, in series, may perhaps bring down costs to the figures indicated in curve *E*. A non-conducting cylinder would make them as shown on curve *A*. Any and all of these curves, *A* excepted, would seem to represent practicabilities to the engineer, and curve *E*, at least, the ultimate probabilities. In any event, the latter will make a good point at which to aim with hope and courage.

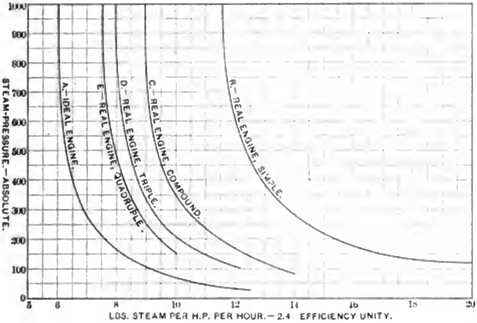


FIG. 5.—ECONOMY OF HIGH STEAM PRESSURE.

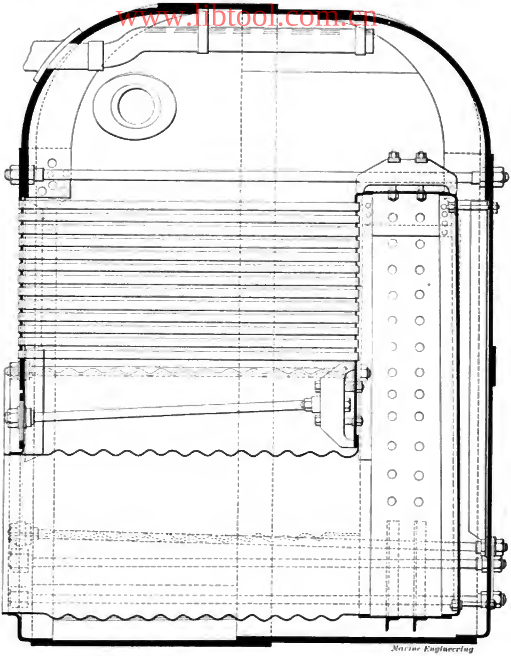
It will be interesting to note that, as better performance is insured by improved construction of engine, the advantages of higher thermodynamic efficiency are approximated more and more closely at progressively lower pressures and that, at the limit *E*, five hundred pounds pressure gives very nearly as good results as one thousand, and it may prove that, all things considered, it will not be advisable to carry the steam pressure to as high a figure as would, at first thought, appear desirable. It does not follow, however, that superheating, or other expedients for the attainment of a wider thermodynamic range of heat-conversion at manageable pressures may not continue commercially advantageous.

We have already, both in the gas-engine and in the steam-engine, brought down the cost of power, in coal consumed, to about one pound per *I. H. P.* per hour; it may prove that another third or even half of the remaining wastes of the steam-engine, and even a higher proportion in the gas-engine, may be extinguished. The question, lying beyond this, of the relative standing of these forms of heat-engine, and of the possible substitution of a machine in which the fuel is burned in the engine-cylinder, in which the products of combustion are the working fluids, and in which maximum visible range of thermodynamic action seems possibly attainable, for the familiar steam-engine, with its at present superior advantages in mechanical efficiency, in high mean effective pressure, its low cost of maintenance, its long life, its handiness in manipulation, in stopping and starting, and its perfect regulation by economical methods, is one which interests every engineer, but one which none can at present answer positively.

A new steamship line between Galveston and New York is a probability of the near future.

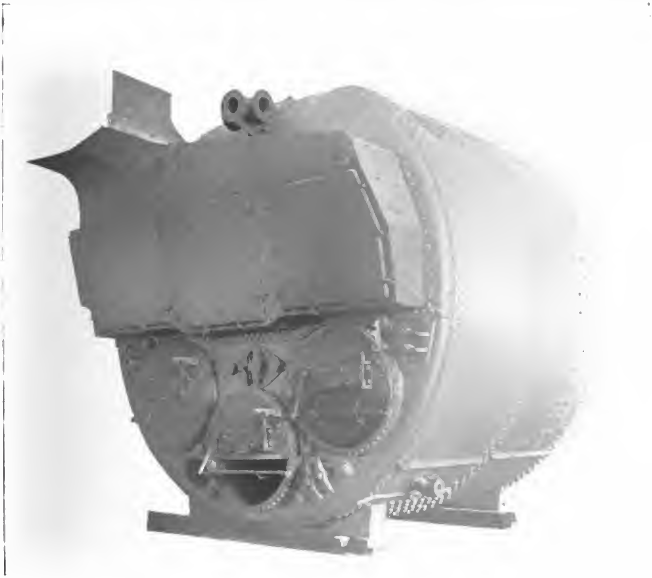
NEW SCOTCH BOILERS FOR U. S. S. CHICAGO.

The accompanying illustrations show one of the four Scotch boilers constructed in the Navy Yard, at Brooklyn, N. Y., for U. S. Cruiser Chicago. In the April issue a description of the engines was given. The photograph of the finished boiler which is here reproduced is of special interest, as this is the first nickel steel boiler built in the United States, if not in the world.



SECTION OF SCOTCH BOILERS FOR U. S. CRUISER CHICAGO.

When the decision was reached to refit the Chicago with new machinery, including a combination of Scotch and water tube boilers, Engineer-in-chief, George W. Melville, U. S.N., decided to give nickel steel a fair trial. It was a progressive step, and one likely, possibly, in time to exert a great influence over the selection of material for boiler construction. Plans for the boilers of the Scotch type were drawn by the Bureau of Steam Engineering, and bids were asked for both nickel and carbon steel. The figures at which the material was offered were such that it was decided to build all four boilers of nickel steel. Preparations were accordingly made at the Navy Yard, by Chief Engineer, Edward Farmer, U. S. N., for the proper treatment of the material. The specifications called for steel, 3 per cent nickel, of a tensile strength of 80,000 pounds, with an elongation of at least 25 per cent in 8 in., and an elastic limit of at least 50,000 pounds per sq. in. When the material was delivered at the yard it was soon foreseen that it woud give trouble. The test pieces showed that the quality was up to contract requirements, but the actual condition of the plates caused the greater part to be condemned. They were badly pitted and scored, as though slag or other waste had been drawn through the rolls. Indeed so pronounced was the badness of the plates that the modified plan to build even one nickel steel boiler came near being abandoned. By careful selection, however, sufficient good plates were laid out for the construction of the shell and heads of the boiler here shown. The combustion chambers, flues, tube sheets, stays, and rivets are of open hearth steel, and the tubes, charcoal iron. All four boilers are identical in dimensions with this one. They are of the single-ended type, 13 ft. 8½ in. dia., and 10 ft. 1½ in. long. A peculiarity of design as will be noticed in the sectional drawing, is the rounded upper ends, which saves a number of stays, only one row being necessary in each boiler above the combustion chamber. These sections are curved to a radius of 3 ft. Another feature, which is in line with modern naval practice, is the isolation of each furnace, with its combustion chamber and return tubes. This prevents accidents when the vessel is steaming under forced draft, should more than one door in the boiler be opened at the same time. The thicknesses of plates used are: shell, 1 5-16 in.; back plate, 3-4 in.; furnace sheet, 3-4 in.; front tube sheet, 7-8 in.; back tube sheet, 3-4 in.; back and sides combustion chamber, 9-16 in., and crown sheet, 9-16 in. The furnaces are Fox's patent, 3 ft. 5 in. inside dia., and 19-32 in. thick, with corrugations 2 in. deep and 6 in. pitch, the corrugations of the center furnace alternating with the corrugations of the wing furnaces. The grates are 6 ft. 7 in. long, the bars being double, of wrought iron, riveted together with distance pieces. The bottoms of the combustion chambers are strengthened by 3 by 3 by 1-2 in. angles. The tops of the chambers are each spaced with five girder braces, made up of two shapes, 7-8 in. thick, held down by 1¼ in. bolts and [washers. For stiffening the back plate two T bars are riveted to the plate between the combustion chambers, following the curve of the



NICKEL STEEL BOILER FOR U. S. CRUISER CHICAGO.

sides of the chambers. These are 4 by 5 in. by 1-2 in. thick. There are nine stays in the upper row. These are of a tensile strength of 60,000 to 70,000 pounds and a ductility of 26 per cent. in 8 in. The stays are 2⅜ in. thick, swelled at the screwed ends to 2⅝ in. The back tube sheet of the center furnace is very substantially braced with 1½ in. shapes, stayed to the front furnace plate and manhole ring by two 2 7-16 in. rods. The wing furnaces are also stayed direct to the front, without the interposition of any braces. There are six bottom stays 2 3-16 in. dia., swelled at the screwed ends to 2¼ in. The boiler contains 417 tubes, of which 143 are in the center nest and 137 in each of the wings. Of these tubes 113 are stay tubes 7 ft. 5½ in. long, 2¼ in. O. D., and 6 B. W. G. in thickness. The ends are screwed 12 threads to the inch. Those which pass through the back tube sheet are reinforced to an outside dia. of 2⅜ in. for a length of 2¼ in., the bore being uniform, and the ends passing through the front tube sheet are reinforced to an outside dia. of 2⅜ in., for a distance of 3 in., and swelled to 2½ in. O. D. The ordinary tubes, of which there are 304, are the same length and dia. of 10 B. W. G. The ends passing through the back tube plate are of even gauge and parallel, with beaded ends. The front ends are swelled to an outside dia. of 2 5-16 in., for a distance of 3 in. All the tubes project 1-4 in. beyond the front tube sheet. They are spaced 3½ in. centers. The edges of the nests are 11 in. apart, and the combustion chambers are 5½ in. apart. They are stayed to each other and to the shells by 1¼ in. stay bolts, swelled to 1⅜ in. at the screwed ends. The tubes were tested to 500 pounds pressure.

The rivets used have a tensile strength of 55,000 to 65,000 pounds and a ductility of 26 per cent in 8 in. They were subjected also to very severe shop tests. The sizes of the rivets vary from 15-16 in. to 1 5-16 in., these last being used for the shell seams. The shell plates have butt joints with double straps, 1 in. thick, treble riveted, with every alternate rivet omitted in the outer row. The rivets in the straps are 15-16 in. dia. Wherever possible, on the shell and chambers, riveting machines were used. For the principal joints in the boiler the mean of the percentage of rivets and plates is: of rivets, 66.477; of plates, 67.953.

Coming to the steam generating capacity of the boiler, the totals of heating surface in square feet are: tubes, 1770.61; furnaces, 134.64; combustion chambers, 166.72; tube sheets, 66.18, a total of 2138.15 sq. ft. The grate surface is 68.33, and the calorimeter 8.8 sq ft.. The evaporative power is 21, 866 pounds per hour, which is equal to 10,488 gallons per hour for the four boilers; or, say, 175 gallons per minute. The weight of the boiler is, approximately, 43 tons. It is to be worked at a pressure of 180 pounds. The hydrostatic test, to 280 pounds, was applied with the most satisfactory results.

In building the nickel steel boiler great difficulty was experienced in working the plates. They resisted all tool work and bending to such an extent that the extra cost for labor of this boiler, as compared with the carbon steel boilers, was fully 20 per cent. The edges of cutting tools were turned or fractured, and while bending the plates the housings of the biggest rolls in the boiler shop were smashed. The corrosion resisting qualities of the material were shown in the pickling. It took just five times as long to dissolve the scale on the nickel plates as it did on the carbon plates. If this is any indication of the possible life of the boiler the increased cost may be more than offset by the durability. The future behavior of this particular boiler will be watched with interest, though, of course, a very long period must necessarily elapse before any real estimate can be made of its special value.

THE OPERATION OF WATER-TUBE BOILERS IN WARSHIPS.*

BY REAR ADMIRAL C. C. P. FITZGERALD, R.N.

Before entering into the merits of the water-tube boiler it may be as well to take a glance at the merits of the boiler which it seems likely to supersede; and under this head, I believe, I shall find many to agree with me when I say broadly, that there never was a period, during the development of boilers for warships, when their general behavior has been so unsatisfactory, and when they have given so much trouble, and been the cause of so much anxiety, as during the last ten or twelve years. I speak as an interested looker-on, who often sees a good deal of the game; and my conclusion is that the Scotch and marine locomotive type of boilers have proved themselves to be unequal to the demands made upon them for the greater pressures and quantities of steam required for the working of fast-running triple-expansion engines. It has been one long monotonous tale of leaky tube-plates and seams, bulged fire-boxes and generally more or less disabled and inefficient boilers. The instrument has proved to be unsuitable to the work required of it, and it has failed.

I shall not attempt to argue whether the boilers of the Belleville type, which are now being fitted in so many of her Majesty's ships, are, or are not, the best type of boilers of this family; but it may be stated broadly that most of the special attributes of the Belleville type are claimed for all other water-tube boilers in a greater or less degree; and no doubt the inventors and patentees of the latter will be able to show claim to many other virtues in addition. The power of being able to raise steam rapidly in a warship is of great importance; under certain circumstances it might

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* From a paper read before the Institution of Naval Architects, in London, April 7, 1897.

be vital. The Sharpshooter[1] (with Belleville boilers) has raised steam in 20 minutes from "fires out" and cold water. She would have taken two or three hours with her old boilers, and, had she tried to do it in less, she would almost certainly have caused leaks; but this rapid raising of steam causes no injury to water-tube boilers, nor does rapid cooling. The ability to make large and rapid increases of speed is of high tactical value to a squadron of battleships; but it is of still greater importance in the case of a cruiser, whether she is employed in scouting, or as a look-out ship, or as a commerce protector, cruising on a trade route. With the Scotch boiler a ship has to be worked gradually up to her full speed, but with a water-tube boiler even a large ship can start off almost like a torpedo-boat.

The Terrible on January 9 was lying in Plymouth Sound with her head to the eastward; at 8:25 she got under way, and had to turn around to get out by the western channel, and at eight minutes past 9, that is to say in 43 minutes, she was going 20 knots. This performance could not have been approached had she been fitted with cylindrical boilers. There can be no question that anything which tends to reduce the disastrous consequences of a violent injury to a boiler, such as might be expected in time of war, is a point well worthy of consideration. And when it is mentioned that each of the Powerful's boilers holds only one ton of boiling water, and that each of the Majestic's holds nearly 22 tons, it will not be necessary to enter into an elaborate argument to prove the comparative safety of the two systems. Boilers of the water-tube type can be cooled with great rapidity, and without any injury, so that they can be quickly examined, cleaned, and, if necessary, repaired. This rapid cooling cannot be done with Scotch boilers without the risk of causing leaky seams and tube plates. That there is a great saving of weight in an installation of Belleville boilers as compared with Scotch boilers, for similar horse-powers, is an indisputable fact. It has been estimated variously in the case of the Powerful and Terrible at from about 400 to 700 tons. If we take for comparison a ship of about the same tonnage, though of less than half. the horse-power—the Majestic, for instance—we find that the weight of her boiler installation, including funnels, uptakes, etc., is 745 tons for 10,000 horse-power, with natural draught, and 12,000 horse-power, with forced draught. The Powerful's boiler weight (similar adjuncts included) is 1,164 tons. She is not fitted with forced draught, and gets her 25,000 horse-power easily without the assistance of that rather doubtful blessing. Her boiler weight with Scotch boilers to get 25,000 horse-power with natural draught, at the same ratio of weight per horse-power as Majestic, would have been 1,862 tons, and with forced draught 1,552 tons. Thus in one case there is a saving of nearly 700 tons, and in the other of 388. The former is undoubtedly the fairest comparison, as forced draught is not generally used in warships except on the trial trip. As to space, there seems to be very little difference in the floor space required for a set of Belleville and a set of Scotch boilers for similar powers. If anything, it appears that a set of Bellevilles require rather more floor space. The evaporative efficiency of Belleville boilers seems to be at least equal to that of the best Scotch boilers as fitted in warships, and I am making no comparison with merchant ships, where the conditions are different. Taking the 30 hours' coal consumption trial of the Powerful, at 18,500 horse-power she burnt 1.81 lb. per indicated horse-power; and the Terrible at the same horse-power burnt 1.71 lb. per indicated horse-power. This was with the engines developing 75 per cent of their maximum power. Comparing this with the 30 hours' coal consumption trials of other large ships with modern engines and cylindrical boilers we find Renown 1.88 lb. at 6,204 I. H. P.; Majestic 1.83 lb. at 6,094 I. H. P.; Magnificent, 1.68 lb. at 6,116 I. H. P.; Sultan, 1.77 lb. at 4,018 I. H. P.; Prince George, 1.82 lb. at 6,216 I. H. P.; and Victorious, 1.6 lb. at 6,205 I. H. P. In these cases the engines were working at 50 per cent of their designed powers, which is about their most economical rate of working per indicated horse-power. The Sharpshooter on her long sea trials varied between 1.7 lb. and 1.9 lb. of coal per indicated horse-power. While desirous of being absolutely impartial on the boiler question, I find that my remarks have been almost entirely favorable to water-tube boilers, and especially so to the Belleville type, that being the type which interests us most, as it is being fitted in so many of our large cruisers, and in the new battleships; but I need scarcely say that I have no interest in the matter, beyond the interest of wishing to see the best type of boiler in all our ships, both large and small. I have been trying to find out something against the Belleville boilers, but I have not had much success. The advantages of water-tube boilers, which I have endeavored to point out, though they will be duly appreciated by executive and engineer officers during ordinary peace service, seem to be just exactly of that particular nature which will cause them to be specially conspicuous under the rougher, more sudden, and more urgent demands of war.

The new locomotive jib crane in the Navy Yard at Mare Island, Cal., is said to be the biggest of its kind in use anywhere. Its capacity is 45 tons, raised at the rate of 14 ft. per minute. The boom will reach 75 ft. from the center of the track, and when it is elevated, 60 ft. The boom can be shifted between these distances in 11 minutes, and the time occupied in making a complete revolution is two minutes. The jib crane runs on tracks 20 ft. apart.

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[1] The Sharpshooter was originally fitted with wet bottom locomotive boilers.

A CLASSIFICATION OF THE WAR VESSELS OF THE WORLD.

BY BERNARD A. SINN.

In numerous naval pocket books and annuals published in recent years, tables purporting to show the strength of the various navies of the world have been included. In most instances, however, there has evidently been no attempt made to systematically classify the various types of vessels, nor take proper account of the characteristics of each. For example, the Austrian naval pocket book, which is admittedly the most complete in the matter of tabulation, classifies vessels as battleships, coast defense vessels, armored cruisers, protected cruisers, and unprotected cruisers; and each of these classes is again divided into two large divisions, depending on date of build. These are also subdivided on the basis of displacement. In these tables the classification adopted is that of the country to which the vessel belongs. Thus the Italians call the Re Umberto a battleship, but as the vessel carries only four inches of armor on her sides, the nomenclature is incorrect. In this pocket book. the Re Umberto is classed as a battleship simply because Italy considers it so, and not because of any characteristics of the vessel. Mr. Laird-Clowes in his excellent naval pocket books, makes a somewhat more accurate classification, but along the same lines as the Austrian publication. In all cases, of course, the classification was intended to include all types of vessels, and the only difficulty is, that Mr. Clowes gives no rules for distinguishing the cruiser from the battleship.

The classification here adopted takes account of the following characteristics. First, size as represented by displacement; second, speed as represented by trial speeds, or in case the vessel has not been tried, the highest speed expected; third, armor as given in the various naval annuals, and in the reports to the legislative bodies of the various countries; fourth, modernness as represented by the date of launch. This latter is a very important consideration, for it is almost invariably a gauge of the kind of armor with which a vessel is protected. Vessels built prior to 1885 were fitted with what would now be considered an inferior kind of armor. The same general rule applies to ordnance, as rapid fire guns were adopted almost simultaneously with nickel steel, and surface hardened armor. It will be readily understood, however, that the accompanying tables are intended for the distinguishment of war vessels generally, and not to include what might be called extraordinary refinements which are usually not obtainable. The purpose is rather to bring together, comparatively, vessels having the same general characteristics and of about the same dimensions.

The ideal classification, of course, would be to consider size, speed, coal endurance, armor, and armament, and reclassify each of these general divisions into subdivisions depending upon the design, modern or obselete conditions, etc.; but that is outside of the scope of this article. The nomenclature here presented is not that adopted by the different countries included, as such a combination would be chaotic. It might be well to note the different values assigned various types of vessels by the powers. England calls the improved Renown class, first-class battleships; yet these vessels carry but six inches of side armor, and it is obvious that such a vessel is not a battleship. Likewise the Italians put their Sardegna in the battleship class, but as this vessel carries only four inches side armor it would be more consistent to call it an armored cruiser. The Russians call the Rossia an armored cruiser, but this vessel has eleven inches side armor, and therefore, would be nearer to the battleship class; and so throughout the world's navies. One vessel is called a cruiser and really approaches the battleship type, and another is called a battleship and approaches the cruiser type.

The greatest difficulty in all matters of this kind is to draw the dividing line. This is purely arbitrary, for no two persons have exactly the same ideas upon the subject. The best opinion seems to be, however, to call any vessel a battleship, which has ten inches armor, and fourteen inches turret, barbette, or citadel armor. There is no scientific reason why eight inches or twelve inches might not be chosen, but ten inches seems to be about the rational limit, owing to the fact that a battleship must meet vessels carrying very large and very heavy ordnance. As the eight inch and ten inch guns would penetrate less than ten inches of armor, this thickness has been generally determined upon as the minimum thickness for battleships. Armored cruisers are all armored vessels of high speed, not having the perquisites, as regards armor, of a battleship, but still carrying heavy ordnance, and armor protection other than a protective deck. This would include then, vessels carrying more than four inches of armor and less than ten. Thus the classification is based primarily on protection from gun fire; secondly, speed; thirdly, size; and fourthly, date of build, which takes account of improvements in armor, armament, and construction. It will thus be seen that the object of this article is simply to offer a suggestion as to the classification of vessels of war, calling all vessels of 5,000 tons displacements, first rates; all over 3,000 tons, second rates; all over 1,000 tons, third rates; and all under 1,000 tons, fourth rates; or calling a battleship a first-class battleship because it is the best ship in the navy to which it belongs.

Table I shows the classification adopted, and Table II the number of vessels each navy possessed in each class on January 1, 1897. Where no date of build is given, in the column headed "date of build," it implies that the class is given irrespective of build. Where no thickness of armor is given, means that none is carried, and where no limit of speed is specified, means without reference to speed. Each vessel is placed in the highest class to which it is entitled.

The last four lines in Table II are given to a numerical comparison of the following navies:

First—England against France and Russia.

Second—England against the triple alliance—Germany, Italy and Russia.

Third—United States against Spain.

Fourth—Greece against Turkey.

The plus (+) sign means that the first named country has that many more ships than the navies with which it is compared, and the minus (—) sign, means that the first named country is weaker by that number of vessels.

TABLE I.

CLASS.	NOMENCLATURE.	DISPLACEMENT, TONS.	ARMOR.	SPEED, KNOTS.	DATE OF BUILD.
1	1st Class Battleships.	10,000	10 inches side 14 in. turret or barbette.	15	After 1885.
2	2nd Class Battleships.	9,000	10 in. side. 10 in. turret.	13	......
		6,000	10 in. side. 14 in. turret.	15	After 1885.
3	3rd Class Battleships.	9,000	10 in. side. 10 in. turret	10	......
		6,000	10 in. side. 10 in. turret	13	.....
		4,000	10 in. side. 14 in. turret.	15	After 1885
4	1st Class Armored Cruisers.	8,000	4 to 10 inches side armor.	17	After 1885.
5	2nd Class Armored Cruisers.	8,000	4 to 10 inches side armor.	15 Mls	......
		4,500		17 Mls	After 1885
6	1st Class Coast Defense Vessels.	3,500	Over 4 in. armor and not included above.	......	....
7	2nd Class Coast Defense Vessels.	Under 3,500	Over 4 in. armor and not included above.	......	....
8	1st Class Protected Cruisers.	7,000	Over 1 in. protective deck.	18	1885
9	2nd Class Protected Cruisers.	7,000	Over 1 in. protective deck.	16	1880
		4,000		18	1885
10	3rd Class Protected Cruisers.	7,000	Over 1 in. Protective Deck.	13	1875
		4,000		16	1880
		2,000		18	1885
11	4th Class Protected Cruisers	All protected vessels not included above.	Over 1 in. Protective Deck.	......	....
12	1st Class Cruisers.	4,000	None.	18	1885
13	2nd Class Cruisers.	4,000	None.	15	1880
		2,000		18	1885
14	3rd Class Cruisers.	3,000	None.	10	...
		2,000		15	1880
		1,000		18	1885
15	4th Class Cruisers.	1,000	None.	......	....
16	Torpedo Vessels.	600 to 1,000.	None.	18	....
17	Torpedo Gunboats	200 ft. and over	None.	18	....
18	Torpedo Boat Destroyers	Under 1,000.	None.	26	....
19	Sea-Going Torpedo Boats.	150 ft. and over.	None.	......	....
20	1st Class Torpedo Boats.	100 to 150 ft.	None.	......	....
21	2nd Class Torpedo Boats.	75 to 100 ft	None.	.....	....
22	3rd Class Torpedo Boats.	Under 75 ft.	None.	......	....

TABLE II.

CLASS COUNTRY.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Argentine	..	..	..	2	..	1	4	..	1	2	1	..	..	1	..	..	2	4	..	10	..	14
Austria	..	2	5	..	2	6	..	..	2	..	..	..	3	10	2	..	..	2	..	55	7	..
Brazil	..	..	2	..	..	2	4	..	..	..	1	2	4	4	4	..	..	6	7	..	..	12
Chile	..	..	1	1	1	..	1	..	1	3	1	..	1	1	1	3	..	4	6	7	3	4
China	..	..	..	..	..	..	..	..	..	3	1	..	..	5	1	1	..	4	..	9	11	2
Denmark	..	..	1	..	..	1	7	..	..	..	..	..	..	4	3	..	..	..	..	12	12	..
England	19	11	7	17	7	29	5	21	24	46	16	1	10	10	23	6	4	90	1	20	14	82
France	17	13	12	3	..	7	9	4	18	14	12	..	..	..	29	6	10	6	8	190	28	14
Germany	7	1	8	1	6	9	13	..	3	..	..	..	3	5	23	2	..	2	10	127	..	2
Greece	..	..	3	..	..	..	1	..	..	..	..	..	..	..	3	..	..	..	..	12	7	12
Italy	5	..	..	11	1	5	2	..	..	8	6	1	..	3	18	13	2	4	1	131	7	20
Japan	3	..	1	..	1	1	3	2	..	7	2	..	..	..	15	..	..	..	4	31	..	16
Netherlands	..	..	..	..	..	5	20	..	3	1	1	..	..	6	4	..	..	..	..	15	22	..
Norway	..	..	..	..	..	2	4	..	3	..	..	..	..	..	4	..	..	..	1	10	6	..
Portugal	..	..	..	..	..	..	6	..	..	..	..	..	..	1	11	..	..	..	9	9	3	..
Russia	10	9	4	5	2	5	20	..	3	2	2	..	..	1	17	..	3	4	..	51	5	98
Spain	1	8	..	..	2	1	..	2	..	..	3	..	..	6	6	10	1	..	..	12	1	4
Sweden	..	..	..	..	..	..	19	..	..	..	..	..	..	..	3	3	..	..	..	21	1	..
Turkey	..	1	1	1	..	4	8	..	2	..	..	..	..	2	4	2	3	..	3	20	1	1
United States	9	2	..	2	..	6	14	2	6	3	2	..	3	1	27	1	..	6	8	4	1	4
England against France and Russia	−8	−11	−9	+9	+5	+17	−33	+17	+3	+30	+4	+1	+10	+9	−23	..	−9	+80	−7	−241	−19	−30
England against Germany, Austria and Italy	+7	+8	−6	+5	−2	+9	−10	+21	+19	38	10	..	+4	−8	−20	−9	−2	+82	−10	−193	..	+60
United States against Spain	+8	−6	..	+2	−2	+5	+14	..	+6	+3	−1	..	+3	−5	+21	−9	−1	+6	+8	−8	..	−30
Greece against Turkey	..	−1	+2	−1	..	−4	−7	..	−2	..	..	..	..	−2	−1	−2	−3	..	−3	−8	+6	+11

With these tables, therefore, a comparison can be made between the several classes in each navy.

THE ORIGIN AND DEVELOPMENT OF THE FERRYBOAT.—2.

BY EDWIN A. STEVENS.

Having briefly reviewed the evolution of the ferryboat, let us take into consideration the condition under which its designer works, and the demands that he must meet. Like every vessel, the ferryboat must be suited to its work, and this work—as we have already seen—varies; but even under conditions of the same kind of travel on neighboring routes, some consideration of major importance may so wholly change the design as to render the vessels entirely dissimilar. As an example of this fact, the ferries from the foot of Cortlandt street, New York, to Jersey City, and the Staten Island ferry, may be cited. On both these routes there is a heavy travel of passengers and teams; the distribution throughout the day being a little more even on the Jersey City ferry than on the Staten Island. The climatic conditions are, of course, the same. The course of the Jersey City boat is directly across the lower Hudson, about three-fourths of a mile in length. The Staten Island boat crosses the mouth of the East River, and runs across the upper bay and the outlet of the Great Kills. The length of the route is about five and one-quarter miles. At Cortlandt street, the tide makes but little difference in the running time, as the current is at right angles to the course of the vessel, and in whichever direction it may be running will offer about the same difficulties and impediments. On the Staten Island routes, however, the greater part of the course has to be covered with either a favoring or a head tide, and portions of it are subject to varying cross currents. The round trip on the Cortlandt street route can be easily run in half an hour, of which from twelve to fourteen minutes will be spent under steam, and about one-third of this time at half speed or backing. On the Staten Island route, however, the round trip will occupy about one hour and twenty minutes, of which from fifty to fifty-five minutes will be under steam, and of this about five minutes will be at half speed or backing. It is very evident that the saving in time, due to increased speed, would yield but a small gain at Corlandt street, while it would be an important factor at Staten Island. A moment's consideration also will show that the boiler power of the boats at Staten Island will have to approach very closely to the full capacity of the engines; while for the short run at Cortlandt street, if sufficient water surface for the liberation of steam, and room for its storage be provided, the boiler capacity may be considerably

FERRY TRAFFIC AT THE MOUTH OF THE EAST RIVER, NEW YORK HARBOR.

decreased below that necessary to continuously supply the engines at full power.

Requirements of one class may be summarized by the statement that a ferryboat is essentially a portion of a plant, whose design has to be carefully considered in regard to other portions with which she has to work in intimate connection. This condition is one not generally of great importance in marine work, and, therefore, apt to be overlooked, or insufficiently studied, in the design of ferryboats. The climatic conditions of the route, and the class of travel will influence the whole design of the superstructure and may entirely modify its character. The shape of the hull will be designed for a certain speed. This speed may depend upon the length of the route and the amount of travel over it, and, to a certain extent, upon the difficulties of navigation thereon. In such crowded waterways as the East River and the lower Hudson, the safe limit of speed is very quickly reached. But even there it varies with the manœuvering qualities of the boat, and especially with her backing and stopping power. The financial prosperity of the route will also have its influence. The power to successfully meet ice cannot be neglected on a route in northern waters. The tendency of the traveling public to concentrate upon the bow of a ferryboat causes these vessels to be generally trimmed by the head, and will force the designer to the use of a full load water line to minimize the bad effects of this undesirable manner of loading. Ease of form will naturally be sought in the shape of the buttock and diagonal lines, and the resulting form will generally give a good bow for ice work. A successful boat must combine easy handling, steadiness, comfort, economy, and adaptability to its special work, including speed, safety, and the comfort and beauty of its passenger accommodations. The designer will, of course, attempt to give his construction as much outward beauty as the ungainly structure will admit of; but this has little or no influence on the work of the boat or on its earning capacity.

A maximum of all the qualities above mentioned cannot, of course, be combined in any one vessel. The consideration to be given to each is a question for judgment in each individual case; and the experience of the route, to be obtained from those who have been employed on it, will be indispensable. But, above all things, whatever type is adopted, the construction should be reliable and should require a minimum of repairs. It is desirable that repairs, when necessary to take care of ordinary wear and tear, or when caused by accidents, should be carried out in the shortest possible time and at the least expense. With these demands, however, go also certain privileges (if I may use the word) that the designer of a ferryboat may avail himself of, and which are not usually enjoyed in other marine work. The hold of a ferryboat not being used for passengers or freight, has to accommodate merely the motive power and auxiliary machinery, with the incident stores of water and coal, and such safety appliances in the way of bulkheads as may be deemed requisite. There is no special need of concentration or for compactness of design. The openings through the deck, however, should be kept as narrow as possible, in order not to unduly diminish the deck space available for teams. The length of such openings, though, is of minor importance. The facilities for loading fuel should be such as would cause as little trouble and delay as possible in coaling up. In the general arrangement of the machinery, accessibility, reliability, and ease in manipulation cannot be lost sight of.

PASSENGERS CROWDED ON BOW OF FERRYBOAT, NORTH RIVER, N. Y.

Any limitation to the depth of shaft may become a serious matter; and this arises sometimes in an unforeseen manner. The racks which run out into the water at the ferry landings, as usually built, consist of piling tied together by stringers, faced with heavy planking, forming a springing fence, which, from the requirements of the service, often has to absorb considerable energy. The footing for these piles is usually in mud; and if to attain the requisite depth, such an amount of this has to be removed as to render this footing insecure, the trouble and expense of rack maintenance may be so increased as to more than destroy the advantages to be gained.

After stating his problem, the designer will find that the first question for solution will be the manner of applying his motive power to propulsion. In other words, whether he should use side wheels or propellers. In the former case, a choice between feathering and radial buckets will have to be decided; while in the latter, the first question will be between single ended and double ended propulsion. On most routes this latter question will be decided by the conditions themselves, in favor of the double ended system. The advantages of screw propulsion over side wheels are: the removal of the paddle box from the space usually assigned for passengers, and the great improvement thereby made in the accommodation and the ease of ingress and egress. There will be a great gain, too, in backing and stopping power. For equal horse powers, the first cost will not vary greatly. As will be subsequently shown, in screw propulsion—as used in the Bergen of the Hoboken ferry and her successors—the power of the engines cannot be as efficiently applied to propulsion as in the case of paddle wheels. On the other hand, the engines themselves will generally show a decrease of consumption of steam per horse power, while the boilers will yield about equal results. The race from the propellers of the screw boat will scour out the middle of the slip without much affecting the footing of the piles and will practically do away with the necessity of dredging. There can be no question of the superiority of the screw in ice work; and it is certainly a great favorite with the traveling public. It requires a different shape of hull. This shape will increase the resistance through an increase of wetted surface, and peculiarities of form. A screw boat will generally steer better. This advantage is partly due to the fact that the center of thrust is below the effective center of resistance to forward motion, and the couple thus created has no tendency to depress the bow. In the side wheels the contrary is generally the fact; and the sidewheel boat in consequence will generally bury her head, while the screw vessel will tend to run out forward and squat aft. As ferryboats have their lateral area symmetrically distributed about the midship section, a tendency to bury the bow is apt to move the center of resistance to steering, ahead of the center of gravity; and the vessel is, therefore, as far as steering is concerned, in a position of unstable equillibrium; the slightest departure from the course giving rise to a tendency to increase the shear to that side. In a screw boat under way, the tendency to squat aft will generally keep the center of resistance behind the center of gravity. Her condition is then one of stable equillibrium. The speed of rotation of the engine, together with the frequent stopping, backing, and steering will render it generally inadvisable to attach any pumps directly to the main engine of a screw vessel. For the consequent complication in the shape of an independent pump plant, the screw vessel will have the advantage of a decreased load on the main engine and a vacuum always ready at starting. If a screw engine be selected as the most suitable type, the judgment of the designer must be exercised in deciding upon the degree of expansion desirable. In some designs, the advantage of two high pressure cylinders, acting on cranks at 90 degrees, for prompt backing, has led to the adoption of double compound engines; and the tendency has been not to repeat the triple expansion engine, used in the ferryboat Bergen.

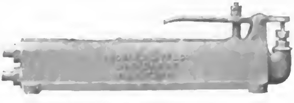
If the side wheel is decided on, the first question will be, whether the ordinary American practice should be followed in adopting a beam engine. The wonderful persistency and long life of this type of design, which is certainly the oldest extant form of the marine engine, fully justify the statement that the system possesses advantages. Its usual form gives wonderful economy for a single expansion engine; its ability to run, and run smothly, with grave defects in alignment; the fact that it is thoroughly well understood by most American engineers and mechanics; its simplicity, accessibility, its economy in repairs, and its ability to satisfactorily operate its own air pump, are strong arguments in its favor. Whether its use as a compound will yield satisfactory results in ferry service, is still an unsettled question. It possesses one great defect, its liability to stop on the center. Even with the greatest care this risk cannot be entirely avoided, especially in ice. Many engineers will recall the trouble and difficulties incident to a prolonged fight with ice in a beam engine boat. In common with all side wheel designs, the wheels are more subject to damage by ice or floating wreckage than screw propellers; they are, however, more easily and more cheaply repaired when damaged.

I know of no attempt to use the oscillating or side lever engines in ferry service; and their use seems to promise no special advantages. The inclined engine, however, has received considerable attention. In the days of single expansion, one-cylinder engines, it was generally considered inferior to the beam engine in ferry work. In the Garrett and Wiman, of the Staten Island ferry, this engine, in the compound form, has been tried under adverse circumstances, and, on the whole, has given good results. It is very doubtful, however, whether the advantages of a smaller diameter and greater propulsive efficiency in the feathering paddle wheel, is sufficient to counterbalance the disadvantages due to the greater complication of machinery and the difficulty of securing equal efficiency in both directions. Whatever design be adopted, except in rare cases, equal efficiency in forward and backward motion must be constantly in sight. In this connection, too, the signaling gear must be such that the engineer will always know in which direction the pilot desires him to go. The beam engine as usually arranged, avoids this difficulty, from the fact that the engineer's station is on the main deck, and he is thus made aware of the direction in which the vessel is being navigated, in a far better way than possible in a system of signals. Whatever signals be used, should be simple, direct, and absolutely certain in their action. Their failure at any time will put the boat in imminent risk. In deciding on a type of engine, the amount of time that the vessel is actually under way—to which attention has already been drawn—should be carefully considered; and the economy in fuel of the various types under consideration should be carefully compared, proper allowance being made for the increased charges, due to first cost, depreciation and maintenance, which will generally be found to attach to the more economical design. The question of weight is generally not of the first importance. It affects, however, the punishment which the boats will inflict on the racks; and as the maintenance of the latter is a large item in ferry expenses, too free a hand should not be used in appropriating displacement. Under the usual conditions, the load of the vessel, both in superstructure and machinery, and passengers, will be distributed over a considerable length, and with metal hulls, ample longitudinal strength will usually be found; but in screw boats, rigidity to preserve the alignment of the long shaft must also be provided. If the vessel be double-decked, the stability ought to be carefully investigated, assuming as usual the most unfavorable conditions. A considerable heel in these vessels is likely to produce a panic among the passengers, and the avoidance of such inclination, and not the absolute safety from capsizing, is the result to be sought. The auxiliary machinery usually consists of the pumping plant, steering engines, electric light engines and dynamos, and heating and ventilating engine. Of the former, little need be said, as they differ in no wise from ordinary marine practice. Heating and ventilating, however, present a difficult problem on account of the shape of the cabins. The most approved method has been the forcing of hot air by fans through outlets, placed in the upper portion of the places to be heated, and escapes for the foul air at the floor level. The improvement effected by this method has been very marked.

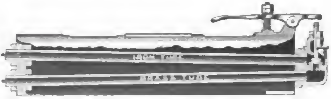
IMPROVED APPARATUS.

The Geipel Steam Trap.

The Geipel Steam Trap, manufactured by Thorpe, Platt & Co., of 97 Cedar street, New York possesses some features of especial interest to marine engineers. In the illustration the lower, or brass pipe, is connected to the steam pipe, the upper, or iron pipe, forming the discharge. When cold, the brass pipe is contracted, and the valve-box is drawn down, leaving the valve free to open. When steam enters the brass pipe it causes it to expand, this raises the valve-box and valve, the stem of the latter comes in contact with the lever, the seat closes onto the valve, and the trap is shut. To blow through it is only necessary to press down the lever. The valve may be readily examined by unscrewing the cap, and the whole trap may be taken apart and put together again in less than five minutes. The shape of the trap is handy for marine purposes. It may be conveniently fixed on the engine columns, or bulkheads, vertical or otherwise, and drains the main steam pipes, the valve casings, the steam jackets (if any), or branch pipes to auxiliary engines, keeping these important parts clear of water without the loss of dry steam. It is claimed that there is a distinct economy in steam, and also in packing, which is found to last longer when this trap is used. It is further stated that as less water is lost through the glands, so there is less fresh water required on board ship. This Steam Trap has been used in numbers of steamships, and in some for the United States Government. Geipel Steam Traps were fitted in the S. S. Inchmona, the engine trials of which were the subject of much interest here and abroad. Many leading shipbuilding firms in Great Britain have adopted it, and The William Cramp Ship & Engine Building Co. has used the trap. The accessibility of the trap will be apparent to all engineers. The makers guarantee it steam tight, and it has a large capacity in proportion to its size.



EXTERIOR GEIPEL STEAM TRAP.



SECTION GEIPEL STEAM TRAP.

Hydraulic Coupling Belt Forcer.

A coupling bolt forcer is one of that class of tools which, while not of everyday use, is of the greatest possible value when its services are required. In the hurry of a break-down repair, such a tool is worth much, for when it is properly adjusted in place and the pressure applied, something has "got to go." The Watson & Stillman Hydraulic Machinery Works, of New York, has produced a compact coupling bolt forcer, which is here illustrated. This is specially intended for use in the shaft alleys of the larger steamers, where there is very limited room to work, and the coupling bolts must be both large and tight. The working action of the tool is the same as in the well known hydraulic punches of the company, except that there is no lever return action to the ram. A rapping bolt extends through to the rear of the cylinder, so that if the bolt does not start with the maximum strain of the tool, a jar may be given by a blow on the pin. The side plate-hooks are made to suit the shaft flanges. The tool shown exerts easily a strain of 45 tons. The ram has a motion of 3 in., and the greatest distance of ram to inside of hooks is 11 in. The weight is 200 pounds.

FOR USE ABOARD SHIP.

Seabury Water Tube Boiler.

An improved form of the Seabury water tube boiler has been designed by the Gas Engine and Power Co., and Charles L. Seabury & Co., Morris Heights, N. Y. An illustration of this is shown as fitted and placed on a vessel. It is a very compact form of steam generator and, indeed, the builders claim to furnish more heating surface for the same floor space occupied than any other boiler. The selection of material and work of construction is very carefully carried out. The drums, which are rolled to shape, have the rivet holes drilled through the lap, and are tested to a pressure of 500 pounds. The tubes, which are bent to the required shapes, are tested to 1,000 pounds pressure. The half manifolds at the sides of the furnace are made by welding a head in each end of a piece of lap-weld iron pipe, cutting through the center lengthwise, and planing the edges to fit a groove in the under side of the tube plate. The joint is made with asbestos wick in the groove, the half manifold being drawn up to the packing by steel bolts and straps. The heads of the bolts are countersunk, and they are fitted with cap nuts, so that a smooth joint is secured, with no part of the bolt threads exposed. The tubes are expanded in place at both ends. It will be noticed the furnace is surrounded by water tubes, spaced between diameters a distance equal to the diameter, so that the gases have free passage the entire length of the tubes. A firebrick baffle plate is inserted between the tubes, over the first row. The feed water heater is placed on top of the rows of inclined tubes, where it receives a considerable portion of the heat, which passes up between the tubes and which would otherwise be wasted through the stack. Shaking grates are provided which can be used either for hard or soft coal, or for wood. The builders claim a very vigorous water circulation in this boiler. All the tubes deliver below the water line in the steam drum. The direction of the water is upwards in all the rows except the outer. Through these the water is returned to the bottom of the boiler, the entire length of the drum, each tube carrying its own water uninfluenced by any other. At no point does the water have to flow more than 12 to 18 in. to get from the up-flow to the down-flow. It is claimed that it is not possible to drive the water out of the tubes by fire, as the more intense the heat the greater proportionately is the circulation. There are good facilities for inte-

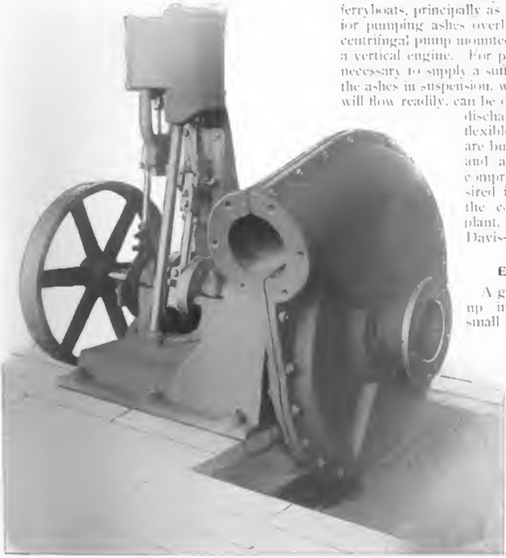
BOILER FITTED IN A VESSEL.

rior cleaning in the shape of man and mud holes. A steam pipe is also conveniently fitted between the tubes and water casing, so that the tube plate, and lower end of the tubes, can be freed from ashes and soot when the boiler is working. Expansion and contraction were carefully considered in the design, and all material used passes severe tests.

GENERAL ELECTRIC COMPANY'S SETS FOR MARINE USE.

Centrifugal Pump and Engine.

A direct connected centrifugal pump and engine is one of the most convenient of the engine room auxiliaries. It lends itself to a variety of useful operations, does not occupy much space, is simple in its construction, and easily kept in repair. The outfit shown in the accompanying cut has been fitted on many modern steamships and ferryboats, principally as a circulating pump, and for pumping ashes overboard. It consists of a centrifugal pump mounted on the same base with a vertical engine. For pumping ashes it is only necessary to supply a sufficiency of water to hold the ashes in suspension, when the mixture, which will flow readily, can be drawn, or forced up, and discharged through piping or flexible hose. These machines are built in a number of sizes, and are also furnished with compression pump when desired for circulating through the coils of a refrigerating plant. They are built by the Davis-Farrar Co., of Erie, Pa.



DIRECT CONNECTED CENTRIFUGAL PUMP AND ENGINE.

Electric Light Plants.

A great demand has sprung up in marine practice for small direct coupled engines and generators for lighting purposes. The principal requirements are compactness, light weight, simplicity of construction, freedom from vibration and noise at high speed, and perfect regulation as well as durability, and low first cost. The sets here illustrated are manufactured by the General Electric Co., of Schenectady with these in view.

These sets are built in sizes varying from 2½ K. W. to 25 K. W. As both engines and generators are manufactured by one concern, there is the greater probability that the fit and alignment are perfect, the finish uniform, and the tests accurate. The engine is simple; it has but one valve driven direct from the eccentric pin of the governor. The set is compact, the engine having a short stroke, and the armatures being specially wound. Both height and length of the sets is reduced to a minimum. The engine bed lengthened carries the generator, and although the appearance is somewhat massive, the bed is so carefully cored out, that without sacrifice of stability, the weight has been brought down to about one pound to 3½ watts. The engine bearings are self-aligning and self-oiling. The coupling between the armature shaft and engine crank is a split sleeve, which allows of easy removal of the armature. The governor is compact, with but few moving parts, which can give practically no trouble, or wear out. All of the generators are four pole 110 volt machines, with the exception of the 25 K. W. generator, which has six poles and a full load voltage of 125 volts. The greatest floor space occupied is 80 in. by 47in. by 66 in. high. The generators combine all the well known features of the General Electric machines, and the rating given to each has been calculated on a most conservative basis. The illustration shows a full line of single cylinder sets—2½ K. W., 7 K. W., 10 K. W., 15 K. W., and 25 K. W. The single cylinder engines are economical. They show as low as 28 pounds of water per I. H. P. hour non-condensing, and 23.5 pounds per I. H. P. hour condensing, using steam at an initial pressure of 80 pounds, direct from the boiler. These results have been obtained by an exact series of tests in sets above 10 K. W. capacity. The smaller sets are, of course, less efficient, but yet well up to the best standards.

NEWS AND NOTES.

The 1897 session of the British Institution of Naval Architects was opened in London on April 7th, with the Earl of Hopetoun in the chair. A number of very valuable papers were read by eminent men. Among these were papers by Engineer-in-Chief, A. J. Durston, R. N., on "The Recent Trials of the Cruisers Powerful and Terrible;" Rear-Admiral C. C. P. FitzGerald on "Water-tube Boilers in Warships," a digest of which will be found elsewhere in this issue; A. G. Ramage, on "A Mechanical Method of Ascertaining the Stability of Ships;" Capt. Lord Charles Beresford, R. N., "On the Fighting Value of Certain of the Older Ironclads if Re-armed;" Hon. Charles A. Parsons on "The Application of the Compound Steam Turbine to the Purpose of Marine Propulsion;" J. Macfarlane Gray on "The Accelerity Diagram of the Steam Engine" and a "Note on the Geometry of Stability;" Prof. Vivian B. Lewes, F. C. S., F. I. I., on "Acetylene and its Probable Future Afloat;" Prof. Wm. Beardmore on "Nickel Steel as an Improved Material for Boiler Shell-plates and Forgings;" Herr F. von Kodolitsch on "Application of Electrical Transmission of Power in Marine Engineering and Shipbuilding. Appropos of Mr. Beardmore's paper an article on the construction of a nickel steel boiler will be found elsewhere in this paper. In the paper on Nickel Steel by Mr. Beardmore he foretold a very extensive use for this material in the future, a use, in fact, the progress of which was only retarded by the price of this material, as three per cent of nickel added $45 a ton to the market price of carbon steel.

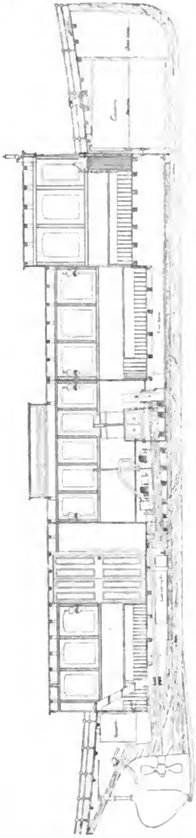
The most remarkable paper, perhaps, which was read at this meeting was that of the Hon. C. A. Parsons relating to the small steamer Turbinia. This vessel displaces 44.5 tons, and is fitted with engines of 1,576 horse power which weigh only 8,056 pounds. A speed of 31.01 knots was attained, the steam consumption being only 15.86 pounds per hour. A vacuum of 13.5 pounds was maintained at 2,100 revolutions a minute. The machinery weights, including water in the boiler and hot-well, were 48,400 pounds.

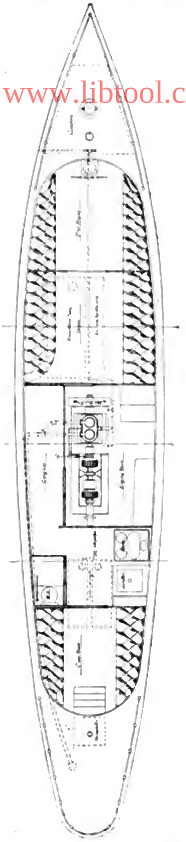
The Institution has decided to hold an International Congress in commemoration of Queen Victoria's Diamond Jubilee. It is the desire of the Association to make this gathering a notable one, and accordingly special invitations have been sent to the Ministers of Marine of all the great powers, and to the American Society of Naval Architects and Marine Engineers. The Prince of Wales will act as honorary President of the Congress, and will deliver the speech of welcome.

The meetings will probably be held early in July.

British smelting interests are deriving a good deal of satisfaction from an inspection of the pig iron output totals for 1896 of the United Kingdom and the United States, with Germany as a sort of happy sequel. The totals for 1896 are, United Kingdom, 8,750,000 tons; United States, 8,623,100 tons; Germany, 6,450,000 metric tons. The figures for the United States are 126,900 tons behind those of the United Kingdom, and show a falling off from the previous year of 823,200 tons. The conditions were decidedly the other way in 1895, for the totals for that year were: United Kingdom, 7,703,000; United States, 9,446,300 or 1,550,700 tons more than the United Kingdom. The top figures for the United Kingdom, prior to 1896 were reached in 1883, when the total was 8,529,000 tons. Since 1890, with the single exception of the year 1894, the United States kept the lead until last year. Germany has been making steady advances, having in 1880 turned out only 2,729,000 tons.

YACHT HELENE PROPELLED BY GASOLINE MOTOR.





The yacht Helene. owned by the Otto Gas Engine Works, of Philadelphia, is an interesting example of a motor boat built for cruising in rough water. She is 53 ft. long, 9 ft. beam and has a mean draught of 4½ ft. The hull is of oak and yellow pine, very substantially put together, and the deck planking is cedar. The saloon, and pilot house, and cabin are finished in mahogany, while the engine room is finished in maple. The exterior appearance of the boat is very handsome, showing graceful outlines, which are set off by the artistic combination of painted and polished woodwork and brass fittings. In the saloon there is sleeping accommodation for seven persons. There is also kitchen and pantry accommodation, and crew room. The propelling machinery consists of a 50 H. P. Otto marine engine, using gasoline. This is stored in the fuel tank forward, which holds 600 gallons. Pipes are laid to the engine room, through which the supply is drawn by a small pump. The motor is fitted with an electric ignition, so that there is no possibility of contact of the fuel with an open flame, and the trouble of handling inflammable oil for heating ignition tubes is avoided. It is also fitted with a self starting device which obviates the necessity of turning the fly wheel or pumping up a charge for the engine before getting in motion. The exhaust of the engine is led into an exhaust pot, and from there carried out underneath the water thus getting rid of all noise and smell. The rate of consumption of fuel is said not to exceed one-tenth of a gallon per indicated horse power per hour. The supply in the tank is sufficient for an extended cruise. In the form of motor used in the Helene the power is transmitted to the propeller by reversing gears. The weight of the engine and reversing apparatus is 2½ tons. The usual method employed by these engine builders is to use a reversible propeller. By this the speed of the boat can be reduced to a minimum by turning the blades to incline at a very small angle. In narrow passages, and when passing through locks, this is convenient for keeping steerage way on the boat. In smooth water, the Helene has attained a speed of 14 miles an hour. Under ordinary conditions an average of 11 to 12 miles is maintained. The Helene has made the trip from New York to Philadelphia on the outside in a very satisfactory manner.

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Engineers and other officers of steamships are cordially invited to call at our office, where will be found the leading marine publications of this country and Great Britain.

Letters and other mail matter can be sent to our care and will be forwarded or held until called for, as desired.

Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

The epigrammatic letter of Mr. Charles H. Cramp, which is printed in part on these pages, is as vigorous a protest against the supineness of the American shipping interests as has yet been heard. There has been a remarkable want of unanimity and decisiveness among the marine interests of the country. Endless discussions of the subject have been undertaken and nothing has been accomplished. The advocates of various systems of Federal support loudly claim exclusive advantages for their systems, and pass resolutions, which are neatly printed and distributed. It is not to be supposed that any system could be adopted which would prove perfect in practice. Yet if a compromise plan was agreed upon, understandingly, and action taken, no matter how defective it might prove to be, it would be progress. The Britisher adopts different methods in his treatment of matters bearing on the nation's prosperity. He uses mass meetings, and resolutions to solve the question of relief for the starving in India, or aid for the revolutionists in Crete. Where the supremacy of British trade is concerned, however, an upper room conference in Lombard street is worth a dozen Hyde Park demonstrations. As to the disposition to let Congress take the initiative. Is it to be expected that a body, many of whose members never saw an ocean vessel until they came East to take office, will be so informed on the question as to act with enthusiastic intelligence? If American shipping interests are to be conserved the parties in interest must carry through the work. The trading classes will not take the initiative. They do not give the subject attention. Probably they think it does not specially concern them. If the merchant has his goods delivered, safely and cheaply, he does not care who owns the ship. Traffic will always flow along the lines of least resistance. Mr. Cramp refers to the activity of British consular officers, in foreign countries, in circulating reports derogatory to American shipbuilding skill. The average foreign shipowner is a man of education and intelligence, and could hardly be largely influenced by reading the sensational blatherskite about ships which is printed in so many newspapers. Indeed, if all the perfecting presses in the world worked overtime from now until doomsday, their run-off would not have a fraction of the weight, which the actions of Messrs. Higgins, Goelet and Bennett have, in discrediting the American builder. Here is a good chance for comparison with the Britisher. Does he go abroad, even for what he cannot get at home? Does he place orders here for sailing yachts which will come in first in a race? His views on the subject were expressed rather forcibly when a Scotch builder sent to Germany for some heavy forgings for certain well known ocean steamships. Even lately the installation of American built engines in an English electric light plant caused the lion to growl deeply. Will the nation which has never known defeat in peace or war respond to foreign progression with resolutions only? We believe not.

In this number there are published illustrations and descriptive matter of the first nickel steel boiler built in the United States, or probably in any country. The use of this material for boiler construction is due to the enterprise of the Bureau of Steam Engineering of the Navy. It required some courage to plan this experiment, and a good deal more to carry it through, owing to the practical difficulties narrated. Many who are interested in this class of work will, doubtless, consider this experiment of little value to manufacturers who have to build boilers at market rates. But the possibility of such an experiment creating a change in practice should not be lost sight of. Should the results be satisfactory, the government will not only be in possession of valuable knowledge in the construction of improved apparatus, but will have conferred a substantial benefit on the mercantile marine interests, by showing where economical gains may be made. The material is expensive, but should a large demand be created for nickel steel, it is not unreasonable to suppose that the price would be reduced. Government practice opens the way often for the private individual to secure substantial benefits without the cost of experimentation. A notable example of this is the universal use of heavy steel forgings in engine building, which, when first introduced were considered luxuries for the purse of a nation only.

MR. CHARLES H. CRAMP ON THE MERCHANT MARINE.

The views of Charles H. Cramp on the Merchant Marine problem are expressed in a paper read before a conference, recently, in the committee room of the Senate Committee on Commerce. This paper in part is here given:

Mr. C. A. Griscom, Chairman of the Sub-committee on the Merchant Marine.

SIR:—We have to deal with real facts and actual conditions. The interests of ship owning and ship building are identical, because no nation can successfully own ships that cannot successfully build them.

No nation can either build or own ships when, unprotected and unencouraged, it is brought in competition with other nations that are protected and encouraged.

This is the existing condition of the ship owning and ship-building interests of the United States.

The resulting fact is that the enormous revenue represented by the freight and passenger tolls on our commerce and travel is constantly drained out of this country into British, German, and French pockets, in the order named, but mainly British; while the vast industrial increment represented by the necessary ship building inures almost wholly to Great Britain.

For this drain there is no recompense. It is sheer loss. It is the principal cause of our existing financial condition.

So long as this drain continues, no tariff and no monetary policy can restore the national prosperity.

The English steamship is a foreign product, and its earnings, which we pay, are a foreign profit.

No sane man will argue that a foreign profit on a foreign product can be a domestic benefit.

Add to this the fact, equally important, that the carrier of commerce controls its exchanges, and the condition of commercial, financial, and industrial subjugation is complete. Such is our condition to-day.

Great Britain has many outlying colonies and dependencies.

The greatest two are India and the United States.

She holds India by force of arms, whereby her control of that country costs her something. She has to pay something for her financial and commercial drainage of India.

She holds the United States by the folly of its own people, whereby her control of this country costs her nothing. She has to pay nothing for her financial and commercial drainage of the United States.

But the amount of her annual drainage of gold from the United States far exceeds that from India.

Therefore, the United States is by far the most valuable of all the dependencies of Great Britain.

In the relation of England to India there is something pitiable because India is helpless.

In the relation of the United States to England there is nothing that is not contemptible, because it is the willing servitude of a nation that could help herself if she would.

England is wide awake to these conditions, and keenly appreciates their priceless value to her.

The United States blinks at them, half dazed, half asleep, insensible of their tremendous damage to her.

England, clearly seeing that, in this age more than ever before, ocean empire is world empire, strains every nerve to perpetuate her sea power and exhausts her resources to double rivet the fetters which it fastens upon mankind.

In recent years Germany on a large scale and in a systematic way, and this country on a small scale and in a spasmodic way, have put forth efforts in the direction of sea power.

England instantly takes alarm. To her the growth of any other sea power, even if its scope be comparatively small and its extent comparatively feeble, is a peril second only to the landing of an invading army in Kent.

England is determined that she shall be not only the supreme sea power, but also that except within limits set by herself there shall be no other sea power at all.

She will tolerate the growth of any other sea power only so far as the point at which it begins to effect her naval supremacy or dispute the ocean monopoly of her merchant marine.

The moment any other national aspiration toward sea power reaches that point England must be prepared to crush it.

She will crush it by intrigue, by cajolery, by treaties, if she can. She will crush it by preponderating force if she must.

English officials abroad, from Ministers and Consuls down, industriously reproduce in the newspapers of Japan, China, Chile, Argentine, and Brazil the misstatements of the English press about American vessels.

The British Post Office delays the American mails for days in the slower ships of the Cunard line rather than send so much as one letter by the American line.

Our Post Office responds by liberal allotments of its European mails to all the British lines.

The result of all this is that while this country has never known such industrial stagnation and such financial distress, England has never known such industrial activity and financial prosperity as now.

To the English estimates for the current year for further increase of her navy amounting to eleven millions nine hundred and five thousand pounds sterling (£11,905,000), say $57,334,500 and a programme involving 108 new ships in all stages between laying down and completion, the United States responds by a sudden halt in even the comparatively feeble programme fitfully pursued since 1885, and a flat collapse of the policy of the new navy as a whole.

To the 1,380,000 tons of new merchant shipping built by England during the past year, what will be the response of the United States?

Now the future lies wholly in the hands of Congress.

From that quarter comes no sign.

CORRESPONDENCE.

[*We do not assume responsibility for the opinions expressed by correspondents.*]

Pointers for the Information of Water Tube.

Your correspondent, "Water-Tube," in the April number of your very interesting paper, is quite right in the assumption that the water tube boiler needs a different kind of treatment, and more watching than the Scotch boiler. He will, perhaps, agree that his new triple, or quadruple expansion engines, and the vast array of auxiliaries under his charge require more and a different kind of attention than his old compound engine, and the simple plant of only a few years back.

The water tube boiler is a later development and will also require more care than the older slow steaming boilers. With some types of this class of boiler the firing will undoubtedly have to be different, this being largely caused by the fact that the design of the boiler gives a grate, in some cases 9 ft. wide, by from 7 ft. to 8 ft. long. Such a grate cannot but be difficult to manage. With grates of the ordinary dimensions, he will find but little difference in management needed. The feed in all water tube boilers does need close attention. This is necessarily so from the fact that a smaller body of water is carried in the boiler, and a higher rate of evaporation called for. All such boilers should be fitted with an auxiliary feed pipe, and have a feed water regulator to control the main feed. Such an automatic feed apparatus is being used even in the boilers in the large torpedo boat destroyers built abroad, and in boilers developing 1,800 H. P. each, where the utmost forcing is necessary, and always with the greatest success.

Given a good feed regulator, large top drum, and good circulation in his boiler, and "Water-Tube" need not fear for the result. E.

Owing to the comparatively small quantity of water in water tube boilers, as compared with "tank" boilers, the steam is apt to rise and fall more rapidly than in the former. Do not, therefore, cover your fire entirely with fresh coal at any one time, as the steam will fall rapidly before the fresh fire is burned through. You should fire "little and often"—the quantity depending upon the size of the boiler. It is also best to use coal of small size. Open your furnace door and throw a shovelful onto each thin spot in the fire, letting each shovel full be surrounded by bright fire as far as possible. This does not knock the steam down to any extent and the bright fire will also burn the gases arising from the fresh coal thrown in. When you are obliged to clean your fire, do not disturb it till you have gradually built up a thicker fire, so as to have something left after cleaning. Do not clean all the fire at once, but clean part at a time, and get that part in good working order before you start on another section. You will find an air cock on all feed pumps, whether attached to the engine or independent, for the purpose of relieving the pressure on the discharge valve, letting the air out, and starting the pump when it stops feeding. You will find it a great improvement to take out this cock and run a small pipe from the same outlet in the pump to a point over the hot well, or filter. Then screw this cock on the end of the pipe. By leaving this cock open a trifle, it will discharge all the air which accumulates in the pump and will also discharge some of the water into the hot well. You will find that you can regulate the feed of the boiler with considerable accuracy by the use of this cock alone (of course, we are referring to pumps used in connection with surface, or keel, condensers) as, if there is too much water in the boiler, you can gradually allow it to accumulate in the hot well by opening this cock widely, and thus less water will be forced into the boiler. It is also best to regulate this cock in such a way that the pump will never take all the water out of the hot well, and thus suck air. When an independent pump does not get any water through the suction it is apt to "race" or "run away," and this necessitates frequent attention to the pump throtle.

THE ROBERTS SAFETY WATER TUBE BOILER CO.

Plan For Securing Oil Cups.

Possibly some of your readers may have been bothered with the cross head oil cups on the main engines, and our experience in this direction may be of interest. During many trips the cups fitted were constantly breaking off at the neck close to the base of the cup. The cups were heavy brass castings, with a small shank screwed pretty deeply, so that there was only a small diameter of metal left to sustain the weight of the cup. When the crank passes the centers the forked end of the rod gets a sharp jerk, and this snapped the cups right off, so that they flew about like base balls. Now we have them cast with a lug, and also screwed in in the old way. The base of the cup gets a good bearing on the cap of the brasses and is held by a small screw, which passes through the lug and fits a tapped hole in the cap. I am told that on some of the English boats the cups have square bases, and a hole at each corner for a screw. In my opinion oil cups are made altogether too heavy. If they were made of light brass stampings they would be just as strong, and not nearly so clumsy as the heavy cast cups. McM.

Deposits In Steam Cylinders.

We do not pretend to know it all, and we do not know what is the trouble with the cylinder oil used by your correspondent who signs himself "Transatlantic," but we think that he will find the use of ordinary kerosene oil (refined coal oil) in his cylinders will cut out the deposit, to which he alludes, and thus keep the cylinders clean and restore the elasticity of the piston rings. R.

In your April issue, under the head of "Correspondence," I notice a letter from "Transatlantic" regarding deposits in steam cylinders. This subject was presented to me some time ago for investigation. After several months' work upon the deposits I prepared a report which I send you. This is entitled, "The Analysis of Cylinder Deposits," and was originally published in "The Journal of Analytical and Applied Chemistry." THOMAS B. STILLMAN.

[The article referred to by Prof. Stillman will be found under a separate heading on page 29

An analysis of the substance sent by "Transatlantic' shows that it contains:

	Per Cent.
Water	4.80
Oil and organic matter	29.40
Sand	8.70
Iron	32.00
Copper	1.80
Tin	2.60
Zinc	5.30
Combined oxygen (by diff.)	15.40
	100.00

The iron exists in the deposits mainly as iron oxide, but particles of metallic iron, or steel, were seen. The other metals are, probably, largely in the metallic state. The cylinder oil which was used in the engine from which this deposit was taken was found by analysis to be mineral oil with a 6 per cent. admixture of animal oil. We would suggest that our correspondent procure a pure mineral oil, for by its use the trouble would, undoubtedly, be greatly modified.—Ed.]

Troublesome Feed Pumps.

I enclose a problem that I would like some of your readers to answer. I am running a triple expansion engine, exhausting into a surface condenser. My pumps are connected to the main engine, including air, bilge, circulating and feed pumps, all except the donkey, which acts independently. My problem lies in the feed pumps. They seem to be fickle about their action. At times they work well no matter how wide open the extra feed is, and at other times they refuse to pump at all. Our feed water is delivered to the boilers at a temperature of 128 degrees F.; our discharge water at 93 degrees F. when the temperature of the sea is 60 degrees. The pumps are single acting. Plungers are 2 in. in diameter and have a 24 inch stroke, have snifting valves on each pump between checks. Foot checks are set at ¼ inch lift, and discharge check at ⅛ in. lift. Hot-well is constructed so that the feed water runs to the pumps. When the pumps stop pumping with the snifting valves open, shutting the valves will sometimes start the pumps, but will cause the boiler check to become noisy. The valves are all ground, and fit nicely. There are no leaks around the suction pipes. The air pump has a vapor pipe. Another air-hole in the top of the hot-well also relieves its exhaust. I would be glad to read any suggestions from my brother engineers. TEXAS.

The Analysis of Cylinder Deposits.

BY THOMAS B. STILLMAN, M.SC., PH.D.

The deposits in steam cylinders, formed by the decomposition of lubricating oils, may be classified as simple or compound, depending upon whether the deposit is due to the decomposition of the oil alone or if foreign matters, carried over in the steam from the boilers, are also present.

In the former case, carbon, hydrocarbons, oils, and iron oxide are the principal constituents, whereas, in the latter, oleate of lime, carbonate of lime, and silica are often present in addition to the former.

The following analysis of a sample from a locomotive cylinder would indicate a simple deposit:

Moisture		2.28	per cent.
Oils soluble in ether.	Animal	10.54	"
	Mineral	11.23	"
Hydrocarbons insoluble in ether		47.97	"
Fixed carbon		23.73	"
Iron oxide		2.83	"
Undetermined		1.42	"
Total		100.00	

And the one given below, of a deposit from the steam cylinders of a large stationary engine, would show that scale-forming material from the boilers had become a component.

Moisture		13.12	per cent.
Oils soluble in ether.	Animal	8.15	"
	Mineral	7.86	"
Soap		2.10	"
Hydrocarbons insoluble in ether		1.67	"
Fixed carbon		2.71	"
Oxides of iron (and aluminum)		6.81	"
Silica		3.65	"
Carbonate of lime		43.22	"
Carbonate of magnesia		10.17	"
Undetermined		0.44	"
Total		100.00	

In many samples, I have found copper and zinc in the deposits, formed by the corrosive action of the liberated oleic acid from the animal oil upon the brass or composition bearings.

This corrosive action is very marked where a poor quality of lubrication oil, composed of animal or vegetable oil, is used; whereas a pure neutral mineral oil has no acid action at steam temperature. Oftentimes the statement has been made to me, when the deposit was given for analysis, "All of our lubricating oil is pure mineral oil; we use no other." And yet, upon analysis, lard oil would be shown in comparatively large amounts.

This is accounted for from the fact that while the consumer believes he is using pure mineral oil—which was sold to him as such—the manufacturer has introduced from 3 to 30 per cent of lard oil.

A large majority of the so-called "pure mineral" lubricating oils for cylinder use contain at least 3 per cent of animal oil; and it is the exception and not the rule to find a "pure mineral" oil for cylinder lubricating purposes.

An analysis of a deposit from the steam cylinder of a large freight steamer gave as a result:

Moisture		16.16	per cent.
Oils soluble in ether.	Castor oil	26.19	"
	Mineral	32.50	"
Fixed carbon		7.92	"
Copper		0.50	"
Iron oxide		25.10	"
Undetermined		1.63	"
Total		100.00	

Pure mineral lubricating oil was supposed by the officers of the vessel to be the only lubricant used, and special care had been taken to secure it, but it appears that the engineer added a small amount of castor oil to the mineral oil, as, in his opinion, it made a better lubricant. The decomposition of the castor oil and liberation of the fatty acid was the primary cause of the deposit.

The action of the fatty acids upon the iron and metal bearings results in different products. That is to say, while the copper when present has generally been estimated as copper oxide, the iron may exist only as oxide or as metallic iron, or both. No doubt the oleic acid acts to form salts of these metals, but it is certain, in many instances, that when formed, they are immediately decomposed or partially so, and a resulting mixture formed that is somewhat difficult of analysis.

In the analysis here given, it will be noticed that the iron was found both as metal and as oxide:

Moisture		3.77	per cent.
Oils soluble in ether	Animal	21.27	"
	Mineral	19.60	"
Soap		traces.	
Fixed carbon		10.90	"
Iron oxide		14.01	"
Iron		27.85	"
Lead oxide		0.82	"
Copper oxide		1.07	"
Undetermined		0.71	"
Total		100.00	

It is very seldom that sulphates are found in cylinder deposits. When the lime and magnesia exist in amounts more than necessary to combine with the carbonic acid (combined) and sulphuric acid (combined) present, the excess may have united with oleic acid to form soaps insoluble in water.

In some instances the lead oxide and zinc oxide will be found as lead and zinc oleates, but in others, while they undoubtedly first existed as oleates, they had become decomposed, and the lead and zinc oxides would be found.

In the United Kingdom there is at present a revival of the scheme to construct a tunnel between Ireland and Scotland. Various routes have been talked of and the estimates vary from $30,000,000 to $80,000,000. It is believed by many that sufficient traffic could not be secured to pay interest on this sum.

The Hamburg-American line will celebrate its fiftieth birthday on the 27th of this month, the Company having inaugurated the service to America on that day, in the year 1847. For nearly ten years the service was maintained by sailing vessels. In 1856, however, the Company purchased the steamships Borussia and Hammonia. The last addition to the fleet is the monstrous steamship Pennsylvania which was fully described in our last issue. The fleet of the Company, exclusive of the Pennsylvania, consists of 55 steamships, with a dead weight capacity of 205,130 tons. More than a dozen new vessels are soon to be added, which will make an addition of nearly 120,000 tons.

MISHAPS AND REPAIRS.

Stern Frame and Rudder Forged and Fitted.

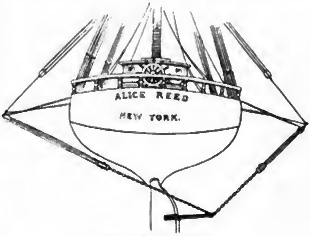
The S. S. Horrox, grounded on the bar at Charleston, S. C., and when she was pulled off was towed to the Erie Basin Dry Dock, Brooklyn, N. Y. There an examination was made, in dry dock, in the latter end of March. The stern frame was broken, the shoe being missing, and the rudder stock was fractured. Both stern frame and rudder would have to be replaced. Repairs were ordered, and the rudder was unshipped, the rivets in the stern frame cut out, the propeller taken off, and the shaft and stern tube hauled in. The portion of the stern frame remaining was drawn out and landed on the dock. Plates were then bolted over the opening in the after bulkhead, through which the stern tube passed, and made watertight. Then the dock was filled, and the vessel hauled out to await the arrival of the stern frame and rudder. Drawings of these were prepared and sent to the forge, and templates were also made of the stern frame. One of these was sent to the forge, and the other kept in the yard and marked and drilled for the rivet holes. The forgings were delivered at the yard in three weeks. The stern frame was laid on blocks near the dock and the rivet holes marked from the template in the usual way. Drilling was then commenced with the portable machines, which are shown in the illustration, while drilling the rudder frame. Four to six of these machines, each driven by an independent vertical engine through suitable gear, and shafts fitted with universal couplings, were worked at the same time, using twist drills. While the rivet holes were being drilled, 2 in. holes were also drilled in the gudgeons. When the frame was ready the vessel was again docked, and the frame put in position. While the riveting gangs were at work the holes in the hub were drilled, and a boring machine, worked by a small vertical engine, put in the dock, was started on the gudgeons to enlarge the holes for the rudder pintles. The hub of the stern frame was also bored out to the center line of the shafting, and also to suit the stern tube. When all this work was completed the stern tube was put in position, the shafting hauled out, and the propeller put on. The rudder meanwhile had been finished in the yard, and when the pintles were put in place, the rudder was shipped, the quadrant and tiller fitted, and the steering gear connected. Then the vessel was ready for sea. The stern frame weighed 12,240 pounds; the rudder frame, 6,422 pounds, and with the plates, 8,980 pounds. The forgings were made by McPherson, Willard & Co., Bordentown, N. J., and the work of repairs was carried out by the John N. Robins Co., ship and engine builders.

DRILLING RUDDER FRAME IN DOCK YARD.

RIVETING STERN FRAME IN DRY DOCK.

Steered 6,000 Miles with Jury Gear.

A simple and very effective method of overcoming a very serious difficulty, is shown very clearly in the drawing of the stern of the bark Alice Reed.



JURY GEAR IN POSITION.

This vessel entered the port of New York recently after having been kept on her course for a distance of about 6,000 miles with the jury steering gear shown. While on a voyage from Montevideo to this port the bark was struck by a squall and the rudder head was twisted off. Steering was, of course, impossible with the ordinary gear, and Capt. Ford decided to rig a jury gear. Spars were run out from the sides near the stern and lashed securely. To the outboard ends block and tackle was secured and connected to the chains of the monkey tiller. Inboard the ends of the tackle were guided by snatch blocks to the wheel house, where they were made fast to the drum of the wheel. The work was finished in a few hours, and when headway was got again the ship was more manageable than would be expected. With this gear the voyage was continued without further interruptions, although very severe gales were encountered in the North Atlantic. The cargo of wool and hides was delivered in sound condition to the consignees here.

CONSTRUCTION NOTES.

The New York Yacht, Launch and Engine Co., Morris Heights, New York City, is building a large cabin launch for W. W. Kenyon, of Brooklyn, N. Y. Her dimensions are 31 ft. over all, 7 ft. beam, and 30 in. draught. The cabin is to be finished in mahogany, with plush cushions on the seats, and lockers under same, and extensions to form berths. In the after end of the cabin is the galley, on the starboard side, and the toilet on the port side. The engine space and crews' quarters come after this. She is built in the most substantial manner, with oak timbers, cedar planking, and is copper fastened. The motive power will be an 8 horse-power Otto gas engine. She is expected to be a very speedy as well as safe boat. She will be ready to launch in about three weeks. The company is also building a 50 ft. oyster boat, with 12 ft. beam, fitted with two 12 horse-power Wing marine gas engines. This boat while 15 ft. beam on deck is only 12 ft. beam at water line, being flared out in order to take a very heavy load. They are also building several handsome launches to be fitted with the Wing marine gas engine.

The Neafie and Levy Ship and Engine Building Co., Philadelphia, Pa., has now under construction for the Winthrop Steamboat Co., Portland, Me., a steel single screw passenger steamer 150 ft. long, over all, 30 ft. beam, and 11 ft. deep. She will be fitted with one inverted, direct-acting surface condensing triple-expansion engine 15 in., 23 in. and 39 in. cylinders by 28 in. stroke of piston, and one boiler 13 ft. 6 in. dia. by 12 ft. long. She will be handsomely fitted up with accommodations for about 900 passengers. The steamer is expected to be completed in about six weeks, and will run on the Plymouth route. The company is also building for the Baltimore and Philadelphia Steamboat Co., one steel single screw passenger and freight steamer intended for service between Philadelphia and Baltimore.

Jackson and Sharpe Co., Wilmington, Del., has made a contract with the Philadelphia Floating Elevator Association for the construction of a grain barge to be used in that port. She will measure 153 ft. between perpendiculars, and 160 ft. over all; 25 ft. 9 in. in breadth and 11 ft. in depth. When loaded she will carry about 26,000 bushels of grain. She will have one deck, with a hatch 14 ft. wide, 120 ft. long, and 30 in. high, and will have a small cabin for workmen, and pilot house. Her hull will be of white oak and yellow pine. The company is also building a tug for the Chesapeake & Ohio Railroad Company. This is a wooden vessel, 100 ft. long, over all, 23 ft. beam and 10 ft. 3 in. deep. She will be fitted with two bulkheads and with propelling machinery consisting of a compound engine, 36 in. and 20 in. by 26 in., and one Scotch boiler 11½ ft. in dia. and 11½ ft. long, to work at 125 pounds. For Hughes Bros. & Bangs, who have the contract for the construction of the Harbor of Refuge in Delaware bay, the company is building two dumping scows 180 ft. long, 40 ft. beam and 12 ft. deep, fitted with pockets and dumping gear, to carry about 1,200 tons. Also a deck scow 180 ft. long, 40 ft. beam and 12 ft. deep, with knee bilge, built in the usual car float style, and to carry about 1,500 tons on deck.

The Gas Engine and Power Co., and Charles L. Seabury and Co., Consolidated, Morris Heights, New York City, have a large amount of yacht work on hand. The Hiawatha, just launched, is 170 ft. over all. She has a steel hull and remarkably handsome lines. She has a triple expansion engine and two Seabury boilers, designed to furnish steam to the 1,000 horse power engines at a pressure of 250 pounds. Two sister steam yachts have also just been launched. One of them, the Punjaub, is for F. L. W. Masury, the other, named the Raynham, is for E. S. Woodward. These boats are 85 ft. over all, with flush deck, single screw and engines of about 175 horse power. They were launched all completed. Among the yachts undergoing repairs are the Wachusett, F. T. Holder, having her stern lengthened and a clipper bow and spars put in; the Wabeno, Frederick Gerken, lengthening her stern and undergoing general alterations; including a new Seabury boiler; the Kanawha, John P. Duncan, lengthening her stern and general alterations; the Althea, T. E. Ward, to be equipped with an electric light plant and general repairs and overhauling; the Orienta, J. H. Ladew, a new shaft and refinishing the saloon and deck; the Alcina, O. A. Dorman, cabin reconstructed and finished in mahogany. The old Hiawatha has been purchased by J. Herbert Ballantine, Newark, and will receive extensive alterations. The Maspeth, Chris. Meyer, is having a clipper bow and her stern lengthened, her steam plant overhauled and renewed. Two steam tenders are also being constructed, also eight or ten naphtha tenders; a naphtha boat for the Health Department of New York City; two for the Police Department; one for the Health Department of Charleston, S. C., and about fifty launches for individuals, varying in length from 18 ft. upward.

The Columbia Engineering Works, McNeil Bros., Proprietors, William and Imlay streets, South Brooklyn, are at the present time making extensive alterations and repairs to the Brooklyn fireboat, Seth Low. The engines are having a thorough overhauling, also the fire pumps, which are having new brass water-backs and new linings. Her boiler has been raised, reset, retubed and thoroughly overhauled. They are also converting the boat so as to run high or low pressure; in doing this they are fitting a new Wheeler admiralty condenser, and new Blake air pump. This necessitates all new copper piping and new valves and hot wells, the former piping having been badly damaged when the boat was in collision some time ago. They are also fitting new tail end shafts on this vessel, and expect to have her ready for service about May 1. The works are also executing repairs on the new steamship, Verona, of Glasgow, which arrived from Sunderland in ballast three weeks ago. They have a force of 200 men at work on this vessel, cutting out and renewing the strained rivets in decks, hull frames, butts and hatches. This vessel encountered fierce gales on her way across the Atlantic. Her engines and shaftings, etc., have been thoroughly examined and repaired, and vessel will soon be ready for sea. They have also just completed extensive repairs to the British steamer Silvia, having overhauled her pumps and boilers and fitted new thrust rings. Other steamers undergoing repairs are the S. S. Rosemarron, docked, and propeller renewed; S. S. Vittoria, of Glasgow, general engine repairs; S. S. Mowen, of Glasgow, fitting out for China, general engine repairs and dry-docking to remove propeller and shaft; also work on the S. S. Edwin, of North Shields; S. S. Brittanic, French; S. S. American, British.

EDUCATIONAL.

THE INDICATOR APPLIED TO THE MARINE ENGINE.—2.

BY HENRY L. EBSEN.

The necessity for the even distribution of power in a marine engine, referred to in the preceding article, can be more readily understood by reference to Fig. 1. This is a theoretical combined diagram of a triple expansion engine. AD represents the volume of steam admitted to the H. P. cylinder, BE the volume admitted to the I. P. cylinder, and CF the volume admitted to the L. P. cylinder. The quantity of steam AD, at the pressure KA, expands in the H. P. cylinder, to the volume BE and pressure KB, and is received by the I. P. cylinder at the pressure KB and volume BE, and by the L. P. cylinder at pressure KC and volume CF, so that the line BE represents the volume of the exhaust of the H. P. cylinder and admission to the I. P. cylinder, and CF represents the volume of the exhaust of the I. P. cylinder and the admission to the L. P. cylinder. In the L. P. cylinder the steam at the end of the stroke is at a pressure of HG, and exhausts to the condenser. In the case of the full lines the powers developed by the cylinders are equal, and the areas of the different cards ADEB, BEFC and CFGHK are equal to each other. Now, if the H. P. cylinder be linked up, the volume of steam entering it will be equal to AL. If the I. P. cylinder is not linked up correspondingly, the volume of the steam to the point of cut off will still be equal to BE, and as a smaller quantity of steam is now passing through the cylinders, it will drop to a lower pressure when it occupies this space. If a perpendicular is let fall from E, intersecting the new expansion curve at M, RM, which equals BE, will be the new back pressure line of the H. P. cylinder, and admission to the I. P. cylinder. In the same way, SM will be the new back pressure line of the I. P. cylinder, and admission to the L. P. cylinder. It will now be seen that the new area of the H. P. card ALMR has not been diminished much from the original area, while the I. P. card has been reduced, and the L. P. card also suffers a reduction in area.

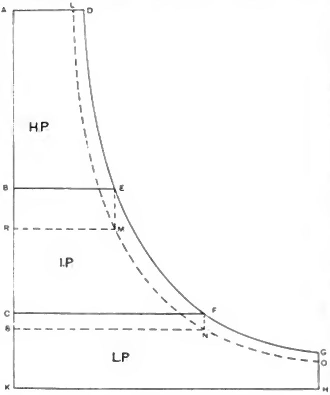


FIG. 1.

The next important function of the indicator is that of locating faulty valve adjustments. It is hardly to be expected after the care that is bestowed upon the design of a valve gear of large marine engines, and the constant care it receives, that their indicator diagrams would ever be so misshapen as those which are occasionally taken from neglected stationary engines. In fact, if any mistakes of this kind did exist, the engine would soon make life unbearable to those who had to live near it and care for it. Nevertheless, the valve adjustment requires much study, and slight changes are made continually, and the effects carefully noted, with the object of bringing the engine to a higher degree of efficiency. As the prevailing style of marine engine is the vertical inverted type, the wear of the valve gear must be closely watched. If the top eccentric strapliner and the saddle block slipper show any wear, thereby lowering the valve, the indicator diagram will show this by the increased length of steam admission on one side and decreased length on the other side, in addition to displacing the points of release and compression. A little experience will enable the engineer to judge what thickness of liner must be inserted under the foot of the eccentric rod to bring the valve to its original position, without having to open up the valve chest to get the setting. In case the power is not evenly distributed between the cylinders, and linking in or out on one cylinder should disturb the point of compression or release to such an extent that the engine would pound, a slight increase or decrease of the steam lap of the valve will often give the desired result, although this would alter the lead. The diagram now taken will plainly show the difference in cut-off, while the lead will remain practically unaltered. This will demonstrate the fact that the indicator diagram is a more reliable means of judging the action of steam in the cylinder than it is of what the dimensions of the valve setting would be. The above case is only applicable to small alterations, as large alterations would necessitate the shifting of the eccentric sheave.

The point of release is another important consideration. It is advisable to have it as early in the stroke as the setting will allow, so that the exhaust steam will reach the following cylinder before cut off has taken place in the latter, otherwise that cylinder will drain the receiver of steam exhausted from the previous stroke of the first cylinder, causing considerable drop in pressure in its admission line, and at the termination of the next stroke the first cylinder exhausts into the receiver again at a gradually rising pressure. If the first cylinder were now to exhaust to the second before its point of cut off, its exhaust line as well as the admission line of the second would be of more uniform pressure. Therefore a small alteration of the release points will alter the shape of the diagrams, and likewise effect the distribution of power. Alterations of this kind are made by diminishing the exhaust lap of the valve, and as this also reduces the compression, which is undesirable, it is usually necessary to alter the angle of advance on the eccentric sheave. The above difficulty is experienced in engines that have not sufficient cylinder capacity so that the point of cut off occurs at more than three-quarters of the stroke in each cylinder.

The point when the valve closes for compression can be easily located on the diagrams of all the cylinders excepting that of the low pressure cylinder. When the piston in this cylinder begins to compress the exhaust at 25 in. of vacuum, the pressure does not immediately begin to rise, as the vapor, or fog as it may be called, requires an amount of compression to bring it to the gaseous state before its pressure will rise. Therefore this cylinder usually does not get enough compression, and as any shifting of the point of compression would disarrange the other points on the diagram, the valves in the more improved engines are usually equipped with Thom's patent passover port; see Fig. 2. Previous to the point of release at one end of the cylinder this port transfers a small amount of steam to the opposite end just as the valve is closing for compression, thus giving the piston something substantial to compress. The diagrams taken from a cylinder fitted with such a valve show a sudden rise in pressure at the compression point, previous to actual compression, and are often a puzzle to the uninitiated. Figures 3 and 4 are diagrams taken before and after the adoption of a valve with a passover port, and the amount of compression in the latter case was sufficient to make the engine run perfectly quiet.

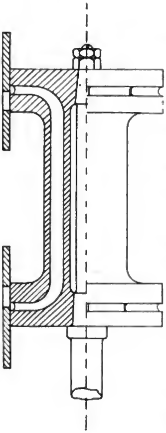


FIG. 2.

Marine engines nowadays are very frequently fitted out with piston valves, the larger cylinders having two of them side by side, the rods of which are both driven from a single crosshead. The weight of this gear is quite considerable, and to avoid having abnormally large eccentric sheaves, straps and rods, each valve has a balancing device. In former years these balance gears were simply cylinders on the valve bonnets, the pistons of which were attached to the valve stems, with steam or atmospheric pressure on the bottom side, and connection to the condenser on the top side. These devices, no doubt, balance the valve gear to some extent, but at high speed the momentum of the gear must be taken into account, as the strains caused by this will sometimes greatly exceed those caused by the weight of the gear. There are different styles of patent momentum balancing cylinders in use, in which the piston lifts the valve gear at the beginning of the up stroke, checks its momentum at the top, assists it to start on the down stroke, and checks its momentum and weight when approaching the bottom. These balance cylinders have indicator connections, and although the diagrams taken from them do not vary much, they are useful to determine any piston leakage that would impair their efficiency. Fig. 5 shows Thom's patent momentum balancing cylinder, which is one of the most efficient, and Fig. 6 is a diagram taken from it. The large shaded portion shows the upward pressure of the piston, and the small shaded portion shows the downward pressure.

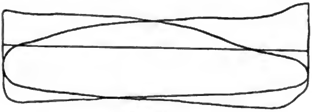


FIG. 3.

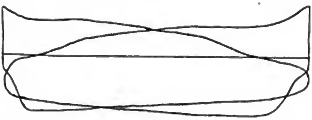


FIG. 4.

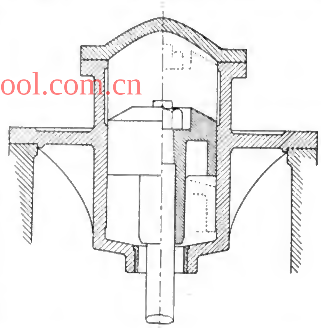


FIG. 5.

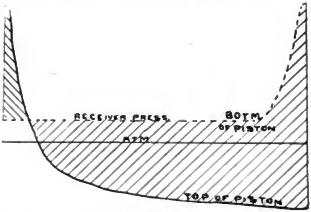


FIG. 6.

The U. S. Gunboat Annapolis, 1,000 tons, built by Lewis Nixon, at the shipyard in Elizabethport, N. J., went on her official trial trip April 22. Everything considered, some remarkable results were achieved, the vessel exceeding the contract requirements in all particulars. The mean speed for the run of 48 knots in Long Island Sound was 13.43 knots. The maximum rate during the trial was 14.18, which figures were promptly painted on the funnel by the crew. The Annapolis is the first of the gunboats fitted with spars and canvass to be completed.

HOME AND FOREIGN EXCHANGES.

Lord Brassey on the British Seaman.

Writing to the London Times from the Antipodes, Lord Brassey discusses the British seaman and the Royal Naval Reserve:

Residents in Melbourne, one of the few busy ports in which large fleets of sailing ships may still be seen, affords exceptional opportunities of judging of the quality of the British seaman of the modern time. I ask leave to give in your columns impressions formed from close personal observation and consultation with experienced ship masters.

Throughout the recent discussions on the manning of our Merchant Navy no doubts have been expressed as to the officers. The confidence of the Admiralty has been conspicuously shown on a late occasion, when commissions were given to a hundred lieutenants selected from the Mercantile Marine.

It cannot be claimed that the same uniform excellence is found before the mast. British seamen of the finest type may still be seen, and more education and as good seamanship as those who have gone before. Their numbers, however, are growing less, while the foreign element is increasing.

The causes of the reduction of numbers are not far to seek:

(1) Sailing tonnage is being more and more displaced by steam. The advantage in certain trades is open to question. The power supplied by the wind is cheap, and, in the average of long voyages, it is less uncertain than might be supposed. Its use should not be discarded for the transport of bulky commodities for which early delivery is not of urgent importance. Steamers may show good profits on their early voyages, but they depreciate rapidly. These considerations should prevent the entire disappearance of sailing ships. Such, however, is the tendency of the hour, and we are gradually losing the best school for the training of young seamen.

(2) The seaman has not fully shared in the social and material progress of those who follow easier callings. For the hardships and privations which are his inevitable lot he has received no compensation in wages, his earnings being below those obtainable in any description of skilled labor on shore. The latest returns issued by the Board of Trade give the monthly pay of seamen in the Australian voyage at 55s. (fifty-five shillings), and there is no prospect of higher remuneration. Excessive competition has brought down freights to the wholly inadequate rate of from 20s. to 30s. a ton from Melbourne to London.

A general review of all the circumstances points clearly to the conclusion that it is only by direct aid from the State that our Mercantile Marine can be preserved as a nursery for blue-water seamen. An ample supply of men from the fisheries may be obtained without assistance from the Government. But a certain proportion of men of a wider experience should be found in the reserve of the Navy.

We have an admirable example of a well-organized reserve in the French Inscription Maritime. Established under Colbert, it has been sedulously perfected by successive administrations, and the results well merit attention. With a Merchant Navy of under 900,000 tons, as contrasted with the 10,500,000 tons of the British Empire, the French have no less than 135,000 men on the rolls. Omitting all non-effectives, a solid contingent of 40,000 men could certainly be furnished to the fleet in time of war. Of the French reserve 71,000 men are drawn from the coast fisheries, 10,000 from the deep-sea fisheries, 18,000 from the coasting trade, 21,000 from foreign-going ships. The remainder are serving in pilot boats and yachts. By skilful organization the French have at their disposal more men than they could employ afloat, while our ability to man our ships is being called in question. We may accept the assurance that the resources for manning are adequate. But the further expansion of the fleet will call for increased numbers of seamen, and considerations of economy must impose some limit on the permanent force. All compulsory service creates burdens which are not shown in Navy and Army Estimates; but when every allowance has been made the direct cost of the French Inscription Maritime is relatively small. The exclusion of foreigners from vessels under the French flag puts no charge on estimates, while giving to the native seamen a valuable monopoly. In addition to this and other privileges the fisheries and Mercantile Marine of France are supported by bounties on a liberal scale. The seaman who has served 300 months afloat receives a pension in old age.

In a work on British seamen published many years ago, at the close of the inquiry of the Unseaworthy Ships Commission, I urged that the training of seamen should be encouraged by a bonus to shipowners as well as by retainers to apprentices and seamen. I venture to renew the suggestion, believing it to be the only means of making our Merchant Navy as capable as that of France of rearing seamen for the fleet. Terms and conditions should be so laid down by the Admiralty as to secure satisfactory results. Only sailing ships should be subsidized. They should be of a suitable type and employed in voyages of circumnavigation. The numbers of their crews and their qualifications should be defined. All seamen and apprentices of the reserve should be bound to serve when called upon. They should appear at stated intervals for inspection.

The Naval Reserve should be more thoroughly trained than at present. Every man in the French reserves serves for forty months in the navy. Our Reservists should do two years' service, possibly in ships specially commissioned.

Canadian Trans-Atlantic Service.

After years of agitation Canada is about to have a fast line of steamers tnat will prove formidable competitors of the best that now make New York their terminus, says the Marine Record. It is announced on what appears to be official authority that the Canadian Government has awarded a contract for a period of 10 years to the English firm of Peterson, Tait & Co., of Newcastle, to place on the route between Montreal and Liverpool four steamships of 10,000 tons each and a speed slightly exceeding 21 knots. Two of the new boats are to be ready for the beginning of the season of 1899 and the other in 1900. They are to have 50 per cent more accommodation for passengers than the greyhounds of the Cunard Line, the Lucania and Campania, and 50 per cent more promenade accommodation, while they will be also superior to them in their appointments and equipment. They will be further supplied with cold storage accommodation to the extent of 500 tons, which, however, if needed, is to be subject to increase to 1,000 tons at the demand of the government.

The boats will run from Montreal, or possibly Quebec, to Liverpool in the summer, and from Halifax in the winter. W. Peterson, of the English firm mentioned, has been in Canada for two weeks, in consultation with the Dominion Government on the matter. It is said the annual subsidy to be paid by the Dominion is $500,000, to which the imperial government will add $250,000. It is stated that the Dominion Government, in addition to entering into an arrangement for a fast Atlantic steamship service, intends deepening the St. Lawrence canals to a uniform depth of 14 ft., the work to be completed within two years.

A British View of American Methods.

At this time, when a large amount of anxiety is felt about the future of English trade, says The Engineer, London, and when all causes that may account in any degree for the depression of it as a whole or in part, and when all possible means which may conduce to its recovery, are freely discussed, it will not be without interest to call attention to a point which has been practically unnoticed so far, and one which we think may not be without important bearings from certain points of view on our commercial interest. We refer to trade secrets. If the characteristics of a country may be legitimately gathered from the press of that country, we may say without hesitation that no country in the world holding important manufacturing interests is so reticent about its methods of work as England. If we turn to American or continental books or papers, we find that the manufacturers of those countries do not only willingly give information about their work, but, if anything, seem to encourage the circulation of such information. For the moment it matters not at all what their ulterior motives in doing so may be. It may be that it is looked upon as a good and cheap advertisement, or the information may be imparted from the sheer love of telling something known, a characteristic largely developed in many persons; or it may be from a self-satisfied feeling of knowing a great deal more about some particular method or system than any one else, and wishing to let the rest of the world appreciate that superiority. The motive does not matter; the fact of its being done is of great importance. Of no country is this observation truer than of the United States.

The Americans seem to be more generally willing to exchange information than other people. For a proof of this it is only necessary to turn to the discussions of their learned societies. Without wishing to disparage our own societies, we are forced to admit that we very rarely have anything that approaches the thoroughness of the investigation which follows the reading of a paper before an American institution. Member after member rises, and each is not content with some mere platitude or weak and unsuggestive question, but gives honestly and fully all he knows about the matter under discussion, and hunts in the recesses of his memory for the last little point of importance. The consequence is that not only are the "Proceedings" of the societies invaluable treatises on varied subjects, but that each member performs the office of a whetstone for his neighbor, urges him to initiate investigations on his own account, and introduces him to new fields of thought. It is only necessary to look to America to see the result. Whatever faults we may have to find with a tendency to exaggerate, from which our cousins are not entirely free, it must be acknowledged that, due discount being allowed for that failing, American engineers and scientists are making rapid strides, and as the foundations of thought gain in firmness from the reasons which we have attempted to indicate above, these strides are made, not with more confidence—that were impossible—but with fewer resulting disasters. In all branches—let us refer particularly to engineering—American work is annually becoming more trustworthy, and the thoroughness with which it is gone into is in marked contrast to a backward tendency in this country.

In France, too, although perhaps more superficially, both books and papers show that manufacturers and scientists are very fairly free with their knowledge. In Germany the technical colleges, being in many cases actually fostered by the makers, do a great deal towards the distribution of information.

It must surely be unquestionable that this readiness to give and take assists the advancement of a people. A selfish desire to make a secret of one's methods is not only harmful to the original person, but hinders as it is of course intended to do the advancement of others. It may seem hard to blame a man for keeping to himself the secret of a success which he has only gained by strenuous work, and the retention of which gives him a monopoly in the matter to which it refers; but there can be little question that if he made his fellows acquainted with all he had attained, and how he attaned it, he would do a great amount of good, and further the interest and welfare of his land. It must be very questionable, too, if he would not in the long run do himself also a service; for not infrequently the person who believes himself in the possession of a master secret is blind to the advance around him, and only becomes aware of it when he finds that his secret is no longer of value, because some better than it has been discovered. Concealment of knowledge is, as a rule, suicidal, not necessarily to the one person, but to the art or craft to which it refers. If our manufacturers went to scientific meetings, not with the intention of carrying away what few crumbs some rival might let fall, but of sharing their loaves round, it is far more than probable that the lack of technical knowledge which exists now-a-days would be unknown, and that a more healthy rivalry at home would have strengthened us against the dangerous rivalry abroad.

Protection for Large Cruisers.

The armored deck of each of the new great cruisers, Powerful and Terrible, which is made up of several steel plates, one over the other, either an inch or an inch and a half in thickness, serves both for the purpose of horizontal and vertical armor, as it rises at the middle line to 3 ft. 6 in. above the surface of the water, and dips at the ships' sides 7 ft. below it, thus giving a camber of 10 ft. 6 in. covered with armor, which would prevent the entrance of projectiles to the vitals of the ship. This armored deck extends from stem to stern. Over the machinery spaces it is two and one-half inches thick upon the flat or crown of the arch. At the curved sides it is 4 in. thick. Forward and aft of these spaces it is 2.5 in. thick from the point where it enters the stem to the projecting portion over the stern post; there are patches at the sides 3 in. thick. No portion of the deck armor is 6 in. thick, as sometimes stated; the idea has possibly arisen from the fact that the sloping nature of the 4 in. deck armor over the curve at the ships' side makes the horizontal distance through it 6 in., or, indeed, a little more. The entire weight of the armored deck is almost 1,300 tons, independently altogether of the vertical shield for the gun casements, etc.—The Navy and Army Illustrated, London.

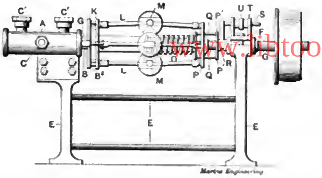
The April issue of the Rudder contains a very instructive illustrated article by Naval Architect A. Cary Smith entitled "Application of Experience in Yacht Designing as Applied to Commercial Vessels."

The Directors of the Cunard Company have submitted a statement of accounts to stock-holders, for 1896, which shows considerable improvement in the past twelve months and good prospects for the future. The profits for the year, including $3,327 brought forward from 1895, were $1,248,940. Of this a reserve of $824,110 was set aside for depreciaion of ship and wharf property, and $162,085 to the insurance fund. This left a total of $160,905 Out of this the Directors recommended the payment of a dividend of 2.5 per cent amounting to $200,000 which left a balance of $10,905 to the credit of the profit and loss account for the present year. The company has ordered three new steamers for the Mediterranean trade.

SELECTED PATENTS.

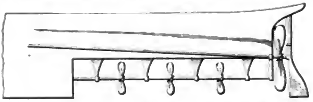
579,204—**Governor for Marine Engines.** *Alexander Wilson, Hull, England. Filed Feb. 10, 1896. Patented in England.*

An apparatus for governing marine engines to prevent them racing, consisting of a large cylinder A^1 and a small cylinder A with piston-valves B and D and inlet and outlet pipes C and C^1 respectively operated by means of arms L and falls M, shaft G having disks J and K, the piston-valve of the small cylinder A being operated by the fork B^2 working in the groove K^1 of the loose disk K, the whole being driven by means of the pulley H connected by a strap or rope to a pulley on the driving shaft of the engine as shown. 2. In apparatus for preventing marine engines racing the employment of a fork R having a screwed end S adjusted by means of a nut U and bearing against connected disks P and P^1 or compressing the spring O, so regulating the movements of the balls M and the shaft G driven by the pulley H connected to the driving shaft of the engine. 3. The apparatus for governing marine engines and to prevent them racing, consisting of cylinders A^1 and A having pistons B and D, springs B^1, pipes C and C^1; the pistons being operated by the fork B^3, disks K and J, rods L, balls M, shaft G, driving-pulley H, spring O, fork R, adjusting nut U, disks P and P^1, all operating in the manner and for the purposes described.



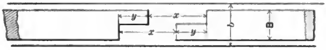
578,987—**Mechanism for Propelling Vessels.** *Jasper Hays, Nashville, Tenn. Filed March 24, 1896.*

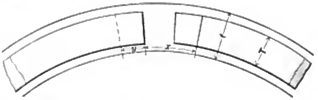
The combination with the hull having a compartment under the stern, a horizontal shaft arranged parallel with the upper wall of the hull and carrying propellers, a shaft arranged above the horizontal shaft, and at an incline, and a single propeller on the outer end of the inclined shaft, the propeller being of larger size than the others and forming the outer propeller of the series.



DIMENSIONS FOR PISTON PACKING RINGS.

The following formulæ and table of dimensions for piston packing rings will be found useful for reference:





D	d	T	t	B	b	x	y	D	d	T	t	B	b	x	y	D	d	T	t	B	b	x	y
10	10 3/4	3/8	5/8	1 5/8	1 11/16	1 5/16	1 3/16	30	31 11/16	1	1 5/16	2 3/4	2 15/16	3 7/8	1 15/16	50	52 9/16	1 9/16	2 1/8	3 9/16	3 13/16	6 1/2	2 3/4
11	11 3/4	7/16	11/16	1 11/16	1 3/4	1 7/16	1 1/4	31	32 3/4	1	1 7/16	2 13/16	3	4	2	51	53 11/16	1 5/8	2 3/16	3 9/16	3 13/16	6 5/8	2 3/4
12	12 13/16	7/16	3/4	1 3/4	1 7/8	1 9/16	1 1/4	32	33 13/16	1	1 7/16	2 13/16	3	4 3/16	2	52	54 3/4	1 5/8	2 3/16	3 5/8	3 7/8	6 3/4	2 13/16
13	13 7/8	1/2	13/16	1 13/16	1 15/16	1 5/8	1 5/16	33	34 7/8	1 1/16	1 1/2	2 7/8	3 1/16	4 5/16	2 1/16	53	55 11/16	1 11/16	2 1/4	3 5/8	3 7/8	6 15/16	2 13/16
14	14 15/16	1/2	13/16	1 7/8	2	1 7/8	1 5/16	34	35 7/8	1 1/16	1 1/2	2 15/16	3 1/8	4 7/16	2 1/16	54	56 7/8	1 11/16	2 1/4	3 11/16	3 15/16	7 1/16	2 7/8
15	15 15/16	9/16	7/8	1 15/16	2 1/16	1 15/16	1 3/8	35	36 15/16	1 1/16	1 9/16	2 15/16	3 1/8	4 9/16	2 1/8	55	57 7/8	1 11/16	2 5/16	3 11/16	3 15/16	7 3/16	2 15/16
16	17	9/16	7/8	2	2 1/8	2 1/16	1 3/8	36	38	1 1/8	1 9/16	3	3 3/16	4 11/16	2 3/16	56	58 15/16	1 3/4	2 3/8	3 3/4	4	7 5/16	3
17	18 1/16	9/16	15/16	2 1/16	2 3/16	2 3/16	1 7/16	37	39	1 1/8	1 5/8	3 1/16	3 1/4	4 13/16	2 3/16	57	60	1 3/4	2 3/8	3 3/4	4	7 7/16	3
18	19 1/16	5/8	15/16	2 1/8	2 1/4	2 5/16	1 7/16	38	40 1/16	1 3/16	1 11/16	3 1/16	3 1/4	4 15/16	2 3/16	58	61	1 13/16	2 7/16	3 13/16	4 1/16	7 9/16	3 1/16
19	20 1/8	11/16	1	2 3/16	2 5/16	2 7/16	1 1/2	39	41 1/8	1 3/16	1 11/16	3 1/8	3 5/16	5 1/16	2 1/4	59	62 1/16	1 13/16	2 7/16	3 13/16	4 1/16	7 11/16	3 1/16
20	21 3/16	11/16	1 1/16	2 1/4	2 3/8	2 9/16	1 1/2	40	42 3/16	1 1/4	1 3/4	3 3/16	3 5/16	5 3/16	2 1/4	60	63 1/16	1 7/8	2 1/2	3 7/8	4 1/8	7 13/16	3 1/8
21	22 1/4	3/4	1 1/8	2 5/16	2 7/16	2 3/4	1 9/16	41	43 1/4	1 1/4	1 3/4	3 3/16	3 7/16	5 3/8	2 5/16	61	64 3/16	1 7/8	2 1/2	3 7/8	4 1/8	7 15/16	3 1/8
22	23 5/16	3/4	1 1/8	2 3/8	2 1/2	2 7/8	1 9/16	42	44 1/4	1 5/16	1 13/16	3 1/4	3 7/16	5 1/2	2 3/8	62	65 3/16	1 15/16	2 9/16	3 15/16	4 3/16	8 1/8	3 3/16
23	24 3/8	13/16	1 3/16	2 7/16	2 9/16	3	1 5/8	43	45 5/16	1 3/8	1 13/16	3 1/4	3 9/16	5 5/8	2 7/16	63	66 1/4	1 15/16	2 9/16	3 15/16	4 3/16	8 1/4	3 1/4
24	25 3/8	13/16	1 1/4	2 1/2	2 5/8	3 1/8	1 11/16	44	46 5/16	1 3/8	1 7/8	3 5/16	3 1/2	5 3/4	2 1/2	64	67 5/16	2	2 5/8	4	4 1/4	8 3/8	3 1/4
25	26 7/16	13/16	1 1/4	2 1/2	2 11/16	3 1/4	1 3/4	45	47 7/16	1 7/16	1 15/16	3 3/8	3 9/16	5 7/8	2 1/2	65	68 3/8	2	2 5/8	4	4 1/4	8 1/2	3 5/16
26	27 1/2	7/8	1 5/16	2 9/16	2 3/4	3 3/8	1 3/4	46	48 1/2	1 7/16	2	3 3/8	3 5/8	6	2 9/16	66	69 3/8	2 1/16	2 11/16	4 1/16	4 5/16	8 5/8	3 5/16
27	28 9/16	7/8	1 5/16	2 5/8	2 13/16	3 1/2	1 13/16	47	49 1/2	1 1/2	2 1/16	3 7/16	3 11/16	6 1/8	2 5/8	67	70 7/16	2 1/16	2 11/16	4 1/16	4 5/16	8 3/4	3 3/8
28	29 5/8	15/16	1 3/8	2 11/16	2 7/8	3 5/8	1 7/8	48	50 9/16	1 1/2	2 1/16	3 7/16	3 11/16	6 1/4	2 5/8	68	71 1/2	2 1/8	2 3/4	4 1/8	4 3/8	8 7/8	3 7/16
29	30 5/8	15/16	1 3/8	2 3/4	2 15/16	3 3/4	1 15/16	49	51 5/8	1 9/16	2 1/8	3 1/2	3 3/4	6 3/8	2 11/16	69							

D=Cylinder diameter.
d =Outside diameter of ring after rough turning.
$d = 1.047D + .24$
$T = .07 + .03D$
$t = .07 + .03D + .07\sqrt{D}$
$B = .5\sqrt{D}$
$b = .54\sqrt{D}$
$x = .131D$
$y = .04D + .75$

ADMIRALTY LAW.

U. S. CIRCUIT COURT OF APPEALS.

In a Collision, Both Parties Negligent.

The responsibilities of navigation in a narrow harbor channel, are considered in the case of the collision between the fruit steamer Bowden and the Decatur H. Miller, of the Merchants' and Miners' Transportation line.

The Miller had discharged most of her cargo at the docks of the company in the inner harbor of the port of Baltimore. She had no steam up and was pulled out of her berth by the company's tug, Venus, to be towed to another wharf, where the remainder of the cargo was to be unloaded. The Miller was about 300 ft. from the wharf, when the Bowden, coming up the harbor, sighted her, and at a distance of about 1,200 ft. blew a blast, indicating that she would pass between the Miller and the wharf. The Miller did not respond, nor did the tug, which was hid from the view of the Bowden behind the hull of the Miller. Getting no response, the Bowden kept on her way, without slackening or stopping, until she was within 300 ft. of the Miller, when, observing that the Miller was gradually approaching her, the Bowden put her helm over and reversed at full speed. She steered badly, however, and did not respond readily to her engines. Consequently, her momentum was not checked, nor her direction changed when she crashed into the port side of the Miller, tearing a hole 12 ft. from top to bottom and about 3 ft. wide. The Miller was towed to her wharf and there sank.

At the time of the collision the Miller was moving under the influence of a breeze, and the momentum acquired by the previous pull of the tug. There was no tide. The lower Court had decided that there had been room enough for the Bowden to pass between the Miller and the wharf, but the pilot of the Bowden had gone too near the Miller, relying upon her to get out of the way. That he thus lost his head, and, too late, found the Bowden unmanageable. The Court of Appeals agreed with this view, holding that it was not a case of "inevitable accident," or a collision which had occurred while both parties used proper care and nautical skill. When the Bowden received no response to her signal whistle, her attention should have been arrested, and she should have taken precautions to avoid the result of negligence, even on the part of the Miller. This she failed to do. Turning to a consideration of the culpability of the Miller, the Court held that though she had the right to the position she occupied at the time of the collision, yet having regard to the narrowness of the channel and her helpless condition, she should have taken extra precautions. As a fact, her master and crew were busily occupied in duties other than those of navigation; as if she was tied up to a wharf. They did not even hear the whistle of the Bowden. True, her master could not have responded with signals indicating a course, as her engines were not going, but he could have blown danger signals, or have caused the tug to signal, or tow her out of the way. It was "manifest that the indifference and negligence" of the crew of the Miller contributed to the accident. Consequently she was also in fault, and the court found, under the circumstances, that the damages should have been apportioned. The case was accordingly remanded with instructions.

Circuit Judge Simonton, Circuit Court of Appeals, Fourth Circuit. Attorneys, Robert H. Smith for appellant and William Pinkney Whyte for appellees.

U. S. DISTRICT COURT.

Stowaway Seeks Damages For Assault.

The means for redress for a stowaway, who had been assaulted, were defined in this case. A. A. Holmes had libeled the steamship Miami to recover damages, on account of personal violence inflicted upon him by the master. The Court decided against the libelant, holding that it was a case of assault and battery, and consequently the civil proceeding against the vessel could not be maintained. Though the act complained of had happened on board the vessel, it could not be held that there was any breach of any maritime duty, or obligation, on the part of the master of the vessel. The libelant was not rightfully on the vessel. He had come aboard clandestinely and hid away, without the consent or knowledge of the master; consequently he was a trespasser. There was no contract between any one representing the vessel and the libelant, and there was no "duty" to him, on the part of the officers and crew. This the Court explained as meaning "maritime duty." There was a duty on the part of the master not to injure or cruelly treat the libelant, a duty not to allow him to die or suffer from starvation, if the master was able to relieve him. This duty, however, rested upon the principles of common humanity, and in no way arose from his duties or obligations as master of the vessel. Though the facts showed the master had "intentionally inflicted unlawful violence" upon the libelant, the Court had no jurisdiction.

District Judge Toulmin, District Court, S. D. Alabama. Attorneys, Smith and Gaynor, for libelant; Pillans, Torrey and Hanaw for the Miami.

Various Claims Growing Out of a Collision.

An interesting decision, covering several points in dispute, was given in the case of the British ship Bedfordshire against the Glencairn, to recover damages for collision in the harbor at Astoria, Oregon. The bill presented by the libelants included these items:

Necessary repairs to the Bedfordshire, and commissions thereon	$3,126.25
Loss of the use of the ship during the time required for repairs	3,650.00
Depreciation of market rates for ship of the class of the Bedfordshire in the meantime	1,618.20
Loss of time, and expenses of master and crew, and the wages thereof	800.00
Injury to the Bedfordshire by reason of the strain suffered, and other and additional losses incident to and resulting from the collision	600.00
	$9,794.45

The owners of the Glencairn admitted their liability, but calculated the damages at $2,299.50, which they deposited in court.

The collision occurred while the Bedfordshire was at anchor. The Glencairn was towed to a nearby anchorage, but her anchor was dropped so close to the Bedfordshire that when she swung around the vessels came in contact. In court, the captain of the Bedfordshire testified there was an agreement to arbitrate, but this the captain of the Glencairn denied, asserting that a third party, Captain Pope, had been called in only to decide whether certain damages had occurred at the time of the collision or before. Captain Pope had decided in favor of the Bedfordshire.

On this point the Court held, though there was no disagreement between the masters as to the understanding, in pursuance of which Captain Pope acted, there was a disagreement as to the effect of the understanding. The agreement to arbitrate should have been certain, and not left to implication, and besides, there were other matters in dispute to which the agreement did not refer. The Court would not allow the claim for damages based on a decline in charter rates, while the Bedfordshire was undergoing repairs. Evidence showed that the Bedfordshire had been in the harbor nearly a month before the collision, and had declined offers for her charter as high as 35 shillings. In the opinion of the Court she was not entitled to recover from the Glencairn the value of the market which she refused.

Considering the claim for commissions on money disbursed in repairs, the Court held, though the allowance might be customary, and had even been admitted in a case cited, in which such a claim was not contested, yet, he was not prepared to recognize such a custom among shippers as establishing a rule of damages in cases of maritime collision. The Court also declined to allow a claim for money to be paid a third person for superintending the repairs to the damaged vessel. This was for $125. In the Court's opinion there was no reason shown why the master could not have superintended the repairs himself. In fact, he was actually present during the whole period, and there was no more fit or proper person for superintending repairs than the master. Other claims were disallowed on purely legal grounds. Subsequent to the filing of this opinion the attorneys for the parties in court agreed that certain additional items, amounting to $340.15, should be paid by the owners of the Glencairn. This the Court included in the decree. He, however, gave the Glencairn's owners their costs, holding, under the rule that courts should facilitate amicable settlements, that they were entitled to it, having made reasonable offers of settlement and paid into court an amount equal to the award of the Court.

Judge Bellinger, District Court, D. Oregon. Attorneys, F. D. Chamberlain and Zera Snow for libelant. C. E. S. Wood and J. C. Flanders for claimant.

NEW PUBLICATIONS.

FUEL AND REFRACTORY MATERIALS. By A. Humboldt Sexton, F. I. C., F. C. S., Professor of Metallurgy in the Glasgow and West of Scotland Technical College; President of the West of Scotland Iron and Steel Institute, etc. London, Blackie & Son., Ltd.; New York, D. Van Nostrand Company. First edition, pp. 343. Illustrated. Price, $2.00.

In his preface to this book, the author explains that it is intended to occupy a place between the extensive treatises on the subject, and the brief material which is to be found in works on metallurgy. The conciseness with which the subject is treated—yet in a comprehensive way—is one of the chief merits of the book. It does not occupy much space and yet within its pages can be found information of an accurate scientific character about this important subject. While it is thus a work of importance, it is worded and illustrated in a manner which should make the contents plain to the intelligent student. From the very nature of it, however, it is not a book which is absolutely essential to the marine engineer, but it is one of those books which would round out a man's knowledge of the properties of fuel, and would direct his attention to still further advanced study, in various practical directions. Looking at the book from a marine standpoint it is a pity that the subject of liquid fuel is not more exhaustively treated, having been given only six pages. This perhaps is accounted for by the associations of the author, for there is a superabundance of space devoted to metallurgical processes. It is one of those convenient books, however, which for the purposes of the practical engineer give a ready means of references on the subject treated.

CATALOGUES.

An album of designs has been issued by Fred W. Martin, Racine, Wis., containing sixty-five or more full-page pictures of various types of boats, with details of design and construction. The little book is very interesting, and to those who seek information about yacht and canoe building it will prove valuable and fully worth the 50 cents charged.

The eleventh annual catalogue of the Pullman Sash Balance Co., Rochester, N. Y., is just at hand. This catalogue describes and illustrates every conceivable kind of sash balance, including quite a number of styles designed especially for use at sea. These are made of aluminum, bronze or other metal so that they shall not be affected by salt water or atmosphere. Ship builders and repairing concerns will find one of these catalogues very valuable for reference.

A very handsome catalogue was published by the Buffalo Forge Co., Buffalo, N. Y., some time ago. It is an octavo volume, very elaborately illustrated. It describes in full detail the various manufactures of this company for ventilating and heating, also forges and engines. So great was the demand for this book that another edition of several thousand copies of somewhat smaller and more compact size is about to be issued. Marine men who wish to read upon the ventilation of vessels, forging outfits for marine use, and other kindred subjects should have one of these new catalogues.

Probably the largest stock and assortment of marine, draughting and mathematical instruments in the country is illustrated in the catalogue of the Keuffel & Esser Co., 127 Fulton street, New York. They include calculators, rules, ship curves, spline weights and sets of splines, sextants, octants, sun dials, compasses of all kinds, barometers, marine glasses in great variety, and, in short, everything that a marine man might need to use in his work, whether he be on shore duty or on board ship. This company is just about to publish a new edition, which will be sent to readers of Marine Engineering upon application, illustrating and describing fully all of these instruments.

BUSINESS NOTES.

A GOOD REPAIR JOB.—Ross Iron Works, at the docks foot of Twenty-sixth street, Brooklyn, N. Y., have just completed repairing the steamer Queen Adelaide, which brought a cargo of sugar to Philadelphia from Batavia. The machinery was given a thorough overhauling, shafting being removed and trued up, and new bearings fitted, etc.

THE U. S. MINERAL WOOL CO.—2 Cortlandt street, New York, has had a steadily increasing demand for its corrugated copper gaskets since the increased use of high pressures. This gasket may be used in place of rubber or other materials in general use for packing. It consists of thin sheet copper, stamped with concentric corrugations. Three to six corrugations are all that are necessary, so that the space within the bolt holes usually determines the width of the gasket. In cases where the flanges are thin, and for this reason liable to bend when the bolts are tightened, it is advisable to extend the copper gasket to the full width of flange. This will, of course, require the cutting of bolt holes in the gasket. Connections made with these gaskets will not blow out after continued use, for each corrugation makes the entire circle of the flange, and so long as the contact is kept complete by compression the joint cannot leak. They may be put in place while steam is leaking through a valve.

VENTILATION ON BOARD SHIP.—It is only comparatively recently that mechanical ventilation has received much attention from ship designers. It is desirable, as a rule, that ventilation should be carried out without the use of cumbrous apparatus, and for this reason electric motors are being largely used for driving ventilating fans and blowers. A combination of this sort is manufactured by the Interior Conduit & Installation Co., 527 West 24th street, New York. These can be used in any part of the ship in which a supply of air can be obtained, and an outlet found to get rid of the foul air. As heat will always ascend to the top of the room the plan usually adopted is to supply cool fresh air at a point near the bottom, and exhaust near the top. With the use of this particular apparatus it is claimed that the temperature of any engine room can be maintained within at least ten degrees of the outside temperature. A fan house is located on the upper deck with ventilating ducts to the engine room. The apertures should be the right proportion so that the cubic contents of the room ventilated can be changed from one to five times a minute. The amount of air can of course be controlled by the speed of the motor. This company gladly furnishes details of the apparatus implied.

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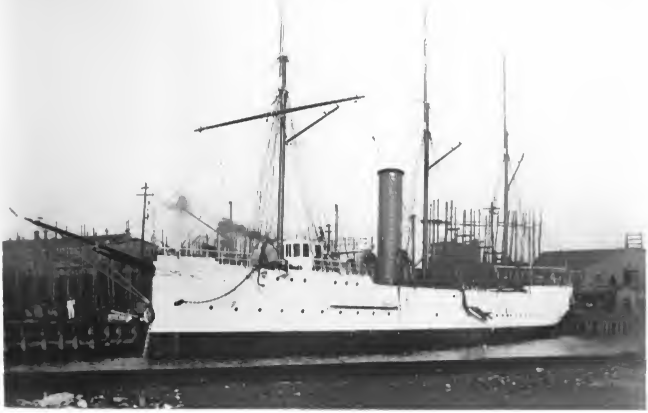
U. S. REVENUE CUTTER McCULLOCH FOR SERVICE IN BEHRING SEA.



U. S. REVENUE CUTTER McCULLOCH LYING AT THE BUILDERS' YARD.

While the Navy has been undergoing the reconstruction period, the Revenue Cutter Service has not been overlooked by Congress, for during the past five years ten new vessels have been authorized, varying in size from 250 to 1,280 tons displacement, and costing in the aggregate nearly $1,500,000. These vessels are all of the most modern type, and while built especially with reference to the duties incidental to the Revenue Cutter Service, their construction is such that they can readily be transformed into despatch boats and small gunboats, thus providing a valuable auxiliary to the regular Navy in time of war. A typical vessel of the new type is the Revenue Cutter McCulloch, now nearing completion at the yards of her builders, The Wm. Cramp & Sons Ship and Engine Building Co., of Philadelphia. This vessel is intended for service in the Behring Sea patrol fleet, and eventually to replace the Revenue Steamer Bear, for the annual voyages to Northern Alaska and Siberia. As these coasts are as yet uncharted, the navigation in the fogs and ice is consequently extremely hazardous; it was therefore determined to make this vessel of composite build, in the belief that wooden planking under water would be far safer for contact with the ice and occasional groundings on the rocky bottom. As the plans for the McCulloch were completed before the appropriations for the 1,000 ton gunboats were secured, this makes the new revenue cutter the first composite built Government vessel of modern construction.

She is 219 ft. long over all, 33 ft. 4 in. breadth of beam molded, 14 ft. mean draft, and 1,280 tons displacement. The frames, and plating above the water are of mild open hearth steel; the stem, stern frame and rudder are of manganese bronze. The entire stem is made in one piece, and is the largest single casting of manganese bronze ever made in this country, its total weight being 14,000 pounds. The physical requirements for this material were a tensile strength of not less than 50,000 pounds per square inch, an elastic limit of at least 18,000 pounds per square inch, and an elongation of not less than 18 per cent in a length of 2 in. The actual results obtained from the tests exceeded the requirements in every instance, thus demonstrating that if strength alone was considered, this bronze is superior to the best wrought iron forgings, and equal to the best forgings of steel. In addition to a flat keel plate of 20 lb. steel and the 15 lb. vertical keel plate, there is a main wooden keel of Puget Sound fir, sided 15 in. by 17 in. in depth, and a false keel of the same material, 3 in. thick and 15 in. in width. There is a steel bilge strake, with numerous diagonal plates connecting it to the outside plating above the water line. The planking extends from the wooden keel to a sheer line about 2 ft. above the water line, amidships. It is of selected Puget Sound fir, and with the exception of the garboard strake, is 5 in. thick on the frames of the vessel and reduced over tie-plates and other plating, to make fair work. The planking is secured to the frames by Tobin bronze bolts, 15-16 in. diam. in the shank. The heads of the bolts are let into the planks on the outside, and covered over with wooden plugs. The nuts on the inside are set up on thin iron washers, with hemp grommets well soaked in red and white lead, underneath. The upper edge of the top strake is protected by a beveled angle iron, riveted to the plating.

Externally the McCulloch presents a handsome appearance; she is rigged as a three-masted schooner and has a bowsprit and jibboom, thus enabling her to carry a large sail spread, to be used as an auxiliary while cruising in the Behring Sea. Her stem is fitted with a port for a 15 in. torpedo tube. Her armament will consist of four 6-pounder, rapid firing rifles, arranged in sponsons, two forward and two aft. It is expected that she will be capable of maintaining an average speed of 16 knots an hour.

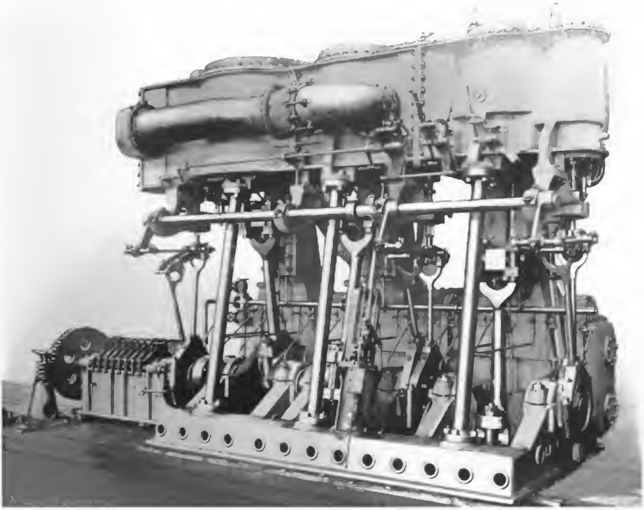
Her propelling machinery consists of one vertical direct acting, triple-expansion engine, capable of developing 2,400 indicated horse power when using mild forced draft. The cylinders are 25 in., 37 1-2 in. and 56 1-4 in. dia. respectively, with a common stroke of 30 in. All three cylinders are fitted with working linings, and the intermediate and low pressure cylinders are steam jacketed. The main pistons are of cast steel, conical in shape. Each is fitted with two cast iron packing rings, 5-8 in. wide, 3-4 in. thick, cut obliquely and tongued. The piston rods are of high tensile open-hearth steel, 5 in. dia. The connecting rods are of the same material, 5 in. dia. at the upper ends, 6 1-2 in. at the lower ends, and 75 in. long between centers. The requirements for the steel used for piston rod, connecting rod and valve stem forgings were a tensile strength of 80,000 pounds per sq. in. and an elongation of not less than 25 per cent in a length of 2 in. Test pieces 1-2 in. square cut from these forgings, were bent double, flat on themselves, after being quenched from a cherry red heat, without showing the slightest sign of fracture. The crank, line, and propeller shafts are forged of mild open-hearth steel. The crank shafts are solid forgings in two sections; the crank pins are 10 1-2 in. dia. and 13 1-2 in. long. The thrust and intermediate shafts are 9 3-4 in. dia. and the propeller shaft 10 1-2 in. dia. The front columns supporting the engine are of forged steel 6 in. dia. The requirements for the steel used in forging the columns, reversing the main shafting were a tensile strength of 60,000 pounds per square inch, and an elongation of not less than 25 per cent in a length of 8 in. The high pressure cylinder is fitted with one piston valve, 14 in. dia.; the intermediate and low pressure cylinders are each fitted with a double ported slide valve. All are actuated by the Stephenson link motion, with double bar links. The travel of the high and low pressure valves is 7 1-2 in., and the intermediate valve travels 6 1-4 in. All eccentric straps are of composition, lined with white metal. The reversing engine is 10 in. dia. by 18 in. stroke, and, in addition to the floating lever attachment, a special cushioning device is fitted to both ends of the cylinder. The thrust bearing is of the horse shoe type, fitted with eight collars, lined with white metal. These are mounted on two steel rods, 2 1-4 in dia. and are each held in place by composition adjusting nuts. The pedestal for the thrust bearing is bolted to the main engine bed plate and in addition the foundations for the main engine and thrust bearing are tied together by a steel plate 3-4 in. thick.

The condenser is rectangular in shape and forms a part of the framing of the engine. There are 1,253 seamless drawn copper tubes, tinned inside and outside, each 5-8 in. dia. 18 B. W. G. thick, and 4 ft. 5 in. long, between tube sheets. The total cooling surface is about 3,000 sq. ft. The inlet and outlet nozzles for the circulating water are each 10 in. dia. The tube sheets are of rolled composition, 7-8 in. thick.

The air pump is of the Blake independent, vertical, duplex type, bolting directly to the main condenser. The steam cylinders are 9 in. dia., the air cylinders 20 in. dia., with a common stroke of 12 in. The air cylinders are lined with composition; the valves are of the best quality of medium hard rubber, held in place by composition valve bolts and springs of phosphor bronze. The main and auxiliary feed pumps are of the Blake vertical, duplex, Naval type, with 8 in. steam cylinders, 5 in. water cylinders, and 12 in. stroke. The circulating pump is of the independent centrifugal type, operated by a single vertical engine, with a steam cylinder 8 in. dia. by 8 in. stroke. In addition to the above, there is a large fire pump, a combined fresh and salt water pump, a hand pump and an air pressure pump for forcing air into the fresh water supply tanks. Two No. 10 Korting boiler injectors are also fitted for feeding the boilers.

The propeller is of the built up type, having four blades of manganese bronze, which are secured to the cast steel hub by bronze studs. The diameter is 12 ft., the pitch (true) is 12 1-2 ft., and the helicoidal area about 43 sq. ft. The blades are 4 1-4 in. thick at the root, and taper to 3-4 in. thick at the tips.

Steam is supplied at a maximum pressure of 160 lbs. by four single ended boilers of the Scotch type, 11 ft. 6 in. outside dia. by 10 ft. long, containing a total heating surface of 5,030.7 sq. ft., and a grate surface of 168 sq. ft. Each boiler has two corrugated steel furnaces, 3 ft. 6 in. internal dia. There are in each boiler 172 ordinary tubes No. 10, B. W. G. thick, and 46 stay tubes No. 6, B. W. G., all 2 1-2 in. external diameter, and made of the best charcoal iron. The shells are each made of two plates, 19 1-2 ft. long, 9 1-2 ft. wide, and 1 1-6 in. thick. The ingots from which each shell plate was rolled, weighed, on the average, 10,000 lbs. The grates are 6 ft. in length, and the bridge walls extend from the rear end of the grate bars to the back of the combustion chambers. There is one double smoke stack, having a sectional area of 30.6 sq. ft.



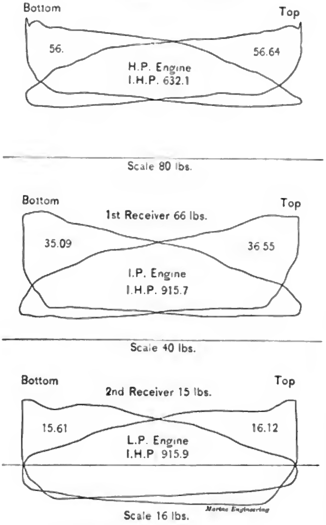
TRIPLE-EXPANSION ENGINE OF U. S. REVENUE CUTTER MCCULLOCH.

There is a complete distilling apparatus, capable of supplying 3,500 gallons of potable water every 24 hours. A machine shop containing a lathe, shaper and drill press is located in the lower engine room. A steam windlass, steam steering engine, hydropneumatic ash ejector, and other modern appliances are also provided.

The machinery was designed under the supervision of Engineer-in-Chief John W. Collins of the Revenue Cutter Service.

TRIAL TRIPS AND DATA.

U. S. S. "McCULLOCH"



April 29th 1897————————3 45 P.M.
Steam pressure at Engine————149 Lbs.
Revolutions per minute———————154
Vacuum——————————————24 5 Ins.

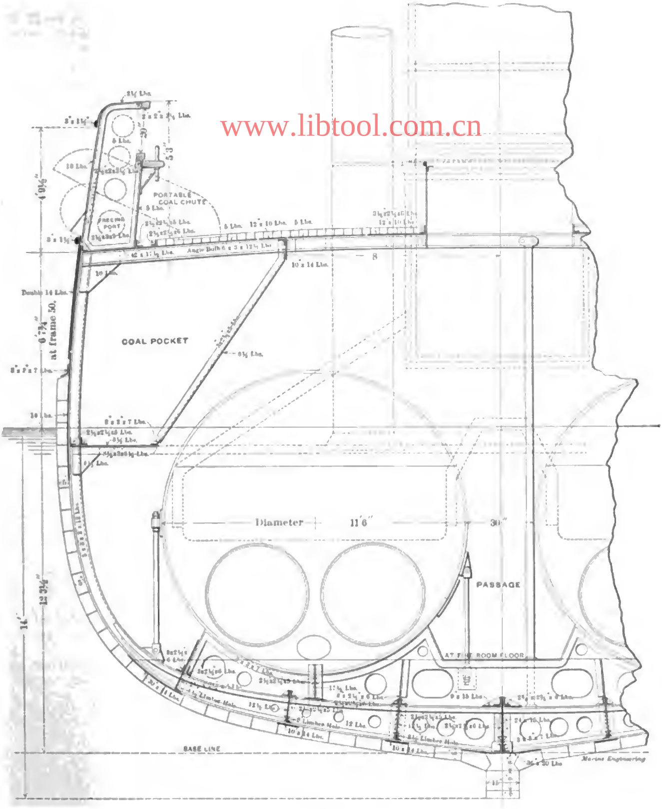
The official trial of the McCulloch took place on April 29th, at sea, off Cape Henlopen, over what is known as the Cramp course, a distance of twelve nautical miles between two buoys. The Board appointed by the Secretary of the Treasury to conduct the trial of the steam machinery, consisted of Captain J. W. Collins, the Engineer-in-Chief of the Service, Chief Engineer F. B. Randall, and First Assistant Engineers C. A. McAllister and W. E. Maccoun. Four runs were made over the course without altering the speed or slowing the engines at the turns. The average air pressure maintained in the fire room was 1.5 in., the boilers steaming freely without great exertion on the part of the firemen. The machinery operated very satisfactorily in every particular, the bearings, with the exception of a light stream on the thrust, worked cool without recourse to the water service. Indicator diagrams were taken every fifteen minutes during the forced draft trial and at intervals of a half hour during the run under natural draft. The following data represent the average performance for the forced draft trial, during a period of four hours.

Speed in knots per hour		17.23
Speed, maximum of the four runs		17.34
Revolutions of main engine per minute		151.8
Slip of propeller, per cent		13.14
Piston speed, in feet per minute		759
Steam pressure at boilers (per gauge)		161.3
Steam pressure at 1st receiver (absolute)		76.3
Steam pressure at 2d receiver (absolute)		28.6
Vacuum in condenser (in. of mercury)		24.5
Opening of throttle		wide
Cut-off, mean	H. P	.703
	M. P	.714
	L. P	.719
Double strokes of air pump per minute		41
Revolutions of circulating pump		165
Double strokes of main feed pump, per minute.		16
Revolutions of blowers, average		756
Temperature of feed water, deg. F		125
Temperature of sea water, deg. F		51
Temperature of discharge water, deg. F		155
Mean pressures in cylinder	H. P	56.23 lbs.
	M. P	35.82 lbs.
	L. P	15.86 lbs.
I. H. P. main engine	H. P	639.5
	M. P	784.3
	L. P	815.5
Total I. H. P. for main engine		2,230.3
Total I. H. P. for main engine and auxiliaries		2,349.9
Maximum I. H. P. main engine and auxiliaries		2,598.3
Mean normal thrust, lbs		28,700
Normal thrust in lbs. per sq. in. of thrust bearing		48.1
Cu. ft. swept per minute by L. P. piston per I. H. P		5.84
Sq. ft. of cooling surface per I. H. P.		1.28
Sq. ft. of heating surface per I. H. P.		2.14
I. H. P. per sq. ft. of grate surface		13.93

The live steam connections were opened to the I. P. and L. P. cylinders during the runs, which will account for the uneven distribution of power in the three cylinders.

Japan is now doing shipbuilding and engineering work on a large scale. Recent reports showed, among other vessels, three steel steamers on the stocks varying from 1,492 to 5,790 tons.

An addition to the fleet engaged in the Canadian-Australian Mail Service has been made by the putting into service of the S.S. Aorangi, formerly running between New Zealand and London. This ship, which is Clyde built and is thirteen years old, has been re-engined and thoroughly overhauled. She is 407 ft. long, 46 ft. beam, 23 ft. 7 in. deep, and has a registered tonnage of 4,268 tons. She has accommodation for 150 passengers. The old engines were compound of 3,000 horse power, and these have been replaced by triple expansion engines of 5,000 horse power, which give a service speed of about 15.5 knots. Four new boilers have been put in to replace six taken out, the new boilers working under Howden's system of forced draught. The new engines have cylinders 32 in., 51 in., and 86 in. by 54 in. stroke. Joy's assistant cylinders are fitted to the intermediate and low pressure slide valves to balance the weight of the heavy valves and gear. Among the engine room auxiliaries is an evaporator with a capacity of 40 tons daily, large provision having to be made for fresh feed, owing to the distances between the ports of call on the Pacific route.



Scale ¼ in. = 1 ft.

CROSS SECTION U. S. REVENUE CUTTER McCULLOCH, AT FRAME 50, SHOWING METHOD OF CONSTRUCTION OF COMPOSITE VESSEL.

APPLICATION OF THE COMPOUND STEAM TURBINE TO MARINE PROPULSION.*

BY HON. CHARLES PARSONS.

It has been suggested by Sir W. H. White that a paper giving some account of the application of the compound steam turbine to the purposes of marine propulsion might be of interest to the members of this institution. The date of this paper is perhaps somewhat premature, as the Turbinia, the first boat fitted with turbine engines, has not yet completed her experimental trials, but as the results so far ascertained are in some respects remarkable, this perhaps may afford some excuse for their publication. The manufacture of the compound steam turbine was first commenced in the year 1885 with the construction of small engines for the driving of dynamos; successive improvements were made, and larger engines constructed, but up to the year 1892 the consumption of steam was not such as to justify the application of this class of engine to the purpose of marine propulsion, though on account of its light weight, small size, and high speed of revolution it presented greater advantages over ordinary engines for certain classes of work.

In the year 1892, however, a highly developed compound turbine, adapted for condensing, was constructed for the Cambridge Electric Supply Company, and when tested by Professor Ewing, F. R. S., showed a consumption of steam equivalent to 15.1 lb. per indicated horse power per hour, the boiler pressure being 100 lb., and the steam superheated to 127 deg. F. above the point of saturation. More recently, compound turbine engines have been constructed up to 900 horse power, both condensing and non-condensing, and consumption of steam as low as 14 lb. per indicated horse power with saturated steam, and 100 lb. boiler pressure, have been ascertained in engines of 200 horse power, and still lower consumptions in engines of larger size. Many of the original engines are still doing good work; some especially the larger sizes of 500 horse and upwards, are frequently kept at work for several weeks without stopping. The returns of the Newcastle and District Electric Lighting Company show a yearly cost of up-keep of 2½ per cent per annum, and the total horse power of turbines now at work in England exceeds 30,000 horse power.

In January, 1894, a syndicate was formed to test thoroughly the application of the compound steam turbine to marine propulsion, and a boat was designed for this purpose. In view of the large amount of alteration that would probably be required before a satisfactory issue was reached, and the large amount of time and expense necessarily involved, it was decided to keep the dimensions as small as possible, but not so small as to preclude the possibility of reaching an unprecedented rate of speed, should all the parts work as satisfactorily as was anticipated. The fulfilment of these anticipations was, however, much delayed, and almost frustrated, by a difficulty which, though foreseen, proved to be of a much more serious character than was anticipated. This difficulty was that termed by Mr. R. E. Froude "the cavitation of the water," or, in other words, the hollowing out of vacuous spaces by the blade of the screw, and this pitfall for the designers of screws for very fast vessels, though indicated by theory to exist, came upon us in the case of our very fast running screw, taxed beyond the usual extent, in its most aggravated form. When the boat and machinery were designed the trials of the Daring, which first drew attention to this difficulty, had not taken place.

The Turbinia—as the boat is named—is 100 ft. in length, 9 ft. beam, and 44½ tons displacement. The original turbine engine fitted in her was designed to develop upwards of 1,500 actual horse power at a speed of 2,500 revolutions per minute. The boiler is of the water tube type for 225 lb. per square inch working pressure, with large steam space and large return water legs, and with a total heating surface of 1,100 sq. ft., and a grate surface of 42 sq. ft.; two firing doors are provided, one at each end. The stokeholds are closed, and the draught furnished by a fan coupled directly to the engine shaft. The condenser is of large size, having 4,200 sq. ft. of cooling surface; the circulating water is fed by scoops, which are hinged and reversible, so that a complete reversal of the flow of water can be obtained should the tubes become choked. The auxiliary machinery consists of main air pump and spare air pump, auxiliary circulating pump, main and spare feed pumps, main and spare oil pumps, also the usual bilge ejectors; the fresh water tank and hotwell contain about 250 gallons. The hull is built of steel plate, of thickness varying from 3-16 in. in the bottom to 1-16 in. in the sides near the stern, and is divided into five spaces by water-tight bulkheads. The deck is of steel plate.

Trials were made with screws of various patterns, but the results were unsatisfactory, and it was apparent that a great loss of power was taking place in the screw. To investigate the question thoroughly, a spring torsional dynamometer was constructed, and fitted between the engine and screw shaft, measuring the actual torque transmitted. The measurements conclusively proved that the cause of failure lay entirely in the screws, and, with the object of further investigating the character of this waste of power, a series of experiments were made with model two-bladed screws of 2 in. diameter, revolved in a bath of water heated to within a few degrees of the boiling point, and, in order that the model screw should produce analogous results to the real screw, it was arranged that the temperature of the water and the head of water

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* Read before the Institution of Naval Architects in London, April 8, 1897

above the propeller, as well as the speed of revolution, should be such as to closely resemble the actual conditions and forces at work in the real screw, the object in heating the water being to obtain an increased vapor pressure from the water, so as to permit a representation of the conditions with a more moderate and convenient speed of revolution than would otherwise have been necessary.

The approximate weights are:

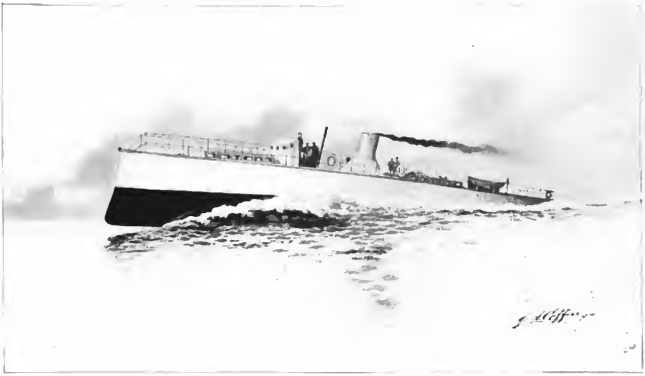
Main Engines	3 tons 13 cwt.
Total weight of machinery and boiler, screws and shafting, tanks, etc.	22 tons.
Weight of hull complete	15 tons.
Coal and Water	7½ tons.
Total displacement	44½ tons.

The screw was illuminated by light from an arc lamp reflected from a revolving mirror attached to the screw shaft, which fell on it at one point only of the revolution, and by this means the shape, form and growth of the cavities could be clearly seen and traced as if stationary. It appeared that a cavity or blister first formed a little behind the leading edge, and near the tip of the blade; then as the speed of revolution was increased, it enlarged in all directions until, at a speed corresponding to that in the Turbinia's propeller, it had grown so as to cover a sector of the screw disc of 90 deg. When the speed was still further increased, the screw, as a whole, revolved in a cylindrical cavity, from one end of which the blades scraped off layers of solid water, delivering them on to the other. In this extreme case nearly the whole energy of the screw was expended in maintaining this vacuous space. It also appeared that when the cavity had grown to be a little larger than the width of the blade, the leading edge acted like a wedge, the forward side of the edge giving negative thrust.

From these experiments it would appear that in all screws, of whatever slip ratio, there will be a limiting speed of blade, depending upon the slip ratio and the curvature of the back—in other words, on the slip ratio and thickness of blade; beyond this speed a great loss of power will occur; and that, should the speed of ships be still further increased, the adoption of somewhat larger pitch ratios than those at present usual will be found desirable.

It is not proposed here to trace further the losses of power by cavitation, but, generally speaking, the effect is felt in the case of the real ship, not in the racing of the screw, but in loss of propulsion effect. In the model experiments, however, in hot water, the effect was both loss and propulsion effect and also racing, as would naturally be expected from the fact of greater vapor density of the water in the latter case rendering the cavities more stable. A series of model experiments on cavitation in cold water on the lines described would be extremely interesting, and probably instructive, but would require more elaborate, powerful and extremely high-speed apparatus than was at our disposal. It would also seem that the limitation imposed on slip ratio tends in favor of larger pitch ratio for very fast vessels.

The single compound turbine engine was now removed from the boat and replaced by three



TURBINIA DOING 32.75 KNOTS ON THE MEASURED MILE.

separate compound turbines, directly coupled to three screw shafts, working in series on the steam, the turbines being the high-pressure, intermediate and low-pressure, and designed for a complete expansion of the steam of 100-fold, each turbine exerting approximately one-third of the whole power developed, the three new screw shafts being of reduced scantling. By this change the power delivered to each screw shaft was reduced to one-third, while the division of the engine into three was favorable to the compactness and efficient working of the turbines. The total weight of engines and the speed of revolution remained the same as before. The effect on the screws was to reduce their scantling, and to bring their conditions of working closer to those of ordinary practice. The thrust of the propellers is balanced by steam pressure in the motors. The rest of the machinery remains the same, though some changes in arrangement were necessary. The usual lignum-vitæ bearings are used for the screw shafts. The engine cylinders lie closely to the bottom of the boat, and are bolted directly to small seatings on the frames of sufficient strength to take the thrust of the propellers. The center of gravity of the machinery is consequently much lower than with ordinary engines.

At all speeds the boat travels with an almost complete absence of vibration, and the steady flow of steam to the motors may have some influence on priming; at any rate, no sign of this has yet occurred with ordinary Newcastle town water. No distilling apparatus has been fitted. The boat has been run at nearly full speed in rough water, and no evidence of gyroscopic action has been observable, though such a result would be anticipated from the known small amount of these forces under actual conditions; indeed, the Turbinia has so far proved herself an excellent sea boat. The oiling of the main engines is carried on automatically under a pressure of 10 lb. per sq. in. by a small pump worked off the air-pump engine; a small independent duplex oil pump is also fitted as standby. The main engines require practically no attendance beyond the regulation of a small amount of live steam to pack the glands and keep the vacuum good.

The advantages claimed for the compound steam turbine over ordinary engines may be summarized as follows:—(1) Increased speed, (2) increased economy of steam, (3) increased carrying power of vessel, (4) increased facilities for navigating shallow waters, (5) increased stability of vessel, (6) increased safety to machinery for war purposes, (7) reduced weight of machinery, (8) reduced space occupied by machinery, (9) reduced initial cost, (10) reduced cost of attendance on machinery, (11) diminished cost up-keep of machinery, (12) largely reduced vibration, (13) reduced size and weight of screw propellers and shafting.

APPENDIX.

Trials of the Turbinia.—In December of last year several runs were made on the measured mile, and the maximum mean speed obtained after due allowance for tide was 29.6 knots per hour, the mean revolutions of the engines being 2,550 per minute. Since then new propellers of increased pitch ratio have been fitted. Further trials were made on April 1. The mean of the two consecutive runs gave a speed of 31.01 knots per hour, the mean revolutions of the engines being 2,100 per minute, the fastest run being at the rate of 32.61 knots per hour. The utmost horse power required to drive the boat at the speed of 31.01 knots is 946, as calculated from experiments on her model, made at Heaton Works, on the method of the late Mr. William Froude.

Assuming the ratio of thrust horse power to indicated horse power to be 60 per cent (which appears to be the ascertained ratio for torpedo boats and ships of fine lines), the equivalent indicated horse power for 31.01 knots is 1,576. The feed water supplied to the boiler was measured by a Siemens water meter previously calibrated under the working conditions, and found to be substantially correct. These measurements were made when running at a speed of 28 knots, and the consumption at 31.01 knots has been calculated from these measurements according to the known law between steam pressure and consumption, and by the observed steam pressures on the engines at the respective speeds. The consumption at 31.01 knots is approximately 25,000 lb. per hour, or 15.86 lb. per indicated horse power. It should be observed that the assumption of the thrust horse power being 60 per cent of the indicated horse power presupposes that the propellers are of the best form attainable, and should those now fitted be superseded by others of higher efficiency, as is possible, and indeed probable, then the figures of consumption per indicated horse power will be correspondingly improved, and the speed of the boat increased. The consumption of steam at 11.4 knots speed has been measured by meter, and found to be 2,700 lb. per hour, or equivalent to a coal consumption of about 24.6 lb. per knot.

Conditions of running of Turbinia at 31.01 knots speed

Mean revolutions of engines	2,100	
Steam pressure in boiler	200	℔
Steam pressure at engines	130	℔
Vacuum at exhaust of engines	13.5	℔
Speed of boat	31.01	knots
Calculated thrust horse-power	946	
Calculated indicated horse-power	1,576	
Consumption of steam, reduced to basis of 31.01 knots	25,000	℔
Consumption of steam per indicated horse-power per hour	15.86	℔
Total weight of machinery, including boiler, condensers, engines, auxiliaries, shafting, propeller, tanks, water in boiler, and hotwell, in working order	22	tons
Indicated horse-power per ton of total machinery	72.1	

Owing to adverse weather, these trials have been much delayed, and had finally to be made under unfavorable circumstances. They are, however, believed to be substantially accurate.

On Saturday, April 10, the Turbinia attained the highest velocity ever reached by a steam vessel, making an average of 32.75 knots on the measured mile.

TWIN-SCREWS SUPERSEDE PADDLES.

Here are shown two types of mail steamships belonging to the City of Dublin Steam Packet Co., which claims the honor of being the oldest existing steamship company, having been founded in 1823. The paddle steamer represents the type of vessel which has maintained an uninterrupted service between Holyhead and Kingstown, across the Irish Channel, for nearly 40 years, carrying the mails. It is over this route that the American mails sent via Queenstown are ferried across the 60 odd miles between England, or more properly Wales, and Ireland. The paddle fleet consisted of the Ulster, Munster, Leinster, Connaught, and the newer Ireland. The first four named vessels have very recently been superseded by twin-screw steamers of the same names, one of which is shown lying beside her wharf, in the illustration. The wonderful record made by the old vessels for punctuality, speed and safety has become a matter of common knowledge wherever steamships are known. Now that they have been sold out of service renewed attention is directed to the service, for the record already made by the new vessels is hardly less interesting. The first of these, the Ulster, on her maiden voyage, attained a mean speed of 23.4 knots, making the across-channel passage in 2 h. 26 min.

PADDLE MAIL STEAMSHIP IRELAND WITH PASSAGE RECORD OF 20.70 KNOTS.

TWIN-SCREW MAIL STEAMSHIP ULSTER WITH PASSAGE RECORD OF 23.4 KNOTS.

The four original vessels of the fleet were built in 1860, the Leinster by Samuda, of London, and the Ulster, Munster, and Connaught by Laird Bros., of Birkenhead, who are very generally known on this side of the Atlantic as the builders of the Alabama. The vessels were of similar dimensions, ranging in length from 327 to 343 ft., in beam from 35 ft. to 35 ft. 2 in., and in tonnage from 1,695 to 1,750 tons. They drew 12 ft. 6 in. forward, and 13 ft. 2 in. aft. All were of iron, and the quality of material and workmanship was so good that when sold the hulls were as sound as the day they were launched. Each vessel was fitted with low-pressure oscillating, jet-condensing engines of 4,500 horse power. Working at a pressure of 26 lbs. to the square in., the paddles doing 25½ revolutions per minute. The highest speed which they attained was 18 knots, considered a wonderful performance when built. It is worth noting that the last passage made by each of these boats in 1897, was quicker than the first in 1860. During all these years none of these boats missed a passage through failure to put out, though the weather in the channel is often fearfully bad. Nor was a single life ever lost from any of the boats though the track which they cross is perhaps the most frequented by shipping of any in the world, and fogs are frequent. The vessels were fitted with new boilers and forced draught some years ago, but the engines were never changed. A record of the performances of the Connaught shows that when new the time of 1,000 consecutive passages, from pier head to pier head, a distance of 56.75 nautical miles, not making any deductions for delay by fog, storms or other cause, was 3h. 51⅓m. And 1,000 consecutive passages, under similar circumstances, commencing in 1885, when the ship had been overhauled and new boilers fitted, averaged 3h. 33m.

The Ireland, which is shown approaching Kingstown at full speed, was built in 1885 by Laird Bros. also. She is a steel vessel 380 ft. long, 38 ft. beam, with engines of the same type as the older boats, working at a pressure of 32 lbs. per sq. in., and indicating 7,000 horse power. Her quickest passage was done in 2h. 45m.

The four new twin-screw steamers recently built by Laird Bros. are sister ships; 380 ft. long, 41 ft. 6 in. beam, with a draught of 13 ft. forward and 15 ft. aft. They are fitted with triple expansion engines, indicating 9,000 horse power when running at 162 revolutions, with 160 lbs. boiler pressure. The record passages for these boats up to the present are: Ulster, 2h. 26m.; Leinster, 2h. 23m.; and Munster, 2h. 25m. During this passage the Leinster was sent at the rate of 24 knots for the greater part of the trip, the engine speed being run up to 172 revolutions. The Munster made her fastest passage in the face of a stiff head wind.

It will be noticed from the illustration that the new vessels closely resemble Transatlantic liners in outward appearance. The hurricane deck forward, the long stretch of deck houses amidships, and the boat deck are characteristic. These boats do not carry any freight other than passengers' baggage, being used exclusively for fast passenger and mail service. They have accommodation aboard for about 1,000 passengers. In a later issue we hope to present some views of the interior arrangements which are very handsome and convenient.

For the photographs which are here reproduced we are indebted to the courtesy of George M. Roche, Cambridge House, Montpelier Hill, Dublin.

LARGEST PADDLE STEAMSHIP AFLOAT, BRITISH OR AMERICAN?

The new paddle steamship Empress Queen, now under construction by the Fairfield Shipbuilding and Engineering Co., at Govan, on the Clyde, for service in the Irish Sea, has been described at length in British technical papers of late, with the comment that when completed she will be "the largest and most powerful paddle steamer afloat." Judging from the build and performances of other boats on the Liverpool-Isle of Man route, the Empress Queen is undoubtedly a magnificent vessel. But the British enthusiasts have evidently forgotten the existence of the Priscilla, of the Fall River Line, running out of New York. She also has some claims to the championship, if the word is permissible, and, to enable the reader to judge for himself, the descriptions of these vessels are here given, with appropriate illustrations. Every statement regarding the Empress Queen is as "big" as her admirers make, for the description is understood to be "official."

BRITISH STEAMSHIP EMPRESS QUEEN.

The Empress Queen is a vessel of 2,000 tons gross, constructed of steel throughout, and, when completed, will rank as the largest and most powerful paddle steamer afloat. She is to have engines of 10,000 I. H. P., and has been splendidly fitted up for the accommodation of a large number of passengers. The new steamer is intended for the Liverpool and Douglas service of the Isle of Man Steam Packet Co. The name Empress Queen has been given her by Her Majesty's special permission and in honor of her diamond jubilee. The principal dimensions of the new steamer are: Length, 375 ft.; breadth, 83 ft. 6 in.; depth, molded, 25 ft. 6 in. The hull is divided into watertight compartments by steel transverse bulkheads, which, besides reducing the risk of foundering to a minimum, materially augment the strength of the structure, forming valuable supports and ties between the decks and framing. The decks are four in number, and are termed "lower," "main," "spar," and "promenade." Dining accommodation for 124 first-class passengers is provided in a handsomely furnished saloon on the lower deck. The forward part of the ship is allotted to second-class passengers. The dining saloon, forward of machinery space, on the lower deck, having bar and pantry adjoining, provides ample accomodation for the second class. On the same deck, and forward of this, is a ladies' second-class saloon. The main deck above is arranged as a second-class shelter, and contains a bar, buffet, mail, and parcel room. On the spar deck aft, in houses, are several private cabins, fitted with berths, etc., in the very newest style; and amidships on the same deck is a cloak-room and combined bar and smoking-room; while all fore and aft every available space is utilized for sitting-room, there being sparred seats sufficient to seat over 560 persons. Above the spar deck is a spacious promenade deck, extending from the fore end of the boiler-room right aft to the end of the first-class cabin, with buoyant seats running the entire length, excepting a small portion at the after end, which is required for the boats. The stowage of the boats has received special attention, so as to allow of immediate launching if necessary. The promenade deck covers about three-fourths of the length and the whole breadth of the vessel, and being unobstructed by anything but absolute necessities, such as captain's house and bridges, it in every way justifies the title, promenade. The bridges which surmount the promenade deck are placed, one at the foremost extremity for navigating purposes, and the other between the funnels, and extending from sponson to sponson. From both of these bridges the bow and stern rudders are controlled by means of wheels connected with independent steam steering gears placed below on the engine-starting platform. A hand-screw steering apparatus is also placed in reserve aft in case of emergency. Docking and engine telegraphs are provided on each of the bridges. A complete installation of electric light is fitted on board, including deck and embarkation lights, etc., all on the most improved system. A steam capstan windlass is fitted for-

ISLE OF MAN STEAM PACKET EMPRESS QUEEN.

FALL RIVER LINE PADDLE STEAMER PRISCILLA.

ward for working the ship's cables, and on the spar deck aft a powerful capstan is fitted for warping and mooring purposes. A double-acting steam winch is fitted forward for the speedy handling of luggage, etc. The vessel will be fitted with compound diagonal surface-condensing engines, the largest and most powerful paddle-wheel engines yet built. There will be three steam cylinders placed side by side, and working on three cranks, the high-pressure cylinder being placed between the two low-pressure cylinders. The high-pressure cylinder is fitted with a piston valve, and each of the low-pressure cylinders with flat slide valves, all controlled by the usual double eccentrics and link motion valve gear. The crank shaft is a ponderous piece of machinery. It is built, and together with the paddle shafts is forged of mild steel and bored hollow. The starting and reversing is effected by a large steam and hydraulic engine on the direct-acting principle. The paddle-wheels are made of steel, and constructed on the feathering principle with curved floats. Steam is supplied to the engine by four double-ended boilers arranged in two compartments, one forward and one aft of the engine-room. The boilers are of the multitubular return-tube marine type, each having eight corrugated furnaces, and constructed entirely of steel to Board of Trade requirements. They are adapted to work with Messrs. Howden's system of forced draught, and the necessary fans and engines will be fitted to supply air to the furnaces. The vessel will have two funnels, and will be rigged as a schooner with two pole masts.

GRAND SALOON OF PRISCILLA.

AMERICAN STEAMSHIP PRISCILLA.

The Priscilla is the largest boat of the Old Colony Steamboat Company's fleet, better known as the Fall River Line. The contractors for the vessel were the W. & A. Fletcher Co., Hoboken, N. J., who built the engines. The hull was constructed by the Delaware River Iron Shipbuilding and Engine Co., Chester, Pa. She was launched August 10, 1893, and went into commission June 25, 1894. Her dimensions are: length, 440 ft. 6 in.; breadth, 93 ft.; depth, molded, 21 ft. 6 in. Her register tonnage is 5,398 tons, and her engines develop 9,000 horse power. The vessel runs between New York and Fall River, Mass., taking the inside course, a distance of 181 miles, which is covered at an average speed of 18 miles. She is built of mild steel, with a double hull, which extends well above the water line. This space is divided into 52 water-tight compartments, and there are 9 additional water-tight compartments between the inner hull and the main deck, 61 in all. The boat is very substantially stiffened throughout. In the salons and cabins,

MIRROR IN GRAND SALOON OF PRISCILLA.

concealed by the elaborate ornamentations and joiner work, steel trusses spring from the decks at the bases of the wall and span in unbroken arches overhead. There are four decks running the entire length, main, saloon, promenade, and hurricane deck. There are 361 staterooms for passengers, and 32 for the ship's officers, and in the dining room 325 passengers can be seated at one time. The main gangway for passengers connects with the quarter deck used as a smoking room or lobby, which is immediately forward of the dining room on the main deck. The various offices of the ship are situated here, together with the barber shop, cigar store and other conveniences. The floor is laid in mosaic, and the woodwork is rich mahogany, the walls relieved with beautiful groups in bas-relief. The windows of the dining room command a splendid view on three sides. The decorations of this room and the table features, which make a very artistic ensemble, can be seen in the accompanying illustration. Aft of the dining saloon there are private dining rooms and ladies' cabins. From the quarter deck a wide staircase leads up to the grand saloon. A view of this is here shown. This saloon rises up through the promenade deck, and is lit by side lights under the span of the roof. The furnishings and decorative work are artistically magnificent, a blending of rich reds and white and gold, with polished metal work. A specimen of the ornamental detail is shown in the illustration of the engine room bulkhead or-

	Launched.	Length.	Breadth.	Depth, Molded.	Tonnage, Gross.	I. H. P.	Passenger Accom.	Dining Room Accom.
Empress Queen	March, 1897	372 ft.	83 ft. 6 in.	26 ft. 6 in.	2,100	10,000	560	124
Priscilla.....................	August, 1893	440 ft. 6 in.	93 ft.	21 ft. 0 in.	5,388	9,000	1,500	325

COMPARATIVE TABLE DIMENSIONS, ETC., PADDLE STEAMSHIPS EMPRESS QUEEN AND PRISCILLA.

DINING ROOM ON MAIN DECK OF FALL RIVER LINE STEAMSHIP PRISCILLA.

namentation. The promenade deck gives communication to the upper cabins in the grand saloon and provides a wide stretch of level deck for passengers, fore and aft and along the sides, except amidships, where the engine trunk is carried up. On the hurricane deck there is a splendid promenade space running all around. On this deck the officers' rooms occupy the center, and the boats are carried at the sides. In the front is the pilot house, fitted with the newest navigating apparatus. The propelling engine is a double inclined compound, with two high-pressure cylinders 51 in. dia., and two low-pressure 95 in. dia., by 11 ft. stroke. The wheels are of the feathering type, 35 ft. dia. and 14 ft. wide, with 13 buckets each. These are 5 ft. by 14 ft. by 1 in. thick, and the dip, at the mean draught of 13 ft., is 8 ft. In design the engines are very massive. The main journals are 27 in. dia. and 30 in. long, and the crank journals are 21¾ in. dia. The engines average 22 revolutions at full speed. Two surface condensers are fitted with a total of 15,868 square feet cooling surface. There are four circulating pumps with 12 in. discharge, and engines 10 by 10 in. Steam is supplied at 130 pounds pressure by 10 Scotch boilers, 14 ft. by 14 ft. 6 in., fitted with Serves tubes. These boilers have 850 square ft. grate surface, and 35,620 square ft. heating surface. There are also two superheaters fitted, 8 ft. 8 in. inside dia. and 12 ft. long. Blowers with 7 in. by 10½ in. engines are fitted so that forced draught can be used. There are two smoke stacks, 9 ft. 6 in. dia., and with tops 100 ft. above the keel line. The bunker capacity is 200 tons, and fresh water tanks, holding 9,210 gallons, are used. The engine room is well supplied with the most improved auxiliaries. The electric light plant is extensive, supplying current to 1,900 lamps. The Priscilla has accomodation for 1,500 passengers and 800 tons of freight, and has a crew of 206 men. She is capable of a much higher rate of speed than that usually attained, but as the run is at night it would cause passengers inconvenience in having to get up too early if she made faster time.

The American Society of Mechanical Engineers held the spring meeting at Hartford, Conn., commencing May 25. At the opening session an address of welcome was read by the Mayor of Hartford. Many valuable papers were read during the meeting, visits were paid by the members to large works in the vicinity, and an excursion was made to the stone quarries at Portland.

On a recent eastward voyage the Cunard liner Lucania covered 2,939 miles in 5 d. 14 h. 54 m., at an average of 21.80 knots. The mean speed for two days' steaming was 22.33 knots.

The Navy Department has selected the U. S. Cruiser Brooklyn to represent the United States at the Diamond Jubilee of Queen Victoria.

STEAMSHIP VIBRATIONS WITH RECORDS OF RECENT OBSERVATIONS.—I.

BY PROF. W. F. DURAND.

The subject of steamship vibrations has within a few years received a very considerable amount of attention from marine engineers and naval architects, and from others similarly interested in the modern development of the science and art of marine construction. The great increase in the ratio of power developed to weight of hull has brought with it the possibility of setting up vibrations of a character so severe as either to preclude the possibility of realizing the power desired, or to threaten the dismemberment of the vessel when pushed to full power conditions.

In order to understand the existence of these vibrations we must first remember that the typical modern ship, as a whole, may be considered as an elastic steel structure, and like any other elastic structure it may be thrown into systems of vibration in a variety of ways. For purposes of general illustration, the ship may be represented by an elastic steel rod, say two feet long and one-quarter inch square section. If in addition special weights, such as bits of lead, are secured along the rod more or less irregularly so as to represent the more important weights of the ship, such as boilers, engines, etc., the analogy will be still more complete, and if still further the cross section of the rod were modified here and there to represent the varying amount of resisting moment in the material of the ship, the representation would be still more satisfactory. Suppose such a system taken in the hand and held horizontally at the middle. Then we know that by shaking it gently up and down the rod will be thrown into vibratory motion in the same direction. In such case the middle and the ends will at any instant move in opposite directions, while between the middle and each end there will be an intermediate point nearly at rest. Such points are called nodes, while the remaining points form portions called loops. Such a mode of vibration is one of the simplest into which such a system can be thrown, and is the type of the principal mode usually found in a vibrating ship. Vibrations of higher orders may exist in such a rod, and in the ship of which it is the illustration. The complete examination of these systems would be beyond the scope of the present article, but those interested may refer to a paper by Herr Otto Schlick published in the transactions of the Institution of Naval Architects for 1894.

In making such an experiment we should soon find that for a given amount of energy expended, a greater and greater result will become apparent as the distinct impulses are more nearly timed in accord with the natural period of vibration of the system with which we are dealing. Another illustration of this well-known phenomenon is found in the excessive vibrations which may be developed even in a massive bridge by the proper timing of the impulses as by a body of men marching across in step and in time with its own natural period. As the timing of the impulses becomes less and less in accord with the natural vibrations of the system, the result for the same amount of effort is less and less, until when the divergence becomes very great, the result for a small effort becomes quite inappreciable. If, however, the impulses are so timed as to be an even sub or over multiple of the proper number (as one-half of twice the number) somewhat greater disturbance may be expected than with intermediate values. These are usually, however, of small relative importance, and with ships we are chiefly concerned with the fundamental system of vibrations. In using the weighted rod as an illustrative vibrating system, we must remember that the ship is a vastly more complex structure, and that instead of being supported at the middle or at the two ends or at any definite number of separate points, it is provided with a distributed support ready to yield in any and all directions. The ship is therefore more complex and less constrained than the representative system, and hence the more ready to respond to periodic disturbing impulses. In fact, we find that any such elastic system is ready to respond to the application of any periodic or regularly timed impulse, and the response will be the more notable, other things being equal, the more nearly the disturbance is timed in accord with the natural period of vibration of the system. We shall recur at a later point to some further features of the relation between the ship and the disturbing impulses, but for the present it will be sufficient to remember that a periodic impulse applied almost anywhere on the ship is sufficient to set up a system of vibrations, more or less severe according to the circumstances of the case.

Let us now look for the possible causes of such periodic impulses. We naturally turn to the engine as the initial source of effort on the ship, and there find a ready response to our inquiries. There are in the engine three principal sources of such periodic impulses: Unbalanced reciprocating parts, unbalanced cranks, and unbalanced pressures on the guides. These we will briefly examine in order.

First let us consider what is taking place during the first part of the down stroke. The net pressure on the piston is down. An equal net pressure acts upward on the cylinder as a whole. Now if the piston and other reciprocating parts were at rest, or were moving with a uniform velocity, there would be no force involved in their acceleration or retardation, and, omitting friction, the net vertical load on the piston would be ultimately transmitted as a vertical pressure on the crank shaft, and by it, to its bearings, and thus to the engine bed-plate. The pressure of the steam would thus introduce two equal and opposite forces, one lifting up on the bed plate by way of the columns, the other pressing down by way of the main pillow block bearings. There would thus be simply a tendency to bend the bed plate, sides up and center down, but no tendency to force it as a whole down on to its seating, or to lift it bodily upward. In the actual case, however, the piston and other reciprocating parts are moving with an accelerated velocity. This means that force is being spent to bring about this acceleration, or in other words, that they are absorbing, so to speak, a part of the net pressure on the piston, and only the remainder is transferred down to the connecting rod and thus to the bed plate. It thus results that there is actually during this part of the stroke, a lesser force down than up, and hence the result is a net lift on the engine and bed plate as a whole, and hence a decreased load on the engine seat and ship in this locality. The result is thus equivalent to a sudden upward impulse applied to this part of the ship's structure. During the latter part of the down stroke, the reciprocating parts are moving with a retarded velocity, and they resist, so to speak, this retardation, and hence transmit down to the connecting rod a greater load than that due to the net piston pressure. In this part of the stroke, then the downward load is greater than the upward, and the result is a thrust downward from the engine upon the seating and structure of the ship. In a similar manner we may see that during the first part of the up-stroke the result is downward, and during the latter part upward. It follows, therefore, that while the piston is in the upper part of the cylinder, whether moving up or down, there is a net lift on the bed plate and seating, and when in the lower part there is similarly a net thrust downward. We have thus a regularly varying effort alternating up and down with every revolution of the engine, and quite sufficient to account for much of the trouble whose causes we are discussing.

Turning now to the cranks we find the webs and pin revolving in circular paths about the shaft axis, while a considerable part of the connecting rod is moving in a path very nearly the same. Due to centrifugal force there is a constant pull outward radially. When the crank is on the upper part of its path, the general resultant of this is upward, and when on the lower part it is similarly downward. The engine bed plate and seating are furthermore so rigid in a transverse direction, that the horizontal resultant of these forces is unable to produce any significant effect, and so far as results are concerned, the centrifugal forces may be considered as giving rise to an alternating up and down impulse, adding, as is seen, its influence to that of the unbalanced parts considered above. This simple analysis does not take account of the angular acceleration of the connecting rod, but is sufficiently complete for the purpose in view.

The third cause of disturbing impulses is found in the periodically varying side thrust on the guides. With the engine turning in any given direction, this is always directed the same way.

and varies from nothing at the two ends, to a maximum at or near the middle. There is thus a side thrust or impulse varying from nothing to a maximum twice in a revolution, and thus tending to cause a vibration in the columns, and a bending or rocking of the bed plate on its seating. These impulses are twice as rapid as those previously considered, and hence their separate effects are not wholly additive. The influences due to the more rapid impulses will, however, enter in and become absorbed by those previously referred to, modifying them more or less according to circumstances. In addition to these principal sources of disturbing impulses, others of less importance are found in the movement of the main slide valves, the eccentrics, the auxiliary machinery, etc.

There is still another cause of disturbance applied at another part of the ship and which we may now briefly consider. The crank effort is continually variable throughout the revolution to an extent depending on the circumstances of the case. Due partly to this, but more especially to the irregularities in the wake or stream in which it works, the propeller moves with a variable angular velocity, and meets with a varying resistance throughout the revolution. Generally speaking, any given blade meets with its maximum resistance when in the upper part of its path, and with its minimum when in the lowest part. There is also a more or less pronounced impulse or blow communicated to the stern post as the blade passes nearest it, especially if the clearance between the two is small. Due to these causes the stern of the ship receives a series of irregular periodic impulses which combine with, and modify the results of those previously discussed.

As a result of the indefinite capacity for vibration possessed by the ship in virtue of its elastic and irregular structure, and of these irregular but periodic impulses, the entire ship is thrown into vibratory movement more or less complex and irregular according to circumstances. Illustrations of the character of such motion are to be seen in the accompanying diagrams, to which special reference will be made at a later point.

The immediate results of this motion are twofold: Discomfort to the passengers and personnel, and a greater or less amount of additional periodic stress thrown on the structure of the ship. The tendency of the latter, if the vibrations exist in excess, is to shake loose riveted and bolted joints, and generally to loosen and disorganize the entire structure. Under such conditions, the decks and bulkheads vibrate like so many drumheads, while the entire structure is rising and falling alternately at the ends and middle. With the existence of such vibrations in excess it may well result, that either the vessel will receive serious injury, or else that the full power and speed cannot be obtained. It may also be pointed out, that such vibrations are in themselves a direct absorbent of power. If the ship were entirely surrounded by air, the power absorbed, once the vibrations developed, would be but small. As it is, however, the ship is partially surrounded by water, and this is a medium most admirably adapted to the absorption of the energy of such a vibrating system. We may, in fact, imagine the energy of the vibrations constantly streaming away into the water, its place necessarily taken by fresh energy derived from the engine as the source of power. While, doubtless in any ordinary case, such loss would be small in amount, yet its existence should not be overlooked.

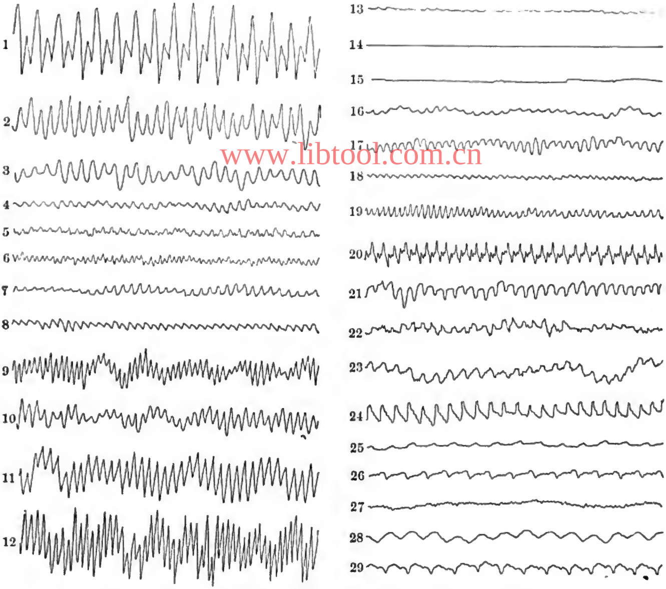
We will now turn briefly to a description of the diagrams shown in the plate. These were taken from the screw steamer Maine, of the Providence and Stonington Lines, on the regular trips of March 31, and April 1, 1897. The principal dimensions and particulars of this ship are as follows:

Length over all	310 feet
Length on water line	302 "
Beam over guards	60 "
Beam at water line	44 "
Draft (mean)	11 ft. 6 in.
Displacement	2,200 tons

Cylinders, 28 in., 45 in., and two 51 in.; by 42 in. stroke.
Propeller 4 bladed, 13 ft. 6 in. diam. by 18 ft. 6 in. pitch.

The cylinders are in the sequence: High, intermediate, first low, second low, from forward aft. The high and intermediate cranks are opposite, as are also the two low pressure cranks, and the two pairs are at right angles. There are two decks continuous except for the space for the engine and boiler trunk. The upper of these, the saloon deck, carries the superstructure containing the staterooms and is covered by a light shade deck arched in the transverse direction. Above the saloon deck forward, is located an additional superstructure, carrying the dining room and café, and above this the pilot house. Below the main deck aft, is a half deck for berthing second class passengers. The hull is of steel and is apparently well built throughout.

Turning now to the plate, Figs. 1 to 12 inclusive, show diagrams of the vertical movement at points on the main deck from aft forward, distributed as nearly uniformly as possible. No. 1 was over the propeller and No. 12 by the windlass. The number of revolutions was about 100 per minute, and the number of principal vibrations is, of course, the same. No. 1 shows at this instant an interference effect evidenced by the partial suppression of every other vibration. A few seconds earlier on the same diagram, the character was similar to that shown in No. 2. Nos. 5 and 6 show the successive growth of another form of interference effect. Each principal vibration in the downward direction on the diagram is modified by an impulse in the opposite direction, until at No. 6, the original vibration of 100 per minute, has been cut up into a double number as shown. In No. 7 the secondary impulse has fallen again to an unimportant feature, and the main vibration of 100 per minute is again established. In Nos. 9, 10, 11, and 12 are shown



RECORD OF OBSERVATIONS OF VIBRATIONS ON PROVIDENCE AND STONINGTON LINES, S.S. MAINE.

effects due to vibrations of longer period or to irregular disturbances due either to the waves, or to cumulative influences arising from the minor vibrations themselves.

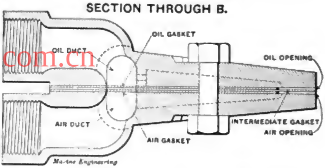
In No. 13 we have the transverse vibration at the same location as for No. 1. Nos. 14 and 15 are similarly related to Nos. 7 and 12. The transverse vibrations are thus seen to be quite negligible. The longitudinal vibrations were found to be quite as small. These vibrations were all taken from the decks. As we shall see later we find pronounced transverse and longitudinal vibrations from other members of the ship. No. 16 was taken from the dining room situated on the upper promenade deck forward. Nos. 17 and 18 were taken from the main keelson, the former at the after end near the stern tube, and the latter about 30 ft. forward of this point No. 19 was taken from the lower engine room floor. No. 20 was taken from the same location as No. 2, when backing, but not at full power. The much greater irregularity of the movement is plainly indicated. Nos. 21 and 22 are from the top of a steam radiator in the after end of the main saloon. No. 21 shows the vertical component and No. 22 the transverse. Nos. 23 and 24 were taken from the head of the after low pressure cylinder. No. 23 shows the vertical component and No. 24 the longitudinal. Similarly Nos. 25, 26, and 27 show the vertical, longitudinal, and transverse components from the same place with somewhat less power. Nos. 28 and 29 show similarly the vertical and longitudinal components from the head of the Intermediate Pressure cylinder. A series of diagrams taken from aft forward on the saloon deck gave results similar to those shown for the main deck, but of somewhat lesser amplitude. These diagrams show that the central portion of the ship was very free from vibration, and that the movement for the most part consisted of vertical oscillations of the ends. In other words the points referred to as nodes in the first part of the article, have drawn together and include substantially its central body of the ship. This seems to be in accord with general experience with ships of moderate size, so far as the point has been observed. In the next article various means for the prevention of vibrations will be considered.

RESULTS OF LIQUID FUEL EXPERIMENTS IN THE U. S. NAVY.—1.

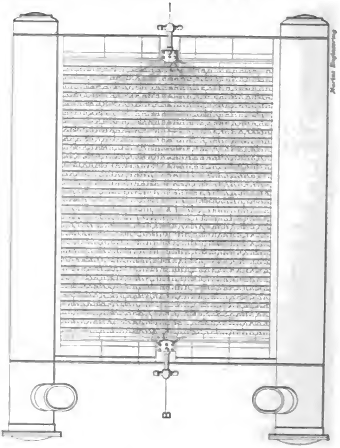
BY J. S. ZERBE.

In September, 1895, Commodore George W. Melville, Engineer-in-Chief of the Bureau of Steam Engineering, U. S. N., authorized the Experimental Board of Naval Engineers to conduct a series of exhaustive tests to ascertain the relative values of coal and liquid fuel, and to determine the efficiency of the latter for naval purposes. Numerous tests have been made in different countries, during the past twenty years, to utilize liquid fuel, but the results have been so varied that no reliable data was obtainable. While many of the experiments showed high evaporative values, the question of efficiency was left unsettled. High evaporation is not always the best criterion. While the relative evaporation of oil and coal may be as two to one, it does not follow that the efficiency is in the same ratio. Time is an element which must be considered. A system of using liquid fuel which will evaporate the largest amount of water within a given time is the most efficient, because the difficulty is and has been to "force" a boiler with oil as with coal. It is in this particular that former experiments have failed for marine purposes. The firing could, of course, be forced, but to do so would invariably produce smoke, cause blistering of crown sheets or tubes and require an excessive use of oil. Such has been the result of naval tests heretofore, and when the Consolidated Gas Fuel Co., of New York, first presented the question of making official tests of its system to Chief Engineer Melville, he was doubtful concerning the value of this fuel for naval purposes, principally for the reasons set forth.

In order to give some idea of the system it will be necessary to point out a few of the distinguishing features employed in the old systems of using fuel oil, and, primarily, it should be observed that there seems to be a general impression among all who have, heretofore, entered this field, that the atomizer or burner is the essential feature in the process of burning oil. The burner is, simply, a stoker, and while it is true that one burner may stoke better than another, this advantage is a small one when compared with the fire box equipment. A fire box which is not specially equipped to burn liquid fuel will never do good work, however perfect the burner may be. Over seven hundred patents have been obtained for burners, and less than thirty for fire box equipments. This shows most emphatically how vigorously inventors have struggled at the wrong end of the problem, and explains why failures are so common the world over. Furthermore, it may be said that there are two ideas predominant in the minds of liquid fuel experimenters beyond which they seem loth to go. The first is that a candle or barrel shaped flame is essential, and that the flame should be ejected against a baffling wall erected within the fire box. These features are primeval in their character, fundamentally wrong in their operation, and radically deficient in results when applied under any type of boiler.

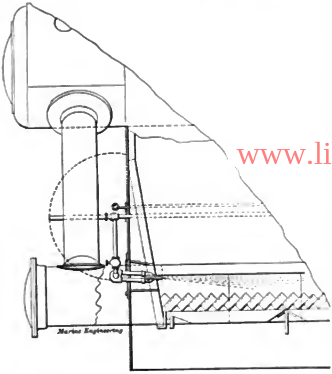


SECTION OF FUEL OIL BURNER.



SECTION OF BOILER OVER GRATE.

The essential thing is to perfectly aerate the hydro-carbon gases evolved by the heat of the combustion chamber. Where oil is thrown into the heated chamber the gases form rapidly, an immense expansion takes place, and the interior of this conical flame cannot receive the requisite amount of air to produce perfect combustion; hence, owing to the rapid movement of the mass, it passes into the tubes with a large portion of unconsumed particles, and thus passes into the flue and out the stack in the form of smoke. At this point the inventor sought by a new expedient to arrest the flame, break it up and produce a mixing operation by introducing a baffling wall. The flame in striking this wall would natu-



POSITION OF BURNER WITH REFERENCE TO GRATE.

rally be deflected upwardly, so that it would strike the boiler sheet or tubes, and thus form a zone of intense heat at the wall, which has been found to be very destructive to the boiler. But this is not all. The wall naturally diminishes the size of the combustion chamber, which should in all cases be larger than for coal, in preference to being smaller. There is also a very serious defect in the old style, so called oil equipments, in the manner of admitting air to the fire box. In all cases it has been customary to admit air in a mass, either around the burner or into the fire box at one point through the grate surface. This results in producing a disagreeable noise; cold air is admitted to the boiler, and when so supplied, in a body, the desirable mixing operation is not accomplished to produce a steady, uniform flame, of great intensity. Some inventors provide conduits and retorts for heating air, while others provide a vaporizing chamber for the oil; but all these attempts to utilize auxiliary mechanism or contrivances outside of the fire box to prepare the fuel and air are needless expenditures of force, make the system complicated and difficult to regulate, and are useless expedients when compared with the "direct conversion" system which contemplates the taking of the fuel and the oxygen in the natural state, and producing complete combustion within the fire box itself. Manifestly such a system is much simpler in construction, more easily operated, and less expensive

The construction of such a system, therefore, contemplates the following features:

First—The fire box must perform the entire operation.

Second—The grate surface must not be decreased in area.

Third—The heating surface of the fire box should not be diminished.

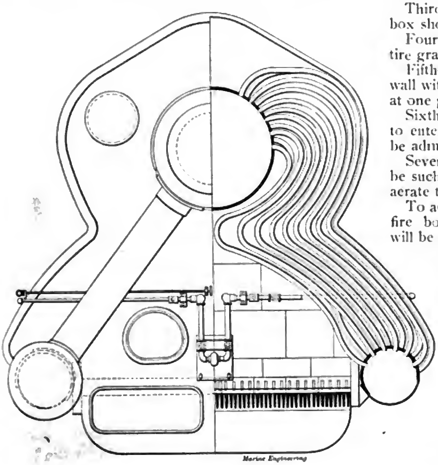
Fourth—The flame should cover the entire grate surface.

Fifth—There should be no retarding wall within to produce a great zone of heat at one point.

Sixth—Cold air must not be permitted to enter the fire box, and it should never be admitted in a mass.

Seventh—The shape of the flame should be such that the air will freely mingle and aerate the entire mass.

To accomplish this a very simple form of fire box construction was provided. It will be seen by reference to the illustrations that the entire grate surface is covered with a single layer of specially prepared fire brick. This brick has, on one side, ducts, partially across one face, and these brick are nested against each other at an angle of 45°, so that when the bars are covered small ducts are formed through this bed over the entire surface. This bed formation has several very important functions. It breaks up the air, so that it enters the fire box in small jets, and after the burner has been in operation a short time the entire bed is heated up to incandescence,



METHOD OF FITTING FUEL OIL ATTACHMENTS.

thus heating the air as it passes through the ducts. The bed, when in this state, also acts as a substitute for an incandescent bed of coal, giving out radiant heat to the boiler, and thus economizing fuel. The burner or atomizer is specially adapted for use with this brick bed, as it is designed to throw a fan-shaped spray, thus causing the flame to cover the entire bed, so that when the subdivided jets of air come up through the ducts in the bed, every part of the flame has its requisite supply of heated air, which readily commingles with the hydrocarbon gases.

The burner is simple in construction, being composed of two castings, an upper and lower part, substantially similar in construction, the upper part having an oil supply connection and the lower part an air or steam inlet. These inlets terminate in open transverse channels, from which radial grooves extend to a point near the forward circular end of the burner. The contact faces of these ducts are dressed off, and between them are placed three copper gaskets or diaphragms, the intermediate one of which has its forward edge extending to the circular rim of the burner, while the upper and lower gaskets have V-shaped notches cut therein, the bases of which communicate with the radial ducts. These gaskets are composed of No. 30 gauge copper or even thinner material, and as the oil and the compressed air, or steam, are forced through the small interstices, the V-shaped openings permit the liquid and the steam to expand horizontally, producing a continuous sheet at the mouth of the burner. The two parts and the gaskets are held together by means of bolts. This form of burner has several distinct advantages. In cutting the gaskets a greater or less number of these ducts can be brought into action, or the flame can be horizontally disposed over a wide or narrow area, dependent on the shape of the fire box. By using thicker or thinner gaskets the capacity can be increased or decreased, and as the oil channel which supplies all the ducts is horizontally disposed the burner can be directed at any angle desired without having an undue flow of oil to the central or the side ducts. In the torpedo boat tests compressed air was used. The illustrations show a water tube boiler designed for the new 140 ft. torpedo boats which are now in process of construction, and will give a comprehensive idea of the system, although the tests were conducted with a Mosher water-tube boiler.

The experiments were conducted in the New York Navy Yard on one of the Government torpedo boats, fully one year being consumed in the entire series of experiments, nine months of which were devoted to liquid fuel and three months to coal tests on the same boat. The experiments were conducted by the Experimental Board of Naval Engineers, composed of Chief Engineers Lewis J. Allen, Prest., George Cowie, Jr., and H. S. Ross.

Holland Submarine Torpedo Boat.

The accompanying illustrations show the submarine torpedo boat, designed by John P. Holland, before and during the launching at the Crescent Shipyard of Lewis Nixon, at Elizabethport, on May 17. The boat is of the familiar cigar-shape, 55 ft. long and 11 ft. dia. in the widest part. It is very substantially built, the skin plating being 1-2 in. mild steel. This motive power consists of a 50 horse power Otto gas engine driving a single screw, while traveling on the surface, and an electric motor taking current from storage batteries, when the boat is submerged. Steering is effected by two rudders, one vertical for steering on the surface, and the other horizontal to regulate the depth at which the vessel will be maintained. Entrance to the boat is effected through the turret which surmounts the structure, and which is telescopic, and fitted with glass lights for observation. The interior of the vessel is more roomy than one would imagine from a view of the exterior. In the forward end the tanks for compressed air are carried, and beneath the floor plates, the storage batteries. Aft of this much space is given to the engine and dynamo and fittings, the floor here being at a lower level. The fighting powers of the vessel are supplied by an ordinary Whitehead torpedo apparatus pointing forward, an 8 in. aerial torpedo gun with a range of 1 1-2 miles in the same direction, and a submarine gun which will eject an 80 pound high-explosive shell aft. Another boat of this type, to be propelled by triple screws is building at Baltimore. For these particulars and the photographs of the vessel we have pleasure in acknowledging the courtesy of C. A. Morris, who is interested in the success of the boat.

INFLUENCE OF MOIST STEAM IN THE ECONOMY OF A STEAM TURBINE.*

BY D. S. JACOBUS.

There has been an impression in the minds of some engineers that the presence of a small amount of moisture in the steam used by a steam turbine might tend to improve the efficiency by increasing the density of the jets of steam that impinge against the buckets of the wheel. This would not follow from the theory of the steam turbine if the friction of the turbine and of the steam in the passages, and other losses, are not included, but as these form a large factor in the economy, and must be taken account of in any theoretical discussion of the effect of moisture, the problem becomes complicated, and it is difficult to predict, from theory, what the exact effect will be.

Tests were therefore undertaken, in which the amount of moisture in the steam was accurately determined, by starting with dry steam and condensing a portion of the same in the steam main leading to the turbine. The heat required to condense the steam, so as to form the moisture, was determined, and from this heat the weight of moisture was calculated. The power developed by the turbine was measured by means of a prony brake. The total amount of water consumed by the turbine was measured by condensing the exhaust in a surface condenser, and from this total amount the moisture in the steam on entering the turbine was deducted to obtain the weight of dry steam used by the turbine.

The conclusions arrived at are:

First.—The average dry steam consumption, or the total water consumption, less the weight of entrained water in the steam entering the turbine, was about the same for either dry or wet steam.

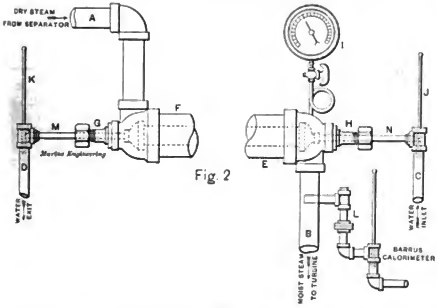


Fig. 2

Second.—This may only hold for wheels of a similar type running under similar conditions.

The pressure of steam in the tests was about 95 lb. per sq. in. above the atmosphere. The turbine wheel was 8 5-8 in. dia., and ran at about 10,200 revolutions per minute.

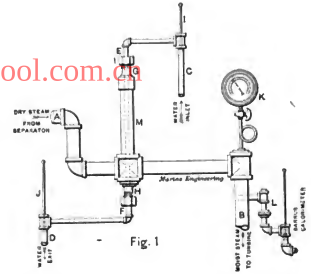


Fig. 1

At 14 1-2 brake horse power the dry steam consumption was about 68 1-2 lb. per hour per horse power, with either dry steam or steam containing moisture.

The weight of dry steam per hour per brake horse power, in comparative tests, is given in Table I. There were sixteen jets of steam impinging on the turbine wheel. These were in groups of four each, and the governor was arranged so that it cut off the steam from one or more of the four groups of jets. Each jet had a width of 1-8 in., measured in a vertical direction to the plane of rotation of the turbine wheel. The smallest cross-section of each jet was about 0.009 sq. in., and the largest 0.015 sq. in. The jets issued at an angle of 67 deg. to the radius of the wheel.

The turbine wheel was of steel. It was 8 5-8 in. dia., and was geared so that the driving shaft ran at 1-10 of the speed of the wheel. The prony brake was placed on the driving shaft. There were 46 buckets in the turbine wheel. The width of the passages in the wheel, measured at right angles to the plane of rotation, was 3-16 in. The area of the cross-section of the passages in the wheel was about 0.032 sq. in. The angles made by lines tangent to the two sides of a bucket in the wheel with a radius passing through the bucket averaged 52 deg. on the inside of the wheel and 69 deg. on the outside.

The devices employed for condensing a por-

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* Read at the meeting of the American Society of Mechanical Engineers, Hartford, May, 1897.

tion of the steam in the pipe leading to the steam turbine are shown in Figs. 1 and 2. The device shown in Fig. 1 was employed for the tests when there was a small percentage of moisture, and that shown in Fig. 2 for the tests when the percentage of moisture was made greater.

The steam from the boiler first passed through a separator (not shown in the figures), and from the separator entered the pipe marked A in Figs. 1 and 2.

In Fig. 1 cold water entered the pipe C, and flowed through the pipe EF, which was enclosed in the steam space in the vertical pipe M. The half-inch pipe EF passed through two stuffing-boxes G and H. The water flowing through the pipe EF was heated, and condensed a portion of the steam. The amount that the water was heated was measured by means of two thermometers, I and J, placed in mercury wells. The weight of water circulated through the pipe EF was determined by collecting it in a large tank placed on a pair of platform scales.

The arrangement of piping shown in Fig. 1 was used in tests Nos. 7, 11, and 13. The pipe M and the pipe EF were made longer in tests Nos. 11 and 13 than in No. 7, so as to increase the amount of steam condensed.

Tests Nos. 15, 17, and 18 were made with the arrangement shown in Fig. 2. The vertical pipe M shown in Fig. 1 was dispensed with, and a horizontal length of 2-in. pipe was used for condensing a portion of the steam, in place of the vertical length of 1-2 in. pipe. The horizontal 2-in. pipe was placed inside of the 4-in. pipe FE, and is shown by dotted lines in Fig. 2. The inlet water passed through the 1-2 in. pipe N, and the exit water passed out through the 1-2 in. pipe M. The pipes N and M passed through the stuffing-boxes H and G. The temperature of the water was measured by means of the thermometers J and K.

The total amount of steam entering the turbine, together with the entrained water in the same, was measured by condensing the exhaust of the turbine in a surface condenser.

In the tests with dry steam no water was circulated through the cooling pipes, and the steam was found to be dry by means of the Barrus calorimeter, marked L in Figs. 1 and 2, or to contain less than 1-5 per cent of moisture, which is considered as dry steam in the present investigation.

The tests with wet and dry steam were made alternately, so as to eliminate errors due to any possible change in the turbine.

The piping shown in Figs. 1 and 2 was coated with hair felt. The exhaust pipe leading from the turbine was of a large diameter, and the back-pressure of the exhaust steam was practically that of the atmosphere.

The prony brake consisted of two hemp ropes passed around a pulley about 12 in. dia., in which were fastened two flanges so as to form a hollow rim. The ropes made a full turn about the pulley, and were fastened to a wooden frame.

TABLE I.

STEAM CONSUMPTION PER HOUR PER HORSE POWER FOR A STEAM TURBINE WITH DRY AND WET STEAM.

TESTS WITH DRY STEAM.			TESTS WITH WET STEAM.			
Number of Test. 1	Horse Power by Prony Brake. 2	Steam per Hour per Horse Power. 3	Number of Test. 4	Percentage of Moisture in Steam. 5	Horse Power by Prony Brake. 6	Steam per Hour per Horse Power = Total Water Consumption Less Weight of Entrained Water in Steam Entering the Turbine. 7
9	15.17	67.5	7	3.7	15.08	68.7
12	15.25	67.6	11	4.7	15.13	67.1
14	15.17	71.9	13	4.6	15.16	69.8
16	13.53	67.5	15	18.5	13.64	66.4
19	13.47	68.3	17	16.8	13.41	70.7
			18	18.3	13.43	69.5
Average.	14.52	68.6			14.31	68.7

TABLE II.

TESTS OF A STEAM TURBINE WITH DRY AND WITH WET STEAM.

Number of Test.	Date of Test.	Percentage of Moisture in Steam.	Load on Prony Brake, in Lbs.	Steam Pressure in Lbs. per Sq. In. above Atmosphere.	Average Time for Prony Brake-wheel to make 1,200 Revolutions, in Seconds.	Revolutions of Prony Brake-wheel per Minute.	Horse Power by Prony Brake.	Dry Steam Consumption = Total Water Consumption Less Weight of Entrained Water in Pounds. Per Hour.	Dry Steam Consumption = Total Water Consumption Less Weight of Entrained Water in Pounds. Per Hour per Horse Pow'r	Duration of Tests in Minutes.
1	2	3	4	5	6	7	8	9	10	11
1	1896. Oct. 13	0	82.0	90	62.07	1,160.0	9.66	680.2	70.4	60
2	" "	0	124.0	92	64.12	1,122.9	14.15	973.5	68.8	60
3	" 14	0	41.5	91	60.15	1,197.0	5.05	404.2	80.0	60
4	" "	0	170.0	112	64.83	1,110.6	19.18	1,257.0	65.5	10
5	" 15	0	118.6	125	62.75	1,147.4	13.83	892.0	64.5	60
6	" "	0	147.8	130	63.83	1,128.0	16.94	1,157.0	68.3	60
7	" 16	3.7	132.0	94.5	64.00	1,125.0	15.08	1,036.1	68.7	60
8	" "	9.3	43.0	92	60.00	1,200.0	5.24	410.7	78.4	40
9	" "	0	132.0	94.3	63.66	1,131.0	15.17	1,023.9	67.5	35
10	" "	0	43.0	95.0	59.90	1,202.0	5.25	382.2	72.8	25
11	Nov. 16	4.7	132.0	92.7	63.82	1,128.2	15.13	1,014.8	67.1	60
12	" "	0	132.0	91.6	63.32	1,137.1	15.25	1,031.0	67.6	60
13	" "	4.6	132.0	96.0	63.70	1,130.3	15.16	1,058.3	69.8	45
14	" "	0	132.0	93.0	63.63	1,131.5	15.17	1,091.1	71.9	20
15	1897. Jan. 15	18.5	118.5	93.2	63.54	1,133.1	13.64	905.1	66.4	60
16	" "	0	116.5	93.6	62.98	1,143.2	13.53	913.5	67.5	60
17	" "	16.8	116.5	94.9	63.53	1,133.3	13.41	948.6	70.7	25
18	" "	18.3	116.5	94.0	63.45	1,134.7	13.43	934.0	69.5	30
19	" "	0	116.5	92.9	63.25	1,138.3	13.47	920.2	68.3	40

Column 7=1,200×60÷Column 6.
Column 8=Column 4×Column 7×0.0001016
Column 10=Column 9÷Column 8.
Revolutions of turbine wheel per minute=Column 6×9, because the gear reduces in the ratio of 9 to 1.

which rested on a pair of platform scales. It was found necessary to play water on the outside of the brake-wheel, to prevent the ropes from burning, as well as to keep water on the interior of the rim. At first great difficulty was experienced in making the prony brake work uniformly under the severe conditions, but all difficulty was eliminated when it was found that a cake of ordinary soap, held against the face of the wheel when running, would cause the brake to work smoothly.

TABLE III.

DATA AND CALCULATION OF PERCENTAGE OF MOISTURE IN THE TESTS WITH WET STEAM.

Number of Test	Steam Pressure in Lbs. per sq. in. above Atmosphere.	Weight of Water circulated through Cooler, in Lbs. per Hour.	Temperature of Cooling Water, in Deg. F.		Weight of Steam condensed by Cooler, in Lbs. per Hour, or Entrained Water in Steam.	Steam and Entrained Water in Same from Condenser, in Lbs. per Hour.	Dry Steam per Hour in Lbs., or Total Water Consumption Less Weight of Entrained Water.	Percentage of Moisture in Steam.
			Initial	Final				
1	2	3	4	5	6	7	8	9
7	94.5	455.0	67.2	133.3	39.4	1,075.5	1,036.1	3.7
8	92.0	940.5	56.2	95.8	42.3	453.0	410.7	9.3
11	92.7	997.0	80.1	122.8	50.2	1,065.0	1,014.8	4.7
13	96.0	730.7	49.9	111.7	51.4	1,109.7	1,058.3	4.6
15	93.2	1,699.0	35.7	142.2	205.8	1,110.9	905.1	18.5
17	94.9	1,474.0	36.0	150.3	192.0	1,140.6	948.6	16.8
18	94.0	1,787.2	36.0	139.2	209.9	1,143.9	934.0	18.3

Column 6=Column 3 (Column 5—Column 4)÷latent heat of one pound of steam at pressure given in Column 2.

Column 8=Column 7—Column 6—Column 9, Table II. Column 9=Column 6×100÷Column 7.

The results of the tests in detail are given in Table II. Table III gives data and calculations of the amount of moisture contained in the steam entering the turbine.

The program for the International meeting of the British Institution of Naval Architects, which is to celebrate the Queen's Diamond Jubilee, has been announced. The meeting will be opened by the Prince of Wales at the Imperial Institute, Tuesday, July 6, and will last throughout the week. The forenoons will be devoted to the reading of papers, and discussions, and visits will be paid to the yachting and fisheries exhibition at the Imperial Institute, also to the London docks, the Thames Iron Works, and to the Southampton docks and Portsmouth naval dockyards. During the week following the meetings those who desire to accept invitations will visit Wm. Denny Bros. shipyard at Dumbarton, where the famous experimental tank will be examined, and the Fairfield Shipbuilding and Engineering Co., at Govan, on the Clyde. Visits also will be paid to the great Armstrong Works at Newcastle-on-Tyne and to Palmer's yard at Jarrow, noted for phenomenally fast torpedo craft. It is expected that several American delegates will attend the meeting, as a special invitation has been extended to the Society of Naval Architects and Marine Engineers.

Gunboat Mistaken for Yacht.

A nice compliment was unintentionally paid the Bureau of Construction and Repair of the Navy, and Lewis Nixon, a few days ago, by one of the leading New York dailies. The former drew the plans for the gunboat Annapolis, and it was at the latter's yard that the vessel was built. The newspaper referred to published an illustration, which is here reproduced, of a "new steam yacht in course of construction on Staten Island Sound." The other illustration is a reproduction of a photograph of the same "yacht." It was a natural mistake, however, for the artist to make, as when viewed from a distance the gunboat Annapolis is like a handsome pleasure vessel. This is not only because the contour of the hull is graceful, but on account of the three slender masts. These will carry a fore and aft spread of canvas, so dear to the heart of the jack-knife sailor.

N. Y. NEWSPAPER CUT REPRODUCED.

U. S. S. ANNAPOLIS, STATEN ISLAND SOUND.

IMPROVED APPARATUS.

New Roller Thrust Bearing.

A new thrust bearing for steamships, shown in the illustration, is the invention of Frank Mossberg, who is well known in engineering circles as a pioneer along the lines of anti-friction bearings. His end-thrust invention, like those of his roller bearings, has been perfected through a long series of carefully executed experiments carried out by practical application to various classes of machines of many forms of construction. The bearing in itself is of the simplest form of construction, consisting of a series of conical rollers held in a cage, which is slipped over the shaft, upon which is fastened a cast iron collar. Between this collar and the cage is interposed a steel disc, one side of which is faced off at an angle to correspond to the conical rollers in the cage. There is a similar disc on the other side of the cage which rests between the cage and a thrust block. When the shaft revolves the friction between the two steel discs causes the conical rollers to rotate and carry the cage with them, making a perfect roller bearing in the form of an end thrust. This style of bearing has been in use for over two years on a number of different styles of machines having a heavy end thrust, such as worm shafts on elevators and wire drawing machinery. A unique application of this bearing has been made to turbine wheels, the turbine being suspended from the bearing in place of the customary position at the end of the shaft. The bearing being above the turbine wheel, no water, scale, or other obstruction can get on the bearing. Steam yachts up to 500 horse power have been equipped with this new bearing and run successfully for the past two years, showing, the patentees claim, an increase in the speed of upward of 5 per cent. The bearing is manufactured by the Mossberg & Granville Mfg. Co., Providence, R. I., which is at present equipping a number of boats.

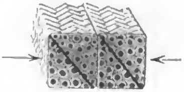
Ball Bearings for Steam Vessels.

The use of ball bearings to relieve the friction of thrust in the propeller shafts of small vessels is a feature of recent engineering practice. The Ball Bearing Co., of Boston, Mass., has devised a bearing of the sort which is here illustrated. It will be noticed that the balls are conveniently held in a brass cage and that they revolve between two hardened steel washers. All the parts are accurately ground true. The arrangement as shown is made double to take the thrust going forward or reversing. It is made also to take it in one direction only. The details of construction are shown in the smaller cut. It will be noticed that the balls are staggered, so as to travel in different paths and prevent grooving. These bearings have already been applied to engines developing from 3 to 100 horse power, with good results. The device is patented.

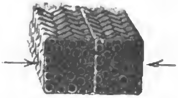
New Sectional Piston-Rod Packing.

A. W. Chesterton & Co., of Boston, Mass., have applied for a patent and lately put on the market an improved piston rod packing, which is especially designed to supersede the old style square flax packing. The new packing is made sectional, as shown in the accompanying cut. It is claimed for this packing that it has more "life" and "give" than the old style, and consequently allows compensation for wear. The ordinary square flax packing, shown in the cut, being placed one turn over another, requires a very considerable pressure on the gland to give lateral compression on the rod. A round packing when

ROLLER BEARINGS FOR SHIPS.



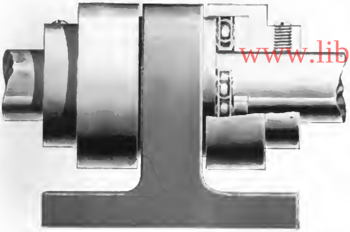
NEW STYLE.



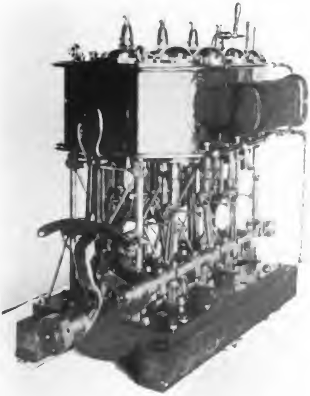
OLD STYLE.

SECTIONAL FLAX PACKING.

used would easily become flattened from the pressure of the gland, and would shape itself to the box, but this advantage has heretofore been lost in the use of the square packing, which, for hydraulic use and in many other places, is necessary. It can be seen by reference to the sections here shown that a very slight pressure on the gland will expand the packing sufficiently to hold it perfectly tight, and as the packing becomes worn it can still be forced on to the rod, and used long after the ordinary square flax would have to be renewed. This, of course, means economy in the cost of the packing and economy in labor, as it will not have to be renewed so often, a saving of friction on the rod, and a tighter joint. It has besides the braided flax feature a section of rubber-back hydraulic packing, which gives elasticity and expansion, also firmness, to the packing, and allows the two sections to easily slide by each other.

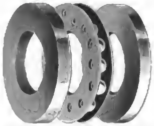


BALL BEARING FOR PROPELLER SHAFT.



SMALL HIGH SPEED ENGINE.

High Speed Engines for Small Vessels.



DETAIL OF BALL BEARING.

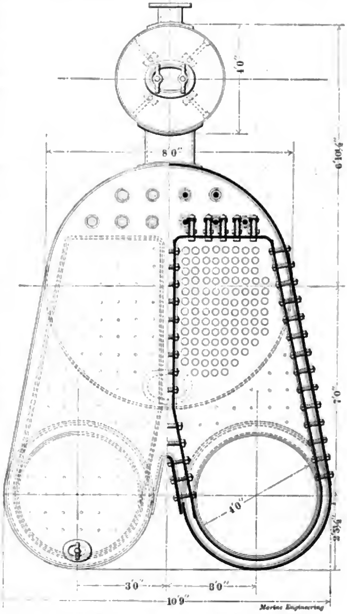
A compact, almost clocklike, four-cylinder triple expansion engine is here illustrated as built by the Lockwood Manufacturing Co., of Boston, Mass. The cylinders are 3 in., 4 1-2 in., and two 4 3-4 in., with 3 in. stroke. The materials used in its construction are phosphor bronze, steel, and cast iron, the latter very sparingly. The cylinder casting, pistons, guides, crossheads, bed plate, and main bearings are phosphor bronze. Steel is used for crank shaft, valve spindles, standards, and moving parts. The piston rings and valves are cast iron. Piston valves are used throughout. These are 1 1-2 in., 2 1-8 in., and two 2 1-4 in. dia. Steam is taken at the ends and exhausted in the middle. The valve motion is obtained from four cranks on the auxiliary shaft, which is run by two fast and loose gears from the main shaft. For reversing, the angle of advance is obtained by rotating the two loose gears with the ordinary lever. The motion is quick and sure and takes up very little room. As the engine is run at very high speed, care has been taken to balance all the moving parts as nearly as possible. To effect this, the high pressure and intermediate pressure cranks are placed opposite each other and their plane is at right angles to that of the two low pressure cranks, which are also opposite each other. This same arrangement is made in the valve shaft. This balances well and makes no dead center. The weight of the piston, crosshead connecting rod, and moving parts of each cylinder is the same, and through it adds slightly to the weight of high pressure piston, it helps in steadiness when running. The engine is designed for steam at 200 to 250 lbs., and has been run light up to 1,180 revolutions per minute, and that with only a couple of small lag screws to hold it. In the boat for which it was designed an average of 650 revolutions with 190 lbs. has been maintained. The air and feed pumps are run by gearing from the main shaft at about one-third the number of revolutions of the engine. The feed pump is 1 1-4 in. by 2 in. stroke, and the air pump is 2 1-2 in. by 2 in. stroke. The workmanship throughout is excellent and the finish very fine. The whole engine was finished bright and the steel parts nickeled with a dull surface.

A New Type of Marine Boiler.

The illustration shows a new boiler for marine or stationary purposes recently built by Kling Bros., who are the inventors and patentees. The features of this boiler are its compact form and great heating surface, having the same amount of heating surface, with one-third less shell than the ordinary Scotch boiler, and producing all the heating surface possible. The furnaces of this boiler, being placed below the shell of the boiler, with a shell or water-jacket outside and connected to the boiler at the front and rear end of the furnaces, is said to give a perfect circulation, the boiler having the same water space all through. These boilers are built to any size required, with one or more either corrugated or plain furnaces. The illustration will clearly show the design of this boiler. The firm would be pleased to show a boiler of this description, of 40 horse power, in operation, to any one interested in this line, at their works, Kling Bros.' Machine and Boiler Works, 287 Hawthorne avenue, Chicago, Ill.

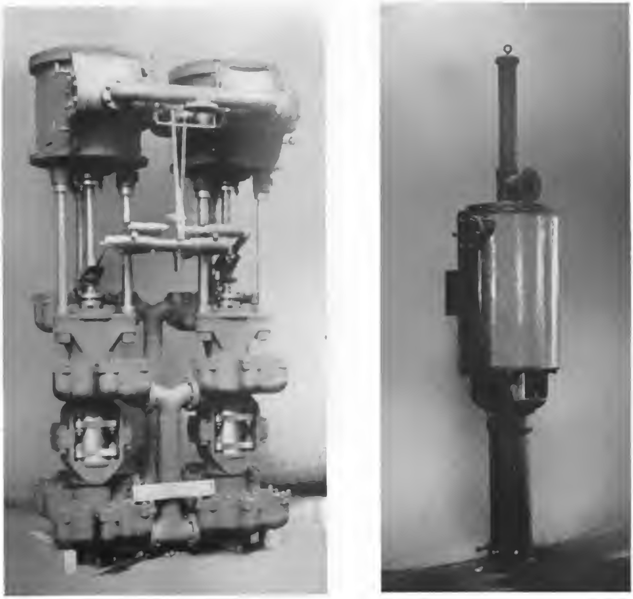
Pressure Pumps and Accumulators.

The illustrations of vertical pressure pump and steam accumulator show the plant which is fitted in duplicate in U. S. S. Iowa, by Henry R. Worthington, of Brooklyn, New York, for operating the turret mechanism and for the ammunition whips. The compactness of the apparatus will strike the reader who appreciates the value of this feature in the confined spaces aboard ship. Each set of pumps and accumulator, together with connections occupies a floor space 10 ft. 6 in., by 9 ft. 6in., and 15 ft. vertically. The pumps have steam cylinders 29 in. dia. with 10 in. plungers and 18 in. stroke. The accumulators have 25 in. steam cylinders with 10 in. plungers and 36 in. stroke. The accumulator steam cylinder has no ports or valve and the ram cylinder is similar to that of a weighted accumulator. Steam at a fixed pressure, acting on the steam piston exerts the force on the ram which in the ordinary accumulator is secured by weights. The ram passes through two stuffing boxes, one in the steam cylinder and the other in the ram cylinder. The former is not tightly packed as its only office is to prevent the leakage of exhaust steam which is let into the back end of the cylinder to keep hot the cylinder below the piston. The supply of steam to the pressure pump is regulated in this wise:—The regulating pipe consists of a polished perforated pipe, which at one end is connected to an opening through the center of the accumulator steam cylinder head and passes longitudinally through the center of the accumulator steam piston into the interior of the ram casting, the joint between this pipe and the steam piston being made by a long self-adjusting sleeve. The steam supply to the pressure pump is taken from the interior of the accumulator steam cylinder through the holes in the regulating pipe, thence through the steam cylinder head to the pump, the holes in the regulating pipe being distributed spirally throughout its length. The position of the accumulator steam piston, which depends on the amount of water stored in the ram cylinder, governs the number of holes in the regulating pipe which open into the interior of the steam cylinder, and so controls the amount of steam supplied and hence the speed of the pump. In service, as the ram cylinder fills, the speed of the pump decreases until just before the steam piston reaches the head of the accumulator cylinder, all the holes in the regulating pipe are shut off by the sleeve in the steam piston, thus stopping the pump. As the water is drawn off from the ram cylinder, the number of holes uncovered in the regulating pipe



KLING PATENT MARINE BOILER.

gradually increases until enough are open to drive the pump at its full speed. By this arrangement variations in the speed of the pump are gradual, which is essential to the quiet operation of a heavy pressure pump on a varying consumption of water. The condensation of steam in the regulating pipe and heating of the ram are avoided by a wall of non-conducting material between the inside wall of the ram and the outside of the regulating pipe. The steam in the steam cylinder is maintained at a constant pressure by means of a reducing valve located in the steam pipe just before it enters the cylinder. This valve is set at a pressure not exceeding the minimum pressure carried in the boiler, thus insuring a constant pressure at all times in the cylinder. The advantages of this accumulator over the ordinary weighted accumulator can be readily understood. The most important and marked difference is in the effect on the water pressure. The steam accumulator is not subject to the tremendous shocks and jars due to the momentum of the weights of the weighted accumulator. The moving parts of the steam accumulator being so light that momentum is not a factor, the machine is very sensitive and the variations of the water pressure very slight. As the steam pressure is regulated by a reducing valve this can be very carefully adjusted and varied at will. It will operate satisfactorily when the vessel is rolling in a seaway, when a weighted accumulator would be very irregular.



WORTHINGTON PRESSURE PUMPS AND STEAM ACCUMULATOR IN U. S. S. IOWA.

The steam accumulator will work equally well horizontally or vertically, and can even be suspended from roof beams. The loss from condensation is insignificant, as the steam pressure is constant, the cylinder not being constantly filled and exhausted as in an engine.

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Engineers and other officers of steamships are cordially invited to call at our office, where will be found the leading marine publications of this country and Great Britain.

Letters and other mail matter can be sent to our care and will be forwarded or held until called for, as desired.

Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

In time to come it is not unlikely that the recent meeting of the British Institution of Naval Architects will be referred to as an event of unusual importance in the history of marine engineering. The success of the water-tube boiler in its larger and least understood form, and of the steam turbine as applied to marine propulsion, was announced, with facts and figures in support. Prediction is not the strong point of the sensible engineer, but there are many who foresee radical changes in practice, and at no very distant date. The reports of papers read at the meeting, and discussions which followed, as published in our last and present issue, will inform our readers of the facts as brought out to date. Having these in mind, there are two points in favor of and against the probability of any revolution in engineering methods, which may be noted. The negative one is, that the results which have been had with the water-tube boiler, and rotary form of engine, have been obtained by the application of the most scientific principles, by masters in their profession, and with little commercial regard for expenditure. With such careful designing and adaptation of parts, superior workmanship, and scientific accuracy of manipulation, results out of the ordinary might be expected. For instance, naval stokers may work by the clock, as was done in the now famous trials of the Powerful and Terrible, but the merchant marine engineer is lucky if he can get firemen who will intelligently watch a steam gauge, not to speak of a clock. In support of a probable change, the tendency toward scientific refinements in practice can be mentioned. There has been wonderful advancement in marine engineering in late years, in the way of increased speeds and pressures, accompanied by a steady gain in economy, both of material and fuel. The best practice to-day, with its expansive engines and numerous auxiliaries, calls for a more exact manipulation than was required a generation ago. Then, too, the results of years of theoretical planning and practical working have made commonplace refinements of practice that not long ago would have been considered finical. Thus the engineer to-day is prepared for radical changes which could only have been slowly evolved in the past.

The fire which broke out on the steamship Leona while on a voyage from this port to Galveston, May 8, with fatal results, ought to be a valuable, if a sad lesson. It was a curious coincidence that this disaster should have happened just when every one was congratulating every one else that no such horror as the fatal fire in the Grand Bazar de Charité, Paris, could occur here. The propriety of stowing inflammable cargo in spaces used as passage ways to passengers' quarters is a question which more concerns the executive or commercial departments, than the engineers of a vessel. It is important to the latter, however, in so far as it concerns their possible duties on a voyage; providing facilities for fighting fire. In the Leona disaster the members of the engineering staff acquitted themselves with splendid intelligence. Their work was not simply brave, it was effective. This experience emphasizes the necessity for the engineer, on joining a vessel, to make himself familiar with the auxiliaries, and especially the lead of all pipes and connections of pumping apparatus. It is not only necessary to know the whereabouts of valves and cocks, but to know whether they are in proper working order. Without this exact knowledge, the engineer is helpless during the early stages of a fire, when an adequate water supply would be most effective.

In commenting on the design of Mr. Harrison B. Moore's yacht Marietta, illustrated and described in our April issue, The Shipping World, of London, says "there are several rather striking peculiarities in the internal arrangements of this yacht. For instance, we find a refrigerating chamber placed in the galley, which, in turn, is next the boiler room." As a fact, the galley is not next the boiler room, the engine room coming between, and the temperature in the galley is just as cool as the assertion of our contemporary. The most "striking peculiarity" about the yacht is the convenient manner in which the interior arrangements have been planned.

A very important contribution to the literature on the subject of vibrations on steamships will be found in this issue, the work of Professor W. F. Durand, of Cornell University.

DISCUSSION ON THE WATER TUBE BOILER.

At the spring meeting of the Institution of Naval Architects held recently in London, a very interesting discussion followed the reading of papers covering the operation of water tube boilers in war ships by Engineer-in-Chief A. J. Durston and Rear Admiral C. C. P. FitzGerald, R. N.

The discussion was opened by J. A. Thornycroft, the famous torpedo boat builder, who spoke favorable on the water tube boiler. He asserted that it suffered less from fouling of the heating surface than the flame tube boiler. Any deposit in the interior of the tubes of the flame tube boiler would obstruct the flow of gases. In the water tube boiler the deposit formed on the outside of the tube, and changes of volume due to expansion and contraction had the effect of cracking off the crust, so that this type of boiler could be effectively used with poor coal. Experiments had demonstrated this. A locomotive boiler and a water tube boiler were tested comparatively. In the former the tubes were blocked by the melting of ashes and other waste, while the water tube boiler continued to steam freely. The speaker believed that the importance of interior examination was overrated. Distilling apparatus was now in general use on ships and there was not much probability of internal deposits being formed. External wasting was the chief thing to be guarded against.

Mr. Moss, who was given the floor, though not a member of the Institution, was very severe in his condemnation of the water tube boiler, and his remarks cause some evidences of feeling. He stated he had had experience with water tube boilers of the Belleville type, which were fitted in the French Messageries Maritimes steamship Ville de Ciotat. Referring to the trouble experienced in the British navy with the Scotch boiler under forced draught, he criticised the design of navy boiler which gave unusually long grates. These extended almost into the combustion chamber, and the practical result was that coal was burned under the chamber tops. This naturally was destructive to tubes, which were small and close together. In the mercantile marine, when forced draught was used, the grates were kept shorter than the furnace tube. Referring to his experiences in the S. S. Ciotat, he said, on a voyage from New Caledonia there had been several failures of boilers. In one boiler a tube burnt along the bottom, necessitating the isolation of the boiler until a port was reached, and a new element substituted for the damaged one. In harbor the main engines were started with the effect that the cylinders were filled with water, which came over from the boilers. Another objectionable feature was the quantity of smoke that was incident to the use of these boilers. Strategically, this was a defect that did not occur with Scotch boilers. The most serious troubles he narrated were the necessity for frequent adjustment of the nuts of the bottom connection of the elements, the bending of the bottom tubes, the splitting of the tubes along the bottom, and the liability to draw apart next to the lock-nut unless the lock-nut itself was drawn away from the junction cap.

Sir Edward Reed, after questioning the pertinence of much of the former speaker's remarks, spoke in defense of the value of trial trip performances of naval vessels. These were standard tests, made with good coal by trained stokers in smooth water, and under conditions favorable to the best results. These results became a standard of excellence from which it was the duty of naval officers to make deductions for adverse circumstances, such as a foul bottom, contrary winds, or the like. Trial trip standards were not intended for the use of uninformed persons, but for the information of naval officers and ship designers who had the ability to use them intelligently.

Mr. Grosse, of John Brown & Co., Sheffield, spoke in defense of the cylindrical boiler. When this type of boiler, as designed at the Admiralty, had failed in war ships, under forced draught with a closed stokehold, he regretted that the Admiralty had not tried the Howden system, or his own system of suction draught, with a suitably designed cylindrical boiler, instead of adapting the Belleville boiler. (This had special reference to the equipment of the large British cruisers, Powerful and Terrible.) His firm had fitted mercantile marine ships with cylindrical boilers working at a rate of fuel consumption of 30 lbs. of coal to the square foot of grate, with grates six feet long, and had obtained on voyages around the world 70 to 80 per cent of the efficiency of the coal, and no such troubles as the navy had experienced had been met with. Taking the weights of boilers, of water, and of coal, his firm give could power equal to the water tube boilers of the Powerful and Terrible on the same weights. If the cylindrical boilers were heavier, the difference would be made up in less coal consumption. With a proper system of draught steam could be raised as speedily in Scotch boilers as in water tube boilers.

Mr. Manuel laid stress on the advantage for naval use of the ease with which repairs could be effected to the water tube boiler. What could be done in a cylindrical boiler to repair a furnace? Engineers in the mercantile marine, however, had found advantages and disadvantages on both sides.

Mr. Howden believed that the excessive laudation of the water tube boiler was premature. He referred to the rates of fuel consumption in the trials of the Powerful and Terrible, which were of a most moderate character. The heating surface, too, was nearly double that adopted in the mercantile marine with Scotch boilers and forced draught. The consumption of fuel, on the trials of the cruisers, should have been the lowest possible. The best coal attainable, hand picked, had been used, and other measures of special care had been taken. The coal burnt per indicated horse power per hour was 1.7 lb.; with cylindrical boilers fired by ordinary stokers, and with common coal, the consumption would have been about 50 per cent better. With the Howden system of forced draught fitted to cylindrical boilers a coal consumption of 1.2 lb. per indicated horse power per hour had been obtained with ordinary coal and ordinary firemen. He believed, that the consumption on the cruisers would reach 2 lbs. per indicated horse power per hour, or 70 per cent more than was ordinarily reached with his system. It was taken for granted that the weight of the Belleville boiler was less than that of the cylindrical boiler, but he was prepared to get 25,500 horse power easily on less than 1,100 tons of boilers and water, and to occupy less space than that needed on the cruisers. The speaker referred to various mercantile steamers, including the North-West and North-Land, on the great lakes, in which the water tube boiler was practically a failure.

A. J. Durston, the able Engineer-in-Chief of the British Navy, stated it was a mistake to say the Admiralty had condemned the cylindrical boiler; their position was, they considered the water tube boiler better adapted to the requirements of the navy. As to the question of large and small tube boilers, they considered that for their purposes big tubes were correct for big ships and small tubes for small ships. It had been stated that more firemen were required with Belleville boilers than with cylindrical boilers. Their experience had been the reverse of this, as the complement of stokers had been reduced in ships fitted with Belleville boilers in the proportion of eleven to nine. In working there had been no indication of priming which had been alluded to by one speaker.

Admiral FitzGerald, in reply to the remarks on his paper, an abstract of which was printed in our last issue, was evidently of opinion that the practice of the navy and that of the mercantile marine did not admit of comparison. A point to be remembered was that in a war ship it was necessary to get the boilers under the protective deck, a condition which did not exist in mercantile marine design.

CORRESPONDENCE.

[*We do not assume responsibility for the opinions expressed by correspondents.*]

To Prevent Oil Getting into Boilers.

I note in your correspondence department a question signed "Ralph," in which the writer states that several large stationary plants have been fitted with surface condensers, but have been compelled to abandon the use of them, because the condensed water returned to the boilers contained so much oil as to do injury to the boilers, causing the plates to bulge, etc., and he would like to know how this is avoided on vessels which are fitted with surface condensers. This subject of oil in boilers is one on which volumes could be written, as all marine engineers who devote study to the subject have different opinions as to the details of the precautions to be taken, but all are very much awake to the dangers that exist in the indiscriminate use of cylinder oil, particularly as damage caused thereby is very likely to elicit censure from the owner or supervisor of the vessel. As the details of the cases are not stated, it is impossible to give any opinion, but it seems strange that surface condensers, which nowadays are so universally used on shore as well as on vessels, should present such difficulties as to cause them to be abandoned. As modern marine engines are of the vertical inverted type, fitted with piston valves, very little cylinder oil is necessary, and in many cases the main engines as well as the auxiliary engines are run entirely without oil in the cylinders. Where there are heavy slide valves or expansion valves, a small quantity is indispensable, but it is used very sparingly. The average amount which I have noted is about a gallon in 24 hours for every 5,000 I. H. P., including oil for swabbing the rods. Many vessels are fitted with feed water filters, of which there are different varieties and sizes on the market. These do not extract all the oil, but they collect the heavy parts of it which do the damage. In transatlantic liners it is customary to examine and clean the boilers at the end of each trip, while boilers in stationary plants are sometimes allowed to be under steam for one or two months or longer at a time, and no particular attention paid to them at that; offering fine opportunities for the difficulties mentioned to develop. A.

From the Engineer, London.

Sir:—Your correspondent, "Once a Tiffy," refers to sheet lead packing in terms of contumely. It may be worth while to tell him that lead packing has been extensively used in Holland with great success. Two systems are used: in one melted lead is poured into the stuffing-box round the rod, the bottom of the box is sharply coned, and so is the gland. By screwing down the latter, the lead is compressed against the rod and swelled out in the box. The other system consists in packing the box with sheet lead wedged in. It is essential that the rods should be in good condition and quite true. A turn of Tuck's packing is an improvement. These packings have been used for years by one of the leading Dutch steamship companies. Lead wire and Tuck make an excellent packing. NOW A TIFFY.

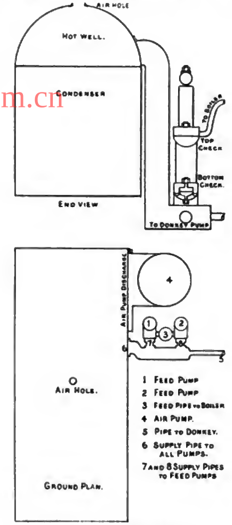
Portsmouth.

Getting Rid of Excess Feed.

In reply to "E" in your Correspondence in April number of Marine Engineering, would state the "poser" is amply simple. Avoid blowing down, even if saturation reaches 5-32. If all the extra feed was put in the boiler he would get all the salt and scale deposited from all the sea water which came from leak, for blowing down does not prevent deposit. Hence, only use amount needed to keep water level. A CHIEF ENGINEER.

Remedy for Troublesome Feed Pumps.

From a long and varied experience at sea, I can endorse what "Texas" says about his style of feed pumps being fickle in their action, and if it was at all possible to get an independent feed pump, of the duplex pattern, fitted, he would have no further trouble. From the sketch I would judge that the greater



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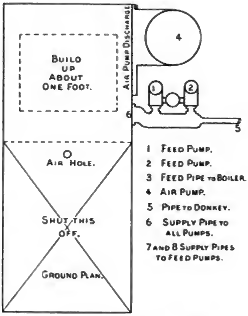


SUGGESTION FOR ALTERATIONS.

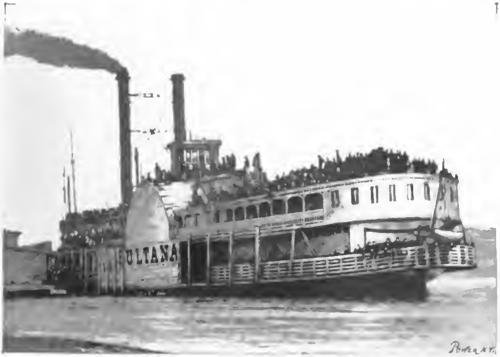
part of his trouble arises from the hot well being too shallow, thus allowing the water at times, when the ship rolls, to uncover the end of the suction pipe and letting air get to the pumps. By shutting off a part of the hot well and building up a foot or two on top of the other part, so that he would get sufficient capacity, he would have a narrow deep well which would always insure the suction pipe being covered with water. C.

I should like to have "Texas" send a section sketch of his feed pump with plunger in its lowest position, and dimensions of plunger and inside of cylinder, whole length, and position of valves, and port from valve chamber to cylinder. I have had his same difficulty with feed pumps, and think with sketch I can suggest a remedy.

F. O. Wellington.

Most Disastrous Explosion on Record.

The most disastrous boiler explosion on record, which occurred on the river steamer Sultana during the civil war, has been the subject of investigation and correspondence by Power. The result has been to bring out an accurate account of this disaster, and a view of the vessel taken shortly before the explosion, which we here reproduce through the courtesy of Power, together with a letter which is explanatory. —Ed.



GOVERNMENT TRANSPORT SULTANA BEFORE THE EXPLOSION.

Editor of Power:—Your correspondent, Mr. Gaston, has "stolen my thunder," but I will add to his communication by sending you a photograph of the steamer Sultana taken ten or twelve hours before the explosion; also a clipping from the Clarion, of Helena, Ark.:

Steamer Sultana, Capt. J. Cass Mason.

This ill-fated steamer was built in Cincinnati, January, 1863; registered 719 tons, and carried 1,300 tons. She was a regular St. Louis and New Orleans packet, and left the latter port on her fated trip April 21, 1865. While at Vicksburg she took on board 2,000 Federal soldiers, just released from rebel prisons in Alabama and Georgia. Her regular passengers and crew numbered some 200, making a total of 2,200 people. At 3 o'clock on the morning of April 27 she had reached a point some seven miles above Memphis, Tenn., when one of her boilers exploded; she immediately took fire and in about twenty minutes was burned to the water's edge. In this, the most terrible of all steamboat disasters, about [illegible],500 people perished.

A few of the survivors recently had a reunion at Xenia, O. Wm. T. Magruder.

Crank Shaft Breakages.

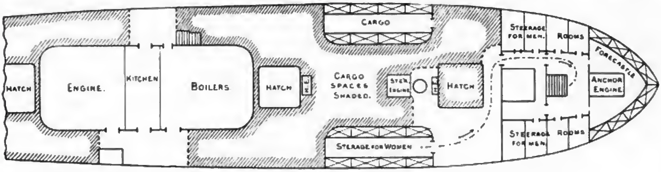
Why is it that crank or line shafts break most frequently in fine weather? An engineer usually associates bad weather with excessive strains in an engine, but from my own observation I would say that the per centage of breakages in storms was small. About the only reason I can perceive for this is that during fine weather a ship develops its greatest power and attains highest speed. In bad weather special attention is given to the engines to prevent racing, and so that excessive strains shall be avoided as much as possible. In fine weather, on the contrary, a ship is pushed to the limit, especially in the case of a calm succeeding a succession of bad days, so that lost time may be made up. Thus the engines are subjected to the heaviest working strains which can be produced, with the natural result that any weaknesses are discovered, some in a decidedly unpleasant way. In fair weather, of course, breakages occur too; for example, in boats trading to the far East, but I speak of the experiences principally in the North Atlantic trade. I should like to hear from other engineers who have given this subject attention. W. I.

A contract has been let by the War Department to the Merritt-Chapman Wrecking Co., for the destruction of the sunken Atlas Line steamship Ailsa, which obstructs the fairway in the Narrows. She was sunk Feb. 29, 1896, by collision with the French liner Bourgogne. The work will be done piecemeal by dynamite. The contract price is $11,975, and the work is to be finished within 90 days.

MISHAPS AT SEA.

Disastrous Fire on S.S. Leona.

A fire which caused the loss of thirteen lives and threatened the destruction of the Mallory line steamship Leona broke out early on the morning of May 9, while the vessel was on a trip from New York to Galveston. The Leona had taken on a miscellaneous cargo, and sailed from New York the previous afternoon, carrying a number of saloon and steerage passengers. Ten of the latter were burned to death, along with three of the crew. The Leona is one of the ordinary type of passenger vessels in the Southern trade. She has three decks; upper, main and lower, and it was on the main deck forward that the fire originated. A rough sketch of the deck is printed, showing the location of the various compartments, and the large quantity of freight which was carried on this deck. This freight was composed mostly of jute in bales, matches boxed up, and sewing machines in crates. When the fire was first noticed the ship's carpenter immediately notified the engineers on watch, and the fire pump, a powerful Cameron pump, was started. The vessel was steaming against the wind at the time, and the captain at once changed his course and headed north, so that the draught would not help to carry the fire aft. As there were only two lengths of hose available, the quantity of water thrown did not reach the capacity of the pumps, which were kept steadily at work for about six hours. The engineers who were not on watch came on deck and gave valuable aid in extinguishing the fire. They cut holes in the upper deck, through which streams of water were sent, and, removing the main hatch, attacked the fire in the rear, as it threatened to spread and make the engine and boiler rooms untenable. The fire soon rendered useless the steam steering gear, and the hand gear was rigged in the tiller room aft. When the fire had gone down sufficiently the loading ports in the sides opposite the main hatch were opened and much of the deck cargo thrown overboard. The fire is supposed to have started among the cargo close to the men's steerage on the port side. This speedily cut off the exit from the women's steerage on the starboard side, as the passageway between the cargo piled over the fore hatch and the forward bulkhead was less than two feet wide. While the fire was in progress the steamship City of Augusta, in response to the Leona's signals of distress, steamed close up



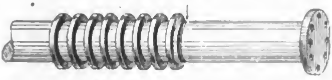
ROUGH SKETCH OF MAIN DECK S.S. LEONA, SHOWING SPACES FILLED WITH FREIGHT.

AFTER THE FIRE, LOOKING ACROSS MAIN DECK FROM WOMEN'S STEERAGE.

and kept alongside for several hours. About noon the fire was out and the vessels parted company, the Leona returning to New York. During the fire the engineers and firemen on watch kept steadily at work, and discipline in this department was strictly maintained.

Broken Thrust Shaft Replaced at Sea.

On her last westward voyage the Anchor liner Circassia broke her thrust shaft. The engineer staff replaced it with a spare one carried, and she resumed the voyage to New York, arriving here only 60 hours late. The fracture occurred at the forward end of the thrust bearing, close to the first collar. The shaft was wrought iron 17 in. dia. and 27 ft. long. The break was remarkably clean, as though the shaft had been sheared asunder. Each length was left free to revolve independently, owing to the absence of ragged ends. The engineer on watch at the time of the mishap was close to the throttle valve lever when he heard a peculiar noise from the direction of the tunnel, and suspecting a break he promptly shut off steam. The engines had come to rest before the propeller end of the shafting had ceased to revolve. Chief engineer Moncur decided to go ahead with the repairs. Portion of the plating of the after bulkhead of the engine room had to be removed, as the thrust bearing was in the tunnel. The spare shaft was an easy fit, as it had been in use before, and when the voyage was resumed gave no trouble whatever. On the arrival of the vessel in port here the shaft was not taken out of the bearing, but the coupling bolts were removed and replaced with new bolts a fit thicker, the holes having been reamed out. This was simply a precautionary measure. The Circassia made the trip home in her usual time. Before she leaves port again a new Whitworth's fluid compressed steel thrust shaft will be fitted. This was the first accident of the sort which happened this fine boat, though she has been in service for a number of years.



FRACTURED THRUST SHAFT S.S. CIRCASSIA.

STEAM CHAMBER IN YARROW BOILER AFTER MISHAP.

Accident to Torpedo Destroyer.

It will be remembered that the Corrientes armored torpedo boat destroyer, built for the Argentine Government by Messrs. Yarrow & Co., lately returned to London, having been damaged in the Bay of Biscay on her way out. It was reported at the time that the vessel was strained owing to the very heavy weather she encountered, but on examination such was found not to be the case. It appears that she ran foul of some wreckage in the Bay during the storm, which damaged the bottom plating of the hull. This led to water gaining access to the forward stokehold, in addition to which water found its way down the forward funnel. The stokers report that at the time they turned back there was 3 ft. of water in the forward stokehold, which it was found impossible to clear, owing to the pumps getting choked with coal dust. There were in all six of Yarrow's patent water-tube boilers, and it appears that one of them ran altogether short of water through the pump stopping and the stokers having left the stokehold. This took place at a time when there was a fairly heavy fire, which was not extinguished until the water level had dropped to 3½ ft. below the upper tube plate, leaving all this portion of the tubes dry and subject to the action of the furnace, and no doubt some part must have been raised to a red heat. The safety valve during this time was blowing off at 200 lbs. per sq. in. It is satisfactory to know that although all the galvanizing has been burnt off the tubes, and some of them are distorted, it was found possible, without expanding the tubes, to test the boiler by hydraulic pressure to 150 lbs. On examining the steam chamber and the upper ends of the tubes, it was found that they had not in the least shifted in position. The tubes in the Yarrow boiler are bellmouthed, and the photograph, taken immediately on the return of the boat by artificial light, represents the inside of the steam chamber. The boiler is at present being retubed, which is being carried out without removing the boiler from the boat or shifting it from its original position.—The Engineer, London.

A very complete description of Eugene Higgin's twin screw yacht Varuna, illustrated by numerous engravings, is published in the May issue of the Rudder. The dimensions are: length over all, 300 ft.; breadth, 35 ft.; depth to upper deck, 18 ft.; tonnage, Thames measurement, 1,564 tons. The hull is of mild steel, with eight transverse water-tight bulkheads. She is also fitted with a double bottom in which there is space for 66 tons of water ballast, and for 9,000 gallons of fresh water. The machinery consists of two triple expansion four cylinder engines, with cylinders 22 1-2 in., 38 in. and two 40 in. by 27 in. stroke. They are very simple in design, with open fronts, the cylinders being carried on turned steel columns on the starting side of the engines. The valve motion is the ordinary double bar Stephenson link. The condensers form part of the back framing, and the air pumps are worked off the high pressure crosshead, by the usual levers. Steam is produced in eight single ended Scotch boilers 11 ft. 9 in. by 7 ft. 6 in., each having 4 furnaces, and working at 160 pounds pressure. Forced draught on the closed stokehold plan is provided for. Electricity is used for lighting, and for driving ventilating fans in the living quarters. The refrigerating plant maintains a low temperature in the provision room, which is 14 ft. by 9 ft. On her trial trip between the Cloch and Cumbrae Lights on the Firth of Clyde, a mean speed of 16.73 knots was obtained with 3,995 indicated horse power, the engines making 158 turns. The mean load draught is 15.5 feet. The builders were A. & J. Inglis, of Glasgow.

EDUCATIONAL.

THE INDICATOR APPLIED TO THE MARINE ENGINE.—3.

BY HENRY L. EBSEN.

To locate the different points on the indicator diagrams with any degree of accuracy, it is necessary that the gear for taking them be carefully adjusted, as large engines have a stroke anywhere between four and six feet, and any distortion of the cards would show the point of cut off to be several inches of stroke more or less from where it ought to be, in addition to giving inaccurate figures for horse power. This is a matter, surprising as it may seem, which does not receive the attention that it deserves, and it is a fact that the gears on most engines give diagrams which are more or less distorted. The reason of this is not so much an oversight, but lies in the fact that space in a ship's engine room cannot easily be spared. Owing to the length of stroke and high piston speed in modern engines, it is impossible, without endangering life and limb, to use any reducing gear secured directly to the crosshead, to be attached or detached at pleasure when the engine is running. Stopping for this purpose is out of the question. The indicator gear must be attached permanently. In ocean steamers, if it is considered that it takes between 800,000 and 1,500,000 revolutions to cross the Atlantic, it is evident that the gear must be substantially built, and be a part of the engine itself. If not, it is sure to get slack in the bearing and probably cause damage to neighboring parts. Most of the gears used are of the usual lever type, swinging from a stud on the column, and driven from the crosshead by a connecting link, the lever being set perpendicular to the guide faces when the piston is at half stroke. According to the general rule a lever ought never be shorter than one and one-half times the stroke, in order that the diagrams shall not be distorted. This rule is almost always violated, the levers usually being about as long as the stroke and in some cases even shorter. The cause of this is simply that there is no place to attach the lever if it were made the proper length, as it would project outside, beyond the columns. Even if provision could be made to swing it from some support, it would interfere with the passageway along the middle platform at each cylinder, or come in conflict with the weigh shaft, and from a practical standpoint be generally undesirable. In some cases the connecting link is attached to the furthest guide shoe to get a longer lever, but this is rarely practicable, as most of the connecting rods have fork ends at the crosshead, and the levers must have quite an offset to clear the brasses. For these reasons short levers are used so frequently, and if the positions of such a lever be plotted down, Fig. 7, for certain equal divisions of piston stroke AB, BC, CD, and DE, it can be plainly seen that these divisions as transmitted to the diagram ab, bc, cd, and de will not be proportionately equal, but vary in size. If the lever is not set perpendicular to the guides when the piston is in the middle of the stroke, or the indicator string is not perpendicular to the lever under these conditions, the diagram will be still further distorted. Fig. 8 is a diagram taken from a cylinder with a short lever and faulty setting of the same, and Fig. 9 is a diagram taken from the same cylinder after a correct gear was fitted.

Of the different gears designed to give accurate results, one may be mentioned here, Fig. 10. It is a telescopic gear, consisting of a steel tube sliding inside a brass tube, the former attached to the column and the latter to the crosshead. As the crosshead moves up and down the tubes draw in and out similarly to the sections of a telescope. The part of the tube at the column is slotted and fitted with a saddle block which drives a vertical bar between guides, in the same manner as a valve stem is driven. The bar

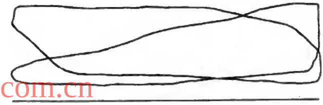


FIG. 8.

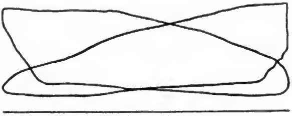


FIG. 9.

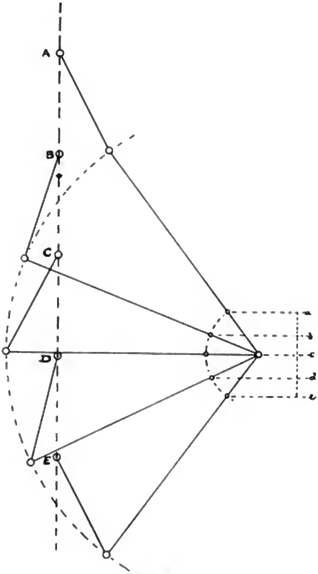


FIG. 7.

connects to the indicator string. This gear wears well, takes up little room, and the action of it is mathematically accurate. In Fig. 11, AC is the path of the crosshead, ac is that of the bar and parallel to each other, and the distances ab and bc which the bar travels will be in proportion to the distances AB and BC of the travel of the crosshead and piston.

Some faulty designs of gears and the arrangements of the same are sometimes ludicrous. For instance: in a certain quadruple expansion engine the cranks of alternate cylinders were placed at 180 deg., or opposite each other. The usual lever gear connected to one crosshead was made to serve its own cylinder and the one in which the crank stood opposite. In Fig. 12, let AC be the connecting rod of the first cylinder, when the piston is in the middle of the stroke. The crank of the other cylinder will be opposite at D and BD would be the position of its connecting rod, showing that its piston was a distance AB below the center of the stroke. As connecting rods of marine engines are very short, from two to two and one-quarter times the length of the stroke, the distance AB becomes quite a percentage of the stroke; in this particular case it amounted to seven inches. So if the gear attached to the first cylinder gave correct diagrams for its own cylinders, it would distort the diagram of the other cylinder, showing the points of cut off in the latter seven inches of piston stroke away from where they ought to be.

On account of the size and length of the cylinders of marine engines, the indicator string is usually quite long, especially when there is not a straight lead from the gear and it has to pass over a pulley. In such cases precautions must be taken against stretching. A good kind of string to use in such cases is one that contains a core of fine brass wire.

In noting the revolutions at the time of taking diagrams on engines of high power, making from 75 to 100 revolutions per minute, one-quarter of a revolution more or less represents considerable power. As a tachometer is unhandy, it is customary to take the average revolutions on the counter for five minutes or thereabouts during the time the diagrams are taken. As it would be impossible without extra help to take diagrams at short intervals during the whole trip to get the average power, usually, several sets are taken. The power on these is proportional to the average power, as the cubes of the revolutions on the diagrams are to the cube of the average revolutions of the voyage taken from the revolution counter. This rule is sufficiently accurate on a trip during fine weather. If there are several days of bad weather, and the engines race to any extent, it is impossible to get reliable figures for average horse power.

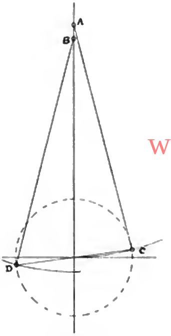


FIG. 12.

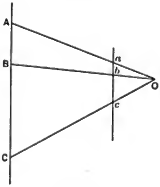


FIG. 11.

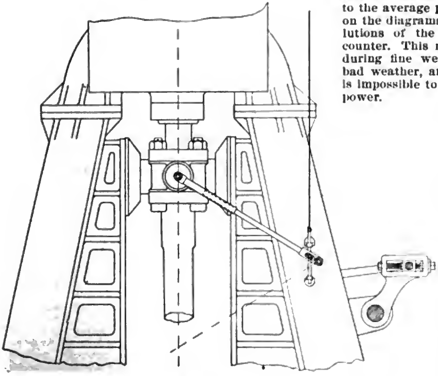


FIG. 10.

New Liner Launched.

The new twin-screw liner "Kaiser Wilhelm der Grosse," for the North-German Lloyd, was launched from the builder's yard in Stettin last month. When completed, she will probably make new records in transatlantic passages. The new vessel is 649 feet long and will displace about 20,000 tons when ready for sea. A sister-vessel, the "Kaiser Friedrich," is well advanced toward completion. These will be the largest vessels ever built in Germany.

HOME AND FOREIGN EXCHANGES.

Marine Engineering Fifty Years Ago.

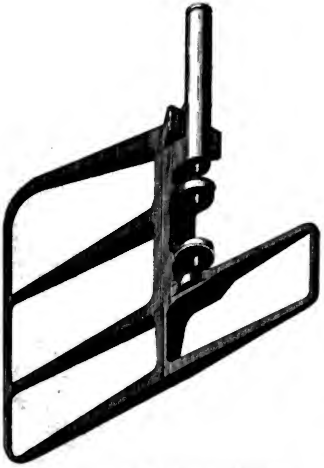
In the year 1842, that is to say, fifty-five years ago, a sharp discussion took place between Mr. William Pole and a gentleman who wrote over the name "Vulcan," in the pages of the Civil Engineer and Architects' Journal, concerning the merits and demerits of certain types of marine engine, says the Engineer, London, editorially. Who "Vulcan" was we are quite unable to say. He appears to have understood his subject fairly well, and made a good fight, although even in those days Mr. Pole was no insignificant adversary. The controversy no longer possesses any practical interest. It turned on the comparative merits of the direct-acting and the side lever paddle engine, Mr. Pole standing up for the former and "Vulcan" for the latter. We quote the discussion now for the sake of the curious light it throws on the position of marine engineering at or about the middle of the present century.

We find, for instance, that Messrs. Seaward had issued a pamphlet in which they claimed for their new type of direct-acting engines a remarkable economy. The firm guaranteed a maximum consumption of 6.5 lb. of good coal per horse-power per hour. "Vulcan" seems to have doubted that this was feasible, at all events with direct-acting engines. If this was considered a performance of which to be proud, what must have been the consumption with inferior machinery? We have no reason to think that Messrs. Seaward over or under-stated the facts. A consumption of 6½ lbs. of coal per horse power per hour was a very good performance for a marine engine in those days, judging by contemporary records. It is worth while to endeavor to discover the causes which brought about so enormous an expenditure of fuel.

At the outset we are met by the difficulty that the words "horse power" seem to have been used in a very vague way. We are not quite sure, therefore, to what Messrs. Seaward's statement refers. Marine engines in 1842, and for many years subsequently, were rated at their nominal power. We have found it next to impossible to find out what relation the nominal bore to the real or indicated horse power in a general way. We believe we shall not be far from the truth if we say that the indicated power in those days seldom, if ever, exceeded the nominal power by two to one. Indeed, so long as the pressures were kept down to 5 lbs. or so, the nominal and the real powers must have been nearly the same, save in special cases. We find H. M. S. Amphion, with engines of 300 horse power nominal, indicating on her trial trip 592 horse power; but the safety valve load was 10 lbs. Probably if we say that the indicated was twice the nominal we shall concede all that can be demanded for the engines of that day. It seems tolerably clear, therefore, that Messrs. Seaward, when writing about the consumption of coal by their machinery, were referring to the indicated horse power, and on that basis we must deal with the question. It is by no means as easy at it seems to be at first sight to give the true reasons for this enormous consumption. Indeed, the more fully we investigate the subject the greater does the difficulty apparently become. In the first place there is no doubt that many land engines were doing better than much larger marine engines. Several years ago we ourselves indicated an old Boulton and Watt beam engine in a spinning mill. The engine indicated only 47 horse power; worked at a pressure of 10 lbs.; had the old, long D, hemp-packed slide valves, and a Cornish boiler. According to the coal bills submitted for our inspection, the engine was giving an indicated horse power for a little over 4 lbs. of good slack per hour. This is probably one-half the consumption of the average marine engine of fifty or sixty years ago. Nor does this extravagance in the use of fuel by the marine engine appear to have passed unnoticed. Various reasons have, indeed, been adduced to account for it. One is that the firemen were grossly incompetent; another that the brineing of the boilers wasted a tremendous quantity of fuel. None of these is, we think, an adequate explanation. It is true that machine tools were not half a century ago what they are now. But, on the other hand, there were available some of the best workmen the world has ever seen. Indeed, no one who has had the opportunity of examining old marine engines by such men as the Maudslays or Penns can have any doubt on this subject. Although built at a period ten years later than that of which we write, the paddle engines of the Great Eastern, with four oscillating cylinders 74 in. dia. and 14 ft. stroke, were magnificent examples of mechanical engineering of the finest possible finish. Metallic pistons were in use, and there is no reason to think that there was any appreciable leakage. As for the art and mystery of firing, that seems to have been as well understood in those days as now. It is easy to show that, although brineing caused a loss, it was not very serious. As a rule the water was not allowed to rise in density much above 3-32. This meant that about one-third of all of the feed water pumped into the boiler cold had to be blown out hot. A very simple calculation will show that this did not represent at the worst a loss of more than 6 or 8 per cent, and that was reduced in many vessels by making the outgoing hot water raise the temperature of the incoming feed.

No doubt many of our readers will say that the true origin of the waste of fuel is to be sought in the low pressure and lack of expansive working. Yet it is not only possible to push this argument too far, but it seems to be invariably so pushed. The work which a pound of steam is capable of doing without expansion is not far from being the same for all pressures. We shall not be much wrong if we say that it is equivalent to about 60,000 foot-pounds. If then, we have a boiler pressure of 15 lbs. above the atmosphere, and allow for clearance, we shall need about 33 lbs. of steam per horse power per hour. But the engine cannot work on a perfect vacuum, consequently an allowance has to be made, but after this has been done we still find that about 37 lbs. of steam should suffice to give an indicated horse power per hour. A tremendous consumption, it is true, but not sufficient to account for 6.5 lbs. of coal per horse power per hour. If the steam was cut off at three-quarter stroke its efficiency would be augmented in the ratio of 1.3 to 1, and the consumption of steam would drop to about 28.5 lbs. If the cut-off took place at half stroke the efficiency would be augmented in the ratio of 1.88 to 1, and the quantity of steam needed would fall to about 20 lbs. per horse per hour. At the latter rate, if a pound of coal produced 10 lbs. of steam, we should have a horse power for two pounds of coal, or about one-third of the actual consumption.

Obviously just here we come in contact with the question of cylinder condensation. We know that because of initial condensation there must be more steam used than would be needed if we worked with a non-condensible fluid, or employed an absolutely non-conducting cylinder and piston. But the initial condensation ought, according to all received argument, to be small. The temperature of steam with a total pressure of 30 lbs. on the square inch is 250° F.; that of the condenser would be about 140° F. The temperature range would therefore only be about 110° F., which is very moderate. It will be admitted, we think, that up to the present the true cause of the extravagnt consumption of fuel has not been stated. We believe that it is in the boiler we must seek for the reason. Theoretically, there is nothing about the engine to explain the enormous waste of coal. The land engine did not need it, and the land engine was not superior to the marine engine. There were, however, two prominent defects in the old type of marine boiler. One was that in a very short time, no matter how carefully brining was conducted, the heating surfaces became incrusted to an extent of which the modern seagoing engineer has no conception. There can be little doubt that whole voyages have been made with the furnace crowns nearly if not quite red hot. They did not come down because the pressure was so small. But the flues were in even worse condition than the furnaces. These last were scaled as often as possible; but the flues presented plenty of inaccessible places; even if the surfaces had been kept in first rate order, the flue boiler must have been wanting in economy. Salted up as it was most of its time, we shall overrate its performance if we say that it gave six pounds of steam for every pound of coal burned on its grate. But this is not all. No particular care was taken to keep the water clean. There is excellent reason to believe that the old box boiler never supplied dry steam. The furnaces were crowded in, and little or no consideration was shown for circulation. It is not, we think, necessary in the present day to stop here to explain how fatal to economy is water in steam. That the old type of marine boiler did not supply dry steam is to a large extent—though perhaps indirectly—proved by the great benefit derived from fitting superheaters. If we suppose that the steam was dry when it entered the superheater, the reduction in the consumption of fuel brought about by the apparatus would be inexplicable on theoretical grounds. Thus, for example, the P. and O. steamer Colombo had her consumption cut down from 52 tons per day to 43 tons by the use of a superheater. In the case of the Norman, a Union steamship, the superheater saved 23.5 per cent. In the P. and O. ship Ceylon the saving of coal was 32 per cent. Such economies are only to be explained on the theory that the boilers supplied wet steam before the superheaters were fitted, and that they wasted a great deal of heat up the chimney. It is worthy of note in this connection that the advent of the surface condenser involved a great reduction in the consumption of coal, while pressures were still low, the engines not compounded, and the ratio of expansion seldom reaching two to one. No doubt the saving was due to augmented boiler efficiency.



FINISHED RUDDER-FRAME FORGING FOR BATTLESHIP.

In the light of existing knowledge it seems strange that marine engineers of the highest reputation should have boasted of a consumption of fuel so enormous as 6 lbs. per horse power per hour. But marine propulsion was a plant of slow growth, and the difficulties which lay in the way of its development were very serious. The marine engineer had to think of a hundred things at once, and to provide for contingencies undreamed of. It was of infinitely more importance that his engines and boilers should not break down than it was that they should be economical in fuel. Experience had to be acquired. Experiments involved not only a large outlay but serious risk, and the present position of marine engineering is due to the caution with which every step in advance has been made sure, and carefully consolidated before another was taken. Marine engineering is of slow growth, but so is the oak, for centuries the emblem of Britain's naval supremacy.

Rudder Frames for U. S. Battleships.

The Cleveland City Forge & Iron Co., Cleveland, is now at work on four rudder frames for the battleships Kearsarge, Kentucky, Illinois and Alabama the first three of which are now under construction by the Newport News Ship & Engine Building Co., Newport News, Va., while the fourth is being built by the Cramp Ship & Engine Building Co., Philadelphia. All four rudder frames are substantially like the one shown in our illustration. They are made from double refined wrought iron and have an extreme height of 20 ft. 9⅛ in., with an extreme width of 19 ft. 3 in. The rudder stocks are 18 in. finished dia., and each has a 5-in. hole bored axially through it. Owing to its intricate shape the rudder stock portion of the frame had to be forged solid throughout and machined out afterward. The stock forging weighed about 25 tons in the rough, exclusive of the bows, counterbalance and braces. The weight of the finished frames will be somewhat less than this, but the exact weight cannot be given until the completion of the work.

These rudder frames are the heaviest and most intricate ever attempted in this country, says the Iron Trade Review, and so far as our information extends none like them have been made abroad in iron. Owing to their unwieldly size they cannot be transported by rail, the tunnels and bridges making this impossible. Moreover, the ordinary canal boat, with its narrow hatches, would not accommodate them. The company has therefore chartered one of the Cleveland Steel Canalboat Company's boats to take the rudders to New York, though it is not entirely certain that all can be so disposed that the four can be taken in one boat. From New York they will be sent to the two shipyards by steamer.

Power Estimates on Ocean Voyages.

Mr. Nisbet Sinclair, in a paper read before the Institution of Engineers and Shipbuilders of Scotland, has been attacking the rather difficult problem of arriving at fairly definite figures in regard to the mean power required to drive any given ship on ocean voyages, says Engineering, London. The experiments were undertaken in order to test the efficiency of certain propellers, but their chief value lies outside their ostensible object. There were several sister ships engaged on the same route. Each voyage was continuous, and the time on the voyage, the distance run, total revolutions, and draught of water at the end of the voyage were carefully noted. Indicator diagrams were also taken. These observations were continued for about a year. The data were not sufficient to determine the average power on any one voyage, but the long series of records enabled the general character of the ship's behavior to be closely estimated, and what the power and revolutions would be under average conditions. Accordingly the card powers were reduced to a common displacement on the assumption that the indicated horse-power varied as the two-thirds power of the displacement. The corrected powers were plotted on ordinates of card revolutions, the fair lines through the spots being held to represent the average power for any number of revolutions within the range of the curve. The average revolutions during each voyage were then plotted on ordinates of average speed in knots for the voyage, the fair line being taken to show the average revolutions for any speed in the range of the curve. From these two curves a speed and power curve was constructed, representing the average behavior of the ship, or, as Mr. Sinclair put it, the "normal locomotive value."

Vessel for Winter Lake Service.

Writing from West Superior, Wisconsin, a correspondent of the Chicago Record says: A gigantic scheme is now under way which has the ultimate end in view of navigation on the great lakes through the entire winter. Should the plans as at present outlined work out satisfactorily they will necessitate the building of a new and novel fleet of winter lake boats and tugs at a cost of $1,500,000.

MODEL OF PROPOSED WINTER LAKE STEAMER.

Commodore B. B. Inman, of Duluth, a gentleman of a business turn of mind, who has followed the lakes for a number of years as a vessel and tug operator, has invented and proposes to build a new type of steel vessel, which, with the aid of powerful tugs stationed at the obdurate points along the great lakes, will run between the upper and lower lake ports through the coldest of northern winters. At first thought such an undertaking would seem visionary and impractical, though there are persons of experience who assert that with the right kind of vessels such an undertaking would not be impossible.

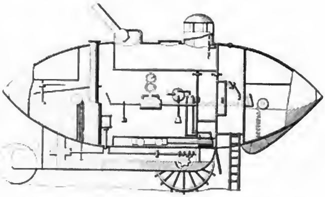
Mr. Inman has given the subject thought for a number of years and is convinced that winter navigation of the lakes will ultimately come. He has invented and with the aid of eastern capital proposes to build a fleet of six steel vessels for this service. The boats are designed to be modern in every way. The changes in the hull, as compared with the modern summer boats, will be in the bow, which will run under the ice and lift it up. The bow will also be wider than is the stern of the ice breakers, so that after the channel is broken by the bow of the boat the remaining portion may pass without injury or friction. These vessels are designed to be of the very largest size, carrying from 4,000 to 6,000 tons of freight, about 530 ft. in length, 48 ft. beam forward and narrowing to 45 ft. aft. They will carry about 30 per cent additional power, possess steel wheels, and will be built throughout for ice breaking.

Commodore Inman has aproached the head-of-the-lakes flour millers on the subject and learned that if winter nevigation can be made practicable they will gladly enter into a contract for their entire winter product, which at present goes by rail to eastern and foreign markets during the winter. Naturally freight rates in the winter, with such vessels, would be higher than in the summer, when the lakes are free from ice, but Mr. Inman thinks that the rail rate could be reduced by the use of his vessels.

SELECTED PATENTS.

581,213—SUBMARINE VESSEL. *Simon Lake, Baltimore, Md. Filed Apr. 5, 1893.*

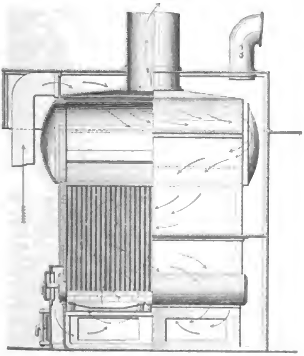
In a submarine vessel provided with means for propelling the same, the combination of oscillatory vanes arranged upon both sides of the vessel, a pressure-gauge communicating with the exterior of the vessel and provided with an index-hand actuated by the pressure of the surrounding water, a motor for oscillating the vanes and an electrical controlling device thrown into and out of operation by the index-hand for starting, stopping, and reversing the motor. A cylinder provided with a piston, piston-rods connected to cranks carried by the vanes, a compressed air reservoir, means controlled by a valve for admitting compressed air to the opposite ends of the cylinder, a pressure-gauge actuated by the pressure of the surrounding water, an armature carried by the stem of the air-valve, two series of electromagnets adapted to be connected with an electrical generator by independent conductors and operating to move the armature in opposite directions, two series of contacts adjustably arranged in the path of the index-hand of the pressure-gauge, and conductors connecting the contacts and electromagnets. The combination with a shifting weight adapted to move in fore-and-aft ways, of a motor for shifting the weight in opposite directions, and means controlled by the movements of the vessel for automatically starting, stopping and reversing the motor to keep the vessel on a level keel. A cylinder and piston for shifting the weight in opposite directions, a compressed-air reservoir communicating with the opposite ends of the cylinder, a valve for controlling the admission of compressed air to the cylinder, and a pendulum for operating the valve when the vessel sinks by the bow or stern. Lazy-tongs connecting the piston and weight, a compressed-air reservoir communicating with the opposite ends of the cylinder. The combination with an air-tight diver's chamber provided at its bottom with a trap, an auxiliary chamber communicating there-



with by a door, a door affording communication between this auxiliary chamber and the interior of the vessel, a compressed-air reservoir, valved pipes connecting the chambers with the air-reservoir, pressure gauges for indicating the pressure of the air in the chambers, and a pressure-gauge for indicating the pressure of the water surrounding the vessel. The combination with a submarine vessel of wheels projecting below the bottom of the vessel and adapted to rest upon the water-bed, means for holding the vessel in contact with the water-bed, means for propelling the vessel over the water-bed upon the wheels when submerged, and means for guiding the vessel over the water-bed, by a steering-wheel. A steering-wheel journaled in the rudder of the vessel and projecting below the bottom to engage the water-bed, this wheel serving to guide the vessel over and help support it upon the water-bed, and means for operating the steering-wheel from the interior of the vessel when the latter is submerged.

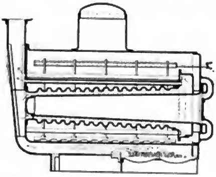
580,060—STEAM-BOILER. *Horace See, New York, N. Y. Filed Sept. 12, 1896.*

A steam-boiler having a fuel-supply opening in its front wall and above its grate, draft-openings in both front and side walls and below the grate, a source of air-supply and an air-casing; the air-casing inclosing all of the openings and conducting the air-supply directly thereto. The air-casing extending around the sides and rear of the boiler. A steam-boiler, having a fuel-supply opening, provided with a hinged door, a draft opening below its grate, an air-casing, having an opening provided with a hinged door in front of the fuel-opening, a source of air-supply communicating with the casing, and a mechanical connection between the hinged doors, whereby the opening and shutting of the outer door causes the simultaneous opening and shutting of the inner door. A bulkhead or partition in front of the fuel-supply and ash-pit openings in the boiler, an air-blower communicating with the space between bulkhead and boiler, a hinged door closing the fuel-supply opening and a hinged door corresponding to it in the bulkhead. A steam-boiler, having water-chambers on each side of its grate, a steam-drum above the grate, inclined tubes connecting the drum and chambers, a casing surrounding these parts and communicating with the uptake, openings in the casing above and below the grate, an external casing surrounding the inner casing, and provided with a door for access to the fuel-supply opening, and an air-blower communicating with the upper part of the external casing. Openings in the front and sides of the ash-pit, whereby the blast from the blower is caused to descend between the casings to the ash-pit openings, thus becoming heated by contact with the inner casing, and to rise through the grate and fire-space to the uptake.



582,416—STEAM-BOILER. *John E. Friend, Wellington, New Zealand, assignor to the Friend's Steam Generator and Imporous Butter Box Company, Ltd., same place. Filed Jan. 22, 1897.*

In a boiler, a conical flue extending through the same, a conical water-tube within the flue, the smoke-box at the large end of the flue, the fire-tubes extending from the smoke-box through the upper part of the boiler to the chimney and the connections between the conical water-tube and the upper and lower water-spaces of the boiler. 2. The flue extending through the boiler, the smoke box within the boiler at one end of the flue, the water-tube let in through the wall of the boiler and through the smoke-box, and the ring about the water-tube and between the smoke-box and the boiler shell. 3. In combination with the boiler having the flue extending through it with the smoke-box at one end of the flue within the boiler, the water-tube extending through the flue and having its flanged end fitting against the boiler-shell, the ring about the tube and between the boiler-shell and the smoke-box and the tubes connecting the water-tube with the upper and lower water-spaces of the boiler. 4. The pipe extending from the lower to the upper part of the boiler to convey the sediment and the upper pocket or receiver into which this pipe discharges with means for blowing the same out. 5. The perforated troughs laid along the bottom of the boiler, the pipes extending upwardly therefrom, the receiving-pocket at the upper ends of the pipes and the means for blowing out the pocket.



A yachting and fishery exhibition is now in progress at the Imperial Institute in London.

Including battleships, gunboats, torpedo boats, and minor vessels, there are now 29 ships building for the United States Navy.

An order for an additional ferryboat for the new Twenty-third street line on the North River, New York, has been placed by the Pennsylvania Co. with Cramp & Sons, of Philadelphia.

The United States cruiser Detroit returned to this port on May 17, after an absence of more than two years on the Asiatic station. The longest runs on her trip were from Columbo to Aden, a distance of 2,100 miles, and from Bermuda to this port, a distance of 2,445 miles. The distance covered on her homeward voyage was 15,324 miles in all.

NEW PUBLICATIONS.

BEESON'S MARINE DIRECTORY. By Harvey C. Beeson, proprietor and publisher, Chicago, Ill. Tenth annual edition, pp. 426. With illustrations. Price $5.00.

This standard book has just been issued with revisions to date. The list of American steam vessels on the lakes, with which classification the subject-matter of the book opens, occupies 43 pages. In this space the vessels are arranged alphabetically with note of their dimensions, class, date and place of build, and ownership. This is followed by bulk figures of vessels enrolled at the various custom houses on the great lakes, the table showing a total, among others, of 1,796 steam vessels. Of this total Buffalo heads the list in point of numbers, having 257 to her credit, and Dunkirk, N. Y., is the least, with two only. The list of sailing vessels is included in the space of 20 pages. A new feature of the work is a record of the engines and boilers of lake vessels. According to the publisher, it gives facts and figures about the machinery of one-third of the steam tonnage on the lakes. Besides these principal divisions of the book, there are data concerning largest cargoes carried, vessels whose names have been changed, weather bureau, federal courts, etc. There are also several newsy articles on matters of special interest to lake navigators, and besides many good process engravings are distributed throughout the work, so that in the make-up the usual dry-as-dust appearance of such publications is avoided. The book shows evidences of careful work, and its accuracy is attested by ten years of successful publication.

CATALOGUES.

A very neat little photograph of a compound engine is being distributed by The Fore River Engine Company, Weymouth, Mass. Everybody applying will receive one all mounted, ready to stick up.

A fully illustrated catalogue with dark green and gold cover has been issued by The Snow Steam Pump Works, Buffalo, N. Y. All sizes and kinds of pumps are illustrated and described, several being especially adapted to marine uses. It is an unusually handsome catalogue, comprising 112 pages.

At the beginning of the year the Knowlton Packing & Supply Co., 19 Pearl street, Boston, distributed 10,000 copies of a pocket calendar for 1897. The edition was exhausted, and we have just received a copy of the second edition of a thousand or more, which is ready for distribution either from the Boston office or from the New York office, 54 John street.

Every engineer should send to the Wheeler Condenser & Engineering Co., 122 Liberty street, New York, for its latest catalogue regarding the Wheeler improved surface condenser. This is a catalogue of 30 pages, handsomely illustrated and well printed, illustrating and describing fully the various types of condensers and other marine specialties manufactured by this company.

A very neat folder has been issued by Henry R. Worthington, New York, giving a partial list of foreign naval vessels which are equipped throughout with Worthington pumps. The list includes about 60 vessels in the English navy, 10 in the Russian, 12 in the German, 6 in the Austrian, and one or more in the Danish, Brazilian, Spanish, Portuguese, Chilian, Argentine and Japanese navies.

A pamphlet of "Testimony in the Case of Economy Drilling Compound vs. Oil, et al." is being sent out to engineers, both marine and stationary, by the White & Bagley Co., Worcester, Mass. It comprises about 50 pages of reproductions of letters received from prominent manufacturers and steam vessel owners, speaking in high terms of the value of this company's lubricating compound.

Every engineer who is interested in the subject of packing should send for a copy of the new catalogue just issue by A. W. Chesterton & Co., 49 India street, Boston, Mass. It is an exceedingly interesting catalogue and is very fully illustrated with pictures of the many kinds of packing manufactured by this company. It is not an ordinary job of printing, but good lithographic effect, and the catalogue contains much information which all engineers should wish to know.

A catalogue has been issued by the Mossberg & Granville Manufacturing Co., Providence, R. I., fully illustrating and describing the Mossberg roller bearing, advertised and described elsewhere in these pages, although the catalogue shows it as adapted to many other uses besides thrust bearings. Many records of tests of the bearing are given, and other detail, so that any one interested in the subject can find all the information necessary regarding this bearing.

The Hub ball and roller bearings manufactured by the Ball Bearing Company, Watson street, Boston, Mass., are well illustrated and described in their catalogue, just issued. There are places in which ball bearings are, perhaps, more advantageous than roller bearings, and this catalogue aims to explain why these conditions exist. The subject of reducing friction is one in which every engineer is deeply interested, and he will find much in this catalogue to interest him.

"Perfection in Anchors" is the title of a catalogue just received from the Baldt Anchor Company, Chester, Pa. The special features of this anchor are fully illustrated and described within these pages and will interest every man who has any use for an anchor. The special advantages of this anchor are fully described, together with tests that it has withstood and tables of anchors required for vessels of various kinds. Several testimonials are also published from well-known marine people.

A supplementary catalogue has just been issued by Murray & Tregurtha, South Boston, Mass., illustrating and describing their new gasoline engine. Several illustrations are given showing that this engine is of a type quite different from ordinary launch engines, and other pictures illustrate launches recently constructed by this company. The catalogue also contains a number of testimonials. This catalogue is supplementary to a larger one describing and fully illustrating the steam engines, launches, and water tube boilers built for this company.

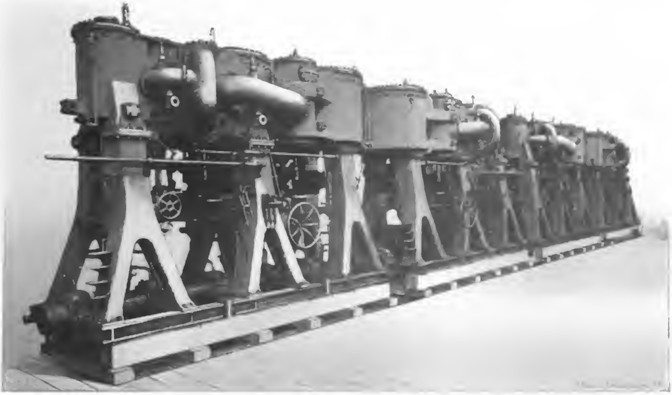
A very attractive catalogue has reached us from The Marine Iron Works, Clybourn and Southport avenues, Chicago. The special work of this company is the building of high grade marine machinery and complete steam craft of medium and small sizes. Everything offered for sale is its own manufacture, and numerous illustrations show in detail the various types of boats, engines, etc., manufactured. The boats include almost everything from small motor launches to stern paddle-wheel pleasure yachts, ferryboats, fireboats, etc. The catalogue is an excellent specimen of press work and contains a great deal of valuable information for intending purchasers of boats. It has an especially interesting series of pictures illustrating the various types and sizes of steam engines manufactured. Copies of the catalogue can be had upon application and by mentioning Marine Engineering.

MARINE ENGINEERING.

Vol. I. NEW YORK, JULY, 1897. No. 4.

U. S. ARMORED CRUISER BROOKLYN PRESENT AT BRITISH NAVAL REVIEW.

The United States Navy was worthily represented at the great naval review held at Spithead, June 26, in honor of the Diamond Jubilee of Queen Victoria. At the review there were 150 ships of the British Navy in line, and in addition ships from the world's navies and many fine mercantile vessels. The Brooklyn was selected as a representative vessel of the latest practice here in armored cruisers. It is consequently appropriate at this time to give some details of her construction and equipment.



TRIPLE-EXPANSION ENGINES OF U. S. ARMORED CRUISER BROOKLYN.

U. S. S. Brooklyn is a twin screw armored cruiser of 9,270 tons displacement. She is 400 ft. 6 in. long between perpendiculars, 64 ft. 8 in. beam, and her mean draught when ready for sea is 24 ft. The contract for her construction was awarded the William Cramp & Son's Ship and Engine Building Co., of Philadelphia, Pa., in February, 1893, at the price of $2,986,000. The keel was laid in August following, and she was sent on her trial trip in August, 1896. The contract called for a speed of 20 knots for four consecutive hours, and on her trial trip she showed an average speed of 21.91 knots, and a maximum speed of 22.9 knots, earning a bonus of $350,000 for her builders.

The hull is of mild steel divided into 242 water tight compartments. There is a double bottom amidships, and a cofferdam runs along each side of the entire length between the berth and protective decks. This is filled with cellulose. The top of the protective deck is level with the water line, and is 3 in. thick, curving downward at the sides with an increase of thickness to 6 in. At the ends the thickness is reduced to 2 1-2 in. This deck joins the hull 5 ft. 6 in. below the water-line. The machinery spaces are further protected by a belt of Harveyized armor 3 in. thick, extending along the sides for about 200 ft. and 4 ft. above and below the water-line. Coal is also carried above the protective deck almost the entire length of the machinery spaces, and also in bunkers below this deck. The bunker capacity is about 1,700 tons.

The Brooklyn stands high out of the water, having 29 ft. freeboard at the bow, and 21 ft. at the stern. She has two military masts and three very tall and rather slender smoke stacks, which combination gives her a very "machine" appearance. The tops of the funnels are 100 ft. above the grates, and 45 ft. above the deck superstructure.

Her armament consists of eight 8 in. guns, mounted in pairs in four barbette turrets, one forward and one aft, and one on each side amidships. The amidship guns can be fired in any point of a half circle from right ahead to right astern, as the sides tumble home sharply. The barbettes are plated with 8 in. and 4 in. armor, and the turrets with 5 1-2 in. armor. A supporting tube of 3 in. armor under each turret extends down below the protective deck and protects the ammunition hoists inside. There are also twelve 5 in. quick fire guns, mounted in sponsons on the gun deck, protected by armor 4 in. thick. There are also carried twelve 6 pounders, four 1 pounders, and four machine guns. A torpedo equipment for above-water discharge is fitted. The conning tower and shield forward are of solid steel, 7 1-2 in. thick.

The machinery equipment of the Brooklyn is, as might be supposed, very extensive. There are four main engines, seen in the illustration, of the three cylinder triple-expansion type, each with 3 cranks set at 120 deg. Each engine occupies a separate water tight compartment, though all connect with doors on the starting platform level. There are two engines on each shaft coupled together with taper coupling bolts, so that the forward engines can be disconnected with comparative ease. The engines are set with the high pressure cylinders forward, and the reversing gear and telegraphs are inboard. Bed plates and frames are cast steel, the latter in shape an inverted Y. On the insides of the frames, ribs are cast, and to these the cast iron crosshead guides are secured, with a space left for water circulation. Each engine has cylinders 32 in., 47 in., and 72 in. dia. and 42 in. stroke, fitted with liners. Steam jackets are fitted to the I. P. and L. P. cylinders, and provision is made for the expansion of the I. P. and L. P. liners at the tops. The valves are single-ported piston, of cast iron, one of 16 in. dia. for the H. P. and two of 16 in. for the I. P. These are fitted with balance pistons 4 in. and 4 3-4 in. dia., respectively, connected on top with the main condensers. The low pressure valves are two in number, the upper 30 in. dia. and the lower 28 1-2 in. dia., with live steam between, so as to effect a balance. The valve gear is of the regular Stephenson double bar link pattern. The pistons are of cast steel, dished, each fitted with two rings 5-8 in. wide and 3-4 in. deep. The rods are of steel 6 3-4 in. dia., and the crossheads are bolted to cast steel slippers lined with white metal. The crosshead pins are 7 in. dia. and 8 in. long, bored with a 2 1-2 hole. The connecting rods are 7 ft. between centers. The crank shafts are forged steel, built up. When the two engines are coupled together on each shaft, the H. P. cranks are opposite. The crank shafts of the forward engines are 27 ft. 6 in. long, 13 1-2 in. dia., with a 6 in. hole. The crank pins are 13 1-2 in dia. and 17 in. long. The dimensions of the crank shafts of the after engines are: length 24 ft. 10 in., diameter, 17 in. with a 7 in. hole, with journals 15 in. dia., and crank pins 17 in. dia. and 14 1-2 in. long. The crank shaft bearings are fitted with bottom brasses and cast steel caps, all lined with white metal, and arranged for water circulation. The main steam pipes are 12 in. dia., of copper strengthened with 1-8 in. steel bands, spaced 6 in. apart. Steam is carried between the various cylinders and condensers by outside pipes of composition, fitted with expansion joints. The reversing gear is so arranged that the two engines on one shaft can be simultaneously regulated from either engine room. A disk stop valve, with balancing piston and butterfly throttle is fitted to each engine. The thrust blocks are fitted close up to the after engines. The pedestals are cast iron of horse shoe form, lined with composition. The thrust shafts are 16 3-4 in. dia. and 12 1-4 ft. long, with a 7 1-2 hole. There are 12 collars on each shaft, 21 3-4 in. dia. and 2 in. thick, spaced 3 in. apart. The propeller shafts are in two sections, 18 in. and 17 in. dia., with 11 in. holes and 72 ft. long. They are splayed, and the outboard ends are carried in heavy steel brackets set close to the propeller hubs. The bracket bearings are 25 in. dia. and 34 in. long. The propellers are of manganese bronze, 3 bladed, true screws 16 1-2 ft. dia. with adjustable pitch normally about 20 ft.

Coming back to the engine room, the main condensers are of cast brass, 10 ft. 9 in. long and 5 ft. 9 in. dia, each fitted with 3,684 tubes, having a cooling surface of 5,425 sq. ft. The tubes are 5-8 in. O. D., 20 B. W. G., spaced 15-16 in. centers. Each engine is provided with one double vertical Blake air pump, with steam cylinders 12 in. dia., and water cylinders 25 in. dia. and 18 in. stroke. A centrifugal circulating pump is fitted for each condenser. Each is driven by a horizontal engine, with a 12 in. by 9 in. cylinder. The suction and discharge pipes are 14 in.

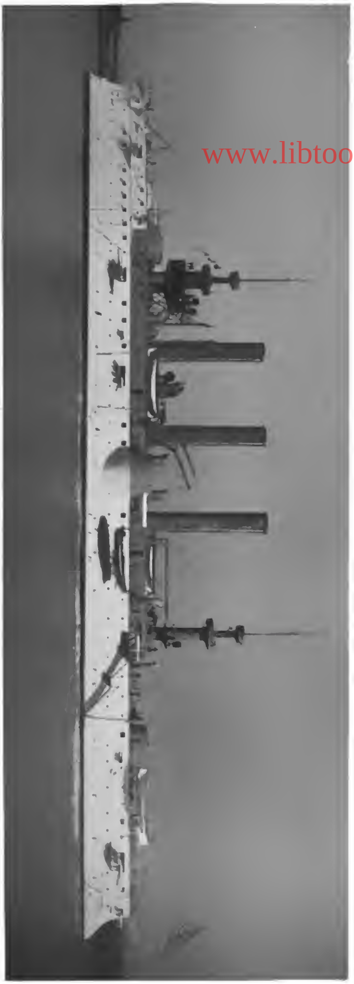
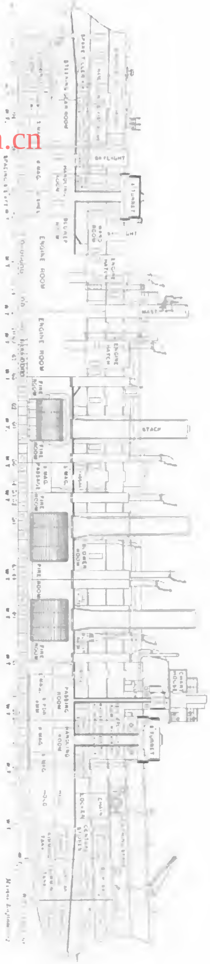


Photo. copyrighted 1897, by Geo. P. Hall & Son, New York.

U. S. ARMORED CRUISER BROOKLYN IN N. Y. HARBOR BEFORE HER TRIP ACROSS THE ATLANTIC.



LONGITUDINAL SECTION U. S. ARMORED CRUISER BROOKLYN.

Steam at 160 lbs. is supplied by five double ended and two single ended boilers, 16 ft. 3 in. dia. Four double ended are 18 ft. long, and one 19 ft. 11 1-2 in. long, and the single boilers are 9 ft. 5 in. long. There are eight Fox's furnaces in each double ended boiler, and four in each single ended boiler. All boilers are under the protective deck in three water tight compartments, and are fired athwartships. Armor bars are fitted inside the smoke pipes. In the double ended boilers there are 904 tubes, 2 1-4 O. D. and 296 stay tubes. The single ended boilers have 466 plain tubes and 152 stay tubes of 2 1-4 in. dia. All are fitted with shaking grates. The grate surface of all the boilers is 1,016 sq. ft. and heating surface 33,432 sq. ft., or a ratio of heating surface to grate surface of 32.9 to 1. Forced draught on the closed stokehold system is used. Each fireroom has two Sturtevant blowers, with double engines, 5 in. by 4 in. and fans 60 in. dia. and 18 in face.

Auxiliary machinery is numerous, and includes auxiliary condensers, feed pumps, fire bilge and water service pumps, turning engines, grease extractors, steam traps, ash hoists, ventilating blowers, distilling apparatus, turret turning engines, ice machine, machine tools and engine, and various other minor engines. The electric plant is extensive, consisting of three separate sets of generators, each with a capacity of 400 amperes at 80 volts. All of the machinery aboard, including the water, weighs 1,543 tons.

On her official trial the four main engines of the Brooklyn developed 18,248 horse power, and all of the machinery in operation gave a total of 18,769 horse power. The main engines averaged a little in excess of 136 revolutions with the boiler pressure at 158 lbs., the vacuum 25 in. and the throttle wide open. The average speed was 21.91 knots. This was on a displacement of 8,150 tons. The air pressure in the fire room was 2.26 in., and the boilers gave steam freely. The temperature in the engine room was 100 deg. and in the fire room 118 deg. Fahrenheit. The proportions of indicated horse power, taking into account all of the machinery in operation were, per sq. ft. grate surface, 18.47; heating surface, .56; cooling surface, .81; per ton of machinery, 12.16. With the after engines alone the Brooklyn can maintain a speed of 17 knots. At full speed she has a radius of action of 1,758 knots, and at 10 knots, cruising speed, of 6,088 knots. Her officers, and men number 560.

For many of the foregoing particulars and for the section we are indebted to the Journal of the American Society of Naval Engineers.

Accurate details of her run across the Atlantic are not yet obtainable, though telegraphic advices report a very satisfactory trip with a good record for economy.

Plans for the hull were drawn by the Bureau of Construction and Repair, and the machinery was designed under the supervision of Engineer-in-Chief George W. Melville, U. S. N.

STEAMSHIP VIBRATIONS WITH RECORDS OF RECENT OBSERVATIONS.—2.

BY PROF. W. F. DURAND.

In the preceding paper the causes of ship vibrations and the immediate results of these causes furnished the subject of discussion. We have next to examine the means available for the diminution or more or less complete suppression of such vibratory motion. The ideal solution, will of course, involve the removal of the exciting cause, and this should be the object of first attention in our examination of the problem before us.

Taking first the case of a single crank engine and omitting the influence due to valves and valve gear, we will examine in some detail the amount and distribution of the forces due to the inertia of the principal moving parts. These may be conveniently considered under three heads: (1) The reciprocating parts including the piston, piston rod, and crosshead; (2) The connecting rod, and (3) The crank. We may also consider the forces under the two heads of vertical and horizontal, of which naturally in vertical marine engines the former is the more important.

These forces may also be represented in two ways. The first of these is shown in Figs. 1 and 2. Counting from the position of the crank when on the center nearer the cylinder, crank angles are laid off on the base line OX, and the corresponding forces, vertical or horizontal as the case may be, are laid off vertically, thus giving the various curves as shown. These give for the entire revolution graphic histories of the vertical and horizontal forces due to the various parts above enumerated. These forces are computed for the moving parts of the high pressure cylinder from the data furnished by the design of a triple expansion engine of the following chief dimensions.

Diameter and stroke.	26", 41 1-2", 66" x 45"
Revolutions per minute..................	100
Ratio of connecting rod to crank......	5 : 1
Weight of reciprocating parts...........	2,155
" " connecting rod...............	2,770
" " crank..............................	2,767

The second method of representation is illustrated in Fig. 3. In this diagram the crank positions are denoted by radii drawn to the circle ABCD. The radius of this circle is of such length as to represent the maximum value of the horizontal force, or the value for a crank angle of 90°. Then in any given crank position OP, the horizontal projection OQ will represent the horizontal force for such position. QR is then laid off to represent the total vertical force for the same position, and OQ will therefore give the total resultant force in both direction and amount. For the entire revolution the representation will take the form MRBND. In general, as is seen, the resultant direction does not coincide with that of the crank. In such a diagram the total force for any weight having rotary motion alone, such as the crank or a shaft counterbalance, is represented simply by a circle. Thus EFGH represents the force due to the crank, while KBLD plotted in the same way as MBND shows that due to crank and connecting rod combined. The circle ABCD shows the part of the total force equivalent to that furnished by a rotating weight. Such weight in this case is represented by the crank plus 55 per cent of the connecting rod considered as having its center of gravity coincident with that of the crank pin. With these circular diagrams the crank being in any position represented by P or S, the radii OP or OS give the constant total force, while the projections OQ and OT or PQ and ST give the horizontal and vertical components.

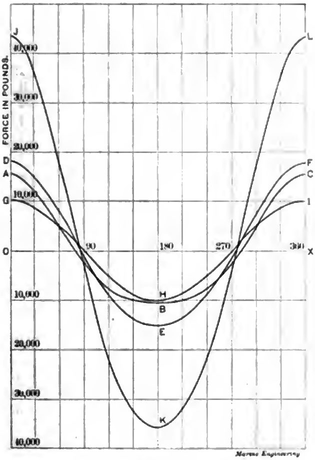


FIG. 1.

ABC—Vertical force due to the reciprocating parts.
DEF—Vertical force due to the connecting rod.
GHI—Vertical force due to the crank.
JKL—Vertical force due to the principal moving parts=sum of the preceding three

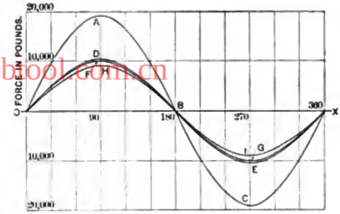


FIG. 2.

OFBGX—Horizontal force due to the crank.
ODBEX—Total horizontal force due to connecting rod.
OHBIX—Horizontal force at crank pin due to connecting rod.
OABCX—Total horizontal force on crank shaft.

These diagrams represent the forces for an actual design as given above, and are determined by means of formulæ given in the appendix. With the general character of these curves before us, it is easy to see the nature of the effect due to any weight or system of weights used as counterbalances, and having motions similar to those of the moving parts of the engine. Thus for a rotating shaft counterbalance, the history would be given by a circle in Fig. 3 as already noted. In no case, however, can such a weight produce a complete balance. If it be so taken as to give a constant radial pull equal to OB, and directed opposite to that of the crank, then it may be readily seen that the horizontal forces will be balanced. In such a case, however, a large unbalanced vertical force will still exist as shown by the diagram. Due to the unsymmetrical form of this diagram, a result due to the angularity of the connecting rod, no such weight can balance the vertical forces. A weight so taken as to give a force represented by OU for example, would be the nearest approximation, but there would still remain unbalanced forces as shown. In such case also, new unbalanced horizontal forces would be introduced by the counterbalance as shown in the diagram. Thus with the crank at P, OQ and QR are the horizontal and vertical forces due to the parts of the engine, while OV and VU are those due to the counterbalance. The differences are apparent. An examination of KBLO shows that a rotating counterbalance can be so determined as to nearly balance the forces due to the crank and the connecting rod combined, but without the reciprocating parts. Such a weight might be so taken as to give a radial pull represented by OB, thus balancing the horizontal forces and leaving the vertical remnant as shown, or it might be so taken as to give a pull represented by OW, thus balancing as closely as possible the vertical forces and introducing a horizontal unbalanced component.

The result of attempting to counterbalance the entire system of forces by a rotating weight giving a radial pull as represented by OU has been already referred to. If it is desired to counterbalance as nearly as may be the entire system of vertical forces without thus introducing large additional horizontal forces, then the counterbalances must take the form of weights having motion similar to that of the parts to be counterbalanced. This plan has been used to some extent on small boats, and the counterbalances thus employed are termed bob-weights. The plan was first brought prominently forward by A. F. Yarrow, whose paper read before the

Institution of Naval Architects may be consulted for further details.[1] The weights are actuated by a connecting rod given motion by an auxiliary crank or an eccentric. Obviously the forces due to these actuating parts must be taken account of, and they may be made to answer as part of the shaft counterbalance. With bob-weights the balance of vertical forces is only approximate, and usually less perfect than could be obtained by a rotating weight. This is due to the angularity of the connecting rod which actuates the weights. Thus if it were the same as that of the main connecting rod and the weights of the counterbalance system were the same part by part as those of the moving parts of the engine, the vertical force developed by the former would be represented in Fig. 1 by shifting ABC along 180°. The result of the combination would be a residual force shown by ABCDE Fig. 4. If the balance were effected by a rotating weight the residual vertical force is readily determined from Fig. 3, and is represented in Fig. 4, by FGHIJ. The latter of these residuals is about one-half the former, and it will be noted in each case that the period is one-half that of the fundamentals, or in other words that there are twice as many alternations per minute as with the original forces.

For the determination of the counterbalance weights in the various cases discussed, the most satisfactory method will be through actual investigation by means of such diagrams as those here shown. In default of such methods, approximate values may be found by means of the following rules:

If a shaft counterbalance is to be used to give a force represented by OB Fig. 3, it must be located opposite the crank, and its moment or the product of its weight by the distance of its center of gravity from the shaft center must equal the similar product for the crank, plus the product of about one-half of the connecting rod weight by the crank arm. In the present case the weight of the cranks webs and pin is 2767 pounds, while their center of gravity is 1.07 feet from the shaft center, the weight of the connecting rod is 2770, and the crank arm is 1.75 feet. Hence the sum of the moments would be 2767 × 1.07 + 1385 × 1.75 = 5374 and the counterbalance weight multiplied by its arm must equal this amount. Thus use might be made of 5374 lbs. at an arm of 1 foot, or 2687 lbs. at an arm of 2 feet, etc. In the present case, as we have seen above, the more accurate value for the fraction of the connecting rod weight is .55 instead of .50. If a shaft counterbalance is to be fitted so as to balance as nearly as may be the entire vertical force irrespective of the additional horizontal forces introduced, then the product of its weight by the distance of its center of gravity from the shaft center must equal weight of reciprocating parts multiplied by the crank arm, plus the weight of connecting rod multiplied by the crank arm, plus the moment of the crank as before. This sum will be of frequent recurrence in the course of our examination, and for convenience we will designate it as the *characteristic moment* of the moving parts. The similar sum for the parts of a counterbalance system consisting of shaft counterbalance, auxiliary crank, connecting rod, and bob-weights, will comprise the product of the bob-weights by the auxiliary crank arm, plus the product of the auxiliary connecting rod by the same arm, plus the moments of the auxiliary crank or eccentric, and of the shaft counterbalance, about the shaft axis. This may be called similarly the *characteristic moment* of the counterbalance system. If the system consists of a shaft counterbalance alone, the characteristic moment is simply the moment of the weight about the shaft axis. In the present case the weight of the reciprocating parts is 2155.

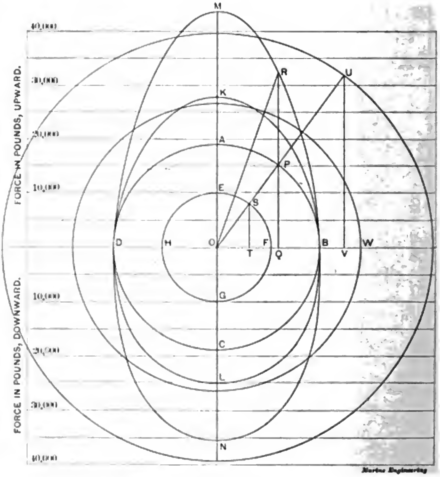


FIG. 3.

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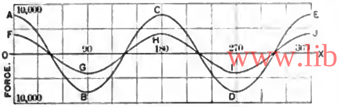
[1] Vol. XXXV. p. 213, 1894.

Hence the characteristic moment of the moving parts is:

$$2155 \times 1.75 + 2770 \times 1.75 \quad 2767 \times 1.07 \quad 11580$$

and the counterbalance must be so arranged as to give the same moment. If a combination of shaft counterbalance and bob-weights is to be used, the characteristic moment of the system must have the same value. In fact the general rule for complete vertical counterbalance requires that however the weights may be divided between shaft counterbalance and bob-weights with their actuating parts, the characteristic moment of the system must equal that of the moving parts of the engine.



CRANK ANGLES. FIG. 4.

Where a shaft counterbalance alone is used, the vertical balance, or that in the direction of the line of motion is more commonly partial rather than complete, and in consequence the moment of the weight would vary between the limits defined as above (in the present case 5374 to 11580), according to the relative importance of a balance of forces in a direction at right angles to the line of motion, or in the direction of the line of motion.

We have thus considered in some detail the balancing of the forces due to the principal moving parts of a single crank engine, for the reason that the principles developed may be readily extended to the more general case of multiple cranks and valve gears. Omitting, however, for the present, the influence due to valve gears, we will proceed with the simpler combinations of cranks. Thus with two cranks at right angles the general result must be obtained by a combination of the curves for the principal moving parts of each engine. In such case if the moving parts are of the same weight the maximum forces up and down will be of the same value, and a complete and practically perfect counterbalance can be obtained by a weight at 135° from either crank and having a moment about 1.4 times the characteristic moment for the moving parts of one engine. If a combination of shaft and bob-weights is to be used, their characteristic moment must have approximately the same value. If the moving parts are not of the same weight the case will require detailed consideration, and the resultant force diagram will give the necessary data for determining the location and amount of weight for counterbalance. An approximate value will be found by taking .70, the sum of the characteristic moments for both engines, and locating it at an angle somewhat greater than 135° from the crank belonging to the heavier parts.

If the two cranks are opposite it is evident that each set of moving parts may be considered as a counterbalance system for the other, and if the moving parts are of the same weight the balance will be complete but not perfect. This point has been referred to above in connection with Figs. 1 and 4, and arises from the angularity of the connecting rod. The residual force is by no means inconsiderable, being in the case of a pair of engines such as here considered, and as shown by Fig. 4, of a maximum value of about 8,000 pounds in each direction, and thus giving a total change of stress of 16,000 lbs. twice in each revolution. The importance of these residual forces was first prominently brought out by Messrs. Robinson and Riall-Sankey in a paper read before the Institution of Naval Architects, to which further reference may be made.[2] If the moving parts are of unequal weight, a counterbalance system must be used of angular location opposite the crank belonging to the heavier parts, and of characteristic moment equal to the difference of those for the two sets of moving parts.

Turning now to the engine with three cranks at 120° and with equal weights of moving parts, we should find by plotting three curves similar to JKL Fig. 1, with an angular difference of 120° that the residual force would very nearly vanish. Such an engine is therefore self-balancing so far as the residual forces are concerned. If the moving parts are not of the same weight, the case will require detailed examination, and the result of the combination of the three curves plotted with 120° angular interval, and taking note of the crank sequence, will show the amount and angular location of the maximum forces, and hence the characteristic moment and angular location of the necessary counterbalance system. If the curves for the three cylinders are combined with some angular relation other than 120°, the result will show whether such a combination is better or worse than that given by the regular 120° relationship. A series of trials in this way would serve to determine an angular relation for any given engine for which the resultant force would be a minimum. Such an investigation may preferably be carried out in the following manner. Any two curves are taken, as for example those for the high and intermediate, and combined at a series of angular intervals until a result is found such that the mean of the extreme values is as nearly as possible the same as the mean for the remaining or low pressure cylinder. The angle thus determined between the high and intermediate is then noted and the location of the maximum and minimum for their resultant will show at what angle the low pressure crank should be connected in order to produce the nearest approach to a perfect balance. Thus with the engine used for illustration the total vertical force for the H. P. cylinder varies from about 43.300 upward to 35.500 downward. For the I. P. the corresponding figures are 47.100 and 38,000, and for the L. P., 56,500 and 44.300. If now these are com-

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[2] Vol. XXXVI, p. 300, 1895.

bined with crank intervals of 120° we shall find a resultant force varying from about 11,500 upward to 9,000 downward. If, however (the sequence of cranks being High-Intermediate-Low, in the order of passing a given point), the angular interval between the high and intermediate is made 105°, and that between the intermediate and low 129°, the resultant force is reduced to about 5,000 in each direction, or about one-half the former range. A system of counterbalances could do but little better, so that by such an arrangement of cranks the engine may be made self-balancing within the limit usually attained.

Passing now to the four-crank engine we find for 90° crank intervals, and equal weights of moving parts, practically a perfect balance. This is readily understood when we remember that the four-crank engine may be considered as two pairs of two crank engines for each of which the residual force is represented by a curve as ABCDE, Fig. 4. The final resultant will therefore be that due to a combination of two sets of such curves with 90° angular interval, and this, as is seen, is practically O throughout the revolution. If the weights of the moving parts are not the same, a special examination will be required, from the results of which the necessary characteristic moment and angular location of a counterbalance system can be determined. In particular it may be noted that with the moving parts of say cylinders 1 and 2 equal with cranks at 180°, and those of cylinders 3 and 4 equal with cranks at 180°, the two pairs of cranks being at 90°, but the weights of 1 and 2 being different from those of 3 and 4, the combination will not give a perfect balance. The result will be represented by the combination at 90° interval, of two unequal sets of curves like ABCDE Fig. 4, and will give a residual alternating force of two complete periods per revolution. In a similar manner as for three cranks, a special arrangement of the four cranks may be found for any given case with different weights of moving parts, such that the balance will be as nearly perfect as possible, and thus the use of special counterbalance may be avoided.

Turning now to the forces introduced by slide valves and gear, we note that the parts may be reduced approximately to the same heads as in the case of the principal parts of the engine, and hence the same formulæ and methods apply without change. We may thus derive for each valve gear a series of curves similar to those above described, and such that when combined at the proper angular intervals with those for the principal parts of the engine, the result will give the total force due to all moving parts. In general with valve gears the angularity of the rods and the total forces are relatively small so that no serious error will be introduced by neglecting the angularity, and taking in each case the vertical force as given by what we have called the characteristic moment for the gear, multiplied by the square of the angular velocity and by the cosine of the angle made with the vertical, and divided by the value of gravity. This would be equal to the vertical force due to a revolving weight on the main shaft having a moment equal to the characteristic moment of the valve gear.

We have thus far examined the question of a balance of the inertia forces considered only with reference to the force resultant. Attention must also be given to the resultant moment as applied to the shaft or bed plate. Thus suppose for a single engine that a single shaft counterbalance were located in the proper angular relationship, but at some distance from the crank. The result of the vertical forces, as is readily seen, would be a rocking moment on the shaft tending to impart a see-saw motion to the engine, the more severe as the moment arm is greater. Similarly if a single bob-weight were connected to an auxiliary crank at some distance from the main crank, the result would be the same. It is readily seen that like conditions will result for two cranks at 180° and for various other arrangements of cranks. The entire system of forces due to the parts of the engine and to the counterbalance system or systems must therefore be considered and adjusted as nearly as may be, so that the vertical resultant and the vertical moment shall both vanish. To this end the history of the rocking moment for the unbalanced engine throughout the revolution must be obtained. This may be found from the curves of resultant vertical force similar to JKL, Fig. 1. Taking three cranks for illustration, we may use the L. P. center line as the origin of moments. We then take for a given angle the vertical forces for the H. P. and I. P. cylinders, and multiply the former by the distance between the H. P. and L. P. center lines, and the latter by the distance between the I. P. and L. P. center lines, and combine the products according to sign. Forces upward may be taken as positive and downward as negative. Thus a positive product would denote a moment tending to elevate the forward end of the engine and to depress the after end, and a negative product vice versa. The result thus found will give therefore the rocking moment for the angle taken. These results being plotted on a horizontal axis of angle as in Fig. 1, the entire history of the rocking moment will be known. In general it will be found periodic in character, showing a tendency to rock the engine to and fro longitudinally once in each revolution. A counterbalance weight or system may then be introduced at the proper angle as shown by the resultant curve, and of proper size and at the necessary distance from the L. P. center line, to give approximately a numerically equal moment of opposite sign, and thus to effect an approximate balance of rocking moments. In the determination of this counterbalance three specifications are required. (1) Angular location. (2) Moment about shaft axis or characteristic moment as defined in connection with a counterbalance system. (3) Location relative to L. P. center line. Item (2) may be taken the same as for the balance of vertical resultant force, and (3) so determined as to give the necessary moment. In general, however, (1) will not agree with the requirement for vertical resultant force, and (3) moreover may give a location far beyond the limits of the engine proper. If the engine and ship formed one rigid whole, the location of the counterbalance system far from the engine would not render it ineffective. But practically the flexibility and elasticity of the structures with which we have to deal, require all counterbalances to be applied at or very near the engine. If item (2) is made larger so as to reduce the distance from the L. P. center line, then the vertical resultant will be no longer approximately balanced. It will thus be found in general that with cranks at equal angles the conditions for the nearest possible balance of vertical forces and of rocking moments cannot be fulfilled at the same time. We shall recur at a later point to such cases as do admit the approximate fulfilment of these conditions.

MECHANICAL METHOD OF ASCERTAINING STATICAL STABILITY OF SHIPS.*

BY A. G. RAMAGE.

The apparatus consists of a small tank A, holding water. The surface of the tank should be just sufficient to admit the wood sections of the ship, and permit them to be turned through the required angles. B—Figs. 1, 2, 3, 4, and 6—is a frame attached to the sides of the tank, guiding the sliding block C, which can be raised or lowered by the screw d; a—Figs. 2 and 4—is the arm to the outer part of which the sections are attached; a can be turned through any angle by the worm E—Figs. 3 and 6—the angle being indicated by the finger h on the plate f—Fig. 6; g—Figs. 1 and 4—is the indicating arm balanced on a knife edge H, and multiplying at its free point the vertical motion imparted to it by the float M through the rod L.

Sections of wood representing mean sections

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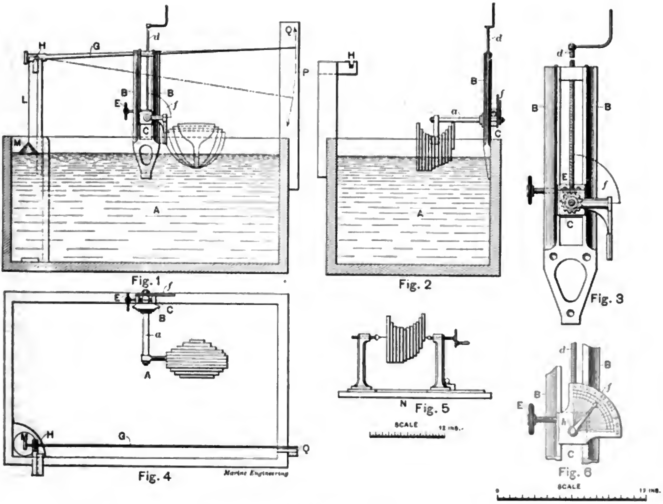
* Read before the Institution of Naval Architects in London, April, 1897.



DIAGRAMS OF APPARATUS FOR ASCERTAINING STATICAL STABILITY OF SHIPS.

over the length each represents in its thickness are attached to the arm a, so that they are vertical when the finger points to zero, and so that the water-line to which the sections are to be immersed is parallel to the surface of the water. The sections are then screwed down into the water by the screw D till they are immersed to the required line. The float having risen owing to the displacement of the water, the indicating hand has moved through a large angle P.

When the water is still mark the position of the indicating hand on the board placed behind it, then raise the sections, and by the worm turn them round to the first angle of heel, say, 20 deg., screw them down till the indicating hand has swept through the same angle as for the upright displacement. They are then at the correct draught for the inclined position. Make a pencil mark on one or two points of the sections at the surface of the water, then lift the sections by the vertical motion. The sides of the tank having been made level to the surface of the water, lay a straight edge across the sides of the tank, and draw the water-line all round. When the inclined water-line has been drawn, unscrew the sections, and saw off the immersed part, balance it on the needle points, and ascertain its center of gravity or center of buoyancy, and measure with a scale its position from the center line and from water-line. Glue the sections together again, putting in a layer of wood to make up the saw rift, and repeat the operation for other angles. The points thus obtained having been set off on the body plan, with the center of buoyancy calculated for the upright position, give us the locus of centers of buoyancy, from which the righting arms may be measured.

I shall now deal with some of the objections which might be raised to the system, and also point out some of the difficulties which have to be overcome, and things to be guarded against. I do not think any one will object to the balancing of sections, because other systems which have gained considerable credit make use of these, and, though the homogeneity of the wood used is an essential, this can generally be secured by selecting clean yellow pine[1] for the purpose. The sections should be balanced first on the center line to prove that both sides are of equal weight. The water-absorbing powers of both sides should also be the same, or else the balancing should be delayed until the wood is dry. Yellow pine absorbs an amount of water, even after being coated with varnish, sufficient to sensibly affect the indicator hand. That is to say, the point of rest of the indicator will be higher after the sections have been lowered and raised than before the sections were put in. Care should therefore be taken that the indicating arm passes through the same arc as in the first instance.

The chief point we have to consider is the sensitiveness of the indicator. May not a layer sufficiently large to affect the accuracy of the result be too small to affect the indicator? Here is a sheet of tin of the size of the cross section at the water-line at 30 deg. inclination, which, on the scale to which the sections are made, represents about 3-8 in. If that sensibly affects the indicator, we may conclude that it is sensitive enough for all practical purposes. I put it in the water, and there is a sensible motion of the indicator. The difficulty of marking the sections correctly, owing to the viscosity of the fluid, is an objection that might be raised, but if some blue be mixed with the water there is not much difficulty in marking the true position of the water-line.

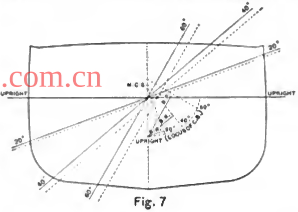
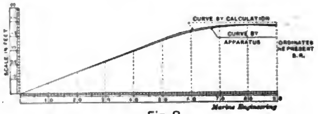


Fig. 7



Marine Engineering

Fig. 8

The time necessary to make the sections and perform the operation is not great if we leave out the time which the glues take to harden when the parts are being reunited. A smart model maker will cut out the sections in about four hours, dipping, sawing, and balancing two hours, and gluing up, say two hours. The advantage lies in this, that the intelligent joiner or model maker can perform the whole operation, and he who is responsible can satisfy himself by a glance at the accuracy of the results, without wading through a labyrinth of figures. Pins can be driven into the sections to mark the position of the centers of buoyancy, the mean position of which should be set off on the midship section drawing. The indicator on my apparatus magnifies the vertical motion of the surface forty times. As to results, you will find on diagram, Fig. 8, curves showing the comparison of the result of calculation with the results given by the apparatus. The time necessary to get a sufficient number of points, say, at 20, 40, 60, and 90 deg., is probably the worst feature of the arrangement; but if three or four vessels are worked at the same time, which can be done, the time taken is much less than for the ordinary calculation. It is very important that the center of buoyancy for the upright position be very carefully calculated.

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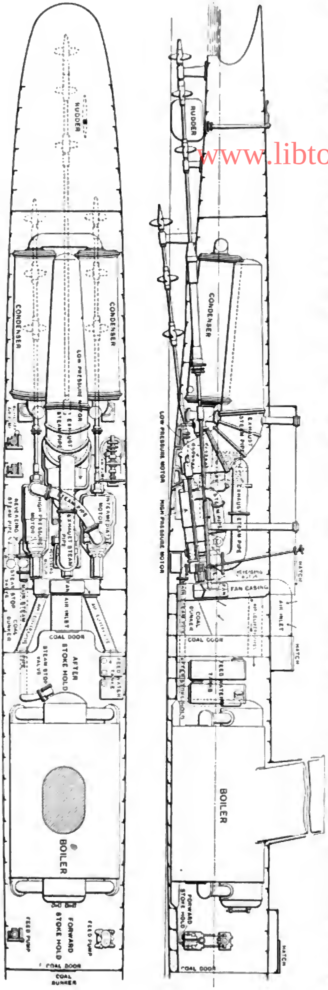
[1] Known in American practice as white pine.



SECTIONAL VIEWS OF THE TORPEDO BOAT TURBINIA FITTED WITH TURBINE ENGINES.

ROTARY AND RECIPROCATING ENGINES AS APPLIED TO SHIP PROPULSION.*

BY HON. CHARLES PARSONS.

The advantages of a rotary motor for the purpose of marine propulsion are manifest as regards a direct application of the force of the steam to the shaft to be driven, and a consequent saving of bulk, weight, friction, and wear. When such a motor is shown to be economical in steam consumption, and that the power delivered by the motor at a high speed of rotation can be economically transformed into thrust-power by the screw propeller, and that the whole of the machinery is simple and easy to work, the position of the rotary motor becomes well established as a rival of the reciprocating engine, provided there are no drawbacks to detract from the advantages which it manifestly possesses. Up to the present no such drawbacks have shown themselves, or seem likely to do so.

The compound steam turbine consists of a series of steam turbines set one after the other on the same axis, so that each turbine takes steam from the preceding one and passes it on to the succeeding one. Each turbine of the set consists of a ring of fixed blades called guides fixed to the casing, and also of a ring of moving blades attached to the shaft. The steam from the steam pipe entering all round the shaft passes through the first set of guides, then through the first set of moving blades, then through the second set of guides, then through a second set of moving blades, and so on through the complete turbine motor. The blades are carefully shaped, as in water turbines, and the action of the steam in each turbine of the set is similar to that of water in the water turbine.

Steam is, however, an expansive fluid, and though its action in each individual turbine is approximately as if the fluid was inelastic, yet a small increment of volume takes place at each passage through the blades, and the expansion going on at something like geometric ratio at each of the numerous successive turbines soon assumes large proportions. Ratios of expansion of fifty up to one hundred or even two hundredfold are common in one single compound turbine of the condensing type; a notable feature in turbine practice being that high expansion ratios and very large volumes can be economically dealt with without necessarily increasing the size and weight of the engine to any large extent, or, what is perhaps more important and gives the turbine a special advantage over ordinary engines, is that practically no increase in frictional resistances is incurred by arranging for the extra expansion, and exceptional economy in steam is thereby realized. The high speed of revolution diminishes not only the weight of the engines themselves in proportion to a given horse power, but also of the shafting,

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* Read before the Institution of Civil Engineers, London, May, 1897.

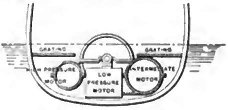
propellers, and supports, as well as of the hull. The total weight of machinery in vessels of the torpedo boat or torpedo boat destroyer class on the turbine system, will probably not exceed one-third that of ordinary engines of the same power. The consumption of steam on recent trials on the Turbinia has been shown not to exceed 14 1-2 lbs. per indicated horse power at full load, or considerably less than that of similar engines of the reciprocating class, so that the size and weight of the boilers, and also the amount of coal carried can be considerably reduced, and consequently the total displacement of the vessel to be propelled will be largely reduced, so that with a given horse power much greater speeds may be attained; or, on the other hand, heavier cargoes may be carried with a given consumption of coal per knot. To these advantages must be added that the space occupied by the turbines is very much less than that occupied by ordinary engines, thus increasing the capacity of the vessel, and also that the turbine machinery being placed near the bottom of the vessel, the center of gravity is thereby lowered, and the stability of the vessel increased. Also, owing to their position—and even in the Turbinia with only 3 ft. draught—they lie almost wholly below the water line—a matter of considerable importance in war vessels.

The almost total absence of vibration, owing to there being no reciprocating parts, admits of a diminution in the weight of the hull, and in fast vessels admits of a degree of comfort not hitherto attainable, and also in the case of warships, enables guns and torpedoes to be worked with ease and accuracy. Another feature is that, owing to the reduced size and weight of the shafts and propellers, this not only facilitates duplication and repair, and enables spare parts to be carried on board the vessel to an extent not hitherto practicable; but also, owing to the smaller diameter of the propellers, it admits of screw-propelled vessels being used for navigating shallower waters.

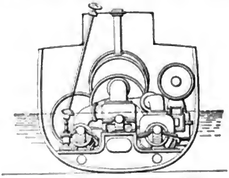
To summarize, the merits of the turbine system applied to marine propulsion appear to be:—(1) Greatly increased speed, owing to diminution of weight and smaller steam consumption; (2) increased carrying power of vessel; (3) increased economy in coal consumption; (4) increased facilities for navigating shallow waters; (5) increased stability of vessel; (6) reduced weight of machinery; (7) reduced cost of attendance on machinery; (8) reduced size and weight of screw propellers and shafting; (9) absence of vibration; (10) lowered center of gravity of machinery, and reduced risk in time of war.

The first ship fitted with turbine engines has been the Turbinia. She is 100 ft. in length, 9 ft. beam, 3 ft. draught amidships, and 44 1-2 tons displacement. She has three screw shafts, each directly driven by a compound steam turbine of the parallel flow type. The three turbines are in series, and the steam is expanded—at full power—from a pressure of 170 lb. absolute, at which it reaches the motor, to a pressure of 1 lb. absolute, at which it is condensed. The shafts are slightly inclined, and each carries three screws, making nine in all. The screws have a diameter of 18 in., and when running at full speed they make 2,200 revolutions per minute. Steam is supplied from a water-tube boiler, and the draught is forced by a fan, mounted on a prolongation of the low-pressure motor shaft, the advantage of this arrangement being that the draught is increased as the demand for steam increases, and also that the power to drive the fan is obtained directly from the main engines.

Up to the present the maximum mean speed attained has been 32 3-4 knots, as the mean of two consecutive runs on the measured mile. These runs were made after about four hours' steaming at other speeds, and the boat on the day of the trials had been fifteen days in the water. It is anticipated that on subsequent trials, after some alterations to the steam pipe, still higher mean speeds will be obtained. As it stands, however, the indicated horse power realized is 2,100 and the consumption of feed water per indicated horse power hour 14 1-2 lb., and the speed the fastest of any vessel, irrespective of size. The weight of the main engines is 3 tons 13 cwt. Total weight of machinery, including turbines and auxiliary engines, condenser and boiler, the propellers and shafts, the tanks and the water in boiler and hot well, 22 tons. Thus nearly 100 horse power is developed per ton of machinery, and nearly 50 horse power per ton of displacement of boat.



SECTION THROUGH MOTORS



SECTION THROUGH ENGINE ROOM LOOKING AFT

In the Turbinia the stresses on the boiler and machinery are, as far as possible, according to the Board of Trade rules, and the scantlings of the hull are heavy for a boat of her size and class. It is believed that when boats of 200 ft. in length and upwards are fitted with compound turbine motors, speeds of 35 to 40 knots may be easily obtained in vessels of the destroyer class.

ON USE OF WATER-TUBE BOILERS IN THE MERCANTILE MARINE.*—I.

BY A. E. SEATON, M.C.I.N.A.

The resurrection and revival of the water-tube boiler and its successful employment for naval purposes has naturally caused the question to be asked on all sides, "Cannot such boilers be used with advantage in the mercantile marine?" and, as may be supposed, the replies of engineers differ very largely on the subject, varying between the extreme opinions that there is nothing to hinder their immediate adoption, and that such boilers are not or never can be fit for mercantile steamships. The controversy, both in political and professional circles, has practically revolved round one particular form of water-tube boiler, so that the general merits of the case have been confused, and in many instances entirely lost sight of.

The water-tube boiler first appeared in America in the very early days of this century, long before Queen Victoria ascended the British throne. The object of Colonel Taylor, in 1807, was to substitute for the heavy, roomy, and somewhat inefficient Cornish boiler a generator more suitable to the exigencies of shipboard, and that after experience with the paddle steamer Clermont on the Hudson. It will thus be seen that at the outset the distinguishing features of a water-tube boiler, viz., light weight and small space occupied, operated to cause it to be proposed in the mercantile marine of America. Many efforts have since been made in America to employ a water-tube boiler of some kind or other in mercantile ships, so that to-day the engineers of the United States are in a much more receptive mood for the adoption of the water-tube boiler than are the engineers of this country, where hitherto the attempts to use that form of boiler at sea have been few and far between, and mostly attended with ill-success. The possibilities of the water-tube system have not, however, either in Great Britain or elsewhere, been exhausted; and although there are at the present time many types in successful use, none altogether fulfil the necessary conditions for the best form of water-tube boiler.

Considering the ideal water-tube boiler to consist altogether of cylindrical components, with either spherical ends or ends of such a form as to require no staying, and subject only to internal pressure, it needs little demonstration to show that such a boiler must be lighter, stronger, and more capable of withstanding rough usage than a boiler which is a combination of cylindrical components—a large portion of which is subject to external pressure—rectangular boxes, flat ends, etc.; and therefore it will be assumed that it is in itself lighter than the Scotch boiler, pressure for pressure, and especially so for high pressures; that it contains less weight of water than its rival; that it can be designed to occupy as little or even less space than the Scotch boiler; and that steam can be got up in it in half an hour as against four to six hours with the Scotch boiler. All these assumptions are, however, borne out by recent practice. In the British Navy, experiments with both the Belleville[1] and Thornycroft boilers have shown that the type can be worked as economically as to fuel as the Scotch boiler, and that the amount of coal required to get up steam is considerably less. There is indeed no prima facie reason why a water-tube boiler, properly designed and properly worked, should not be capable of evaporating as much water from a pound of fuel as the ordinary boiler can.

The enduring powers of the water-tube boiler have not yet been demonstrated, and as that is a question of cost, it necessarily has a very important bearing in determining their use in commercial steamships. But here, again, there are no prima facie reasons why a water-tube boiler should not last as long as any other boiler; indeed there are many reasons why it should last longer, not the least of which is the fact that it is not subject to distress of itself as a whole, or of any of its more important parts, on rapidly raising steam, or on rapidly cooling down, whereas a Scotch boiler is very materially affected by these circumstances, and the length of its life is probably in the inverse ratio to the number of times steam is raised in it. It must, however, be understood that this statement does not imply that any of the existing boilers comply with the ideal conditions, and consequently their lasting powers may possibly be not so great as that of the Scotch boiler; but the evidence of the boilers that have been fitted into ships of the mercantile marine points in the direction of equal or greater longevity for the water-tube boiler.

The prime cost of the Belleville boiler is undoubtedly very much greater than that of the best cylindrical boilers, and it is probable that every kind of water-tube boiler in which so much screwing and so much accuracy of fitting is involved, and for which so many special fittings are required, will always exceed the cost of the old type of boiler; but the Babcock & Wilcox boiler, and boilers of the type in which the tubes are simply expanded in place, and for which no special appliances are necessary either for circulation or for fuel burning, cost little or no more than the ordinary boiler. Experience with both the Belleville and the Babcock boiler has shown that defects and mishaps may be remedied at sea by the vessel's own staff, and that mishaps of a more serious nature can, at comparatively slight expense and in a short time, be effected in port. On the other hand, the mishaps to the tank boiler, especially when it is getting old, are much more serious, repairs can very seldom be executed

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* Read before Institution of Civil Engineers, London, May, 1897.

[1] 10.3 lb. of water per lb. of coal—from and at 212 deg.—has been evaporated from the boilers of H. M. S. Furious when burning over 30 lb. of coal per square foot of grate.

at sea, and when done in port necessitate a considerable expenditure of time as well as money. With existing designs of water-tube boiler, a little more care in stoking is necessary, especially if the best results from the fuel are required; but there is nothing so serious as to prevent the ordinary everyday marine fireman from being educated in a few hours to manage the fires of a water-tube boiler as well as he manages those of the Scotch boiler. From the conditions of employment in the mercantile marine this is likely for some time to be a difficulty; still it is not an insuperable one, and, if ships' engineers will take the proper precautions, need not be one of long duration in any ship.

The ideal boiler referred to—or perhaps, preferably the boiler of the future, because it is not likely that any boiler will ever quite fulfil every requirement of an ideal boiler—must have a rapid, uniform, and definite circulation, the upcast tubes should be very considerably inclined from the horizontal, and the nearer they are to the vertical position the better; they may be large or small according to fancy or circumstances; they should be capable of easy examination, and therefore must be straight or nearly so, and their arrangement should be such that any one of them may be easily drawn and replaced; the downcast pipes, or those from the steam drum to the water pockets, should be as direct as possible and of considerable size, and at or near their bottoms there should be a receptacle with no circulation—in other words, a dead end, so that solid matter can, by gravity, be separated from the liquid; the fireplace and its surroundings should be of such size and nature as to allow of the proper combustion of the fuel and its effluent gases, while the general structure of the boiler should be such as to enable it to bear sudden expansion and contraction with impunity, and the whole of the surface exposed to flame and hot gases should be accessible for cleaning. If these conditions are fulfilled, there is no absolute necessity for using pure fresh water, inasmuch as the rapidity of flow will prevent deposition on the upcast pipes by the mechanical scour of the water; the dead ends permit of the deposit at a safe place, and if there is any deposit on the downcast pipes, they—being of considerable size and easy of access—can be cleaned when opportunity serves and if necessary, would go for a considerable period without cleaning. The absence of these conditions in the boilers of the Propontis and other ships which have not been successes, has no doubt conduced to their failure, and although to-day the means of obtaining fresh water by evaporators, etc., permits of the use of pure water in boilers, and has to a large extent been the means of the admission of these boilers on shipboard, that it is really no more a necessity with the type when properly designed than with the Scotch boiler.

ORIGIN AND DEVELOPMENT OF THE FERRYBOAT.—3.

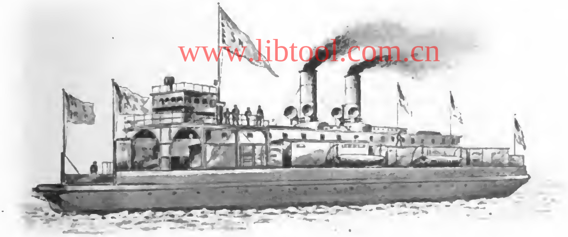
BY EDWIN A. STEVENS.

While the detail of construction of the older boats possessed historical interest, the means employed by various designers to meet the conditions of the problem of ferryboat construction can best be exemplified by descriptions of boats now in actual service.

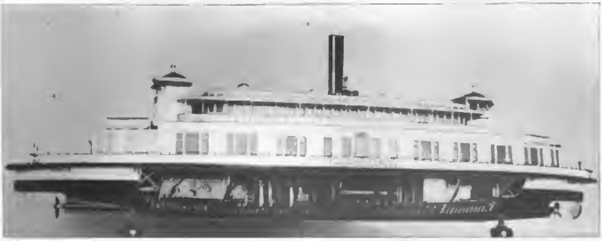
There are now operating on the same route, side by side, driven by practically the same engines, wooden boats of twenty or twenty-five years of age, and iron and steel boats. The models have not varied greatly as a consequence of the change in material, excepting possibly on the Hoboken ferry. On that route the wooden boats were built with midship section of a triangle with its apex cut off, the frames being straight and the floor narrow, but perfectly flat. On other routes a vertical side and a nearly flat bottom were the universal characteristics. The propelling machinery of the side wheel boat usually consists of a beam engine, single expansion type, with poppet valves generally actuated by Stevens cut off. The diameter of the cylinders varies from 42 in. to about 50 in.; the stroke in late years has been rarely less than 10 ft. Boilers of various types are used, some of them closely resembling the straight through design known as the Admiralty boiler, in others the double return drop flues are used; a single boiler is the rule. Condensation is obtained by a jet, the air pump being driven from the main beam. Steam pressure is carried at about 30 lbs., though in a few boats the pressure allowed by the Inspectors reaches some 10 or 15 lbs. above that figure.

The displacement of the Orange and Montclair, of the Hoboken ferry, taken as typical of this type of boat, is about 800 tons; their length on water line is 217 ft.; the beam on the water line is 32 ft. The cabins are heated by steam in radiators placed under the inboard seats on the main deck. Ventilation is generally secured by outlets through the upper deck. This system can hardly be said to give satisfactory results in Winter, when the doors are closed as much as possible. The passage connecting the cabins at the ends of the boats, which is rendered necessary by the presence of the paddle boxes, practically makes each cabin a separate compartment for the purposes of ventilation; the opening of the doors, therefore, at both ends of the boats, even if simultaneous, does not ensure enough circulation to entirely remove foul air. The Orange and Montclair were designed by F. B. Stevens, and were built in 1886; the hulls by T. S. Marvel & Co., of Newburgh; the engines by the W. & A. Fletcher Company, of Hoboken, N. J. These boats when new represented the best and most advanced practice of their day.

A number of such vessels have been double-decked, and in this form have performed satisfactory service. Where good results have not been attained, it has been due to lack of stability, power, or structural strength of hull. The most highly developed form of side wheel boats in this country have been the Garret and Wiman, of the Staten Island route. These boats are 235 ft. in length, and 32 ft. beam on the water line. They are driven by two cylinder compound engines, 39 3-8 in. and 70 in. dia. by 60 in. stroke, of the inclined type, resembling closely some of the English designs for side wheel vessels. There are two double ended Scotch boilers, with a heating surface of some 5,300 sq. ft., and 170 ft. grate surface, designed for 110 lbs. pressure. The paddle wheels are of the feathering type, 17 ft. dia. The engines are run at an average of about 40 revolutions per minute. Owing to the fact that the dip of the wheels is greater than designed, the adjustment of the eccentrics governing the angle of the buckets has been so arranged that the full advantage of the feathering principle is not obtained. These boats came out in 1888. They were built of steel by the Columbian Iron Works, of Baltimore.



MACKINAC, MICH., TRANSFER STEAMER ST. IGNACE.



DOUBLE-SCREW FERRYBOAT HAMBURG OF HOBOKEN FERRY.

The Bergen of the Hoboken ferry was built in 1888 by T. S. Marvel & Co., of Newburgh. Its engines are by the Delamater Iron Works, of New York. Until this year she has had but a single deck. Her length is 200 ft.; her beam at the water line 32 ft., with about 17 ft. depth of hold. Her engines are triple expansion, cylinders 18 1-2, 26, and 42 in. dia. and 24 in. stroke. She has two boilers, of what is known as the Admiralty, or gun-boat type, with straight through draft, designed to work at 160 lbs. pressure. The Bergen's air pump is operated by levers from a low pressure crosshead, but the circulating pump and feed pump are independent. The objection, alluded to in a previous article, to the use of an air pump directly from the main engine of a screw vessel, has been justified in the case of the Bergen. Although its attachment to the main engine was of excellent design, and no fault could be found with the workmanship, the amount of care required to prevent undue loss of motion has impressed those responsible for her operation with the undesirability of this arrangement. The longitudinal section of the Bergen, shown herewith, gives a clear idea of her general arrangement.

She was the first of the screw passenger ferryboats successfully operated in this country. There had been previous boats built from designs of Livingston Brady, and alluded to in a previous article, though since the date of publication some doubt has been raised as to whether these boats were even tried in ferry service. While the Bergen was being designed, W. S. Cowles, who, to a considerable experience in ferry service, added the advantages of a thorough mechanical education, published a paper before the American Society of Mechanical Engineers, at its Boston meeting, in 1885,[1] in which he suggested a vessel designed especially for the Staten Island route. Apart from some details as to the arrangement of gangways and smokestacks, the system of working the rudders, and the protection afforded them from ice, their design closely resembles the Bergen. The greatest difference is, that in Mr. Cowles' design, two universal joints were suggested, one placed at each end of the engine. This would have allowed for the alteration in shape undergone by all vessels for change in their loads. It also allowed the midship section to be made considerably shallower, thus reducing the wetted surface.

The Oxton, a boat built in the eighties for service between Liverpool and Birkenhead, and driven by four screws, two at each end, had used continuous rigid shafts from screw to screw. The example set by her designer, Simons, of Renfrew, was followed in the Bergen, and in the other American boats that have followed her.

Measurements were taken on the Bergen to determine the deviation due to the variation in load. These deviations were found to be small enough to be negligible. Exposed as ferryboats are, continuously to collision, experience has shown that the guards overhanging the hull afford great protection, but there have been cases of serious damage to the hull, and, while this has been mainly at the ends, the increased risk due to the use of steel hulls rendered some further protection amidships desirable. The natural method of guarding against accidents at the ends is by the use of collision bulkheads; but, in order to secure safety against accidents in the region of the water line, toward the middle of the vessel, longitudinal bulkheads were introduced, running from one collision bulkhead to the other. These bulkheads form longitudinal girders of great efficiency, materially stiffening the hull.

A short time previous to building the Bergen, the St. Ignace was designed and built by the Detroit Dry Dock Company for service as a car ferry on the Straits of Mackinaw. This branch of ferrying has of late years assumed great importance upon the Lakes. Although, at first, the apparent incongruity of carrying so large a non-paying load, in proportion to the paid, appeared to limit its usefulness.

The St. Ignace, a sketch of which is shown, was especially designed for ice breaking, and thus may be viewed as a precursor of the Pere Marquette, illustrated and fully described in the May number of Marine Engineering. The main differences, apart from the accidental one of superstructure, and the use of steel in the latter vessel for material instead of wood, lies in the fact that the St. Ignace has two sets of propelling machinery, the larger one operating a screw 16 ft. dia. at the stern, the smaller one of 12 ft. at the bow, the engines and screws being entirely independent.

The second of the passenger screw ferryboats to appear in New York waters was the John G. McCullough, built by Neafie & Levy, of Philadelphia, connecting the New Jersey terminus of the Erie Railroad with New York city; she entered the service in the latter part of 1891. This vessel is 214 ft. over all, 43 ft. beam over the hull, and 62 ft. over all. She is built of steel, with two longitudinal and four athwartship bulkheads. The machinery consists of a compound engine, with cylinders 26 and 50 in. dia. by 30 in. stroke; two Scotch boilers, and a surface condenser, and independent circulating air and feed pump. Her length is slightly less than that of the Orange, above described, but slightly greater than that of the Bergen. The beam in all these boats is exactly the same.

It is curious to note, however, the difference in seating capacity. The Orange in her single deck form provided seats for 254 passengers, the Bergen for 296, and the McCullough for 328.

Toward the close of 1891 and beginning of 1892 four more screw boats were put in service on the Hudson River. They were the Cincinnati and Washington, of the Pennsylvania Railroad, and the Hamburg and Bremen, of the Hoboken ferries. The latter boats were built from the same design. They are 217 ft. long, 40 ft. in beam over the hull, about 36 ft. beam at the water line, and 62 ft. beam over the guards. Their arrangement is very clearly shown in the photograph of a model of the Hamburg. As will be seen in the illustration, the plating is removed from a little beyond the collision bulkheads at each end of the boat, and the frames are stopped short at the turn of the bilge. On the left of the illustration, just beyond the collision bulkhead, may be seen the diagonals of the truss, which extends the longitudinal bulkhead until its line intersects the skin of the vessel. Indistinctly shown behind these diagonals is the steering engine, which is of the Williamson type. Within the main body of the vessel, just aft of the collision compartment, is the electric light engine and dynamo, while on the opposite side, and removed for the purpose of clearness, is placed a ventilating engine and its coil of heating pipe. Next to the electric light engine is a combined air and circulating pump, designed and built by the Geo. F. Blake Co. Next again comes the main engines, with four cylinders, two of 20 and two of 36 in. dia. by 28 in. stroke. Against the midship bulkhead, but still in the engine room, is seen the donkey boiler, a small upright boiler of the ordinary type. Be-

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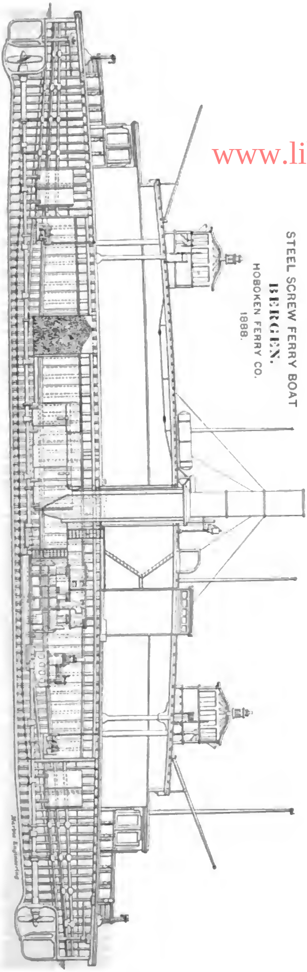
[1] Vol. vii, p. 190.



STEEL SCREW FERRY BOAT
BERGEN.
HOBOKEN FERRY CO.
1888.

yond the midship bulkhead are the main boilers and coal bunker, then a vacant space intervening before one reaches the forward collision bulkhead, beyond which is another steering engine. In the ends, out of sight in the model, are the water tanks. The photograph shows clearly the longitudinal bulkhead, and its method of construction, with openings close to the deck for ventilation of the wing compartments. The shaft may be traced under the engine room, while the propellers and rudder are in clear view.

The cut of the Bergen shows the difference of the suspension of the rudder in these two boats. On the Hoboken ferry it has been usual to use balanced rudders hung by the head only. On other routes the rudders have usually been hung by pintals.

In other screw boats there is usually a stern post which affords the propeller some protection, but at the cost of a loss in efficiency. At one time the Hoboken boats suffered from broken propellers, and the risk of leaving them without protection should be considered. The greatest dangers are old piles and other water-logged timber, which have a perverse habit of settling down for a rest in ferry slips. The breakage by ice, so formidable to side wheels, is not to be feared with propellers.

An unofficial trial trip of the large steam launch Ellide, built at Ayer's shipyard in Nyack from the designs of Charles D. Mosher was carried out June 18. This boat is 80 ft. long, 8 ft. 4 in. beam, and has a draught of 3 ft. 6 in. According to the newspaper reports, a speed equivalent to 31.9 knots was attained on the measured mile, not allowing for tidal corrections, and it is said that this would have been exceeded had not the engineer misunderstood the slowing down signal. The boat is fitted with a quadruple expansion engine, with cylinders 9 in., 13 in., 18 in., and 24 in., with 10 in. stroke. With 250 lbs. pressure in the boiler, which is of the Mosher water-tube type, and the throttle valve partially closed, the engines are credited with 650 revolutions. The trial was witnessed by the owner, E. Burgess Warren, of Philadelphia, and Harrison B. Moore and Francis Magoun, of New York. The boat is composite build with steel frames and mahogany planking. The hull is divided into five water tight compartments. The boat is described as having a forward deck 13 ft. long, aft of which is a cockpit 13 ft. long, fitted with the navigating apparatus, with seats along the sides and lockers underneath. Next aft is an ice chest and china closet on the port side, and toilet conveniences on the starboard side. Further aft are the machinery spaces, and then a dining room 18 ft. long, fitted with side seats and lockers, an extension table, and pantry and buffet. The after deck is about 12 ft. long. The Ellide has a large awning running almost the entire length, a single brass smoke stack, and carries a 13 ft. boat.

NOTES ON BRITISH SHIPYARDS AND METHODS OF CONSTRUCTION.*

BY WALTER MILLER.

In this paper the author gives his impressions of many of the large marine engineering establishments in the United Kingdom, which he visited not long ago. As these contain many valuable hints and ideas, the following extracts relating to the better known yards are given:

A. & J. Inglis, Engineers and Shipbuilders, Glasgow. The engine shops rather old style. Round bottomed bushes are used in the main journals of the bed plates with flat tops, wrought iron binder plates and bolts. Bushes filled with white metal. Top ends of eccentric rods forged solid, then are bored for the link pin, bushes drilled for the bolts and are then cut apart. Cranks built up in three sections; the separate parts are put together by shrinkage, gas being used to heat the parts. The crank pins and coupling shafts are farther secured on the crank arms by round steel keys. The bed plates of the engines are planed off on the bottom. In machine shop tools, the large upright planer, horizontal boring and radial drills are prominent. The shipbuilding yard is equipped with hydraulic rivetors. Stationary oil furnace is used to heat the rivets, steam traveling cranes handle the material about the yard. The riveting up of the reverse frames, floor plates and beams, is done very rapidly. The frames are all faired up on the scrive board, the floor plates laid in place, and the holes marked off. The frames, together with the reverse bar, floor plate and beam, are all re-assembled after punching, bolted up fair, then taken by the steam crane to the hydraulic riveter, which is swung on a gib crane, having a radius long enough to reach all the rivet holes in the assembled frames. The rivet boy takes the rivets out of the furnace by the shovelful, and with a light pair of tongs drops them in the holes, and the riveter follows up and completes the work.

J. &. G. Thompson Co., Lim., Clydebank, Glasgow. These works are very large and shops modern; completed with overhead cranes and new tools. Large vertical planers, horizontal drilling and boring machines. The engines are erected in pits. Large Government contracts on hand. In the boiler shops on all the inside work on the Scotch boiler, the riveting is driven countersunk; the heads of the rivets are nearly flush. Front and back head flanges turned in; the last head riveted by hand. The rivet holes are countersunk, the rivets driven full and finished by a set. Vertical rolls are used for rolling the boiler shells.

The Fairfield Ship and Engine Co., Lim., Govan, near Glasgow. These works are very large; the general plan of the shops is a series of bays, and each bay is served with one and two overhead cranes. All of the shops are complete with new and modern tools. In the machine shops large vertical planers, horizontal drilling and boring machines are used extensively. Boiler shops have vertical rolls and large horizontal drilling machines for drilling, tapping and screwing in of stay-bolts. Tops of cylinder heads are finished, false covers of rolled steel plates cut on band saws to fit heads and chest covers. All of the large engines are erected in pits. The cylinders are fitted with liners and a false valve faced. Double and triple slides and piston valves are used.

Wm. Denny Bros. & Co., Shipbuilders, Dumbarton, Scotland. The shipyards of this company are very large and well fitted with tools. Experimental tank is complete with every convenience for testing models. Very elaborate experiments are carried out here. These people attach great importance to the use of the experimental tank, as it enabled them to design a vessel to have a speed of 21 knots to a certainty; this was an advance in speed of 6 knots. The fastest vessel they had previously constructed had a speed of 15 knots. All the different departments in the yard are fitted for doing all the work necessary to finish the vessel entire. Seasoning of lumber, sawing and dressing the same, finishing of hard woods, carvings, upholstering, painting and decorating, etc., even to the decorations on the stained glass used for sky and side lights. The machine shop is well arranged with new erecting shop, with side walls of white glazed brick. Engines are designed and built on Walter Brock's patent plan; high pressure cylinder forward; low pressure cylinder in the middle, and intermediate pressure cylinder aft. Valve chest facing port side. Cylinders bolted together with receiver spaces on same side. Valve gear combination of single eccentric and crosshead, with levers and curved links pivoted on back of condenser. Eccentrics connected to one end of the curved link, which has a throw equal to the extreme travel of the valves, and lap and lead being obtained by a combination of lever fulcrumed on radius rod at one end and connected to crosshead at the other. Crank shafts are built up in the usual way and are coupled by taper bolts with round heads. The bolts are fitted with brass washers under heads of bolts. Have to forge all bolts and nuts. The boiler shops are open on the front side, fitted with overhead cranes. Heating furnace has floor plates in front of furnace served with small steam hammer mounted on gib crane, for straightening out plates and flange work. They do not bore out the furnace mouths on the front heads of the boilers. All of the flanges are trimmed off on the plate planers.

Harland & Wolff, Belfast, Ireland, have the largest and most complete works of the kind in the United Kingdom. Shipyard, engine and boiler plant equipped with most modern tools. Boiler work good. All of the tapping and screwing in of the stay bolts is done by large, horizontal drilling machines, the boilers being

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* From a paper read before Civil Engineers Club of Cleveland, May, 1897.

brought up and lined in front of the machines. Flush riveting is done on all inside work and on the front head in way of the breachings and around furnace mouths. All holes drilled, flanges planed, screw stays full size of bar, plain tubes not beaded over, and nuts on stay tubes. All of the flanges on the boiler heads are turned inward. The back head rivets are driven by hand. All rivets driven by hand are countersunk. Cylinders all have liners and false valve faces. Piston valves are used on high pressure cylinders only. Excepting in small sizes the cylinders are cast separate. The eccentric yokes are of wrought iron, finished and lined with white metal. Crank shafts are built up in separate parts in the usual way.

Messrs. Maudsley, Sons & Field's (Lambeth, London) shops are old but famous. For many years they have been large contractors for engines and boilers for the British Navy. Machinery that is built for the Navy is usually of their own design. This company manufactures the Belleville boiler. The work done on these Belleville boilers is quite similar to what was done on the Belleville boilers of the S.S. "Northwest and Northland," excepting that the tubes are larger in diameter, and the elements are longer and higher, thus making each boiler of greater power than those built here. The Belleville boilers, made at these works for the Navy, have the ends of the tubes upset before the thread is cut, so that the tubes have their full section after the threads are cut. All of the castings are of steel, including the heads of the steam separator, mud collector, and feed water regulator. The return tubes are used on each of these boilers, which improves the circulation very much. Had some very fine examples of marine engines in hand. Cylinders fitted with liners and steam jacketed. Piston valves on high pressure cylinder, double ported slide, balance valves on the intermediate and low pressure cylinders. As designed, each engine is separate and the cylinders are supported on four cast iron columns, which form the guides as well. Each pair of columns are connected athwartships below the guide by a wrought iron girt. Tie rods connect cylinders about half-way up. Engines of this design take up more room, fore and aft, than usual, but gives ample room below, and it makes them very accessible and easy to get at. The engine room floor plates are level with the journal caps, thus placing the crank shaft well below the floor plates. The stern tube bushes are all planed for the wood filling. This work is done with a round bar on the planer.

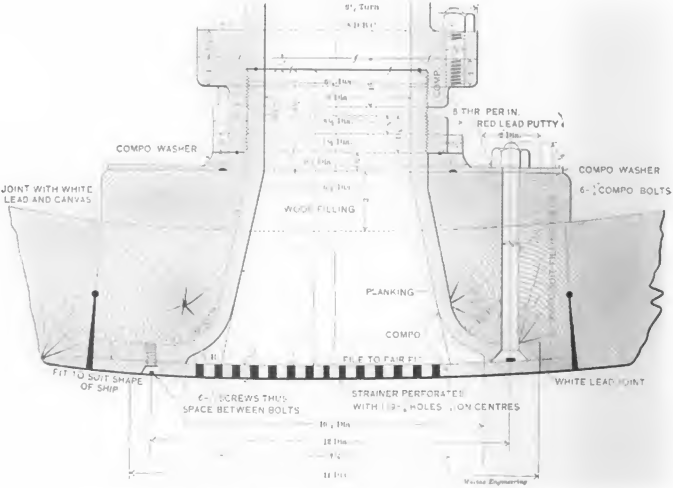
Humphrey & Tennant, Depford, London. Builders of marine engines and boilers. They build largely for the Navy. The boiler work is very fine. The engines have steel castings for the columns and bed plates. Round bottomed brass bushes are used on the lower side of the main journals in the bed plates. All the bushes are filled with white metal. Cylinders are cast separate, but are connected with tie rods. The cylinders and columns are thoroughly braced. Round steel columns in front. Link motion, single bar. Eccentric rods take hold of the bar at end. The end of eccentric rod is outside of link block. Suspending rod takes hold of go-ahead eccentric rod pins, which makes a very short suspension rod. Eccentric straps wrought iron, lined with brass and white metal. The valve stem guide is fitted on the after side of gear, and is open on the forward side. All cylinders, piston heads, and chest covers are steel castings. Columns have slipper guides. The large planers in the machine shops plane both ways, using a revolving tool holder, tool turned by cord from belt shifter. In boiler shop back head flange turned in and rivets driven by hand. In all rivets that are driven by hand the holes are countersunk. Through braces upset at ends. Thin nuts on the inside and full sized nuts on the outside.

John Thornycroft & Co., Chiswick, London. Plant designed for small work only. Engines are built of very high speed and peculiar design. The cylinders are arranged at an angle overlapping each other, thus enabling the centers of each cylinder to be placed closely together. Each pair of cranks are nearly at an angle of 180 deg., with two journals to two cranks, making only six bearings in each bed plate. There are four steam cylinders; one high, one intermediate, and two low pressure. One piston valve and three double ported balance slide valves are used. The intermediate and two low pressure cylinders are of the same size, with the pistons all of the same weight. The engines are nicely balanced, but small ratio between cylinders. Economy not so much an object as a high speed. Link motion is fitted to all the valves, the high pressure valve being adjustable only. All around steam and hand reverse gearing used. The exhaust is taken out through the back of the slide valves, thus simplifying the cylinder castings.

Laird Bros. & Co., Birkenhead, on the Mersey. Plant old, but output very large. They have large docks capable of building battle-ships over 400 ft. in length, and have one at the present time nearly that length, which will weigh about 15,000 tons, and will be floated out of the dock complete, with armor, engines, boilers, etc. The engines for this ship are triple expansion twin screw, and are of a good strong design, with a liberal display of bearing surface, the valve gear being especially heavy. The faces of the eccentrics are very broad. The cylinders for the torpedo boat engines are fitted with piston valves on all of them. The intermediate and low pressure cylinder valves are of enormous size compared with the bore of the cylinders. The valve seats are without bushings, the ports being cut through the casting after the seat is bored out. The bodies of the piston valves are of brass, machined whenever possible to do so, and made as light as consistent with good work. The valves are fitted with rings and great care seems to be taken with the valve gear in fitting up. Some of these large valves have the "Joy" assistant steam cylinder, which takes the strain off the valve gear to a great extent. The columns of these engines are very light, but well braced. The cross girders of the bed plates are of steel castings and very strong. They are not fitted to the floor plates, but are bolted between fore and aft steel channel bars, which take a bearing on the longitudinal in the vessels. The lower bushes for the main journals are round bottomed, and lined with white metal. The keels on all of these fast boats are cut away from nearly amidships, and the bottom extends with a long, easy curve up to the water line at the stern.

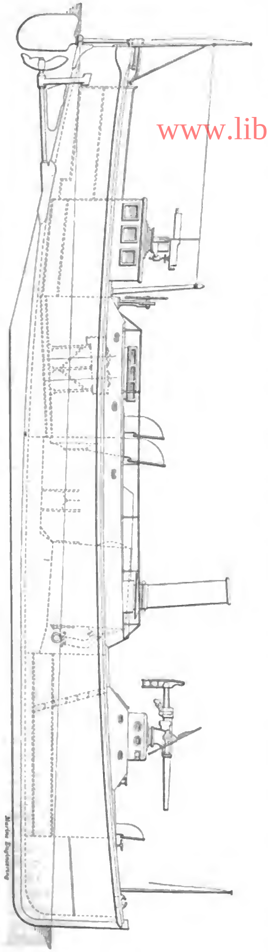
Fitting of Sea Valves to Composite Vessels.

The fitting of the openings for sea and injection valves is a very important matter on both steel and composite built vessels, especially so in the latter class. The method universally adopted on steel vessels, of riveting wrought iron stiffening rings around the opening, provides a safe and rigid seating for the attachment of the valve boxes. In composite vessels the conditions are such, with planking only four or five inches thick, and the frames spaced two feet or more apart, that great care must be exercised, not only to provide a solid seating, but also to prevent leakage through the seams. The accompanying sketch shows the method adapted by Engineer-in-Chief John W. Collins in securing the sea and injection valves to the new composite Revenue Cutters Manning and McCulloch. This, it will be seen, consists of a composition cone, put in from the outside, with a thread cut on the inboard end, and a flange fitted outboard. To provide the extra stiffness, a circular piece of wood is fitted on the inside of the planking, and a joint of white lead and canvas made between it and the skin of the ship. A thin composition washer or stiffening plate, as shown, is put over the nozzle, and set up snug by a composition nut screwed down. In the bottom of the washer is a groove, which is filled with red lead putty, thus making a water-tight joint, under the washer. A flange, corresponding to the flange on the sea or injection valve, is screwed on the top of the cone, to which the valve is bolted. Composition bolts pass through the outward flange on the cone, and the washer on the inside, as shown, thus providing a permanent and rigid fitting. The perforated strainer on the outside is of composition, and made flush with the outside of the planking. The combined area of the 5-8 in. holes in the strainer is equal to twice the area through the valve, as is customary, in order to provide ample opening in case some of the holes become plugged up by seaweed or other obstructions.



SKETCH SHOWING METHOD OF FITTING SEA VALVES TO COMPOSITE VESSELS.

TYPE OF STEAM PINNACE ADOPTED BY THE ADMIRALTY FOR THE BRITISH NAVY.



SECTIONAL VIEW STEAM PINNACE, FOR EQUIPMENT OF LARGE WAR VESSELS.

A very efficient and handsome type of boat now being built for the British Admiralty is here illustrated and described. The Thames Iron Works has on hand a contract for a large number of such vessels. The section here shown is of one of the largest boats with a length of 56 ft.; breadth, 9 ft. 9 in.; depth, 4 ft. 7 in., and displacement at load draught of 17 tons. The boats will form part of the equipment of large battleships and cruisers for such purposes as surveying and sounding along shore, or for the exploration of rivers, or in other places where a light draught, manageable and roomy boat is needed.

The hulls of these boats are constructed of two thicknesses of teak planking, the inner one being laid diagonally, and the outer longitudinally, secured to frames, of Canada elm, steamed and bent to shape; the beams being of galvanized steel, as are also the five bulkheads—four of which are water-tight—with which each boat is fitted. They are built on the "turnabout" system, having straight stem and cutaway stern, as shown in the engraving. Internally the boat is fitted, forward of the boiler, with a forecastle for the crew, and aft of the engine space, with a comfortable cabin and cockpit for the officers.

The armament consists of a 3-pounder quick firer, a 45-in. Maxim, and two 2 sets side dropping 14-in. Whitehead torpedoes.

The propelling engines are of the compound inverted-cylinder type, the cylinders being supported on turned steel columns well stayed together, and carrying the piston-rod guide-bars, the engines being inclined to suit the propeller shaft. They drive a three-bladed gun-metal screw propeller, 3 ft. 4 in. dia., which is supported by an A bracket and sleeve piece of gun-metal, as shown, and are capable of developing about 220 I. H. P. The engine is fitted with a surface condenser, built of copper plate with gun-metal doors, and its tubes are so arranged that the cooling water passes once through them; this water being supplied by a centrifugal pump having a 10 1-2 in. dia. impeller, driven by an independent engine, with a cylinder 2 1-2 in. dia., and 2 in. piston stroke. The air pump is driven by a small crank from the main engine shaft, and is, like the engines, designed for a very high speed. To this end the whole of the machinery fitted in these boats is of the lightest possible description, every device having been adopted to keep down the weight.

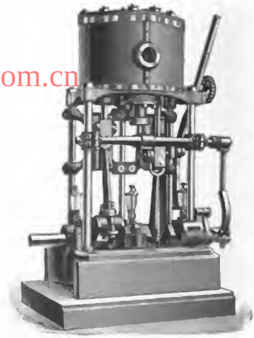
Steam for the engines is supplied by a Thames Iron-works water-tube boiler, working in a closed stokehold, with an air pressure of 2 1-2 in.

On the official trial of the first of these boats, displacing over 17 tons, a mean speed was obtained of 14.6 knots, with 214 I. H. P. developed by the engines. We are indebted to The Engineer, London, for the illustration from which the sectional view was prepared, and also for the details of construction.

IMPROVED APPARATUS.

Small High Speed Forbes' Engine.

In designing and building small engines there has been a general tendency to do a certain amount of real designing and considerable guess work. Small parts must be considerably larger than calculations would show proper, simply because if made just right the difficulty of machining is too great, so many parts are let go almost any size or shape. This has answered fairly well in slow speed engines, but when speeds of 500 revolutions and over are to be provided for the guess work system has to be dropped. It is not to be supposed small engines can conform to recognized formulæ throughout, for obvious reasons, but closer regard to them can be given. In the engine herewith illustrated the builders, W. D. Forbes & Co., have striven to go as far toward proper designs as practicable, and great care is shown in all the details. It will be noticed that the crosshead guides are somewhat of a departure and act as a brace for the columns. The crosshead shoes of brass are on the guides, as in so placing them the crossheads can be made lighter, they being thus relieved from any bolts for holding or adjustment; the latter, difficult to make nicely, and the former, open to the danger of shaking loose; but the main gain is the lightening of the reciprocating parts. The valve is of the piston type and distributes steam to both cylinders. The crossheads are forged on the piston rods and are fitted with brasses for the crosshead pin, the take up being by means of a wedge on the lower side of the brasses to better compensate for wear on the crank pin brasses, which results in shortening the connecting rods. This is a matter of considerable importance, as the clearances in the cylinders are kept down to the least possible limit. The connecting rods are hollow and are fitted with a tool steel pin, and the crank and brasses are made as light as possible. This style of connecting rod gives considerable more strength and stiffness than can be obtained by having the crosshead pin brasses on the forked end, and the pin solid in the crosshead. The Marshall valve gear is used on the engine illustrated, and is very satisfactory, but usually the makers fit their engines with the Stephenson link of the double bar type. The crank and all forgings are, of course, of steel and without welds, and the pistons are turned all over and are also of steel. The engine illustrated is 3 in. dia. and 4 in. stroke, double cylinder with cranks set at 180 deg. The greatest care is taken by the builders to insure a fine running balance, and the engine has been run at 800 revolutions most satisfactorily. Its usual speed is, however, 500 revolutions. Oiling devices are fitted to all surfaces so as to allow a constant supply at all times. This style of engine is also made compounded and for direct connection with dynamos, when either a throttle or automatic governor is supplied, the latter being especially designed, and taking up very little space, its body being forged on the crank. This makes a most satisfactory job. W. D. Forbes & Co. are aiming at a very high grade of engines, and those interested can obtain every information by writing to them at 1300 Hudson street, Hoboken, N. J., or they will be very welcome at the shop.



HIGH SPEED FORBES' ENGINE.

Steam Pump for Use on Yachts.

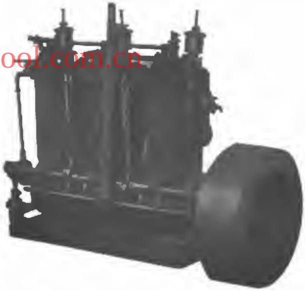
A new steam pump designed especially for use on yachts is shown in the accompanying illustration. The requirements on yachts and launches are so different from those of larger work that this pump has been specially designed, having in mind a combination of minimum of weight with a maximum of strength, compactness and effective working capacity. This pump is designed to feed boilers carrying steam at high pressures, and it can be placed almost anywhere. The covers are fastened with 1-2 in. studs with 1 3-4 spaces between the centers so as to secure unyielding joints to hold the packing securely. The pump is 23 in. long, just under 12 in. high, and 9 in. wide without deflecting valve. It is 11 in. wide with deflecting attachment for turning the exhaust into the suction chamber. The steam cylinder and yoke are tough iron, and the water cylinder plate and hood are phosphor bronze. The steam cylinder is 6 in., water cylinder 2 1-2 in., and the stroke 4 in., total weight 125 lbs., and designed maximum capacity 1,800 gallons an hour. The ratio of steam to water cylinders is 5.77 to 1, in order to obtain effective speed with working steam from low pressure line. A number of these pumps have been installed on some of the neatest yachts of the season. They are manufactured by the Battle Creek Steam Pump Co., Battle Creek, Mich.

Self Starting Gasoline Marine Engine.

The accompanying illustration shows a 10 H. P. three cylinder, reversing and self starting gasoline marine engine, manufactured by the Wolverine Motor Works, Grand Rapids. This engine is of the latest and most improved pattern, and contains, the manufacturers claim, many points of superiority over older types of gasoline engines. It is of the two cycle type, and receives three impulses at each revolution of the crank shaft. It turns very steadily, and can be run at a high rate of speed without any perceptible vibration. The space occupied, and the weight, are small for the power developed. A 10 H. P. engine, complete with fly wheel, can be placed in a space 36 in. in length, 16 in. in width, and 28 in. in height. These engines can be reversed as easily as a steam engine, the going ahead or going astern motion being controlled by a reversing lever, which is simply moved to and fro. The engines are built, at present, in various sizes, from 10 to 30 H. P. for the three cylinder type, and from 3-4 to 20 H. P. in the single and double cylinder types. The material used is subjected to tests, and the workmanship is excellent. The manufacturers have recently furnished a 38 ft. launch equipped with one of these motors to the U. S. Government for the use of the engineer in charge of the dredging work on Grand River, at Grand Rapids. The headquarters address of the manufacturers is 12 Huron street, Grand Rapids, Mich.

Direct Connected Lighting Plants.

There are limitations imposed upon the builder of generating apparatus for use aboard ship much more exacting than those which usually confront the designer of the similar apparatus for use ashore. The plant on ship must occupy the least possible space for a maximum output, it must be highly efficient, and give its full load at constant voltage, with little attention, under varying conditions of steam pressure. With supply from the main boilers at high pressure and exhausting into the condenser, or on much less pressure from the donkey boiler while running simple. The dynamo must be built to run cool in a hot engine room practically without ventilation, and also be proof against injury, even when freely besprinkled with sea water. These, of course, are extreme conditions, but they exist, nevertheless, for in older boats the plant has generally to be put wherever it fits. These conditions have been kept in mind by the Rushmore Dynamo Works of Jersey City, in designing their direct connected generating sets. The illustration shows one of the new sets of the 20 K. W. capacity at 350 revolutions per minute with 25 H. P. engine. The dynamo has but one bearing, which is self-oiling, and has a new form of settling chamber which removes all sediment from the oil. The frame is extended and carries the engine. The armature is of the iron clad type wound with continuous copper bar on a new wave system. It is insulated with mica, and guaranteed against injury



WOLVERINE GASOLINE MARINE ENGINE.

MARSH YACHT STEAM PUMP.

when saturated with sea water. The engine is of the marine type, with frame of finished steel bar, which gives great strength with least possible weight. The crank shaft with counter weights and couplings is one solid steel forging machined all over and drilled hollow, and bearings are of large size to carry the weight of the armature. There is no coupling, but the engine flange bolts directly to the armature core body, thus saving space and weight, and insuring perfect alignment. The automatic cut-off governor is very powerful and regulates within one per cent. The Rushmore Works build also a complete line of high power projectors, ranging in size from 10 in. to 72 in., and taking from 5 to 300 amperes. They are now building a number of 30 in. naval projectors for the large battleships, with electrical distant control mechanism. A machine weighing three tons which will grind the parabolic lenses up to 6 feet dia. with an accuracy heretofore considered impossible is now in use. The cut shows one of the latest type projectors with parabolic lens as used on the trans-Atlantic liners.

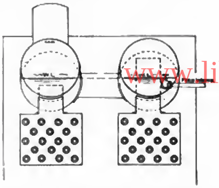


FIG. 2. END VIEW DURR BOILER.

RUSHMORE MARINE PROJECTOR.

Durr Water-Tube Boiler.

The distinctive features claimed for this boiler are the means by which the tubes are fastened in the water chamber and kept tight without the usual rolling or expanding in the tube sheet, and without packing of any kind; the method of circulation by which the feed water and the steam carrying water are kept separate; and the circulation of the steam by which all moisture is separated so that steam enters the throttle valve perfectly dry. Fig. 1 shows an elevation of a boiler ready for work. Fig. 2 is an end view of the same, and Fig. 3 is an enlarged view of tube and portion of water chamber. It will be noticed that

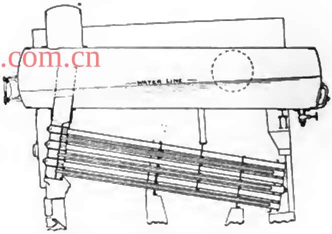


FIG. 1. SIDE ELEVATION DURR BOILER.

DIRECT CONNECTED LIGHTING SET.

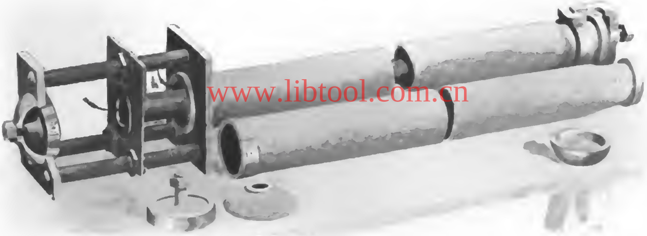


FIG. 3. DETAILS OF TUBE CONNECTIONS. DURR WATER-TUBE BOILER.

FIG. 4. DURR BOILER FOR STEAMER.

the tubes are fastened only at one end, the other (rear) end being closed by a cap and supported on a rack. The method of fastening without expanding in the tube sheet will be readily understood from Fig. 3. The tubes have a collar welded on; this is turned in a lathe perfectly round and true, and is tapering; the tube is inserted through the front into the tube sheet, which is bored conical, and the tube is pressed against this conical seat by the steam pressure. The front is closed in a similar manner by a conical plug also held tight by internal pressure. It is a matter, therefore, of but a moment to remove or insert a tube. Indeed, in marine boilers subject to long periods of idleness, the tubes can all be removed in a short time, and cleaned on laying up, if desirable. By far the most important point, however, is that the tubes, being fastened only at one end, are left free to expand lengthwise, preventing entirely the bending of the tubes and consequent liability to leakage at the tube sheet, so often seen in other boilers. Referring to Fig. 1, the feed water enters at the upper right hand drum. It will be seen that the connection to the water chamber here is extended up and considerably above the usual water level. The feed water is therefore made to travel back, and at the rear end of the drum flows across and forward into the left hand drum; and here it finally enters the water chamber. This latter is divided by a separating wall, shown in Fig. 3; the front part of the chamber stands in connection with the left hand drum; the feed water, therefore, enters this side and flows into the feed pipes, shown in the center of each tube. It is carried back, and, returning through the tube, is heated, and the steam and water is carried up through the rear part of the water chamber and into the right hand drum. Now the separation of the water takes place as the steam travels back and through into the left hand drum. Here it is eliminated because of the inclination of the drum; the velocity of the steam is constantly decreased on account of the constantly increasing steam space, and that this is correct has been proved, the manufacturers say, by independent tests. Fig. 4 shows a view of a marine boiler of 2,000 sq. ft. water heating surface and 50 sq. ft. grate surface. The manufacturers will grant license for the manufacture of these boilers in the United States. They are represented in this country by Viggo V. Torbenson, Westville, N. J.

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Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

Under an appropriation of $800,000 made by Congress for the construction of three torpedo boat destroyers, the Secretary of the Navy called for bids, which were opened a few days ago. The circular, which was issued by the Department, informed intending bidders that two of the boats were to be of not less than 230 tons displacement, and one not less than 260 tons. All were to be capable of maintaining an average speed of not less than 30 knots for two hours, and in all their parts the boats were to be of domestic manufacture. Ten bidders submitted estimates, and complied with all the legal requirements, so that they will probably be eligible competitors for the award to the lowest best responsible bidder. It will be noticed that the lowest may not necessarily be the best. The bidders include some of the most responsible concerns in the country, and some which never before figured as competitors for this class of work. An inspection of the bids is interesting. It will be seen that the prices range from $680 to $1,000 a ton, with the average about $750 a ton. This is certainly a low figure, and especially so when compared with the prices which obtain abroad. The British builders who have been generally credited with the advantage of being able to turn out work more cheaply than the American yards, get an average of $1,000 a ton for this class of work. This is a competitive figure, and one made by builders who have often as many as a dozen boats of this type, in various stages of construction, in their yards at one time. The great difference is all the more remarkable when the exceptionally exacting and, so far as some of the bidders are concerned, unfamiliar nature of the work proposed to be undertaken is borne in mind. If the figures submitted represent the cost of this work, and a fair profit to the builder, they give the lie to the oft repeated statement that ship construction is dearer here than elsewhere. On the contrary, if the prices do not stand for this, bidders manifestly must have put in low figures for good and sufficient reasons. The intention to gain experience in this class of work with a view to further home or foreign orders, or the desire to keep yards busy during a slack season, might be actuating and commendable causes. It will be the duty of the Secretary of the Navy, however, when the awards are made, to have strict attention given to the construction of these vessels, so that every detail shall be carried out in the most scientific and workmanlike manner. A good start has been made by the issue of general requirements which prescribe certain limitations of design, material, and construction. The scandalous favoritism and empiricism which, for instance, made possible the use of odd sizes and bastard threads is properly stopped. It would be well if those concerned in the building of these boats would keep in mind the uses other than spectacular fine weather runs to which destroyers may be put. It is not toys for students of navigation that are needed, but good staunch seaboats, that can fight and win. Boats that can maintain a high speed with always a spurt in reserve. Boats that will not break down or blow up, and that can be repaired with such tools and materials as are available in any yard. The bids are as follows:

George Lawler, Boston, one boat, 410 tons for $280,000; Bond Equity Trust Company, one boat, 270 tons, for $269,000; John H. Dialogue, Camden, N. J., one boat, 243 tons, for $243,000, or two for $480,000; Bath Iron Works, Bath, Me., one boat, 300 tons, for $217,900, or two for $432,000; Wolff & Zwicker, Portland, Ore., one boat, 249 tons, for $214,500, or two for $424,000; Charles Hilman Ship Building and Engine Company, Philadelphia, one boat, 270 tons, for $230,000; William Cramp Ship and Engine Building Company, Philadelphia, one boat, 340 tons, for $245,000; Gas Engine and Power Company, New York, one boat, 235 tons, for $210,000, or two for $410,000; Union Iron Works, San Francisco, one boat 330 tons, for $245,250, or two for $490,500; one boat, 225 tons, for $225,000, or two for $440,000; Columbia Iron Works, Baltimore, one boat, 230 tons, for $210,000, or two for $415,000; one boat, 230 tons, on different plans, for $195,000, or two for $385,000; one boat, 260 tons, for $225,000, or two for $444,000; Harlan & Hollingsworth, Wilmington, Del., one boat, 280 tons, for $244,000, and one boat, 340 tons, for $235,000, or both for $449,000; one boat, 267 tons, for $212,000, and one boat, 340 tons, for $235,000, or both for $447,000; two boats of 340 tons for $467,000; two boats of 276 tons for $425,000, and two boats of 267 tons for $421,000.

DIFFICULTIES MET WITH IN HIGH SPEED ENGINE CONSTRUCTION.

A serious mishap, which occurred recently on the British torpedo boat destroyer Star, is the subject of interesting comment in Engineering, London. The mishap was subsequently attributed to the giving way of one of the crankpin bearing bolts, which was flawed. The comment of our contemporary is the more interesting as it applies to this class of boats in general.

The serious accident which occurred to the torpedo boat destroyer Star illustrates very forcibly the unforeseen difficulties that arise with every advance in marine engineering practice. The vessel was on her trial in the Solent, and had been steaming at her full speed for about a quarter of an hour, when the starboard low pressure cylinder split. The steam was quickly shut off by the stop valve, but this operation naturally took some time. Five of the contractors' men were scalded about the face and hands, and were sent to the hospital. The Star is one of the fifteen 30 knot boats ordered by the Admiralty last year, and for eight of which Palmer's Shipbuilding Company undertook the contract. No one will suppose that the experienced designer of the Star's machinery—even if there were no Admiralty overseers—did not allow sufficient section of metal in the low pressure cylinder to withstand any pressure that could arise in the normal course of events. This vessel had already gone through some rather stiff trials with very creditable results. On her first run after being launched she made over 30 knots on the measured mile. On her second trial she was loaded with over 40 tons, and made just over 31 knots as a mean of three hours' steaming, the air pressure averaging 3 1-4 in., and the steam pressure being 232 lbs. The engines have cylinders 18 in., 27 1-2 in., and 42 in. dia. the low pressure stage not being divided into two cylinders. The slide valves are all of the piston type. The stroke is 18 in. There are four Reed water tube boilers.

The accident is attributed in the report to a "split" cylinder, and probably this is the correct expression to use. The designer of light, quick-turning engines, such as those fitted in destroyers, which run up to 400 revolutions a minute, has to reduce the clearance to the lowest permissible limits, in order to obtain the needful efficiency. There is in such cases very little space left at the end of the stroke for water that may be present in the cylinder. Such water has, therefore, to be compressed into a comparatively thin film with much surface. Although there may be the usual methods of relief, either through special relief valves or the slide valve being forced off the slide surface when flat valves are used, the action is so quick that any water at a distance from an opening has not time to get around. The consequence is that there is a heavy blow, most likely on one side of the piston only; this tends to tilt the piston and bend or crack the rod. If this action be continued, it is quite possible that the piston may get skewed, and thus bring to bear stresses which the walls of the cylinder are not calculated to withstand. The tendency of opinion seems to be to look on relief valves for quick-running engines as useless appendages, for the reasons stated; but though they are not a perfect safeguard, at least they reduce the risk of mishap. They will allow some water to escape, and thus prevent an accumulation which might otherwise prove fatal.

It is very certain that some means will have to be taken to overcome this danger. One can never be sure that a quick-steaming boiler, of whatever type, will not start priming at any minute when running at full power. Salt water getting in will almost invariably produce such an effect, and it is really exceedingly alarming to hear the hammer of water in the cylinders even at low speeds. Exactly how the difficulty will be overcome it is not easy to forecast. The most efficient remedy would be—as ordinary relief valves do not extend over a sufficient area—to make the cylinder-cover all relief valve, with perhaps long holding-down bolts and spiral springs round them. Even if the obstacles in the way of such an arrangement—the difficulty of making a steam-tight joint, for instance—could be got over, it would only deal with the top cover, as at present arranged. A more obvious and practical method of dealing with priming water is by the use of separators. These must be of ample size in order to be efficient, and, as they must be made to stand the full boiler pressure, they necessarily add considerably to the weight of machinery carried. We think that the vortex action might be more often utilized in reducing the size of steam separators. By aid of the centrifugal forces acting in a small-diameter cylindrical separator, placed vertically, the heavier priming water could be brought to rest and be drawn off at the bottom, whilst the steam would be more quickly affected by the draught to the engine. Naturally the inlet orifice into the separator would have to be tangential to the circumference. The best designed separator, however, cannot be relied upon beyond a certain point, and it is an open question whether it would not be more profitable to throw the extra weight into a larger steam drum—in the case of water-tube boilers—and thus avoid additional complication. The relief obtained by the ordinary slide valve receding from the cylinder face when pressure inside exceeds the total pressure on the back of the valve, is not generally present with piston valves, but a device has been introduced whereby the valve is allowed to recede through being placed in an outer case.

No doubt the ingenuity of the talented designers who produce the machinery of torpedo craft will be equal to getting over this undoubtedly serious danger, as it has surmounted others that have arisen in times past; and, indeed, the whole history of engineering progress has been one of creating and overcoming difficulties in order to purchase increased efficiency. No sooner is one engineering problem solved than it gives rise to others more complex, and doubtless the Sisyphian round will continue so long as a force of nature remains to be bent to the use of man. When high steam pressures were viewed from afar it seemed as if the only difficulty that had to be surmounted was to get the requisite strength in boiler shells and furnaces; but no sooner did improved material and design roll this obstacle to the top of the hill than it rebounds in the shape of burst steam pipes and other disastrous manifestations. Now that we have steam of very high pressure plentifully at command, and steam pipes made secure by substituting steel for copper—with or without riveted butt straps, but preferably without—a bridge is made for dangers to travel from the apparatus which generates steam—formerly the great center of anxiety—to that which uses it.

The running of trials of torpedo craft is one of the most risky operations carried out in peace time, as weights are cut down to the lowest limits, and the machinery is then tested in a manner that it seldom is afterwards. It is to be hoped after this sad object-lesson that no more full-speed trials of destroyers will be run without a medical man being present.

There is one simple fact well worth bearing in mind in case of an escape of steam into an engine room or stokehold: Unless you can escape immediately, lie down, especially if the burst pipe or cylinder be overhead. Air is heavier than steam, and, moreover, a bad conductor of heat. There is sometimes a stratum of comparatively cool, fresh air on the floor plates, whilst the upper part of the engine room is at boiling point. Of course, if the escaping steam were directed downwards this hint would not apply.

CORRESPONDENCE.

[*We do not assume responsibility for the opinions expressed by correspondents.*]

Another Experience with Cylinder Lubrication.

I have been interested in the correspondence in your April and May issues in regard to oil deposits in cylinders. Apropos of that correspondence, I have little to say in regard to cylinder deposits, except that in five years as an engineer at sea I never found any trouble from them, for the very simple reason that we never supplied oil to the cylinders. I do not say that the cylinders never got any oil. They were thoroughly oiled before the beginning of a voyage, when they were open for overhauling, and when running they probably got a little, which may have passed through the stuffing boxes from the swabbing of the piston rods, but they certainly got it in no other way. There were lubricators attached to the engines, but they had not been used for so long that I don't think we could have used them if we had tried. This was on voyages from London to Australia and London to Indian ports, lasting from four to six weeks, with a stop at Port Said and sometimes at Colombo of a few hours. The engines were triple and quadruple expansion engines, using steam at 165 lbs. and 180 lbs. pressure. The cylinders were opened and pistons adjusted and oiled at each end of the trips, the best mineral oil being used, and I may say we prided ourselves on the appearance of our cylinders. Your correspondent, "Ralph," in April issue, may also find here an answer to his question.

KANGAROO.

Packing Steam Boiler Water-Gauge Glasses.

Since the introduction of high-pressed steam boilers the breakage of gauge glasses has caused great annoyance, and given rise to numerous complaints, and many suggestions have been made of introducing substitutes; but the question arises whether the substitutes would be any better, and whether the gauge glasses now in use—if of good quality—are not sufficient for all that is required of them. I am of opinion that they are, provided always that the quality is good. I have made a large number of experiments with the Perth gauge glasses, and find that they will stand a hydraulic pressure of 5,000 lb. to the square inch without breaking. You may take one of the glasses in your hand by one end and insert the other into a flame that will bring a red heat on it in about half a minute, also without breaking. Such being the case, the question naturally arises, Why should a glass that will stand the variation above described, and that can be subjected to 5,000 lb. hydraulic pressure, be broken with 200 lb. or 300 lb. steam pressure? To that it might be replied, that in one case the tests are done separately, while in the other the heat and pressure are combined. This looks like a formidable objection; but it is only so in appearance, as I am quite sure I will be able to prove that the glasses are broken neither by the pressure nor the heat, but by the expansion of the glass being interfered with. Increased pressure of steam means increased heat, and the heat and pressure combined means an increase in the expansion of the glass; and if the glass is packed too tight, or in any way to interfere with its natural expansion, breakage is unavoidable. It must break the moment it reaches the point of resistance. In regard to the packing of gauge glasses, there are a number of points to be noticed. First, you must have a good gauge glass. There are glasses in the market that will not stand 200 lb. pressure, pack them how you may, and the glasses must not be too full for the size of the gland; more glasses are broken from this cause than would be credited, if the amount were known; in the second place, the gauge cocks must be set perfectly true, otherwise the glass will have too little space for expansion on the one side, and the packing must be suitable and of the very best quality. Rubber washers of the best quality are not suitable of themselves. With steam at 200 lb. or more, they get softened to pulp in a very short time, and are blown out. To prevent this they should have a ply of asbestos twine or cord on each side of them, which protects them effectively. The next point to be noticed is the screwing up of the glands. You should be able to move the glass with your finger and thumb after the screwing is finished. If you cannot do so, the room for expansion is not sufficient, and breakage will result. With the glass left easy, there will be a little leakage when the steam is put on; but this will take up as soon as the glass and the packing expand. To ensure perfect safety, however, it would be as well to slacken the nut almost to leaking point again. One point to be particularly noticed is that the glass breaks most frequently at the steam end of the gauge cock; that is because the steam is hotter than the water, and causes more expansion. This should be kept in memory when screwing up the glands. If these directions are followed, a good gauge glass should stand perfectly well in the highest pressure boiler that has yet been made. As the proper packing of a gauge glass is so important to engineers and stokers, especially where high-pressed boilers are used, I may take the liberty of formulating these hints into a kind of rule: First, a good gauge glass must be used, which should not be too full for the size of the gland; second, a good rubber washer should be used, protected by a ply of asbestos twine on both sides; and, third, the glass should be movable by the finger and thumb after the glands have been tightened up. The steam end of the glass should be left a shade slacker than the water end; and last, but not least, the whole operation should be carried out with intelligence. This last instruction is quite as important, if not more so, than any of the others. I may state that these experiments have been carried out on a steam boiler with a working pressure of 300 lbs. At first there were a great many breakages, but after experience showed what kind of packing was required, etc, it was almost impossible to break one.

JOHN MONCRIEFF, in The Engineer, London.
Perth.

A Correction About Pumps.

In your illustrated article descriptive of the U. S. Revenue Cutter McCulloch, as published in your last issue, we notice you give description of machinery, including the independent air pump of our make. You were misinformed about the type of this pump, as it is not of the vertical "Duplex" pattern, as you mention, but was built on the Blake vertical "Twin" system. There is quite a difference in the two systems, as you will note by the following extract, taken from the official report of the trial trip of the U. S. Cruiser Minneapolis, which vessel is fitted out with similar air pumps, only several sizes larger. The quotation referred to is as follows:

"The operation of this 'Twin' air pump differs from that of the 'Duplex,' where one pump engine drives the steam valve of its neighbor, as here the engine which drives the main steam valves has no other function to perform, and is adjustable to its work. The arrangement for this may be briefly described as follows: The beam which positively connects the main piston rods of the pumps operates (from a point near its center, and by means of rod and bell crank) the slide valve of the horizontal cylinder which lies between the main steam cylinders. The piston of this horizontal cylinder is really the driving engine of the main cylinder steam valves, a function which it performs by means of a system of internal levers. All the ports are of fair size, and the operation of the pump is not only as positive as any Duplex, but is decidedly more regular and complete. The adjustable collars shown on the valve stem of the 'valve driving engine' afford a means for regulating for a full stroke at any speed, while suitable cushion valves give a further control over the action during the stroke, in regulating distribution of work and preventing slamming of foot valves. The power of this 'Twin' air pump is only about one-sixth (1-6) of one per cent of the horse power of the main engines."

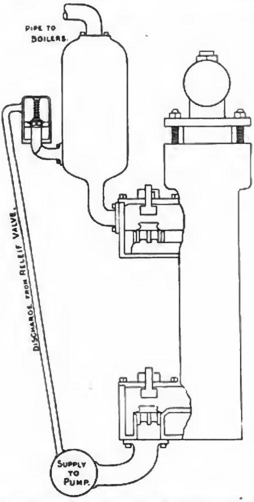
Thanking you in advance for publishing this letter,

THE GEO. F. BLAKE MFG. Co.

Texas Discovers the Cause of His Trouble.

As I had trouble with my feed pumps some time ago, and was for a time quite puzzled to know the cause, I gave the problem out to your readers, thinking I might find some engineer who had had trouble similar to mine, and could suggest a remedy, which he or they might be generous enough to impart. I have since then found the cause of the trouble with my pumps and will in turn inform you that it may be useful to others. Of course, it was like a great many other things, very mysterious until found out, then ever so simple. Attached to the air chamber is a relief valve which is intended to open and relieve the excess of pressure in the feed pipe, should the boiler checks be shut down. The discharge pipe from same leads back to the supply pipe to the pumps. This valve was found to be leaking. It was taken apart at sea and sheet gum washers were put in between the valve spindle and seat, and the trouble disappeared. When we reached port, we "ground in" the valve, and the pumps have worked perfectly ever since. I enclose a rough sketch of the pump to enable your readers to get a better understanding of the problem. I am very much obliged to "C" for his letter of information.

TEXAS.



MISHAPS AT SEA.

Collapse of Donkey Boiler Flue.

A case of total collapse is shown in the illustrations of a vertical flue removed from the donkey boiler of the S. S. Ardenberg upon her arrival recently in this port. The flue was of mild steel, 5 ft. 3 in. long and 18 1-2 in. outside dia. and 7-16 thick, lap welded, with a flange at the lower or fire-box end. The water level was 12 in. above the crown sheet, and the bulge in the flue started about 3 in. above this and extended right up about 3 ft., close to the angle iron ring at the top of the boiler. The bulge was about 3 ft. 6 in. long, and 10 in. deep at the point where the steel cracked. The crack was about 5 in. long and 1-4 in. wide in the center. From the appearance of the surrounding metal, the place where the flue cracked was not badly burnt, and the hole, which was drilled just at the fracture, showed that the metal retained its usual properties. The failure did not occur along the weld, as this was perfectly sound after the mishap.

COLLAPSED FLUE OF DONKEY BOILER.

The flue was removed at the Columbia Engineering Works, in Brooklyn, and a new flue of 1-2 in. plate substituted.

Copper Steam Pipe Failure.

The failure of a main steam pipe on the S. S. Indrapura was the subject of an inquiry by the British Board of Trade, in which the necessity for the careful inspection of pipes during the process of flanging was emphasized. The steamer was at sea at the time of the mishap. The main steam pipe of the starboard boiler cracked circumferentially through the solid copper over a length of about 9 in. at the neck of the flange connecting it with a T piece. The steamer has two double ended Scotch boilers. The steam mains are led upwards from the stop valves of the boilers to a brass T piece. From thence a single pipe extends to the stop valve on the engine. The pipes are of copper 1-4 in. thick. The main between the engine and the T piece is about 6 ft. long, and 9 in. outside dia. The branch pipes between the T piece and the boiler stop valves are about 14 ft. long and 7 1-2 in. dia. The regular working pressure of the boiler is 150 lbs. More than a year before the accident a crack was noticed at the neck of the flange connecting the main steam pipe to the engine stop valve. The pipe was then shortened, the flange rebrazed, and a distance piece 1 1-4 in. thick fitted. The fracture in the steam main of the starboard boiler is attributed to the vibration of the machinery during very heavy weather, which set up a bending motion at the neck of the flange at right angles to the line of stress. The steam pressure at the time of the break was 145 lbs. per sq. in. The pressure was let down to 120 lbs., and after fourteen hours' steaming, the vessel was anchored in harbor, where the pipe was disconnected and a blank flange fitted next the T piece. The steamer than proceeded under one boiler to Falmouth for permanent repairs. The Board found that the steamer is built with a plate keel, and is not provided with rolling chocks, and, when in ballast trim, labors heavily in bad weather. The steam pipes are arranged in easy bends and angles, which were stated to be not sufficiently elastic to adapt themselves to the conditions which prevail in a light vessel in heavy weather with the engines racing. The Engineer Surveyor-in-Chief made the comment that copper pipes are very frequently injured in the neighborhood of brazed flanges by injudicious heating during the process of brazing on the flanges. In the present instance, however, there was nothing to show that any portion of the fractured pipe had been overheated.

Failure of a Boiler Stop Valve.

An explosion, the result of a collision of the steam tug Anglia with the wall of the Collingwood Dock at Liverpool, was also considered by the board. This was a very peculiar and unfortunate accident, the chief and second engineers being scalded to death. The boiler was of the usual marine type, 10 ft. dia. and 9 ft. long, with two plain furnaces, each 3 ft. dia. and 6 ft. 6 in. long. The stop valve, which gave way, was on top of the boiler about 3 ft. from the after end. It was jointed to a wrought iron block, which in turn was riveted to the shell. The stop valve chest was of cast iron, the body being spherical in form 7 3-4 in. outside dia., and 1-2 in. thick. The valve was 4 1-8 in. dia., and with its seating was made of brass. The lower neck of the valve was 5 1-2 in. outside dia., and 4 in. inside dia., the metal having a uniform thickness of about 3-4 in. all around the neck. There were no webs connecting the lower flange to the body of the valve. The boiler was not securely fastened in place in the tug, and the stop valve was fitted close against the end of an iron casing which covered the boiler. There was consequently no room for play, should the boiler move in a fore and aft direction. This it did when the vessel came to a sudden stop by contact with the granite wall of the dock. The impetus of the boiler moving forward on its seating brought the stop valve into violent contact with the iron casing and the metal gave way at the neck, the valve parting from the bottom flange. For some unexplained reason the orders on the dial of the engine-room telegraph were printed in French, and the pointer was in a go-ahead position when the pilot had rung "full speed astern." The engineers were strangers to the vessel or they probably would not have been in the way when the mishap occurred.

Of the $541,250,000 expended by the British nation on the Royal Navy since the year 1885, a total of $507,151,250 was paid to private contractors, and only $34,099,000 worth of work was done in Government dockyards and arsenals.

EDUCATIONAL.

THE ART OF MAKING MECHANICAL SKETCHES, FOR MARINE ENGINEERS.—I.

BY PROF. C. W. MAC CORD.

DRAWING has been happily called "the universal language;" the master of the pencil needs no interpreter, and he speaks more clearly and concisely than the master of the pen. This is true, not only in respect to drawing of the higher class, such as the artist uses in decoration and in pictorial representation, but it applies with equal if not with greater force to the lower order of delineation employed for the guidance of the artisan. And from a merely practical point of view the latter is the more important of the two, as any one will at once see who reflects upon the enormous development and extent of mechanical constructions in this utilitarian age. Because it is in relation to these that the superiority of the graphic language is most pronounced; it is in fact indispensable in their execution. The detail drawings of a proposed structure are what the workman depends upon and must have; and they tell him at a glance, no matter what his native tongue, more than he could learn from a volume of description.

A machinist, then, must possess at least such a knowledge of the principles and methods of mechanical drawing as will enable him to understand and to read with ease the working plans furnished for him to follow; whether he be able to make them or not. And nearly as much may be said of many other artificers as well—the moulder, the blacksmith, the sheet-metal worker, the plumber, carpenter, and cabinet-maker; indeed, of all those engaged in the industrial arts, there is not one to whom such knowledge would come amiss, or who would not feel himself a more competent workman for being thus enabled to execute intelligently any new design that might be brought him.

Now, working drawings are usually made carefully to scale, by professional draughtsmen; and it is right that this should be so, since measurements may be taken directly from the plans, and also because a clearer and better idea of the structure is conveyed when the different parts are shown in their true relative sizes and exact forms. It is not, however, always necessary. A mere sketch, if the dimensions are correctly figured, might be and in fact sometimes is, employed instead. But, although not accurately drawn to scale, and though on occasion made wholly with the free hand, it is obvious that in order to be a safe guide the sketch must convey clearly all the needed information as to size and form. In short, the sketch is neither more nor less than a rough mechanical drawing, and the same principles are involved in the one as in the other.

But, although in a machine shop, rough, full-size sketches made in chalk or charcoal upon smooth pine boards are often used for the guidance of the blacksmiths, pencil sketches are seldom given out to the pattern makers or the finishers; they are most often put in the hands of the draughtsmen, who construct accurate drawings in accordance with them. These, whether inked in or not, are then traced, and from the tracings blue-prints are made for use in the shop.

It is hardly necessary to say to those at all familiar with mechanism, that the design of a new machine is seldom if ever conceived in perfection as a whole. Almost always there are more ways than one to accomplish a desired result, more particularly in regard to the arrangement and proportions of details. And in order to make comparison of these, and thus to decide which is the best, preliminary sketches of approximate accuracy are absolutely necessary, even if the designer be his own draughtsman; and both designer and draughtsman must be able to make them. But the ability to make such sketches is often quite as advantageous to those who take charge of and operate the machine when completed and set at work as to either the designer or the maker. Repairs on account of wear or breakage are always necessary sooner or later, and if the attendant can measure the damaged parts and make on the spot a good and reliable sketch, it is easy to see that the repairs may often be effected in much less time than if he had lacked that accomplishment. Again, the attendant or operative, if of an observing and thoughtful cast, frequently finds it desirable to make some changes in existing arrangements, or to attach some new device to an engine or other piece of machinery. In this case he will find the ability to make clear working sketches, by means of which the proposed change or addition can be explained and carried out if approved, to be a qualification of no small value. In short, this is an accomplishment which should be possessed, not only by every mechanic, but also by every one who has charge of machinery of any kind; particularly marine engineers. It may be acquired, too, in a very practical and useful degree, without the aid of an instructor, by any one who sets resolutely about it. Some of our readers who are thus disposed may lack other facilities for self-instruction. In what follows we shall therefore attempt to give such explanations as will give them a fair groundwork and an understanding of principles; but it must be kept in mind that the best way to learn a thing thoroughly is to do it repeatedly; and proficiency can be gained only by careful practice.

It is possible to make very excellent free-hand sketches, using nothing but a lead-pencil. It requires considerable practice, however, to do it only passably well, even for those gifted with a true eye and a steady hand. And, further, it takes much longer to produce a satisfactory sketch in that way than by the use of instruments; and since for practical purposes the latter method is quite admissible, we unhesitatingly recommend it for beginners.

No expensive outfit, however, is needed. A pair of "school compasses" of the best kind, which may be had for twenty-five cents, will answer for drawing circles in pencil, and subdividing them if required, a common two-foot folding rule of the same value, will suffice for setting off distances, and on a pinch will serve as a straight-edge. With these and a No. 3 pencil, a sharp knife to trim it with, a piece of India rubber, and a pad of paper of moderate size, our tyro is ready to begin. It is the same old story; in the early times when man lived by the chase alone. "the swiftest men caught the most animals, and the swiftest animals got away from the most men." Clearly, the swiftest men were those who carried the least weight; and so to-day, he who can do without the most things has a distinct advantage in the race. And in this line of work much may be done with little. In the absence of dividers, distances can be very accurately measured and transferred by marking them off upon the sharp edge of a sheet of writing paper, and by folding the paper so as to bring the two marks together, the distance is bisected with reasonable accuracy. A simple folded sheet makes a respectable ruler. By folding it again, bringing the edges of the first fold fairly together, we have a right angle, serving to draw lines perpendicular to each other. Still another fold gives us an angle of 45°. If two points, well separated, be set off at the same distance from a given line and on the same side of it, the line drawn through them will be parallel to the first—all of which is readily done with a paper folded as above. If compasses are not at hand, an arc or even a complete circle can be struck by merely sticking the sharpened point of the pencil through a hole in a strip of paper, using a common pin for a center—a very useful expedient if the radius happens to be too large for the compasses, even if that instrument is at hand. These few instances serve to show that simple expedients will sometimes enable one to do fairly well, even if he does not have the appliances best suited to the work; although, of course, that is no reason why those should not be procured if possible. And, while the few simple articles first mentioned can be made to answer very well, it is not to be denied that he who can spare a little more, can work more conveniently and rapidly if he procures from the instrument dealer a pair of 5-inch compasses, jointed in each leg, with interchangeable points; as well as two ebony-edged triangles—one of 45°, the other of 60° and 30°—to be used as rulers, as well as for drawing lines parallel, perpendicular, and at various angles to each other. If the longest side of each be from 8 to 10 inches long, these will be found very convenient in use.

It is seen that in the above, provision is made only for rough sketching; but, since the principles, and indeed the methods, which we shall explain and illustrate in succeeding articles, are, as already remarked, the same as in making finished drawings, we shall also in due course consider some of the additional apparatus required for their execution.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—I.

BY WM. BAXTER, JR.

A man who understands the operation of a steam engine, but is not versed in electrical science, will say that it is easy enough to understand how a steam engine works, because the steam which moves the piston is something real, and, therefore, an effect is produced by a tangible agent; but in the case of an electrical machine the action is due to an invisible cause. As a matter of fact, the cause is just as invisible in one case as in the other; but familiarity, in so far as the steam engine is concerned, causes this fact to be overlooked, and the heat, which is the real cause of the motion of the piston, is lost sight of, and the steam, through which it acts, is made to take its place. Heat is an invisible force, just as much so as electricity and magnetism. Heat acts through the medium of steam, which is material and tangible, but electricity acts through the medium of copper wire and iron, which are also material, and decidedly more tangible than steam. From these self-evident facts it is easy to see that when the principles upon which electricity and magnetism act are properly understood, the operation of electrical machinery of any kind becomes, to say the least, as simple as that of the steam engine. These principles are not in the least complicated, nor does it require a profound intellect to fathom them, as will be made evident in the following lessons.

Electricity and magnetism are so related to each other, and their actions in many instances are so similar, that formerly it was believed by many that they were one and the same thing. At the present time, however, it is understood that one is the resultant of the other, and, except under certain conditions, the necessary accompaniment of it. The needle of a mariner's compass will point north and south, the reason being that it is itself a magnet, and is attracted by the earth, which is also a magnet. The magnetism of the earth exerts a force that tends to draw any substance affected by magnetism into a north and south position, but its action is more vigorous upon another magnet, owing to the fact that in such a case the force of the earth's magnetism is assisted by that of the magnet; therefore, the pull is the result of the two forces combined. A bar of iron suspended by a string so as to be able to move freely will be drawn into a north and south position, providing its movement into that position is not resisted by a force greater than the earth's magnetism, but it will be prevented from swinging to the north and south line by a resistance much smaller than that necessary to arrest the movement of a magnetized needle of the same size.

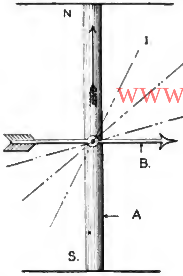


FIG. 1.

Since the magnetism of the earth draws a needle into a north and south position, it is evident that to hold it in any other position will require the application of a force that will oppose the magnetism of the earth. It is also evident that this force must itself be magnetic—that is, if it is not mechanical. To be sure, we could move the needle with the finger and hold it in any position, and the force we would exert would not be magnetic; but to cause it to move without being touched, the force that holds it north and south, which is magnetic, must be counteracted by a similar force—that is, a magnetic force.

If we place a copper wire in a north and south position, as shown in Fig. 1, and suspend over it a magnetized needle, the latter will point in the same direction as the wire, providing there is no electric current flowing, but as soon as a current is passed through the wire the needle will swing around in the direction of the hands of a clock, providing the current runs north, as indicated by the arrow in the figure. This experiment shows us that the passage of an electric current through the wire develops a magnetic force which acts against that of the earth. If the current is very weak, the needle may move as far as the line 1 and stop; if the strength of the current is then increased, the needle may move as far as line 2 or 3; and if the current is made sufficiently strong, the needle will reach the position in which it is shown in the figure. From this we learn another fact, and that is, that the intensity of the magnetic force developed around the wire by the passage of the electric current is proportional to the strength of the current.

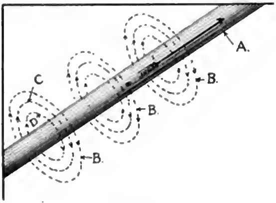


FIG. 2.

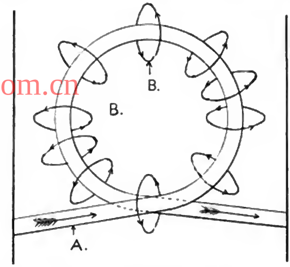


FIG. 3.

In this experiment we have assumed the wire to be placed in the north and south position, simply because when in this position the action of the magnetic force developed by the current against that of the earth can be made manifest. If the wire were placed east and west, the needle would be drawn into the position shown in the figure by the earth's magnetism and as the magnetism develops by the current would be in the same direction, its effect would not be seen. It makes no difference, however, in what direction the wire may be, if there is an electric current flowing through it, a magnetic force will be developed around it. This is more clearly shown in Fig. 2, in which A represents a wire in which a current is flowing in the direction indicated by the arrow, and the curves B C D indicate the direction in which the magnetism developed exerts a force, or

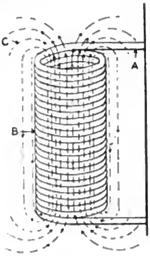


FIG. 4.

pull, the arrow heads showing the direction in which the north end of a magnet needle would point if suspended along the path of the curves so as to move freely.

Not only is the magnetism developed by the current uninfluenced by the direction of the wire, but it is also uninfluenced by the shape into which the wire may be formed. If the straight wire of Fig. 2 is replaced by a coil, as in Fig. 3, the passage of a current will develop a magnetic force, which will be in the same direction, relative to the current, as in the case of the straight wire, as can be seen from the direction in which the arrow heads point on the curves B of this figure.

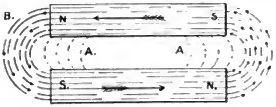


FIG. 5.

If the single coil of Fig. 3 is replaced by one having many turns, as in Fig. 4, the magnetic force will surround all the turns of wire, as indicated by the lines C. In this case the several turns of the coil B will be enveloped by the magnetic force, just the same as the single turn in Fig. 3. If the current passing through the wire in Figs. 3 and 4 is of the same strength, the magnetic force developed in the latter will exceed that in the former to an extent nearly equal to the number of turns in coil B. This is so owing to the fact that the magnetic force developed is in proportion to the strength of the electric current, and the passage of the same current around the coil a number of times is equivalent to increasing the current to the same extent through a single turn. To make this point clearer we will say that if the number of turns in the coil is, say, twenty-five, the magnetism developed will be nearly as great as if twenty-five times as strong a current were sent through a single turn. The statement that the magnetism would be "nearly as great" requires an explanation. The natural inference would be that there would be absolute equality, as in both cases the total current flowing around the circle would be the same. By comparing Figs. 3 and 4 it will be seen that the curves B of the former are very much shorter than the curves C of the latter. Now air, iron, and steel offer a resistance to the flow of magnetism, and consequently, the longer the path in which the force acts, the weaker it must be if developed by an equal magnetizing force. The electric current is the magnetizing force, and the strength of magnetic force it will develop will be proportional, not only to the strength of the current, but also to the amount of resistance in the path of the magnetic force. If it were not for this fact, the magnetic force along the curve B in Fig. 2 would be just as great as that along curve D; but, as the latter curve is the shorter of the two, the force along it is the greatest. The greater the distance from the wire, the weaker the force, and at a comparatively short distance it becomes so weak as to be indeterminable. If the wire in coil B of Fig. 4 were made smaller than that in Fig. 3, so that it could be bunched into the same cross section, then the length of the magnetic path, or circuit as it is called, would be the same in both cases, and then the strength of the magnetism developed in Fig. 4 would be the same as that in Fig. 3 if the single current in the latter were equal to the sum of the current flowing in all the turns in the former.

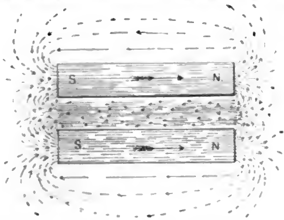


FIG. 6.

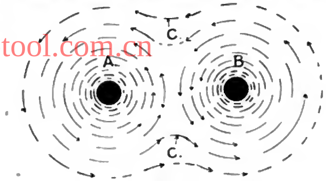


FIG. 7.

A natural process of reasoning would lead us to infer that the longer the magnetic circuit the greater the resistance, and hence the weaker the magnetism, for it would be difficult to conceive that the strength of the magnetic force would be just the same at a distance from the wire, in Fig. 2, as near by. The action of magnets toward each other, as well as that between electric currents, serves to further illustrate the truth of this inference. The tendency of magnetism is to either shorten the circuit in which it acts to the greatest possible extent, or to increase the cross section of the path, or both. When two steel magnets are placed side by side with their poles in opposite directions, as shown in Fig. 5, they will attract each other, but if the poles are in the same direction, as shown in Fig. 6, they will repel. The nearer they are to each other, in the first case, the stronger the attraction, and the further apart they are, in the second case, the weaker the repulsion. A study of the two figures will show why these actions take place, and also why in Fig. 5 the attraction in-

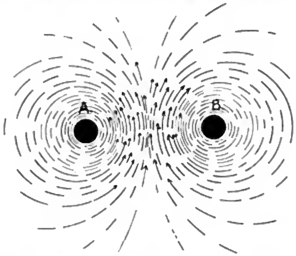


FIG. 8.

creases as the distance between the magnets is reduced, while in Fig. 6 the repulsion decreases as the distance is increased.

In Fig. 5 the direction of the magnetic force in the two magnets, being in opposite directions, each one forms a path through which the circuit of the other may pass. If the resistance of air and steel to the passage of the magnetic force were the same, the attraction between the two would not be very greatly increased by reducing the distance separating them, as the length of the circuit would only be reduced to a small extent; but the resistance of the air is many times as great as that of the steel, the difference being such that very nearly all the resistance opposed to the magnetic flow is that of the air—that is, of the path along the curves connecting the two ends of the magnets. This being the case, reducing the distance between the magnets, greatly reduces the total resistance opposed to the magnetic force. It might be supposed that the magnetic force, instead of following the curves shown at the ends of the magnets, would pass from one to the other in a straight line, as by so doing the path could be still further shortened, but if this were done the cross section of the path would be reduced, and this of itself would serve to increase the resistance; therefore the magnetism will spread out so as to reduce the resistance by widening its path as well as by shortening it. Some of the magnetism will begin to leak out before reaching the ends of the bars, as shown by the curves A, and some will spread out even further than indicated by the lines B.

In Fig. 6, as the poles of the magnets are in the same direction, one cannot serve as a circuit for the other, therefore the path of each will have to run through the space between the two—that is, for that part of the magnetic force that acts on the sides that face each other. If the intervening space is narrow, the magnetic force will tend to spread the bars, so as to widen its path and thus reduce the resistance in its path. In Fig. 6 the magnetism is shown as acting on all sides of the bars, while in Fig. 5 it is only shown along one path—that through the magnets. As a matter of fact, in both cases it will act in all the space surrounding the bars, but in Fig. 5 by far the greater part will be in the path shown, and when the two magnets are brought into actual contact there will be very little magnetism acting in the surrounding space. In Fig. 6, as the two magnets do not help each other, the effect will be to actually reduce the strength of the magnetism between the bars, and make it stronger at all other points. In the figure the lines between the bars are drawn closer together than on the outside, thus indicating that in this space the force is the greatest, but in reality it is not, owing to the fact that the cross section over which it acts is reduced. On the outside the magnetism is more diluted, so to speak, but the area over which it acts is very much greater. The actual condition of things is exaggerated in Fig. 6, so as to more clearly illustrate why magnets placed with their poles pointing in the same direction repel each other.

Wires carrying electric currents also repel and attract each other, but the action is just the reverse of that with magnets—that is, two currents flowing in the same direction will attract each other, and if in the opposite direction, they will repel. Why this is so can be seen from Figs. 7 and 8. In the first figure the current in both the wires A B is supposed to be running in the same direction. The wires are shown in section. The current being in the same direction, the flow of magnetism around both must be in the same direction; hence, the magnetism of both will meet, in the space between them, running in opposite directions. As a consequence, only that portion which is very close to the wire will keep to its true course; the remainder will join hands, as it were, with that of the neighboring wire and flow around the two wires, and by their contrasting tendency draw them together. This is indicated by the curves C.

In Fig. 8 the current in the two wires is supposed to be flowing in opposite directions, and, therefore, the direction of the magnetic force around the two will be in opposite directions. From this very fact, however, the direction of the two magnetic forces in the space between the wires will be the same; hence, all the magnetism of both wires will tend to crowd into this space, and as a result the wires will be forced apart.

News and Notes

Recent British advices report the closing of the contracts between the British and Canadian Governments, and Petersen, Tate & Co., of Newcastle, for the equipment of the new fast mail and passenger line between Canada and the United Kingdom. The new boats, of which mention was made in our May issue, will be of not less than 10,000 tons gross register, and will have a sea speed of 21 knots. A fast tender of the torpedo boat type with a speed of 22 knots is to be provided at the Canadian end of the route.

One of the largest steam tugs on the Great Lakes is now under construction at the Bell Steam Engine Works, Buffalo. The boiler for this tug is to be furnished by Thomas Kingsford, Oswego, N. Y. This boiler is to be of the flat crown sheet type with double furnaces and single combustion chamber, each furnace 5 ft. by 6 ft. 6 in. long. Each furnace is to have four main fire flues 17 in. dia. Boiler will contain 196 tubes, 3 1-4 in. dia. by 12 ft. 4 in. long. Diameter of shell 12 ft. Length of boiler 16 ft. Steam drum 48 in. dia. by 8 ft. long. Height of boiler to top of shell 13 ft. 7 in. Boiler to be built for a working pressure of 150 lbs.

A collision at sea between trans-Atlantic liners occurred May 27, fortunately resulting in no loss of life and comparatively little damage to the vessels. The Atlantic Transport line steamship Mississippi from London for New York was run into in a fog, off the Banks, by the Thingvalla line steamship Hekla. The Mississippi was moving cautiously, having heard fog signals, when a big steamer was sighted approaching her on the port side amidships. The captain of the Mississippi put his helm hard over, and the Hekla at the same time reversed her engines. The blow was a glancing one, the Hekla ramming the port quarter of the Mississippi, tearing a big hole in her skin well above the water line, and carrying away several feet of the rail. The Hekla backed off with her bow crushed in to a point near the water line, and leaving part of her plating, a hawse-pipe and cable and anchor on board the Mississippi. The steering gear of the latter was damaged, but repairs were promptly made and she proceeded on her way, reaching this port safely June 1. The Hekla also continued her voyage, reaching Christiansand with passengers and cargo in good condition.

HOME AND FOREIGN EXCHANGES.

The Long Coal Car Dumping Machine.

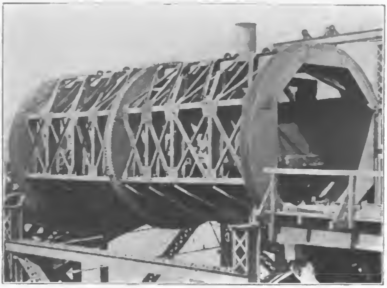
The essential feature of the machine is a large cylinder constructed for receiving a car filled with coal and turning it upside down, discharging the coal into chutes which guide it into the hatchways of the vessels being loaded. The illustration, Fig. 1, is reproduced from a photograph showing a general view of the machine. Fig. 2 shows the cylinder with a car in place ready for dumping, and Fig. 3 shows the telescople chutes filled with coal ready for discharging. The cylinder is 40 ft. long, has a clear internal diameter of 11 ft., an external diameter of 16 ft., weighs 40 tons, is constructed entirely of steel, and is supported at each end by two heavy steel T rails. The level of the railway tracks at the point where it was desired to locate the machine was about 28 ft. above the dock level, and therefore in order to meet these conditions the cylinder was supported on a steel superstructure and placed on a level with the existing tracks. This makes a practical and convenient plant, as the space beneath is an ideal location for the power plant and operating machinery.

LONG CAR DUMPING MACHINE.—FIG. 1.—GENERAL VIEW.

The cylinder in dumping a car is simply rolled along its supporting track by means of wire ropes, which are passed around its periphery. A double cable is used at each end of the cylinder, and after being passed around the cylinder is carried over sheaves and down to a steam cylinder 30 in. dia. and 10 ft. long, which lies in a horizontal position at the base of the superstructure. This cylinder contains a piston, which is by means of a piston rod attached to a crosshead, which also carries the lower end of the cables referred to. Steam pipes are arranged for admitting steam to either end of the cylinder, but under ordinary conditions steam is applied only for dumping, as the track on which the dumping cylinder rolls is placed on an incline, and it will return to its normal position by gravity, and in so doing carry the piston and cables with it. Between the rails which form the track upon which the cylinder rolls there are a series of steel pins about 4 in. in diameter, which engage with a series of corresponding holes in the cylinder, thus insuring that the travel of the cylinder will be equal on both ends and also that there will be no slipping.

The machine is operated from a small platform located at one end, where both the apparatus and the vessel being loaded are in plain view. There are only two operating levers used. One of these controls the pair of hydraulic cylinders which are used in holding supports against the lower side of the car as it is being dumped. The other lever admits and discharges steam to the operating cylinder. This operating lever gives the operator absolute control of all motions of the cylinder and by simple manipulations of this he can roll a car load of coal which, together with the cylinder, weighs about 80 tons, as though it were only a feather's weight.

An important feature of the apparatus is the telescope chutes shown in Fig. 3. By their use the breakage of coal is reduced to a minimum. The chutes are arranged on an angle of about 45°, so that the coal does not have a direct drop, but slides down the incline at a speed which is not sufficiently great to break it. In order to still further avoid breakage, controlling doors are arranged on the lower end of each chute, and before any coal is discharged these doors are closed tight, the chutes are then filled, and by means of the doors the flow of coal is under absolute control. Each chute is supported by wire cables, which are controlled by a pair of hoisting engines and operated from the same platform as the dumping apparatus. By means of these cables the chutes may be moved about and raised and lowered to any posi-



LONG CAR DUMPING MACHINE.—FIG. 2.—DUMPING CYLINDER.

tion allowed by the dimensions of the hatchways. It is stated that the operator has such control over these chutes that trimming is a comparatively simple and inexpensive operation.

Only three men are required for handling the entire machine. These are an engineer and fireman, both of these positions being filled by one man; one man to operate the cylinder, and a third to control the movements of the chutes. The machine has handled 300 cars or 7,500 tons of coal in a day of ten hours, and the reduction in the cost of loading vessels has been such as to almost revolutionize the coal business at the point where the machine is in operation. The machine is equally well adapted to use in taking cars from the dock level and dumping them into the hatchway of a vessel by a simply arranged incline.

The machine at "Erie" docks in Cleveland, Ohio, unloaded over it last season, from the 10th day of April to the first of December, 23,155 cars, amounting to 550,127 tons of coal, and could have unloaded half as much more if the shippers had had the customers, coal and boats.

The Excelsior Iron Works is now working on a Long coal car unloading machine, to be erected at Conneaut, O., on the P. S. & L. E. R. R. docks, Carnegie's coal and ore dock, which will be the finest on the lakes.

For the description of this apparatus and the illustrations here used, we are indebted to the courtesy of The Coal Trade Journal.

Comment on the Use of Nickel Steel in Ships.

There would appear to be no doubt that nickel steel is destined to be much more extensively used at an early date. For armor plate purposes its use is rapidly extending, and it is also notable that for important forgings, such as those required for crank and propeller shafting and connecting rods, it has been adopted in the Japanese battleship at present being built on the river Thames. In the adoption of nickel steel for marine engine purposes, United States engineers, however, were the pioneers, this material being used for the shafting and piston rods of the engines of the Fall River Line steamers, and the United States war vessels Columbia and Cincinnati, and for propellers in torpedo boats. The American Line steamer Paris was the first merchant vessel to be supplied with a length of shafting of nickel steel, and in the three years that have since elapsed further progress has been made in introducing the material in another direction, viz., in the construction of marine boilers. In our present issue, says the Engineers' Gazette, we give an illustrated description, from our latest American contemporary, of the boiler which has been built of nickel steel for the United States Cruiser Chicago. Originally, it had been intended that the four cylindrical boilers of the Chicago were to be of nickel steel, and the plates were ordered and delivered, but the greater part had to be condemned, owing to being badly pitted and scored, as though slag had been amalgamated with the material. From the same cause only the boiler shell was formed of nickel steel plates, the internal plates and stays, as well as rivets, being of ordinary steel. It is also stated that the extra cost for labor, owing to the difficulties that occurred in working the nickel steel plates, was considerable. This is quite contrary to the testimony of Mr. William Beardmore, who, in his paper read before the recent meetings of the Institution of Naval Architects on "Nickel Steel as an Improved Material for Boiler Steel Plates, Forgings, and Other Purposes," stated "nickel steel can be bent and punched quite as successfully as ordinary carbon steel." It may be that the plant employed in bending the nickel steel boiler plates of the Chicago were inadequate, seeing that in the process "the housings of the biggest rolls in the boiler shops were smashed," but it is also stated that "the edges of cutting tools were turned or fractured," presumably in planing the edges of the plates.

Doubtless, practical difficulties do arise in dealing with new materials, but they are usually soon overcome, and possibly in the case of the boiler of the Chicago they have been unduly magnified. In two American gunboats part of the shell plating is of nickel steel one inch thick, and little difficulty was experienced in rolling these plates, and the surfaces were satisfactory. Further, Mr. J. G. Eaton, of the U. S. Navy, states in a communication to the Iron and Steel Institute, "no trouble was experienced in machining and fastening this material;" and further, that it was "certainly proved that nickel plates in this form could be successfully used in ship construction, and that the only increase in cost came from the cost of the nickel in the alloy." In one respect, and that a most important one, viz., as to the relative immunity that nickel steel has from corrosion, there is a practical uniformity of testimony. At the conclusion of the description of the boiler on the Chicago on another page, it is stated "the corrosion resisting qualities of the material were shown in the pickling. It took just five times as long to dissolve the scale on the nickel plates as it did on the carbon plates." It can scarcely be said, however, that this slowness in getting rid of the mill scale is positive proof of the anti-corrosion quality of nickel steel. Ordinary iron ship-plates lose the mill scale more readily than Siemens-Martin steel, but in practice the latter is generally found to corrode more rapidly. Mr. Henry A. Wiggins, of Birmingham, found, in an experiment on a small

LONG CAR DUMPING MACHINE.—FIG. 3.—TELESCOPE CHUTES.

scale, extending over three months, that nickel steel in 10 per cent salt water kept at a boiler temperature corroded only about half as much as open hearth steel under the same circumstances. Similarly when subject to steam, the nickel steel showed an advantage of about 25 per cent. Mr. William Beardmore, in his paper already referred to, gives the results of experiments carried out at Leith Docks extending over twelve months, and in this instance nickel steel had more than 20 per cent the advantage of mild steel. Should further experience confirm those results, and it be found that nickel steel can better resist the effects of alternate heat and cold, and can dispense with anti-corrosive coatings, then, despite its enhanced cost, it might speedily come into use for those parts of the hulls of vessels that are peculiarly liable to corroding tendencies, owing to their inaccessibility for cleaning and painting and their proximity to the boilers, and for deck plating, where, owing to the constant traffic, together with exposure to the weather, it is extremely difficult to keep the surfaces coated with paint or other similar material. It is also probable that it would become a favorite material for propellers.

Corrosion in Steam Vessels Remedied.

Soon after the application of steel in the construction of the English coasting steamer, with the consequent diminution of thickness allowable with that highly tenacious material, it was found that the forward part of the bottom of these vessels, for a few feet before the collision bulkhead to about ten or twelve feet abaft, became, after a few months' work at sea, very much more corroded than elsewhere. The countersunk points of the rivets were found pitted, the rivets sometimes were loose, and the shell plating was so much set in between consecutive floors as to suggest that the vessels had been ashore. Associated with this phenomenon was a wasting of the lower edges of the outer strakes of plating at the same part of the bottom, and this wasting proceeded at such a rapid rate that after two or three years' service it had extended to the rivets in the lap of the plate edges.

Considered by itself, the setting-in of the plating between the floors and the loosening of the rivets attaching it to the frames, seemed to point to a straining effect due to the weight of the large body of water carried in the fore-peak tank for trimming purposes when steaming without cargo. Measures were at once taken for reducing the depth of the fore-peak tank and for affording a stronger connection between the peak bulkhead and the hull of the vessel. But, despite continued efforts in both directions, the mischief still went on, until the wasting of the plate edges and the corrosion of the rivets suggested that some other cause was at work than had at first been suspected.

It was ultimately discovered that, although an undue and, as it turned out, unnecessary weight of water in the fore-peak tank had produced some straining effect in the vicinity of the peak bulkheads, yet the principal cause of the phenomenon was the violent pitching movement of the vessel when driven head to sea in a light condition. For, with the machinery right aft, the vessel necessarily trims by the stern, even with the fore peak filled with water. Whether the tank be large or small, the pitching motion, when driving head to sea, is a frequent one, and the forward immersion being but small, it follows that the comparatively bluff bow repeatedly rises and falls with a thump on the approaching sea.

The relatively thin steel plating was thus, in the course of time, set in between consecutive floors, while the atmospheric air, imprisoned between the "luff of the bow" and the sea at every plunge, acted corrosively upon the surface of the plating and the countersunk points of the rivets and the lower landing edges of the outer strakes in the same way as it does upon the forward upper edge of a screw propeller blade.

When once the cause of the mischief was discovered, a remedy was speedily found. Floors at alternate frames, while sufficiently close at the other parts of the vessel on the fore side of the machinery space, were evidently too far apart to properly stiffen the plating where these blows were received without something more rigid than an ordinary frame angle between them. Hence the intermediate frame angle bars were replaced with six-inch bulb angles throughout that portion of the length of the bow where the mischief was found to extend.

For the rest, the shell plating was increased at the bow to at least the same thickness as in the strakes amidships, and the edges of the troublesome strakes were arranged in boat-plank fashion. In this way the plating was sufficiently stiffened to stop the vibratory movement that had loosened the rivets, and sufficiently thickened to allow a deeper and better countersink for those rivets. Moreover, the imprisonment of air bubbles at the landings, with the consequent wasting by corrosion, was prevented and the evil was cured. The plating still rusts more readily there than elsewhere, but this is remedied by frequent painting.—J. S. P. Thearle in Cassier's Magazine.

The "Oceanic's" Stern Frame.

The Darlington Forge Company are now engaged in preparing the stern frame and brackets for the new White Star liner from steel castings made by them, and which are the largest of the kind ever produced in this country, says the Shipping World, of London. The stern frame is in one piece, and as a casting weighs 41 tons, and when completely machined and ready for erection will weigh 35 tons. Its height is 53 ft. by 24 ft. 3 in. over the keel piece, the section of the post being 21 in. by 11 in. Attached to this frame are the after brackets, a huge casting also in one piece, which will weigh 55 tons as it leaves the foundry, and 45 tons when machined and erected in position. The height of the flanged portion of the bracket—that which is attached to the frame of the ship—is 26 ft., whilst the width from center to center of the bosses is 23 ft., the bosses themselves being 4 ft. 3 in. dia., by 5 ft. 7 in. deep. The forward brackets, which are entirely built within the plating of the vessel, will weigh 30 tons when machined and erected.

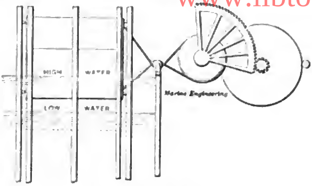
Contracts for 180,000 tons of coal have been let in England by the Cunard Steamship Company, the prices varying from $2.35 to $2.50.

James Davidson, shipbuilder, West Bay City, Mich., has just completed a steamship 285 ft. long, 44 ft. beam, and 26 ft. depth. This steamship has triple expansion engines, Howden system of forced draft, steam steering gear, steam windlasses, steam capstan, and a complete electric light plant. There are also on the stocks at this yard, nearly ready for launching, two large schooners, each of which is 300 ft. long, 45 ft. beam, and 25 ft. molded depth. These schooners each have three spars, supplied with sails, and they also have large pony boilers, steam windlasses, steam deck hoists, and steam pumps. In addition to the above there are also nearing completion three large tugs, two of which will go to Duluth, Minn., and one to Chicago, Ill.

SELECTED PATENTS.

582,931—**Steering Gear For Ships.** *Frank E. Kirby, Detroit, Mich., assignor to the Detroit Dry Dock Company. Filed Dec. 24, 1896.*

The combination with a rudder stock and a steam steering gear adapted to operate the same, of a tiller secured to the stock, a tiller loosely sleeved on the stock, a locking device on the loose tiller adapted to automatically connect the two tillers together, means for holding and locking the device out of engagement, and a hand steering gear connected with the loose tiller. The combination with a rudder stock and steam steering gear, of two tillers, one rigidly secured to and the other loosely mounted upon the rudder stock, an arm pivoted to the loosely mounted tiller, and provided with a yoke for engaging the rigidly secured tiller, and a lever for holding the yoke from engagement with the rigidly secured tiller. The combination with a rudder stock, and a steam steering gear for operating the same, of two tillers, one rigidly secured to and the other loosely mounted upon the rudder stock, an arm pivoted to the loosely mounted tiller and provided with a pendent yoke to embrace the rigidly secured tiller, and a lever pivoted to the arm for holding it elevated with the yoke disengaged from the rigidly secured tiller.



SAGER TIDE MOTOR.

583,821—**Tide Motor.** *Eli E. Sager, Duluth, Minn., assignor of one-half to Peter Gilley, same place. Filed Mar. 15, 1897.*

The combination with vertical guides, and a float-body mounted for vertical movement, of a pulley located at one side of the float-body, a drum rotatably supported in advance and in line therewith, cables connected to the float-body near the upper and lower ends and passed in reverse directions about the pulley and beyond the same passed in reverse directions about and fastened to the drum, a toothed sector rocked by the drum, and a train of gearing operated by and connected to the sector. The combination with vertical guides, and a float-body mounted for vertical movement therein, of a plurality of pulleys located at the side of the float-body, a corresponding number of drums supported for rocking and aligning with the pulleys, pairs of cables carried over pulleys and secured to drums, as described; a shaft for supporting the drums, and means for conveying motion therefrom. The combination with the series of guide posts or standards located as shown, the float-body, and the anti-friction rollers mounted on the latter and riding over the posts, of the breakwater, the bearings supported thereon, the pulleys journaled therein, the opposite side frames, the main shaft mounted in bearings thereon, the large drums carried by the main shaft, the pairs of cables connected to the upper and lower ends of the float-body and passed in reverse directions about and secured to the drums, toothed segments of greater diameters than the pulleys and drums mounted on the main shaft, a transverse shaft journaled in the side frames, small gears carried thereby and meshing with the sectors, large gears carried by the transverse shaft, a crank shaft journaled in bearings on the side frames, small gears carried thereby and driven by the gears of the transverse shaft, and a pitman rod connected to the crank portion of the crank-shaft.

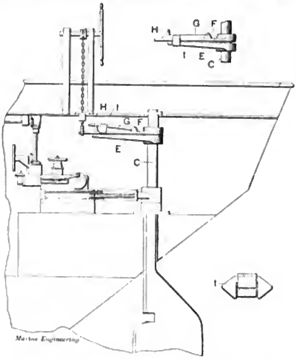
CATALOGUES.

The Hyatt Roller Bearing Co., Havemeyer Building, New York, has just issued its 1897 catalogue, which gives in full detail the various uses of this company's roller bearing.

J. N. Hayden & Co., Grand Rapids, Mich., did not propose that their catalogue should be destroyed when it was published, so it was printed on asbestos paper. The catalogue describes in full detail the "Globe" box metal, and gives directions for using it, in addition to letters regarding it which have been received from customers.

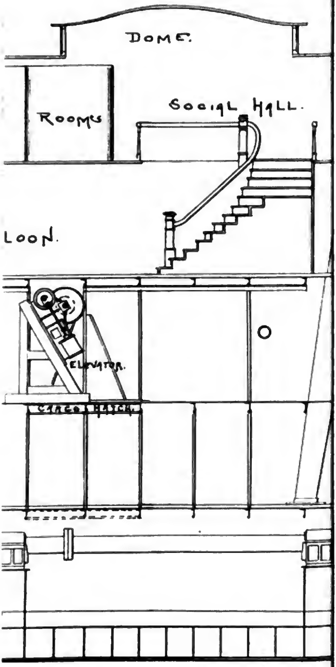
A general catalogue has just been published by the Lake City Engineering Co., Erie, Pa., regarding centrifugal pumping machinery and marine engines. These two devices are the specialties made by this company, and information enough is contained in this catalogue to give a very excellent idea of what they are like. The catalogue is very convenient in form, and the press work is very clear, an extra quality of paper being used.

The 1897 catalogue of the New Britain Machine Co., New Britain, Conn., is just ready for distribution. It is an exceptionally fine specimen of the printer's art, having a dark green cover printed in gold, while the text is in black, with headings in red. Most of the pages are devoted to the chain saw mortiser, manufactured by this company, a very remarkable tool for finishing woodwork for vessels and other uses. The well-known Case steam engine is also illustrated and described.



KIRBY STEERING GEAR.

The 3-4 H. P. gas engine, manufactured by the Pierce Engine Co., Racine, Wis., is described and illustrated in full detail in a catalogue just issued by this company. The printing is black with red headings, and several illustrations add to the value of the text. This company has found such a demand for this size of engine that up to the present time it has limited itself to this one engine for boats designed


DOME.
ROOMS
SOCIAL HALL.
LOON.
ELEVATOR.
CARGO HATCH.

MARINE ENGINEERING.

Vol. 1. NEW YORK, AUGUST, 1897. No. 5.

LATEST ADDITION TO THE FLEET OF THE OLD DOMINION STEAMSHIP CO.

Another fine coast liner, the Princess Anne, which has just been added to the fleet of the Old Dominion Steamship Company, is shown in the accompanying illustration. The vessel was launched May 6 last, at the yard of the Delaware River Iron Shipbuilding and Engine Works, Chester, Pa., and started on her first voyage from New York for Norfolk, July 29. She is modeled on the lines of other well-known vessels in this company, and is fitted out in much the same style, with the addition, of course, of many improvements, suggested by Captain Henry A. Bourne, Pres. and William Rowland of the company.

The Princess Anne is 326 ft. 5 in. long, 42 ft. beam and 27 ft. deep molded, and is 3,078 tons gross. She is fitted with two steel masts schooner rigged and has a cargo capacity of 150,000 cu. ft., and on a load draught of 17 ft. is

OLD DOMINION STEAMSHIP CO'S NEW COAST LINER PRINCESS ANNE.

expected to attain a speed of 16 knots with 3,500 horse power. Her hull is of mild steel, with iron rivets, and she has been constructed throughout according to the highest class of the American Shipmasters' Association, and the U. S. Steamship Owners, Builders' and Underwriters' Association. Captain James A. Smith represented the company during the construction of the vessel which occupied the remarkably short space of eight months. She has five decks, two of which are of steel. The decks are lower and upper 'tween decks, main deck and promenade deck extending right fore and aft, and a hurricane or boat deck carried over the tops of the deck houses and to the rail on the quarter, instead of having awnings over the promenade deck, as on the other boats of the line. There are four water tight cross bulkheads and a water tight shaft alley, giving considerable stiffening to the ship. The saloon is located on the main deck aft of the machinery spaces. This is very handsomely finished in mahogany, with hardwood carpet floor and mirrors conveniently disposed, and all metal work, gilt or silver plated. A beautiful mahogany sideboard occupies the forward end of the room alongside the pantry opening which is situated on the port side of the engine trunk. There is seating accommodation at table for seventy passengers. State rooms extend along the sides of the saloon, which is lighted by skylights and by a central dome, which is overhead the main staircase, leading up to the social hall above on the promenade deck. There are sixty first-class rooms in all on the ship, many of which are fitted with brass beds and they all are provided with the newest toilet accessories, and with Fowler and Wolff steam radiators. The rooms are finished in white, with natural color sycamore woodwork and rich colored carpets. A passageway, with cabins on either side, extends a short distance aft to a sitting room, which is also very tastefully finished in mahogany and furnished with large bookcase and grand piano. Still further aft there is a retiring room for ladies and a finely fitted toilet room on the port side. There is also a large lavatory and toilet room on the starboard side communicating with the sitting room, for men's use. The toilet rooms are fitted with automatic flushing apparatus and rubber tile floors. A promenade space surrounds the deck houses on this deck. The pantry is supplied with a very thorough equipment for keeping foods and dishes warm and has steam apparatus for brewing tea and coffee. Engineer's store room and porters' room are forward of this, alongside the engine trunk, which is near the center of the vessel.

Forward of this casing, conveniently squeezed in between this and the smoke stack, the galley is arranged the full width of the deck house. A French range and steam cooking apparatus are provided, along with the usual complete outfit of culinary utensils for a liner. An ice house and spacious store rooms are also at hand. The galley is ventilated by a shaft carried up close to the funnel housings. Forward of the smoke stack there is a large 'tween deck space for the storage of perishable freight, such as vegetables and fruits. Lidgerwood and Williamson hoisting engines are fitted at the hatches here, and there is also a powerful double elevator, for lowering package freight into the hold. Large cargo ports are conveniently fitted in the sides, with sliding doors so the unsightly outside hinges are avoided. A similar equipment of cargo handling machinery and ports are fitted aft, as will be seen in the longitudinal section published as a supplement to this issue. Forward of the cargo space there is a large room for third-class steerage passengers, fitted with adjustable bunks so the sleeping accommodation can be arranged for any number up to 50 persons. An iron bulkhead here cuts off the forward portion of this deck clear across the ship. On the forward side of this the sleeping cabins for the second-class passengers are situated, the men's and women's communicating by separate staircases, with a sitting room on the promenade deck above. These accommodations are very superior, the privacy of separate cabins being afforded the women passengers. The forecastle is occupied by the crew, bunks for seamen are fitted on the starboard side and for firemen on the port side. Between this and the second-class quarters is the heavy steam windlass and capstan of the American Ship Windlass Co.'s pattern. Ninety fathoms of chain are supplied for each anchor, 1 7-8 in. dia. for the port and 1 3-4 dia. for the starboard.

The hurricane deck does not extend forward of the second cabin deck house, and from the windows of this house on the promenade deck a fine bow view can be had in all directions. Additional state rooms for the first-class passengers are situated on this deck at the back of the intermediate sitting room, with entrances on the sides. The space at the cargo hatches is planked over when the vessel is at sea. Next comes the steel foremast in front of the pilot house, which latter has observation windows looking ahead and to either side. Over the pilot house there is a navigating bridge extending to the sides about 40 ft. above the water. In the pilot house hand wheels are fitted and so connected with a Sickles' steering engine on the deck below that in case of breakdown the engine can be readily disconnected and the vessel steered from the house, by two or four men. Aft in the tiller room there is also a powerful Napier screw gear for use in emergencies. An indicator in the house of the Russell-See patent is connected with the electric side and mast lights, so that should any light go out immediate notice would be given. There is also an electric automatic signal apparatus put in by the Signal and Control Co., which can be set to blow a 7-second blast at intervals of 53 seconds. The after portion of this deck house is occupied by the captain's and executive officers' rooms. The former is very spacious, the full width of the house, and lighted from above as well as the sides. It is fitted as a combined living and chart room, beautifully finished in white and gold with polished mahogany furnishings and cherry and maple floor. The first and second officers' rooms divide the rest of the house on either side and are finely finished in polished sycamore with hardwood floors. The lower portion of this deck house is occupied forward by the steering engine and between this and the funnel casings by eight outside deck rooms for first-class passengers. These are the most desirable cabins on the ship. The side promenades widen out here into spacious lounging places, where deck chairs can be comfortably placed.


UPPER GRATING, ENGINE ROOM PRINCESS ANNE.

On the promenade deck the large officers' mess hall is sandwiched in between the funnel casings and the engine trunk and overhead there is a spacious smoking room for the first-class passengers. This is very comfortably upholstered in grained leather with polished hazel woodwork. Tables and usual fittings are comfortably placed about. Aft of the engine trunk the social hall and state rooms occupy the deckhouse, light-wells in the center with handrail permitting a view of the main saloon below. The social hall is furnished with upholstered seats and extension table. The state rooms extend to the rear of the deckhouse. On the hurricane or boat deck there is a very complete equipment of patent metallic boats and life rafts.

The machinery equipment of the Princess Anne is very compactly arranged. Experience gained in the operation of the other boats of the line has been put to good use here by George V. Sloat, superintending engineer of the company, not only in the introduction of new apparatus, but also in the convenient arrangement of all. The installment was made at the builders' yard, under the immediate supervision of John B. Sundall, who is now chief engineer of the vessel. The engine which drives the single screw is of the triple-expansion type fitted with Marshall valve gear. This permits of a very compact fore and aft arrangement, as the valve chests are situated on the starting side of the engine. The cylinders are 27 in., 44 1-2 in. and 72 in. by 54 in. stroke. Both cylinders and valve chests are lined with hard cast-iron liners and the main pistons are fitted with tail rods. All the valves are of the piston type, the L. P. cylinder having two. Both the I. P. and L. P. cylinder valves are fitted with assistant cylinders, the I. P. connecting with the H. P. receiver and the L. P. with the condenser. The engine frames are A shaped, the front columns having long openings fitted with doors so that ready inspection of the big ends is afforded when running. The crank shaft is 14 1-2 in. dia. with crank pins 14 1-2 by 16 in. long. The line shaft is also 14 1-2 in. dia. The condenser is rectangular, extending the length of the engine and forming part of the back frames. The air and bilge pumps are worked by levers off the L. P. crosshead, which is over the after crank. Starting gear is fitted on the port side between the I. P. and L. P. columns. The space between the transverse bulkhead and the skin on this side is used for water tanks and bunker shelves. On the starboard side, in a recess which extends to the skin, several auxiliaries are conveniently arranged. There are two powerful feed pumps of the Deane of Holyoke pattern, with brass water ends, a direct connected engine and centrifugal circulating pump, feed-filter, Korting injector and turning engine. On the middle platform on the starboard side there is a large Deane fire-pump and duplex Deane sanitary pump; also an oil filter, to which all drainings are pumped from the crank pits, and also reservoirs for oil. On the upper platform in a recess on the same side, the electric light plant is located. This consists of an Ideal horizontal engine, belted to a General Electric 20 K.W. generator with switchboard overhead. In the passage between the engine and boiler rooms below there is a separator on the main steam pipe connected with a water glass in the engine room. There are two 6-in. bilge ejectors fitted aboard, one in the engine room and one in the forehold.

There are four cylindrical boilers of the regular marine return-tube type. They are single ended 14 ft. 3 in. dia., by 12 ft. 7 in. long, built by the W. & A. Fletcher Co., Hoboken, N. J. The furnace ends are inboard and opposite, two on each side of the fire room. Mild steel of 60,000 lbs. tensile strength was used for the boilers. The shells are 1 3-8 in. thick and carry a working pressure of 190 lbs. to the square inch. The combustion chambers are isolated. Tubes are 3 1-4 in. dia. and 9 ft. long, fitted with retarders. A 70 in. American Blower Co.'s fan is fitted on the open stokehold system. There is also an arrangement for induced draught, Bloomsburg jets being fitted at the base of the smoke stack. This is oval 9 ft. by 7 ft. dia. with top 80 ft. above the grates. On a level with the middle platform between the engine and boiler rooms there is a donkey boiler of the Sloat return tube pattern which occupies very little space and gives steam freely. A See's ash ejector is in the fire room, together with an independent Deane ash pump. There is bunker capacity for 180 tons and fresh water storage for 15,000 gallons. The propeller is of cast steel, made by the Pennsylvania Steel Co., of Chester, 16 ft. dia. and 22 ft. pitch and a true screw. It weighs 14,800 lbs. and is a remarkably perfect casting. The Princess Anne will run on the New York-Norfolk route. Her commander is Capt. John Hulphers, who has been with the company for many years.

The method usually employed in testing the speed of a war vessel, before acceptance by the Government, was departed from recently in the case of the gunboat Newport. A run was made over a mile course in each direction at full speed, and the elapsed time for each direction taken. This was halved so as to get the speed of the vessel without the need of taking account of the influences of wind or tide. Further runs were then made at reduced speed and a speed curve was constructed showing the speed of the gunboat at the several different rates of revolutions of the propeller. With this information a time test of four hours was run and the speed ascertained by reference to the curve. The usual method has been to mark a course, with stake boats, of sufficient length to enable a trial run of four hours' duration to be made at full speed. On each stake boat naval officers took note of conditions during the run. These observations acted as a check upon those taken on board the trial vessel. The objections to this system are: the necessity for using a suitable course, the length of time necessary for a trial, and the great expense involved in the use and equipment of the stake boats. The method employed in the Newport trial, which has been tried here before, and is frequently employed abroad, is quick and comparatively inexpensive, though open to some objection. Commodore George Dewey, U. S. N., President Board of Inspection and Survey is of opinion that by the use of this method controversies, depending on the manner of drawing the speed curve, might arise where large pecuniary interests were at stake; while there can be no difference of opinion as to results secured by the usual method.

NAVAL REVIEW AT SPITHEAD IN HONOR OF QUEEN VICTORIA'S JUBILEE.

BY CHIEF ENGINEER JOHN D. FORD, U.S.S. BROOKLYN.

At noon of June 3 we discharged our pilot off Sandy Hook and stood over for Old England, bearing the flag of Rear Admiral Joseph N. Miller, the special Ambassador appointed to represent the Navy of the U. S. at the Queen's jubilee—the 60th anniversary of her reign. After ten days and ten hours' economical steaming through smooth seas and light breezes we dropped our anchor at about ten o'clock on the morning of June 14 in the Solent-Southampton water off the famous old Netley-Abbey. The next few days were devoted to rubbing off the marks of the sea, burnishing up the ship, fraternizing with the good people of Southampton, and exploring the mysterious old pile that is known as Netley Abbey.

June 19 we steamed down to Portsmouth outer harbor—Spithead—and took our place in the line of guests.

Portsmouth harbor is a splendid sheet of water capable of sheltering the navies of the world, and has sheltered some of the most imposing armaments that have ever been assembled. She has borne upon her bosom the most distinguished naval heroes of English history, and the people of Portsmouth and Gosport have, from the earliest ages, looked upon the many craft, as marvelous in the early days, for their times, as the present great fleet is in these days. Henry VIII, in 1545, sent forth 100 sail. In 1628 the Duke of Buckingham fitted out a great squadron for the relief of the Protestants in France, but an assassin's hand struck him down on the High street and the fleet was dispersed. In 1856, at the end of the Russian war, 254 steam line-of-battle ships, steam frigates, sloops, mortar vessels, floating batteries and troop ships were reviewed here by the Queen. To-day we find the great fleet anchored in three lines of battle, as for the defense of Portsmouth, making a line that is more than twelve miles long, where every vessel is so close to its neighbor that there is only safe distance for swinging to the tide between them. The heaviest and most powerful vessels are in the outside, the cruisers in the middle, and the smaller vessels, torpedo boats and destroyers, are in the inner line, making one of the most imposing sights that it has ever fallen to the lot of man to witness.

Just across the narrow passage between our lines are the Jupiter, Mars, Magnificent, Majestic, Prince George, and Victorious, six of the newest battleships, the oldest of them, the Majestic and Magnificent, having been commissioned in 1895. They are practically alike and displace about 15,000 tons with coal, ammunition and stores on board. Each carries four 46-ton wire wound 12-in. guns, firing 850 lb. shot with cordite ammunition; twelve 6-in. rapid-fire guns, which discharge 100 lb. shot, and 38 smaller guns. The 46-ton guns are placed in pairs at each end of the vessel, behind armor shields. They have 9-in. thick plating of Harveyed steel and the deck plating varies from 4 to 2 1-2 in. thick of steel. The ends of the ship are unarmored. Their speed varies from 17 1-2 to 18 1-4 knots. There are four torpedo tubes below the water line and one at the stern above the water line. They are quite high out of water and are intended to be weatherly at sea. They have two masts, which are fitted with tops containing 3-lb. rapid-firing guns and an electric search light. The Hannibal, Cæsar and Illustrious, sister ships, are nearly ready for service. They each have two smoke pipes abreast and very close together.

The Renown is really a smaller Majestic. She is of 13,000 tons displacement and has a speed of 18.7 knots, being the fastest of the British battleships, carries four 20-ton 10-in. and ten 6-in. rapid-fire guns, which are supplied with high-explosive shells, in which cordite is used instead of powder. She also carries 30 small guns—12 and 3 pounders. The 6-in. guns are in casements which are from 4 to 6 in. thick. The side armor is 6 and 8 in. thick of Harveyed steel. She is sheathed with wood and coppered. She has four under-water torpedo tubes. The Renown is a great favorite in the British Navy, and nine similar ships, but of improved design, are being built. She has two smoke pipes abreast and close together.

Further up the line are the Empress of India, Repulse, Resolution and Royal Sovereign. The four are about alike and were finished in 1892. They each have a displacement of 14,000 tons and a speed of 17 knots, and carry four 67-ton 13 1-2 in. guns, in pairs, in pear-shaped turrets that are of 17 in. thickness of steel. The breeches are depressed to load them when they are turned; loaded, and elevated or depressed by hydraulic power. They are armed with 10 6-in. rapid-fire and 30 smaller guns. The armor is compound-wrought iron faced with hard steel. They have seven torpedo tubes. The armor deck lies horizontal about the level of the water line.

The Sans Pareil is a sister ship to the unfortunate Victoria, which was cut down and sunk by the Camperdown in the Mediterranean Sea on June 22, 1893. She has a displacement of 10,500 tons and a speed of 14 knots. She has two 111-ton 16 1-4-in. guns, the largest guns afloat, which are placed side by side in an 18-in. thick turret. She carries a 29-ton 10-in. gun behind a 2-in. steel mask, 12 6-in. guns and 32 smaller guns.

The Benbow, Howe and Collingwood, known as the "Admirals," are of about 10,500 tons displacement and have a speed of about 16 knots. They are not as powerfully armed.

The second-class battleships, in the second line, are the Colossus and Edinburg turret ships, short and squat, like our monitors. They are each of 9,400 tons displacement, with a speed of about 13 knots. The armor for one-third of the length is from 14 to 18 in. thick. There are four 12-in., five 6-in. and 22 small guns besides two torpedo tubes. The Inflexible is of 11,800 tons displacement, with a speed of about 12 knots. She carries four 80-ton 16-in. muzzle-loading guns in turrets. The old Alexandria, which grounded under the Turkish forts while forcing a passage through the Dardanelles, under Admiral Hornby in 1878. Her speed is about 14 knots and she carries four 22-ton 9.2-in. breech-loading and eight 18-ton 10-in. muzzle-loading rifles, besides smaller guns. Her armor is of iron from 2 to 6 in. thick. The two old turret ships, Devastation and Thunderer, complete the line of battleships. They have a displacement of 9,300 tons and a speed of about 12 knots. They carry four 29-ton 10-in. breech-loading guns. The armor is from 6 to 12 inches thick.

Near the center of the middle line are the four armored cruisers. First the Warspite of 8,400 tons displacement, with a speed of 17 knots. She has four 22-ton 9.2-in. guns in four separate turrets, besides ten 6-in. breech-loading and 24 smaller guns. Her armor is from 8 to 10 in. thick and she is sheathed and coppered. The next three, the Aurora, Australia and Galatia, are each of 5,600 tons and have a speed of 18 knots. Their armament consists of two 22-ton and ten 6-in. rapid-firing guns. They have a narrow belt of 10-in. armor on the water line, and a 3-in. thick steel deck.

The two newest first-class cruisers, the Powerful and Terrible, are anchored, near the center of the outer and middle line. They are of 15,000 tons displacement, with a speed of 21 knots. They are 538 ft. long and are powered with water tubular boilers. They have a bunker capacity of 3,000 tons, and are armed with wire-wound guns. One 23-ton, 9.2-in. gun is placed behind shields at each end of the vessel, and there are twelve 6-in. rapid-fire guns in casements behind shields of 6-in. Harveyed steel, sixteen 12-pounders, 23 smaller guns, besides four torpedo tubes. There are 48 separate boilers and the engines develop 25,000 H.P. The steel armor deck, near the water line is 4 inches thick. The Blake and Blenheim are of 5,000 tons and have a speed of about 20 knots. They each have two 23-ton, 9.2-in. guns, ten 6-in. and 25 small guns.

The smaller Blakes are the Royal Arthur, Edgar, Endymion and Theseus. They are of 7,700 tons, 12,000 horse power and 19.5 knots speed. They each carry one 22-ton and twelve 6-pounder guns, and they have an armor deck which varies in thickness from 1 to 5 inches. The largest of the second-class cruisers are the Diana, Dido, Doris, Isis, Juno, Minerva and Venus. They are sister ships, have a displacement of 5,600 tons and a speed of 20 knots. They each carry five 6-in., six 4.7-in. rapid-firing, besides 14 smaller guns. The machinery and magazines are protected by a steel deck, varying in thickness from 1 1-2 to 3 inches, and they have a bunker capacity for 1,100 tons of coal.

The Bonaventure, Charybdis, Flora and Hermion are of 4,360 tons, with a speed of 19.5 knots. They are armed with two 6-in. and eight 4.7-in. rapid-fire guns. Still smaller are the Apollo, Eaolus, Andromache, Latona, Brilliant, Melampus, Naiad, Sappho, Sirius, Spartan, Terpschore, Thetis and Tribune, small cruisers of 3,500 tons, with a speed of about 19 knots. They are armed with two 6-in., six 4.7-in. rapid-fire and 13 smaller guns, with four torpedo tubes. The protective deck is from 1 to 2 inches thick. As they only carry 535 tons of coal their usefulness is limited.

The old Mersey of 4,000 tons, with a speed of 17 knots, carrying two 8-in. 14-ton and ten 6-in. rapid-fire guns, and a three-inch thick steel deck, together with the Leander and Pheaton of 4,300 tons and a speed of 17 knots each, carrying ten 6-in. rapid-fire guns, end the cruiser second-class.

The Pelorus of 2,135 tons, a speed of 20 3-4 knots and armed with eight 25-pound rapid-firing guns, leads the van of third-class cruisers. Her coal capacity is limited to 250 tons, which very materially hampers her usefulness as a cruiser. The Barracouta of 1,580 tons and a speed of 16 knots, armed with six 4.7-in. rapid-fire guns, is placed in the inner line, near the entrance to the harbor.

The Medea, Medusa and Magicienne of 3,000 tons and a speed of about 14 knots, have batteries of six 6-in. breech-loading rifles and ten smaller guns, and are placed on the inner line, near the Barracouta.

Twenty torpedo gunboats of the Halcyon class are placed in the inner line of defence, and extend from the Gosport side of the entrance to the inner harbor, away for about three miles. They vary in size from 810 to 1,070 tons and have a sea speed of about 16 knots. They are armed with two 4.7-in. and four 6-pounder rapid-fire guns, besides three torpedo tubes. They have no armor. The Speedy is fitted with Thornycroft water tubular boilers and is the swiftest boat of the group. The 30 Destroyers extend from the torpedo gunboats to the end of the line. Their long, low rakish black hulls, with smoke stacks varying from two to four, give them the appearance of pirates. Their tonnage varies from 240 in the Havock to 300 in the Desperate, and the speed varies from 26 to 30 knots. The horse power from 3,500 to 6,000 or more. The armament consists of one 12-pounder and five 6-pounder rapid-fire guns and two torpedo tubes (the Daring has two 12-pounders and three 6-pounders). Covering the Portsmouth side, entrance to the inner harbor the twenty numbered, but nameless, torpedo boats were grouped. They vary from 127 to 150 feet long and have a speed of about 21 knots. They are armed with five torpedo tubes and two 3-pounder guns. Behind the cover of the fleet rode some 31 old hulks, slow gunboats, tenders, training ships and vessels of no fighting value.

The British war ships were painted black, with white ribbons, with white upper works and yellow smoke pipes and ventilators.

In the outer, or off shore side the foreign vessels were lined up in the order of their arrivals.

The United States was represented by the armored cruiser Brooklyn, bearing the flag of Rear Admiral J. N. Miller. The Brooklyn was fully described in Marine Engineering for July.

France was represented by the armored cruiser Admiral Pothnan, bearing the flag of Rear Admiral C. Marquis de Comthille. The Admiral Pothnan is 370 ft. 6 in. in length, 50 ft. 2 in. beam, of 10,398 ind. horse power and has a speed of 19.2 knots. She has an armament of two 7.4 in., ten 5.5-in., sixteen 1.8-in., eight 1.4-in. guns and five torpedo tubes. She cost $1,920,000 and was built in Havre.

Russia sent the armored cruiser Rossia, bearing the flag of Rear Admiral Nicholas Skrydloff. The Rossia is 480 ft. long, 68 ft. 6 in. beam, with over 12,000 tons displacement, has three propellers, water-tube boilers that are fitted to burn oil or coal, develops 14,500 ind. horse power and has a speed of 20 knots. She carries four 8-in. 192-pounders, sixteen 6-in. rapid-fire, and forty-two smaller guns. She is the largest cruiser in the world, after the Powerful and Terrible, and was built at St. Petersburg.

Italy had the Lepanto, bearing the broad pennant of Vice Admiral Morin. The Lepanto is a barbette ship, 400 ft. 6 in. in length and 74 ft. beam, develops 15,800 ind. horse power and has a speed of 18.38 knots. Her armament consists of four 100-ton (Armstrong), eight 6-in., four 4.7-in. rapid-fire, one 2.2-in., thirty-four 1.4-in. guns, and four torpedo tubes. She cost $5,750,000 and was built at Leghorn.

The Japanese sent the Fuji, Captain Isao Muira. The Fuji is a barbette ship, 374 ft. long, 73 ft. beam, displacing about 12,450 tons, 14,000 ind. horse power and a speed of 18 knots. Her armor varies from 18 to 4 inches of Harveyed steel. She has four 12-in. 850-pounder wire-guns, ten 6-in. rapid-fire and 24 smaller guns and five torpedo tubes. She has two military masts, with tops. She was built on the Thames and was not quite finished as there were about 200 mechanics at work on her during the review.

Germany's representative was the Konig Wilhelm, Rear Admiral H. R. H. Prince Henry of Prussia, K. G. The King Wilhelm is a first-class cruiser, 355 ft. long and 60 ft. beam, 8,350 ind. horse power, with a speed of 14.7 knots. She was an old battle-ship, rebuilt at Hamburg during the past year. She has armor from 6 to 12 ins. thick. . Her armament consists of twenty 6-in. and eighteen 20-pounder rapid-fire guns and five torpedo tubes. She cost $2,525,705 and was originally built at Blackwall.

Spain was represented by the armored central-battery ship Vizcaya, Rear Admiral Bermejo y Merelo. The Vizcaya is 340 ft. long, 65 ft. beam, a displacement of 6,890 tons and has a speed of 20 knots. The armor is from 8 to 12 ins. thick. She carries two 11-in., ten 5.5-in., rapid-fire guns and four torpedo tubes. She cost $3,000,000 and was built at Bilbao.

Austria sent the Wein, a battleship of 5,500 tons, bearing the flag of Vice Admiral, The Baron Von Spann. The Wein is 305 ft. long, 55 ft. 9 in. beam, 8,500 ind. horse power and has a speed of 17.6 knots. She is plated with armor 3 to 10 ins. thick. Her armament consists of four 9.4-in., six 5.9-in. rapid-fire, fourteen 47 m. m., rapid-fire guns and four torpedo tubes. She cost $1,695,000 and was built at Trieste.

H.M.S. TERRIBLE. H.M.S. MAGNIFICENT. H.M.S. HOWE.
U.S.S. BROOKLYN. H.I.M.S. ROSSIA. H.M.S. ROYAL SOVEREIGN.

The Netherlands was represented by the Evertsen, a coast defence turret ship, carrying the flag of Rear Admiral Engelbrecht. The Evertsen is 282 ft. 9 in. long, 47 ft. beam, 4,735 ind. horse power and 16 knots speed. She carries three 8.2-in., two 5.9-in., six 2.9-in. rapid-fire and eight 1.4-in. guns and three torpedo tubes. She was built at Flushing.

Denmark's turret ship Heligoland, bearing the flag of Rear Admiral Koch, has a length of 257 ft. 6 in., beam 59 ft. 2 in., ind. horse power 4,000, and a speed of 12 knots. She carries one 12 in. Krupp, four 10.2-in., five 4.7-in. and four torpedo tubes. She cost $1,375.000 and was built at Copenhagen.

The central battery ship Vasco de Gama, with Captain Vascomelles, represented Portugal. The Vasco de Gama is 200 ft. long and has a beam of 40 ft., is of 3,600 ind. horse power and has a speed of 13 knots. She carries two 10.2 in., 18-ton Krupp, one 5.9-in., two 2.5-in. rapid-fire guns and was built at Blackwall.

Sweden's little coast defence turret ship Gota, bearing the flag of Rear Admiral Kluetberg, has a length of 258 ft. 6 in. and beam of 48 ft., is of 4,677 ind. horse power and has a speed of 15.9 knots. Her armament consists of two 10-in., four 6-in. and five rapid-fire 6 m. guns, and three torpedo tubes.

The little gunboat Frithjof, Rear Admiral Von Krogh, stood for Norway. The Frithjof is 216 ft. 6 in. long, 35 ft. 10 in. beam and develops 300 ind. horse power. She carries two 4.7-in., four 2.9-in. rapid-fire, four 1.4-in. guns, and three torpedo tubes (one submerged).

The most important battle ships at the review are the Majestic, Prince George, Victorius, Mars, Jupiter and Magnificent, all of which are identical in displacement, horse power, armor and armament and practically alike in speed.

Near to each other are the Powerful, Terrible, Rossia and the Brooklyn, the four greatest cruisers in the world. The two former carry the heaviest batteries and have about the same speed as the Brooklyn, but the Brooklyn's side armor and protective deck give her greater powers of endurance and the Rossia, being slower than either by more than two knots, excludes her from the race.

At about 3 o'clock in the afternoon of July 26, the royal yacht Victoria and Albert having the Prince of Wales and suite on board, steamed slowly out of Portsmouth harbor, followed by the members of the House of Lords, the Commons (in a large merchant steamer) and the Lords of the Admiralty in their yachts. As soon as the reviewing party were well out of the Ryde, the Royal salute was fired by the vessels, British and foreign, of the great fleet. Superstructures and casemates were manned, and, as the reviewing fleet passed along, the band on each ship played the British National Anthem and the crew gave three cheers for the Prince of Wales.

Moving about and through the lines the little Turbinia, like a whale with a man on his back to steer, did her thirty-five and forty miles an hour with ease. Here, there and everywhere the little craft flew through the water, demonstrating to all the possibilities of the future.

The engineers of the fleet rejoiced that the Queen had seen fit to especially acknowledge her appreciation of and recognition of the services of the Royal Naval Engineers by conferring knighthood upon three Inspectors of Machinery.

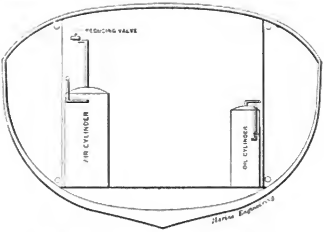
About 6 o'clock in the evening the clouds lowered and soon the rain fell in torrents with sweeping gusts of wind, which continued until about 8 o'clock, when the rain ceased to fall, except in fugitive drops, but the clouds continued black and threatening. At 8:30 o'clock, as if by magic, every vessel of the great fleet flashed forth its illumination and each ship was in a blaze of lights, except the Rossia, which wore its somber colors, but sent forth beautiful fire-works during the whole evening.

Besides the rainbow dressing of electric lights of the Brooklyn, one of her ensigns was fixed aloft and a search-light threw its powerful rays upon it, giving it the appearance of being fixed in the black clouds. The colors were brought out beautifully and the effect was fine. The British flag was treated in the same way from the bow end and the compliment was loudly cheered by our cousins who live on the other side of the great ocean.

RESULTS OF LIQUID FUEL EXPERIMENTS IN THE U. S. NAVY.—II.

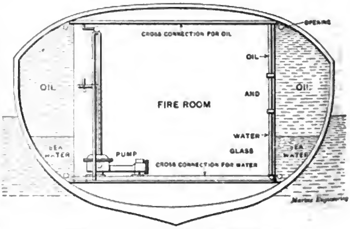
BY J. S. ZERBE.

The torpedo boat used by the Government in its experiments with liquid fuel was designed and built for the use of coal, hence special provisions had to be made for the storage of oil and for supplying the burners. There was no room within the shell of the vessel, and a reservoir was, therefore, placed in each cockpit, fore and aft, the capacity of the two being about fifteen barrels.



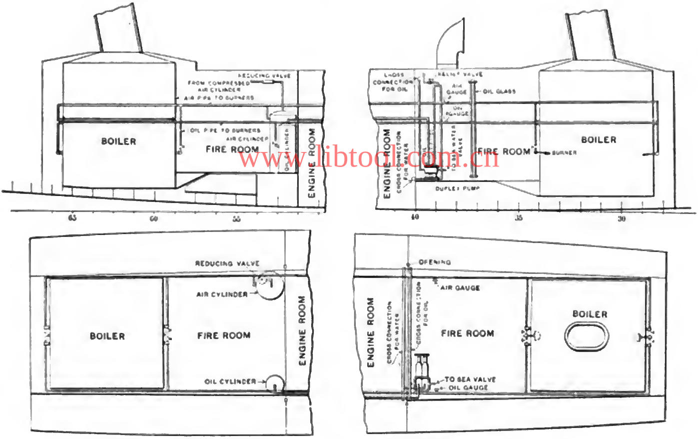
SECTION, LOOKING FORWARD, THROUGH 55

The supply pipes were all exposed and laid along the outside of the shell, so that there was no protection during the severe winter, when many of the tests were made. The results showed that this fuel can be used at all seasons with equal success. The oil used is known as "fuel oil," from 34 to 37 gravity, but tests were also made with Lima crude with substantially the same results. It is possible, however, that severe cold would make the crude material sluggish in its movements if used under these same conditions.



SECTION, LOOKING AFT, THROUGH 35

It is desirable that a vessel of this character should keep an even keel and uniform displacement throughout a run, particularly where, as in this case, the fuel forms the ballast. To provide for this a duplex pump is used, one side of which forces sea water into the bottom of the storage



PLANS FOR EQUIPMENT OF 140 FT. TORPEDO BOAT WITH FUEL OIL APPARATUS.

reservoirs for use under the boilers. Pipe connections are made across the tops of the reservoirs and also at the bottom, so that the oil and water is always kept at the same level. As a result there can be no splashing of the liquid fuel, and gases cannot accumulate, because all the spaces within the reservoirs and pipes are at all times filled with either oil or water, and when the

SUMMARY OF TRIALS OF FUEL OIL APPARATUS ON GOVERNMENT TORPEDO BOAT.

Date 1896.	Steam in lbs.		Temperature Fahrenheit.							Barometer.	Pyrometers.		Air Pressure in In. in Fire R.	Oil Consumed in Lbs.	Water in Lbs.			Air Pressure on System in Lbs.	
	Boiler.	Engine.	Air.	Oil.	Engine Room.	Fire Room.	Feed.	Dry Bulb.	Wet Bulb.		Starboard.	Port.			Feed to the Boiler.	Vaporized from temperature of feed.	Vaporized from and at 212°	Oil.	Air.
Jan. 30	102.5	100.	41.37	55.	65.	94.	97.	..	..	30.	779	455	.912	887.5	12,929	14.56	16.88	25	15
Feb. 5	100.3	98.5	31.25	35.	60.	81.	94.	..	..	29.5	700	400	.6	635.8	10.965	17.33	20.22	25	7
Means.	101.4	99.2	36.32	45	62	88.	96	..	..	29.7	739	427	756	761.6	11,947	15.74	18.45	25	11
Duration of these tests four hours; engines running; 2.98% of moisture in the steam at 100 lbs. pressure; 22 observations.																			
Jan. 31	150.	148.7	46.5	49.5	60.	86.7	96.5	..	..	30.1	851	505	1.65	881.7	13,073	14.82	17.33	30	10
Feb 5	150.	151.	38.6	50.3	55.5	80.2	105.5	..	..	29.1	840	490	1.347	966.6	14.293	14.78	17.14	35	10
Means.	150.	149.8	42.5	49.9	57.7	83.5	101.	..	..	99.6	845	497	1.498	924.1	13.683	14.80	17.24	32.5	10
Duration of first test 3 hours, 28 minutes; second test 4 hours; engines running; 3.33% of moisture in steam at 150 lbs.; 22 observations.																			
Mar. 6	186.	185.3	50.0	50.2	64.7	90.	82.8	..	..	29.8	? 1252	680	1.862	1088.	16.792	15.43	18.34	30	7
" 28	199.7	198.3	55.1	58.1	65.	88.5	106.7	..	..	30.	out of order	?1040	1.592	1213.8	21.778	17.92	20.80	35	7
Means.	192.8	191.8	52.5	54.1	64.8	89.2	94.8	..	..	29.9	..	860	1.727	1150.9	19.285	16.68	19.61	32.5	7
Duration of tests four hours; engine running; 3.87% of moisture in steam at 200 lbs.; 28 observations.																			
June 8	214.2	..	88.	92.9	..	97.4	71.1	78.	73.	30.5	533	543	.895	625.	9.250	14.8	17.79	30	10
" 9	215.4	..	78.5	85.1	..	98.1	70.	73.5	70.3	29.8	528	547	.941	562.5	8.657	15.4	18.12	30	7
Means.	204.7	..	83.2	89.	..	97.7	70.5	71.6	71.6	30.1	530	545	.918	593.7	8.958.5	15.1	17.96	30	8.5
Duration of tests 3 hours, blowing into the atmosphere.																			
June 10	257.	..	66.6	80.2	..	100.8	68.5	66.6	63.6	29.6	618	623	1.817	800	13,046	16.3	19.76	25	10
" 12	250.	..	76.2	92.8	..	110.5	72.	76.6	61.6	29.7	658	621	1.450	812.5	13,457	16.5	20.01	27.5	12
Means.	258.	..	71.4	86.5	..	105.6	70.2	70.6	62.6	29.7	638	621	1.633	806.2	13,251.5	16.4	19.88	26.2	11
Duration of tests 3 hours; blowing into the atmosphere.																			

oil is exhausted an equal weight of water, approximately, is within the reservoirs. A relief valve is placed within the water line of the piping between the pump and reservoir, so that the pressure within the reservoir will never exceed two pounds per square inch. The oil side of the pump forces oil from the reservoir to a compression cylinder, which also has a relief valve, and an overflow back to the reservoir, assuring positive regulation of the oil feed.

Compressed air was used at a pressure not exceeding 25 lbs. Under natural draft the pressure was as low as 12 lbs. The oil pressure also varied, not exceeding 30 lbs. at any time.

The accompanying illustrations show the designs for the liquid fuel equipment of the 30-knot torpedo boats, which are now being built. In method of connecting up the oil and air and in furnace equipment they are substantially the same as employed in the torpedo boat tested, but the reservoirs are built in the hulls of the vessels and all the piping is within the shell.

The trials were made with boiler pressures of 100, 150, 200 and 250 lbs. and with natural and forced draft. In making the tests a "Barrus Universal calorimeter" was used, and the design was to make the data full and complete in every detail, extra precautions being taken in all observations. The tabulated statement here given is selected from the entire series of tests, and the average at all pressures is 18.61 lbs. of water evaporated, per lb. of oil, from and at 212 deg. Fah.

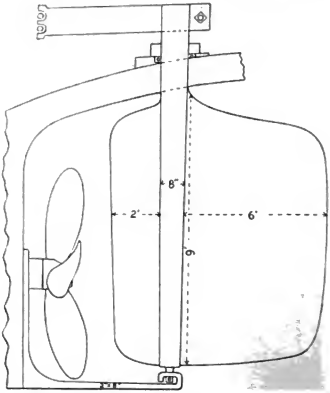
Before making the official tests numerous trials were made to determine the most effective oil and air pressures in the system, and it was found that the best results were produced with air at from 7 to 10 lbs. and oil at from 25 to 30 lbs. The average evaporation with the best Pocahontas coal in the same boiler was about 8 lbs. of water from and at 212 deg. Fah.

A dispatch from Galveston, Texas, states that the North German Lloyd Steamship Co., will inaugurate its service between Galveston and Bremen, August 20. The Hamburg-American Company,, which has established a service between Galveston and Europe, has determined to operate several of its steamships direct between Galveston and Europe without touching New Orleans, which has been custom heretofore.

The William Cramp & Sons Ship and Engine Building Company reports for year ending April 30 last, says the Marine Journal, gross income of $4,500,000, from which was realized a profit on labor and material of $770,000; deducting $340,000 for general expenses, repairs, salaries, interest, taxes, insurance, new machinery, etc., leaves a profit for the year of $430,000, equal to 8.86 per cent on its $4,848,000 capital stock as a result of the year's operations. The debt of the company was reduced $995,000.

LARGE RUDDERS FITTED TO CHICAGO TUGS.

A tugman from the seacoast, on seeing a Chicago tug in dry dock, might be puzzled to make out whether the rudder was an attachment of the tug or whether the tug was merely an adjunct of the rudder. The rudders of the tugs in use in Chicago River and harbor are truly enormous—necessarily so on account of the service required. The narrow, tortuous stream, the innumerable bridges, and the heavy traffic all combine to demand tugs of an extraordinarily high degree of efficiency. And the tugs in use in Chicago are the most efficient in the world. At least, that is what those who ought to know say of them. Seven years ago some one discovered that big rudders made tugs easier to handle. Since then all tugs have been equipped with rudders entirely beyond all rules of proportion laid down by marine architects, and the limit of size has not yet been reached, for each new tug that is built has a still larger ratio of rudder area to submerged area of hull. In detail the practice varies a little, but the principal is everywhere the same. Every builder is convinced that the particular design he follows is the only correct one. The smaller details of measurement vary so much that it is only practicable to speak of general rather than specific types. The general type of Chicago River tug, then, is 80 ft. long over all, 68 ft. long on the load water line, 18 ft. beam and 11.5 ft. deep, draws 9 ft. of water forward and 11 ft. aft. Such a tug would have a rudder 8 ft. long and 10 ft. deep. One-fourth of the blade would be in front of the stock as a counter balance. Sometimes the



SKETCH OF STERN OF CHICAGO RIVER TUG.

material is iron, but usually it is oak. In the latter case the stock would be oak, with an iron casing, the diameter being 8 in. The thickness on the blade would be 8 in., flaring out to 10 in. at the back, so as to give a slightly concave surface. The usual shape is that of a parallelogram with corners rounded off. Such a rudder when hard over catches almost the full force of the current from the wheel. This gives the tugs great power on a lateral pull and enables them to drag heavily loaded steamers with keels scraping along on the river bottom back and forth across the narrow, devious way they must follow to reach open water. In places where the river is 275 ft. wide one of these tugs will start from the dock on one side, turn around and come up nicely to the dock on the other side. The weight of the rudder is carried on an iron collar clamped to the stock and bearing on an iron block resting on deck. The foot of the stock ends in a pintle setting in a bearing in the iron shoe, which is usually of 2 by 8 in. material. All tugs in Chicago harbor have power steering apparatus, for it would be impossible to manage such enormous rudders in actual service by hand. The time required to put the rudder over from hard over one way to hard over the other way is from seven to nine seconds.

TUG TOWING SCHOONER UP CHICAGO RIVER.

Our London correspondent, in a personal letter referring to the Spithead Naval review, writes thus about the United States Cruiser Brooklyn: "The American was the handsomest of all foreign ships and made a splendid show at night when illuminated."

STEAMSHIP VIBRATIONS WITH RECORDS OF RECENT OBSERVATIONS.*—III.

BY PROF. W. F. DURAND.

In addition to moments tending to rock the engine about a transverse axis, we shall also have moments due to the same forces tending to twist it to and fro about a vertical axis, and reference in the first paper has been made to the forces applied at the slides tending to rock it about a longitudinal axis.

We may now properly inquire as to the relative importance of a balance of resultant force, or of rocking moment. This point was first comprehensively discussed by Herr Otto Schlick[3], who showed that an answer to the question must be sought in the relation of the disturbance to the geometrical characteristics of the natural vibration of the ship. Thus in Fig. 5 is shown the nature of the typical vibration, or vibration of the first order, as referred to in the first paper. If now the engine is located at or near C, where the natural movement is up and down with little or no change of angle, rocking moment is of small relative importance, and the balance of resultant force should receive first attention. In other words, at this point a resultant force will set up strong vibration, while a rocking moment will have but little effect. If, instead, the engine is located at or near the node B, where the amplitude of the motion is small, but where the change of angle is considerable, resultant force is of small relative importance, and the balance of moment should receive first attention. It thus appears that the influence of a resultant force is greater the greater the distance of its point of application from a node, while the influence of a rocking moment is greater the nearer its region of action is to a node. Thus with one end of the engine at B and the other end forward, a resultant force would aid a rocking moment in setting up vibrations. This shows that when the location of the engine is near B or slightly forward, as is usually the case, the L. P. cylinder or heavier moving parts should be aft or near the node, as is customary in usual practice. If on the other hand the engine were aft of the node as is common in tank and lake steamers, the preferable arrangement would be to place the L. P. cylinder

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* In the second chapter of this paper, published in the July issue, there are several typographical errors to which attention is here called. On page 4, 9th line from bottom, letters "OQ" should read OR. On page 5, 2d column, 6th line from bottom, commencing "An examination of KBLO," these letters should read KBLD. On page 7, 1st column, 3d line from top, should read $2155 \times 1.75 + 2770 \div 1.75 = 2767 \times 1.07 = 11580$.

[3] Trans. I. N. A. Lond., Vol. XXXV, p. 350, 1894.

forward or nearer the node. Since, moreover, the usual location of the engine is slightly forward of B, and since we cannot at present be sure of locating it on the node, it is evident that resultant force and moment should both be counterbalanced as far as possible, and that only by such attention to both can the best result be attained. It is also evident in general, that the rocking moments may be decreased by placing the cylinders with the heavier moving parts between those of lighter parts. Thus with a triple expansion engine the order of the cylinders from forward aft might be HLI, or with a quadruple expansion, HLI_2I_1.

It may also be noted that it is possible to have vibrations of the second order with three nodes and the natural number of vibrations about three times that for the vibrations of the first order as hitherto considered. If the revolutions should rise to this point, serious vibrations of this character might be set up, and as the geometrical distribution is quite different from that of the vibrations of the first order, it might happen that an engine well placed and balanced, relative to vibrations of the first order would give serious vibrations of the second order under the conditions assumed.

We will now state briefly various combinations of cranks or of cranks and counterbalances, for which an approximate balance of rocking moment will exist, as well as those combinations which admit of an approximate balance of both resultant force and moment at the same time.

With a single crank engine the regular counterbalance system may be divided into two equal parts at equal distances forward and aft of the engine, as for example on the crank webs as with the usual crank counterbalances. If the parts are of unequal weight, the product of the weight of each into its distance from the center line should be the same. With two cranks at 90°, each engine may be counterbalanced singly, or the rocking moment relative to either cylinder center line may be eliminated by a single counterbalance system at that end of the engine, with angular direction the same as that of the crank at the opposite end. The longitudinal location of the counterbalance may be such that its characteristic moment multiplied by its distance from the center line of the nearer cylinder will equal the characteristic moment of the moving parts for the other cylinder multiplied by its distance from the same center line. This arrangement will, of course, introduce unbalanced vertical forces, and is therefore of doubtful advisability. With two cranks at 180°, each engine may be single balanced or as above by the introduction of unbalanced vertical forces a balance of rocking moment may be effected by the use of a counterbalance system near either end, of angular location the same as the crank at the other end. The longitudinal location may be such tnat the product of the characteristic moment of the counterbalance by its distance from the center line of the nearer cylinder shall equal the product of the characteristic moment of the moving parts of the farther cylinder by the distance between the center lines of the cylinders. This arrangement is similar to three cranks of which the two outer are in the same direction and the inner one is opposite. If in such case the weight of the moving parts for the inner crank is equal to the sum of those for the outer cranks, an approximate force balance will exist at the same time. With three cranks at 120°, each engine may be separately balanced, or with equal weights of moving parts the rocking moment may be balanced by the use of a counterbalance system near either end of the engine, of angular location at 90° to the middle crank, and 150° from the nearer of the two end cranks. The system may furthermore be so placed that the product of its characteristic moment by the distance to the center of the engine bed plate will be about 1.7 times the product of the characteristic moment of one set of moving parts by the mean distance between the center lines of the cylinders. This latter arrangement will introduce unbalanced vertical forces, and is therefore not advisable unless there are special reasons for the elimination of the rocking moment. With four cranks at 90° as usually arranged, each engine may be separately balanced, or with equal weights of moving parts the rocking moment may be balanced by the use of a counterbalance system near either end of the engine, of angular location 135° from the crank at that end, and 45° from the crank at the opposite end. The system may furthermore be so placed that the product of its characteristic moment by the distance to the center of the engine bed plate will be about 1.4 times the product of the characteristic moment of one set of engine moving parts by the mean distance between the center lines of the cylinders. This arrangement will also introduce unbalanced vertical forces, and is therefore not advisable unless there are special reasons for the elimination of the rocking moment.

We will now turn to such combinations as admit of an approximate balance of both moment and force. As already noted this is possible with three systems of moving parts with angular locations all in one plane, as with a single engine with two counterbalance systems, or a three crank engine with two outside cranks opposite one inside crank, the weight of the parts for the latter being equal to the sum of those for the former. Where the crank angles are other than 180°, however, a balance of both resultant force and moment requires in general at least four sets of moving parts, of which, of course, none, one, or two may be counterbalance systems. Of these the angular location of any two may be taken at pleasure, and it may then become possible to find locations and amounts for the other two such that an approximate balance of both force and moment shall subsist. If moreover the characteristic moments of one or both the latter are determined within narrow limits, as would be the case with engine moving parts, it may still be found possible by adjusting angular and longitudinal locations to obtain an approximate balance of both force and moment. This may be seen more clearly by noting that the two systems whose locations and characteristics are fixed, will give a certain resultant force, and with reference to any assumed origin, a certain resultant moment. Suppose now the characteristic moments of the two other systems fixed. Then it may be possible by placing them at a certain angular relation to each other to obtain a resultant force of the necessary amount. If the combination of these two systems is then placed in the proper angular relation to the two given systems, the resultant force will have the necessary direction. Next the second systems may be adjusted longitudinally with reference to the origin of moments, so as to give a vertical rocking moment of the necessary maximum amount. It may then be possible to so change these locations longitudinally as to change the angular location of this maximum without changing its amount. This may be seen to follow from the fact that if one system were located longitudinally at the origin of moments the other could be so placed as to give a moment of the necessary maximum amount, and the angular location of such maximum would be that of the latter system. In this way the angular location of the maximum vertical moment might be brought to either of those for the counterbalance systems, and hence by intermediate locations to intermediate points. This adjustment as a whole may be structurally impracticable, due to the interference of the various systems, and the impracticability of locating them where the conditions would require. Herr Otto Schlick has, however, shown in the paper previously referred to, that with usual proportions of moving parts of four crank engines, several closely approximate adjustments are attainable. In such case the angles between the cranks are quite irregular, and the turning effort will in consequence be more uneven than in the usual case with equal crank angles. In any case the design of such an irregular arrangement of cranks and moving parts must be considered in connection with the question of general structural arrangement and design.

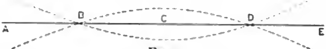

Fig. 5

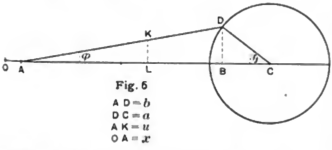

Fig. 6

A D = b
D C = a
A K = u
O A = x

We have thus considered the various means available for counterbalancing the systems of forces developed by the inertia of the moving parts of an engine, and thus of reducing the final resultant to the smallest practicable limits. We may next state briefly the quantities on which the amounts of such forces depend, in order to show the general relation between the characteristics of the engine and the magnitude of the system of inertia forces. In general, the magnitude of these forces varies as the characteristic moment of the moving parts, and as the square of the angular velocity, or as the square of the revolutions. The forces depend therefore, fundamentally, on the weight of the moving parts, on the length of stroke, and on the revolutions. It is furthermore evident that the change of revolutions is relatively more important than change of weights or of stroke. It must also be remembered that the larger the ratio of connecting rod to crank, the more effective will counterbalance systems become, and the smaller the final residual forces; while the smaller this ratio, the less effective in general a system of counterbalances, and the larger the residual forces. In the example used above for illustration, this ratio is 5 : 1. With ratios of 4 1-2 : 1 or 4 : 1, as are sometimes found, the residual forces given in Fig. 4 would be respectively about 10 per cent and 25 per cent greater than there shown.

Turning now to the ship itself, the conditions generally favorable to the development of the vibrations have been mentioned in the first paper. These will naturally suggest the opposite conditions for which the vibrations will be small. These are as follows: Absence of synchronism or equality of period between the natural period of the ship and the revolutions of the engine. Small power per ton of displacement. Large ratio of depth of ship to length. Large moment of inertia of cross-section of ship relative to the product of displacement by length.

The only modification in the strength of the ship itself which can be made to reduce vibration is in the moment of inertia of the structural cross-section. If the ship is structurally weak or insufficient to withstand the vibratory impulses, members may be introduced giving greater longitudinal strength and rigidity, and thus reducing the extent of the vibrations. In addition to this, the natural period of vibration may possibly be changed somewhat by a considerable change in the distribution of the weights included in the cargo, but usually the resulting modification is small, and but little aid can be expected from this source.

If the whole question of design is under consideration, two points aside from the detailed design of the engine may be made to yield valuable results. If the natural period of vibration of the ship can be predicted with reasonable certainty, the revolutions of the engine can presumably be chosen so as to differ considerably from this number, and thus the region of synchronism may be avoided. To this end Herr Otto Schlick has proposed[4] the following formula as giving with reasonable accuracy the natural number of vibrations for ships of the various types indicated:

$$N = \phi \sqrt{\frac{T}{D\ L^3}}$$

In which:—
N = Natural number of vibrati ns per minute.
T = Moment of inertia of mid-ship section, areas being measured in square inches and arms in feet.
D = Displacement in tons.
L = Length in feet.
For vessels with very fine lines, such as torpedo boat destroyers.. ϕ = 136850.
For large trans-Atlantic steamers with fine lines..... ϕ = 143500.
For cargo steamers with full lines...................... ϕ = 127900.

The second point lies in the location of the engines relative to the location of the nodes and loops of the vibrating ship. The importance of the relation between these locations and the nature of the residual forces due to the moving parts of the engines has been already pointed out. The satisfactory predetermination of these points however, is still a matter of considerable uncertainty. Herr Otto Schlick states[5] that for ships with fine lines he has found the after node at a distance of from .231 L to .253 L forward of the stern, while the forward node was found at a distance of from .310 L to .365 L aft of the bow.

The satisfactory determination of many of these questions, however, cannot be carried on without more data with which to aid the theoretical investigations. While the detailed examination of the problem is beyond reach of purely theoretical means, the approximate theory is not especially complex, and with more extended data, fairly reliable results might be attained. Beyond the reach of all theory, moreover, many points can only be settled by direct and detailed experimental examination, and it is in this field that information relating to the general subject is most needed.

APPENDIX.

In Fig. 6 we have for x, the distance of the upper end of the connecting rod from the origin, the following value:

$$x = a + b - a \cos \theta - b \sqrt{1 - \frac{a^2 \operatorname{Sin}^2 \theta}{b^2}} \quad \ldots\ldots (1)$$

Let b ÷ a = μ and expand the radical by the binomial formula, omitting all beyond the second term. This will give as a closely approximate value:

$$x = a + b - a \cos \theta - \mu a \left(1 - \frac{\sin^2 \theta}{2 \mu^2}\right) \quad \ldots\ldots (2)$$

whence:—

$$\frac{dx}{dt} = a \left(\sin \theta + \frac{1}{2 \mu} \sin 2\theta\right) \frac{d \theta}{dt} \quad \ldots\ldots\ldots\ldots (3)$$

and,

$$\frac{d^2 x}{dt^2} = a \left(\cos \theta + \frac{\cos 2 \theta}{\mu}\right) \left(\frac{d \theta}{dt}\right)^2 \quad \ldots\ldots\ldots\ldots (4)$$

Again, let *u* be the distance of any element of the connecting rod from the cross-head end. Then for the point K thus located we have the following vertical† and transverse co-ordinates:

$$\left.\begin{array}{ll} \text{Vertical} \ldots\ldots & x + u \left(1 - \frac{\sin^2 \theta}{2 \mu^2}\right) \\ \text{Transverse} \ldots & \frac{u \sin \theta}{\mu} \end{array}\right\} \ldots\ldots\ldots\ldots (5)$$

This gives for the corresponding velocities and accelerations the following:

$$\text{Velocities} \left\{\begin{array}{ll} \text{Vertical} & \frac{dx}{dt} - \frac{u}{2 \mu^2} \sin 2 \theta \left(\frac{d \theta}{dt}\right) \\ \text{Transverse} \ldots & \frac{u \cos \theta}{\mu} \left(\frac{d \theta}{dt}\right) \end{array}\right\} \ldots (6)$$

$$\text{Accelerations} \left\{\begin{array}{ll} \text{Vertical} & \frac{d^2 x}{dt^2} - \frac{u}{\mu^2} \cos 2 \theta \left(\frac{d \theta}{dt}\right)^2 \\ \text{Transverse} - & \frac{u \sin \theta}{\mu} \left(\frac{d \theta}{dt}\right)^2 \end{array}\right\} (7)$$

Let W_1 denote the weight of the reciprocating parts including piston, piston rod, and cross-head; dW_2 the weight of an element of the connecting rod, W_2 the entire weight of the connecting rod, M_2 its statical moment about the axis of the cross-head pin, and I_2 its moment of inertia about the same axis. Also let F_1 and F_2 denote the total vertical forces due to W_1 and W_2. Then if *n* denote revolutions per *second* we have:

$$\left(\frac{d \theta}{dt}\right)^2 = 4 \pi^2 n^2$$

and from (4) we have:

$$F_1 = 1.226\, n^2\, a\, W_1 \left(\cos \theta + \frac{\cos 2 \theta}{\mu}\right) \ldots\ldots\ldots (8)$$

Also from (7):

$$dF_2 = \frac{dW_2}{g} \frac{d^2 x}{dt^2} - u\, dW_2 \frac{\cos 2 \theta}{\mu^2 g} \left(\frac{d \theta}{dt}\right)^2 \ldots (9)$$

Whence,

$$F_2 = 1.226\, n^2 \left[a W_2 \left(\cos \theta + \frac{\cos 2 \theta}{\mu}\right) - M_2 \frac{\cos 2 \theta}{\mu^2}\right] (10)$$

Similarly for horizontal force H_2 we should have:

$$H_2 = 1.226 \frac{n^2 M_2}{\mu} \sin \theta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

It is readily seen that for any given position of the rod defined by the angles θ and ϕ, the moment of the horizontal forces about the cross-head pin is:—

$$\text{Moment} = 1.226\, n^2 \frac{I_2}{\mu} \sin \theta \cos \Phi$$

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[4] Vol. Trans. I. N. A. Lond., XXXV, p. 350. 1894.

[5] Vol. Trans. I. N. A. Lond., XXXVI, p. 287. 1895.

† The term *vertical* is used with reference to a vertical engine and not with reference to Fig. 6.

The horizontal force H_3 on the crank pin due to the connecting rod will equal this moment $\div$ b cos φ.

Hence we have:—

$$H_3 = \frac{1.226\, n^2\, I_2}{a\, \mu^2} \sin \theta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

or

$$\frac{H_3}{H_2} = \frac{I_2}{\mu\, a M_2} = \frac{I_2}{b\, M_2}$$

The horizontal force on the cross-head is, of course, the remaining part of H_2.

If M_3 denotes the moment of the crank about the shaft center, then the vertical and horizontal forces due to this member are as follows:—

$$\left.\begin{array}{ll} \text{Vertical Force} & = 1.226\, n^2\, M_3 \cos \theta \\ \text{Horizontal "} & = 1.226\, n^2\, M_3 \sin \theta \end{array}\right\} \quad \ldots\ldots \quad (13)$$

NOTE.

In regard to the actual extent of the vibrations on the S. S. Maine, the records of which were reproduced in the June issue, it may be well to note that the instrument magnifies the movement somewhat. The actual excursion for vibration No. 1 was from 5-16 to 3-8 in. The others are, of course, in like proportion. The instrument with which these vibration records were taken was constructed specially for observations of this character from designs by Prof. Milne, of the Imperial University of Tokio. It registers simultaneously the vertical component of the motion, and a horizontal component which may be made either transverse, longitudinal, or oblique, according to the way in which the instrument is placed.

Admission of Engineers to the Revenue Cutter Service.

While existing laws prevent young men, who are graduates of technical institutions, from obtaining commissions in the regular Navy, the Engineer Corps of the Revenue Cutter Service presents a field for marine engineers who are desirous of entering the Government service. The Treasury Department has recently issued a circular, which is here reproduced, setting forth the requirements for admission to this service. This will be of much interest to those who contemplate following the profession of marine engineering. The examinations are strictly competitive, no political influence being necessary. Any young man who fulfills the requirements may be designated to appear before the examining board. The salary of a Second Assistant Engineer is $1,200 per annum, that of a First Assistant Engineer $1,500, and of a Chief Engineer $1,800. In all three grades the allowance for rations is the same as that for officers of the Navy, thirty cents a day. On detached service where no public quarters are provided, an allowance is also made for commutation of quarters. These positions are for life, subject only to dismissal for incompetency or bad conduct. There are thirty-six vessels of the Revenue Cutter Service, stationed at the various seaports of the country, from Maine to Alaska. The usual term of duty on a vessel is three years; at the expiration of that time the officer is detached and ordered to another vessel. There are at present three vacancies in the list of Second Assistant Engineers, and an examination will be held to fill the same some time during the month of August.

GENERAL ORDER No. 32.

Division of Revenue Cutter Service.

Treasury Department,
Office of the Secretary,
Washington, D. C., June 11, 1897.

The following rules and regulations amendatory to paragraph 8, Regulations of the Revenue Cutter Service, governing the admission of candidates to the grade of Second Assistant Engineer in said Service, are hereby published for the information and guidance of all concerned:

1. No person will be examined for, or commissioned a Second Assistant Engineer in said Service, who is not a citizen of the United States.

2. Candidates must not be less than 21 nor more than 28 years of age, and must be of vigorous constitution, physically sound and well formed, and not less than 5 ft. 3 in. in height.

The application for examination must be in the handwriting of the applicant and addressed to the Secretary of the Treasury. It must state the date and place of birth, and the State of which a resident. If the applicant be of foreign birth it must be shown that he is a citizen of the United States.

3. The application must be accompanied with satisfactory evidence of the good moral character and correct habits of the applicant, and certificates showing his experience either in a machine shop or in charge of a steam engine, in a technical institution, or in the engine room of a steamer, as required by paragraph 6.

4. Candidates will be required to pass a satisfactory examination as to their physical qualifications before a board of medical officers, to be designated by the Secretary of the Treasury. The physical examination will precede the professional, and should the candidate be found physically disqualified he will be examined no further.

5. To be eligible for examination, a candidate must have had not less than eighteen months' experience in a machine shop, or responsible charge of a steam engine for that length of time; or, if

a graduate of a technical institution, he must have had the full four years' course in mechanical engineering; and, in addition to either of the three preceding requirements, he must also have had not less than six months' experience in charge of, or assisting in the care and management of the steam machinery of a *sea-going vessel in actual service*.

6. Candidates having been found physically qualified will be examined professionally by a board of engineer officers of the Revenue Cutter Service, in the following subjects, the questions and answers all being written:

(*a*) Grammar, spelling, punctuation, composition, penmanship.

(*b*) Statement of shop and engineering experiences and sea service.

(*c*) Elementary mathematics, including arithmetic, algebra, geometry, trigonometry, and use of logarithms.

(*d*) Elementary mechanics and physics, including mechanical powers, friction, laws of falling bodies, force, work, etc.

(*e*) Practical problems connected with steam engineering, such as calculation of loss by blowing off, gain by use of heaters, amount of condensing water required, safety valve problems, etc.

(*f*) Incrustation and corrosion in marine boilers, and problems connected with combustion.

(*g*) Marine boilers, description of various types, with their advantages and disadvantages, repairs to same, practical management of boilers, and discussion of accidents and difficulties, such as foaming, back draft, etc.

(*h*) Heat, steam, theory of expansion, use of steam.

(*i*) The steam-engine indicator, interpretation of diagrams therefrom, calculation of horse power, and evaporation from diagrams.

(*j*) Marine engines, description of the various types, including those used with paddle wheels, with advantages and disadvantages, special attention being given to multiple-expansion engines, practical questions relative to care and manipulation of engines, overhauling and repairs, alignments, etc,

(*k*) Valves and valve gears as applied to marine engines, including those used on side-wheel steamers, but with special attention to modern types used with propeller engines.

(*l*) Condenser, pumps, steam gauges.

(*m*) Strength of materials, including simple problems in proportions of marine engines and boilers. Inspection of materials.

(*n*) Screw propellers. Description of common types. Definitions and simple problems connected therewith.

7. The professional examination will be competitive, and all candidates who pass the minimum standard will be placed upon an eligible list in the order of proficiency exhibited by them, respectively, in the examination. From this list selections will be made in regular order, as vacancies occur, until another examination is held.

8. The standard of proficiency has been fixed at 75 per cent and candidates failing to obtain that average will be rejected. They may, however, if otherwise qualified, take another examination when the next board shall be convened. Failing in the second examination will result in the final rejection of the candidate.

9. No person shall be originally appointed to a higher grade than that of Second Assistant Engineer.

10. Any person producing a false certificate of age, time of service, character, or making a false statement to the board of examiners, shall be disqualified for appointment.

11. Any person who, subsequent to his examination, may become disqualified from moral considerations, will not be recommended for appointment.

12. All correspondence with reference to the provisions of this order should be addressed to the Secretary of the Treasury, Washington, D. C.

W. B. HOWELL, Assistant Secretary.

ON USE OF WATER-TUBE BOILERS IN THE MERCANTILE MARINE.*—II.

BY A. E. SEATON, M.C.I.N.A.

The shipping of the mercantile marine may be roughly divided into (1) passenger steamers pure and simple; (2) cargo steamers carrying passengers; and (3) cargo steamers pure and simple. The passenger steamer must necessarily be a fast one, and is usually of 14 to 22 knots speed. Its speed is dependent on its form and the power its machinery can develop. Without the fine form the largest power is unavailing for speed, and without the necessary power the fine form is useless. Fineness of form means minimum of displacement, and consequent minimum weight of hull and machinery. Great power means great weight, therefore in this class of ship everything is resolved into a question of weight. The hull of the vessel has to be designed and constructed in accordance with the rules and regulations of registries and the British Board of Trade, which circumscribe the designer. The engineer in designing the machinery is similarly fettered; but he can, by causing a small engine to work at a large number of revolutions, and by skilful design, considerably reduce the weight per indicated horse power. The great item of weight, however, is the boiler and the water contained in it. Consequently, by changing from the heavy Scotch boiler, with its mass of water, to the lighter water-tube boiler, with its small quantity of water, much more horse power can be developed in the ship, or her lines may be fined, or there may be modifications in both directions with perhaps the best results. Large numbers of passenger steamers are on short service, making daily and nightly runs of a few hours at a time, steam being raised on each occasion, and lowered when done with. The water-tube boiler accommodates itself admirably to this; and not only so, but seeing that steam can be raised in half an hour the boiler room staff of such a boat can have ample rest between the runs, besides requiring only a small consumption of fuel to raise steam, so that even if the boiler when running is not so economical as the Scotch boiler, the total result of a run of a few hours' duration is a consumption of no more coal. It is also necessary in passenger steamers that the running should be uniform. The water-tube boiler, with its very high pressure and reducing valve, permits of this, as the variation of pressure in the engine room is exceedingly slight.

With the second class of steamers, namely, the cargo and passenger boat combined, speed is desirable, but it must not be on extravagant conditions; it is usually from 12 to 15 knots; therefore any saving in weight by the adoption of a water-tube boiler would not be taken advantage of to increase the speed very largely by increasing the power, but it might, and probably would,

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* Read before Institution of Civil Engineers, London, May, 1897.

lead to an increase in speed by the fining of the ends of the ship without loss of cargo-carrying power. If, however, the owners were quite content with the speed they could effect a very considerable gain in the increased cargo-carrying capacity obtained by the saving in weight of machinery; in some trades and in some ships the difference would often mean a useful margin of profit instead of a loss. In certain vessels of this class a saving in weight of boiler would permit of the carrying of a larger quantity of fuel, which might be bought at a cheap port and enable the ship to return to a cheap port instead of being obliged to purchase it at a dear one, as is often the case now; and this without disturbing the question of cargo-carrying, so frequently a nice point with ships of this class. In the cargo and passenger steamer in short trades, the same advantages in the raising and lowering of steam would be appreciated as in the passenger ship.

In the cargo boat pure and simple, the water-tube boiler does not make such a good bid for acceptance as in the other two classes; but it still has something to offer, especially to those of moderate and small size, namely, the advantages stated above for the cargo-passenger steamer.

There are not lacking signs that the final adoption of the water-tube boiler in the mercantile marine will be preceded by the use of a mongrel form or combination of a water-tube and a tank boiler, and in some respects such a boiler is more tempting to the mercantile engineer than the pure article. Such boilers would, of necessity, contain more water than the water-tube boiler pure and simple, and consequently would not evaporate dry in so quick a time in case of the feed falling temporarily—a fear often expressed by practical sea-going men. The tank portion of the boiler with the internal tubes is also supposed to be a cure for flaming at the funnels, as well as for economizing fuel; but, when it comes, the boiler of the future will be found not to require such an appendage for either purpose. The water tube is also likely to be tried tentatively in the immediate future by fitting certain mercantile ships with an installation of half-tank boilers and half water-tube boilers, in order that the advantages of both systems may be enjoyed, viz., the rapid getting up of steam to leave port, with the bringing into action of the tank boilers later on, and the saving of a portion of the weight that is possible. Unfortunately, such an arrangement also possesses the disadvantage of both systems.

Judging by the animosity of certain inventors, one would suppose that the water-tube system was incapable of enjoying the benefits of their inventions; but this is not so; in fact, it was not certain that the definite supply of heated air is not of greater advantage to the water-tube boiler than to the cylindrical or Scotch type of boiler.

It may be asked, "Is there any reason for discarding the present form of boiler, which has done good service so long in the mercantile marine?" The same reasons which have brought about the change in warships apply equally well to a large number of merchant ships. The desire for higher pressure of steam is expressed unmistakably by every class of shipowner, as much from him who directs the great lines of ocean express steamers as from him who owns the humble trawler; and the steam-tramp managers vie with one another who shall have highest-pressed boiler. Speeds which a few years ago were deemed impossible with the largest ships are now required with comparatively small ones, and are obtained by raising the working pressure and decreasing the boiler and adopting forced draught.

A pressure of 200 lb. per square inch is not enough to satisfy the demands, and even now 250 lb. is spoken of as desirable. A Scotch boiler for this pressure, even of moderate size—say 14 ft. diameter, and having three furnaces 40 in. in diameter—will require shell plating 1 25-32 in. thick, furnaces 3-4 in. thick, and 1 1-2 in. diameter screwed stays, 7 1-4 in. pitch, with combustion chamber plates 5-8 in. thick. The shell must have treble-riveted seams throughout and double-butt straps at the longitudinal joints; the rivets will be 1 7-8 in. diameter and only hydraulic machinery of massive type can close them. The furnaces may at any time collapse should a little grease by accident get into the boiler. The combustion chamber is liable to serious bulging from the same cause; and the stays fracture if careless firemen get steam too rapidly a few times. The life of the ordinary Scotch boiler, with a working pressure not exceeding 100 lb. per square inch,

TABLE I.

	s. s. Dido. No. 403.	s. s. Otello. No. 408.	s. s. Zero. No. 407.	s.s. Cameo. No. 457.	s. s. Hero. No 394.
I. H. P.	2,200	2,200	1,433	1,201	1,465
Number of boilers	3 single-ended.	3 single-ended.	2 single-ended.	2 Babcock & Wilcox.	2 Babcock & Wilcox.
Size	11 ft. 6 in. by 11 ft. 4 in.	14 ft. 3 in. by 11 ft. 6 in.	13 ft. by 11 ft.	....	....
Working pressure	200	200	200	200	200
Total heating surface	3,971 sq. ft.	6,414 sq. ft.	3,814 sq. ft.	4,400 sq. ft.	4,400 sq. ft.
Grate area	120 sq. ft.	181½ sq. ft.	108 sq. ft.	88 sq. ft.	88 sq. ft.
Weight of boilers, uptake and lagging to funnel base	100 tons.	137 tons.	76¾ tons.	....	....
Weight of hot water	40½ tons	63 "	33½ "	10½ tons.	10¼ tons.
Weight of fire mountings and bricks	9¼ "	10 "	5½ "	9¼ "	9¼ "
Weight of boiler mountings	4½ "	5 "	3½ "	....	....
Weight of fans, heater tubes, &c.	14¼ "	....	....	....	....
Weight of seatings	7 "	4 "	2¼ "	4 "	3 "
Total weight of above	176¾ tons.	219 tons.	119 tons.	66 tons.	67 tons.
I. H. P. per ton	12.48	10.04	12.01	18.19	21.85

and of which every care has been taken, is from ten to twenty years, depending on the service; that of similar boilers for 200 lb. to 250 lb. pressure is not likely to be nearly so long. That such a boiler is liable to the accidents abovenamed is amply proved by present every-day experience. Most of the water-tube boilers as now made, and those likely to be made in the future, will have no part exposed to heat thicker than 1-4 in., and although from the same causes accidents may ensue, they will be of a comparatively trivial nature, easily remedied, and not likely to cause serious damage to the surroundings or to life and limb.

There appear, therefore, good prima facie reasons for expecting the adoption of the water-tube boiler in the mercantile marine in the immediate future, and that satisfactory results will be obtained by its use; but caution is necessary both in the choice of design of boiler and in the arrangement of the same, and care should be exercised in seeing that such boilers are properly constructed and fitted in the ship, as well as properly looked after when there, especially as the economic working of these boilers depends so much on care and attention to details.

APPENDIX.

Table I, of the appendix, prepared by a member of the author's staff, A. H. Tyacke, shows at a glance the fullest particulars of the different kinds of boilers, as determined by their makers or advocates, for engines of 10,000 indicated horse power.

Table II, a statement of the weights, etc., of some water-tube boilers fitted by Earle's Shipbuilding and Engineering Co. into ships during the past two years, and those of Scotch boilers fitted in similar ships during that time.

TABLE II.—WEIGHTS, &C., OF BOILER INSTALLATIONS FOR PASSENGER STEAMER 10,000 I. H. P[1].

	Closed Stokehold.	Martin.	Ellis and Eaves.	Howden.	Belleville.		Babcock and Wilcox.		Seaton.	Thorneycroft.
		Induced.	Induced.	Forced.	Forced.	Natural.	Forced.	Natural.		
Number and description of boilers	4 double-ended cylindrical.	4 double-ended cylindrical.	4 double-ended cylindrical.	4 double-ended cylindrical.	12 11-element.	18 11-element	10	12	8 double-ended.	8 single-ended.
Size of boilers	15 ft. 2 in. by 19 ft. 6 in.	15 ft. 2 in. by 19 ft. 6 in.	14 ft. 9 in. by 20 ft.	13 ft. 9 in. by 19 ft. 6 in.	4 in. element tubes 2¾ in. economiz'r.	4 in. element tubes 2¼ in. economizer.	....	....	....	....
Working pressure, boilers	200	200	200	200	200	260	200	200	250	210
Working pressure, engines	200	200	200	200	200	200	200	200	200	200
Total heat surface, sq. ft.	20,000	20,000	....	15,400	21,000	31,500	27,000	32,410	26,000	28,000
Total grate area, sq. ft.	536	536	....	436	633	950	615	738	536	480
Air pressure	1—1½ in.	....	....	1—1½ in.	¾ in.	....	1—1½ in.	....	1½—2 in.	1—1¾ in.
Weight of boilers, uptakes lagging to funnel base	355 tons.	359 tons. (fan castings included).	410 tons.	267 tons.	150 tons.	206¾ tons.	200 tons.	246 tons.	155 tons	105 tons
Weight of hot water in boilers	159 tons.	159 tons.	140 tons.	132 tons.	22 tons.	32 tons.	66 tons.	79 tons.	60¾ tons.	16¾ tons
Weight of fire mountings and bricks	30 tons.	30 tons.	35 tons.	31 tons.	75 tons.	112 tons.	70 tons.	85 tons.	32½ tons.	25¼ tons
Weight of steam and water mountings	5 tons.	5 tons.	5 tons.	5 tons.	6 tons.	8 tons.	6 tons.	7 tons.	6 tons.	6 tons.
Weight of fans, air blowers and heater tubes	9 tons.	9 tons castings not included.	45 tons.	7¼ tons.	23½ tons.	43¾ tons.	9 tons.	4 tons.	9 tons.	4 tons.
Weight of air-tight flats, locks, and seatings	12¼ tons.	7 tons.	7 tons.	13¾ tons.	13½ tons.	20¼ tons.	20¼ tons.	18 tons.	12 tons.	11¾ tons
Total weight of above	570¼ tons.	569 tons.	642 tons.	455¾ tons.	290½ tons.	422¼ tons.	371¼ tons.	439 tons.	274¼ tons.	168 tons.
I. H. P. per ton	17.54	17.57	15.57	21.94	31.4	23.69	26.94	22.82	36.0	59.5
Weight of funnels	18 tons.	17 tons.	16 tons.	20 tons.	17 tons.	25½ tons.	20 tons.	21 tons.	18 tons.	15¾ tons.
Weight of stokehold floor	7½ tons.	7½ tons.	7½ tons.	7½ tons.	7½ tons.	11½ tons.	6¼ tons.	5½ tons.	6½ tons.	5¾ tons.
Weight of feed pumps	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons
Weight of copper pipes	6½ tons.	6½ tons.	6½ tons.	6½ tons.	9 tons.	10 tons.	6½ tons.	6½ tons.	6½ tons.	6½ tons.
Weight of spare-gear	5 tons.	5 tons.	5 tons.	5 tons.	10 tons.	15 tons.	5 tons.	5 tons.	5 tons.	5 tons.
Weight of separators and reducing valves	....	....	....	....	7 tons.	10 tons.	....	....	1¾ tons.	1¾ tons
Weight of ash hoisting-gear engine	1 ton.	1 ton.	1 ton.	1 ton.	1 ton.	1½ tons.	1 ton.	1 ton.	1 ton.	1 ton
Weight of coal carried for 64 hours × 25 per cent.	700 tons.	700 tons.	600 tons.	475 tons.	625 tons.	750 tons.	720 tons.	720 tons.	700 tons.	725 tons.
Total weight of installation	1,313¼ tons.	1,311 tons.	1,283 tons.	955¾ tons.	982 tons.	1,259¾ tons.	1,135 tons.	1,200 tons.	1,018½ tons.	934½ tons.
I. H. P. per ton	7.61	7.62	7.8	10.24	10.18	7.99	8.81	8.31	9.82	10.73
I. H. P. per sq. ft. of grate	18.65	18.65	18.13	22.91	15.8	10.52	16.26	13.5	18.65	20.62
Total heating surface per I. H. P.	2	2	1	1.54	2.1	3.15	2.7	3.24	2.6	2.8
Lbs. of coal per I. H. P. per hour	1.96	1.96	1.61	1.33[2]	2.1	1.75	2.01	2.61	1.96	2.06
Length of boiler space over bunkers	124 ft.	124 ft.	112 ft.	97 ft.	121 ft. 9 in.	145 ft.	99 ft. 3 in.	105 ft.	112 ft.	104 ft.

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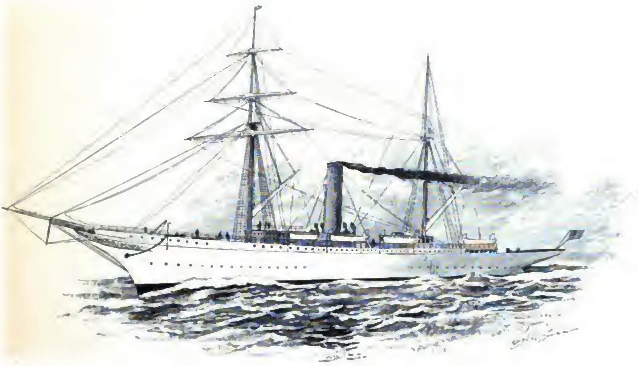
[1] The above weights, &c., are based on the assumption that Welsh coal is used, and that the consumption of steam for all purposes throughout the voyage will be equivalent to 16 lb. per indicated horse power per hour.

[2] This estimate of the coal consumption per indicated horse power has been supplied by Messrs. James Howden and Company. I am not prepared to say that it is verified by personal observation made from sea-going practice. The coal consumption given, viz., 1.33 lb. per indicated horse power per hour, when taken in conjunction with the water consumption per indicated horse power per hour, would mean that the evaporation of water per 1 lb. of coal would be 12.03 lb. from and at 212 deg.

BRITISH BUILT YACHT MAYFLOWER FOR OGDEN GOELET OF NEW YORK.

Another British yacht for an American millionaire has been sent to sea recently. This is the Mayflower, designed by G. L. Watson for Ogden Goelet, of New York, and built at the yard of the Clydebank Engineering and Shipbuilding Co., Ltd. She is an expensively built vessel of 1,780 tons gross and 1,009 tons net measurement. Her length is 275 ft. on the water line, 320 ft. over all, beam 36 ft. 6 in., and depth 30 ft. to the bridge deck. The hull is divided into nine water tight compartments, so arranged that it would float though two compartments were full of water. The arrangement of decks is somewhat peculiar. There is a short forecastle, separated from a long bridge amidships by a well, but the side plating is carried in an uninterrupted line aft nearly to the end of the bridge. Here it is lowered 4 ft. on a line with the main deck bulwarks, and is carried at this level to the overhang. The interior finishings and furnishings are unusually magnificent. The reception room is on the main deck and is reached through the main gangway on the starboard side. This room is finished in oak. The engine trunk is fitted with plate glass windows, permitting a view of the propelling machinery. On this deck there are also the drawing room, 21 ft. long and extending the width of the vessel, fitted in Louis XIV style, and the library containing 2,000 volumes. Besides there are such conveniences as cloak room and bicycle store. The dining room is situated on this deck between the engine and boiler casings fitted in the style of Louis XIV. The table has a space for 24 persons, and there is a big fireplace to give a comfortable look to the room, in cold weather. Below there are six staterooms of unusually large dimensions. The woodwork is solid mahogany covered with white paint rubbed to a luster surface. Each room is fitted with running hot and cold water, water and electric heaters and electric fans, and a pipe system of ventilation. There are also placed conveniently doctor's room, maid's room, and bath rooms for guests.



NEW STEAM YACHT MAYFLOWER AT SEA.

Kitchen arrangements are elaborate. There is a refrigerating chamber 18 ft. by 12 ft., fitted for all kinds of provisions and kept cool by an ammonia plant installed by the Kilbourn Co., which is here used also for making ice. The pantry is laid with white tiles, and contains a hot press for heating china and keeping food warm; also a decanting table and a cold box for butter, wines, etc. There is the usual outfit of table utensils. A filter is also fitted, and an earthenware sink with hot and cold flowing water. There is also a bakery for breadstuffs. The saloon galley is fitted with a large French range, nickel plated grill and coal box, dresser and garbage dump. Special attention was given to the ventilation of the galley by natural draft and fans, and excellent results have been secured. Near the galley is the laundry, fitted with earthenware washtubs, and machinery for finishing clothes.

In the rooms set apart for the owner and his family the decorator and upholsterer have been especially lavish. Mr. Goelet has a large state room and bath room, and Mrs. Goelet a large state room, a boudoir and bath room, on the main deck. Miss Goelet has also a suite of rooms, of which the boudoir is fitted on the weather deck. In these staterooms all modern conveniences are used. Electric and steam heaters and open fires, ventilators and fans and tilting windows form contrasts for extremes of climate. There is voice pipe connection between the owner's room and the chart room, and navigating bridge. Bath rooms are supplied with apparatus for every style of spray and plunge bath. The floors and lower parts of the walls are tile laid.

A splendid promenade is provided on the bridge deck 190 ft. long and 10 ft. wide on each side of the yacht. Between the space is occupied by the machinery casings, finished in teak. The sanitary water supply tanks are also carried here. From the forward end of the promenade a staircase leads to the top of the forward deck house, which is supplied with chairs as an observation stand. Forward of this is the navigating bridge fitted with modern apparatus. The yacht's officers are housed forward below the break deck. A mess room 20 ft. by 10 ft. occupies the center of the vessel, and on either side the sleeping rooms are fitted up. There is accommodation for thirteen men. The rooms are well heated and ventilated and fitted with wash basins. Forward of this there are rooms for six under stewards and six petty officers. Below there are storerooms, ammunition room and fresh water tanks for 45 tons and a passageway leading through the coal bunkers to the fire room, so that the firemen can go forward for meals. The living room for the firemen is fitted on the lower deck between the boilers and engines. In the forecastle there is accommodation for a crew of 22 seamen.

There are two sets of propelling engines, of the triple-expansion, four-cylinder, four-crank type. The motion and cranks are so arranged as to give a minimum of vibration. The cylinders are 22 1-2 in., 38 in., and two 40 in. with 27 in. stroke. Piston valves are used on the H. P. and I. P. cylinders and Thom's patent slide valves are fitted to the L. P. cylinders. All are balanced. The valve gear is of the Stephenson link pattern controlled by a Brown's combined steam and hydraulic engine. The frames are open front with steel stanchions, the back frames carrying the condensers. Very complete auxiliary apparatus is fitted, including evaporators, feed water filters, auxiliary condenser, feed, bilge, sanitary and fresh water pumps. The electrical installation is in duplicate and gives current to about 700 lamps. Steam is generated at 160 pounds pressure in two large single-ended boilers, each fitted with four furnaces. On her trial trip the Mayflower developed 4,600 horse power and obtained a maximum speed of 16.75 knots. Her coal capacity is 530 tons, with which she can steam 2,000 knots at full speed, and 6,000 knots at 12 knots speed.

PRACTICAL APPLICATION OF MODEL EXPERIMENTS TO MERCHANT SHIP DESIGN.

To shipbuilders throughout the world, the Leven shipbuilding experimental tank used by the William Denny & Brothers is, perhaps, the most interesting apparatus possessed by any private concern. By its use the Dumbarton, (Scotland) yard has been able at times to secure results which were believed impossible. It has also been enabled, as a matter of course, to know more exactly the future behavior of any vessel whose model was made in this yard, than could be forecast by any other builder. Consequently the paper read by Archibald Denny at the engineering conference of the Institution of Civil Engineers, in London, on the tank work is of unusual interest.

The Leven tank is 300 ft. long, and for a distance of 250 ft. is 22 ft. wide and 10 ft. deep. The remaining 50 ft. is occupied by two shallow docks for adjusting the models. The tank contains 1,500 tons of fresh water, and over the water a double line of rails 3 ft. 4 in. gauge is stretched, and on this runs a dynamometer truck, and screw truck drawn by an endless wire rope. This is driven by a two-cylinder engine, with especially sensitive governor, designed by R. E. Froude, so that a practically uniform speed is secured. The tank was built in 1882, and the first experiment was made in February, 1883. The construction of the tank did not produce immediate results of a profitable kind. For four years, indeed, the work was purely experimental, no practical results being obtained. This was caused by the impossibility of correctly applying the results obtained in the tank. The relation between the resistance of the ship, or E. H. P. as shown by the model in water and the actual power of the ship on trial, was not understood. Without having a large amount of these data it was impossible to predict the efficiency or relation between the I. H. P. and E. H. P., even though it was possible to obtain the form of least resistance for any given set of conditions. When the tank was completed, however, the concern had available a large collection of data concerning actual measured mile trials, and so was able to proceed at once with investigations of the models of these vessels.

The first important result of the tank was secured in 1887, when the Belgian Government was in the market for fast sidewheel steamers for the Ostend-Dover route. The concern went vigorously to work on models for the proposed ships, the first of which represented a vessel 300 ft. long, 35 ft. wide, and about 8 ft. 6 in. draught. Results of much experimentation showed that a maximum speed of 19.5 knots could be had. Other builders had secured such a speed, however, and so the Dennys continued the experiments, and produced a model which enabled them to guarantee a speed of 20.5 knots. They secured the order for the ships, the Princesse Henriette and the Josephine, both of which maintained a sea speed in excess of 21 knots, when built. The result was extraordinary when it is remembered that the fastest boat of the type previously built at this yard made only 15 knots. During the experiments, model paddles driven by an electric motor were tested with the hull model.

In paddle vessels the dip of the wheel had been found to be a very important consideration. Longitudinal waves, if not properly allowed for, might entirely upset all calculations, with the result of too much or too little immersion of the wheels, when at speed. With the aid of the tank it was possible to locate the exact position, depth or height, and form of wave at the wheels in the completed vessel. In the case of the Belgian vessels the depression of the wheels was about 10 in. at 20.5 knots. In the case of screw vessels also the tank was peculiarly useful in determining the form of screw best adapted to any vessel. The problem had been found to be very complex, and there seemed little possibility of being able to formulate any general rules for guidance. It had been found, however, that there is no one perfect form of ship, but that on the contrary, the form must vary with every varying condition of length, draught, displacement, and speed. The same applies to the screw also, and the screw of one vessel which had produced extraordinarily good results, would probably give as positively bad results on another form of vessel.

To further illustrate what could be accomplished with a tank, Mr. Denny related a case in which a twin screw vessel 270 ft. long was to be built with a trial speed of 17.5 knots. Circumstances made it necessary that the contract should be exceeded, if possible, so power for about 18 knots was figured on. Trial data for a very similar, though slightly larger, vessel was also available, but the new ship when tried astonished every one by giving only 17 knots, with an expenditure of power quite out of proportion to the speed. Further trials were carried out, and it was found that by trimming the vessel nearly level, instead of 18 in. by the stern, an additional 1-3 knot could be secured. This demonstrated that the stream lines aft were abnormal, and consequently tank trials were made with various types of propeller. A conclusion was reached that with a propeller of the same diameter and pitch and about 20 per cent more surface the speed, at normal draught and trim, would be increased half a knot. The change was made and the predictions verified. Another case was cited where models for sister ships were tried, resulting in the prediction of a speed of 0.3 for one vessel over the other, which subsequently was fulfilled in practice. Mr. Denny made the statement that, "No amount of investigation will even allow the laying down of general laws for producing the best form of hull and propeller without model experiments; the same routine must be gone through in each case, and before the tank can be profitably used, a store of data must be accumulated and years spent in investigation."

In the discussion which followed R. E. Froude learned that the length of the Denny models was 12 ft. At Haslar, where the British Government tank is in use, the models were 14 ft. long, sometimes approaching a ton in displacement. Paraffine wax was used for model making, which, though often costing $100 for one model, was not expensive, as one model could be melted down to make another. Paraffine wax would not swell in water, could be easily shaped, having no grain, and could be melted at a low temperature, besides being good casting material. In using the tank the same wave profile would be shown on the model corresponding to the actual ship, or, in other words, the actual effects obtained by a ship were reproduced in miniature. The disparity in size between the model and the ship necessitated the use of large multipliers, however, with a possibility of large errors. It was thus necessary to correct the deductions drawn or to confirm them by practical experience. Some shipbuilders believed they got along very well without a tank. This was so, the speaker said, for vessels could be designed on empirical data so long as builders kept to established lines. Should a radical change take place, however, the tank would be a necessity were assured results sought. The tank was also needful if a designer sought to ascertain what particular element in the design produced an improvement in trial results. It would be necessary to conduct so many experiments that only model experiments were possible if the cost was to be kept within prohibitive limits.

Prof. Biles told of a case in which the commercial value of a tank was demonstrated. A vessel of unusual dimensions and speed was desired, and its construction offered to several firms, but only one of these would accept the conditions, the Messrs. Denny. They succeeded in meeting these and were paid the highest price asked. He referred to the need of information on surface friction, and said that additional experiments were required, but on a full sized scale, using planes hundreds of feet long. He referred to the tank planned for the United States Government, which is to be larger than any in existence, so that larger models can be used. He referred also to the proposal to build a tank on the Clyde to be used in common by Scotch builders. There had been difficulty, however, in securing the co-operation of rival builders.

Sir W. H. White, chief constructor of the British Navy, believed the United States Government was right in building a tank larger than those in use. The initial expenditure of such a tank was nothing to the risk sometimes taken by shipbuilders in overstepping the bounds of experience. Referring to war ship designs he said the question of resistance was often forced aside by the important consideration of stability.

Mr. Denny, in replying, said his firm had tried models of various sizes from 6 ft. to 20 ft. long, and had found 12 ft. the most convenient. He agreed with the statement that the tank killed imagination, for he had early found out that what appeared to be a beautiful model, often was proven no good by the tank, and on the contrary, what looked like a wretched model, with thick middle and no ends, gave first-class results. At the Leven tank, he said, a staff of 15 persons was employed, the yearly expenses exceeding $10,000.

Traffic in "Soo" and Suez Canals.

In a paper recently read before the Civil Engineers' Club of Cleveland, Joseph R. Oldham, N. A., made an interesting comparison between the traffic in the "Soo" and Suez Canals, with regard to the tonnage of shipping engaged in these trades.

To more readily draw a comparison between these trades, he said, I have drawn curves to a common scale illustrative of the tonnage passing the two great waterways. I also show in somber lines the still declining condition of our tonnage engaged in the foreign trade. Now it is a melancholy fact that we have not one single steamer engaged in the Suez Canal trade, therefore this comparison resolves itself, into one between the American ship tonnage passing the Sault Ste. Marie and the tonnage of other nations passing Suez. The time required for making the average voyage through the Suez canal is about twelve times as much as the time occupied in an average voyage through the St. Mary's Falls Canal. Therefore, in estimating the tonnage engaged in these trades time should be taken into account. The distance from Alexandria to Aden will be about the same as from Buffalo to Duluth. The ordinary Suez Canal trader could make ten trips from Alexandria to Aden in about the same time as it takes her to steam from London to Hong Kong; but the time required for loading and unloading is much greater in the foreign trade. If the detention in port were the same as on these waters the Suez Canal traders could make twelve trips between Aden and Alexandria in the same time as they now require to make an actual average voyage. So that their tonnage passing that point would then be twelve fold of what it now is, and if last year's clearances through the Asiatic waterway be multiplied by twelve, it represents a Suez Canal trade of over 100,000,000 tons per annum, or say 67,000,000 tons for two-thirds of a year.

There are about 2,500,000 tons of shipping regularly engaged in the Suez Canal trade. We have not quite 400,000 tons in the "Soo" trade. The average tonnage of a Suez Canal steamer is 2,460 tons, that of a St. Mary's Falls steamer 927 tons.

This is not intended to detract in the slightest degree from the fact that over 16,000,000 tons of cargo were handled and transported through St. Mary's River and Canal locks in 232 working days. The feat is phenomenal and has never before been equaled in the world's history.

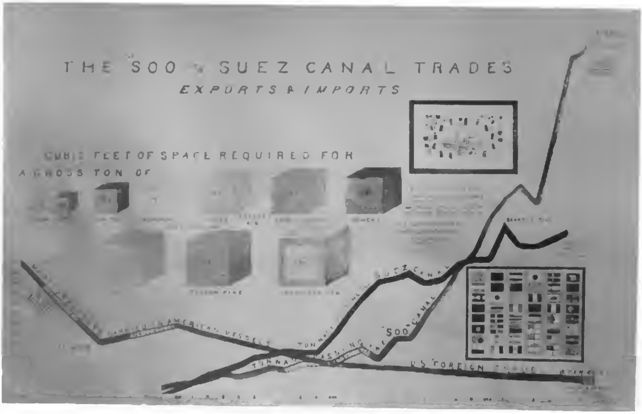


DIAGRAM SHOWING, COMPARATIVELY, TRAFFIC IN "SOO" AND SUEZ CANALS.

IMPROVED APPARATUS.

Wing Marine Gas Engine.

An interesting installation of auxiliary power has been made by F. L. Sheppard on a 35 ft. cat boat, which is here illustrated. Immediately under the deck in the cockpit is installed a six horse power Wing marine gas engine. No valuable space is occupied, and yet the engine is easily reached. The screw is of the feathering type, 22 in. dia., and makes 350 revolutions a minute. Wing reversing gear is used and the thrust is a ball bearing one. The oil tank is located in the bow and has a capacity of a barrel. The hull is of the usual cat boat type, but the rig is somewhat unusual, in that a jib sail is used.

GAS ENGINE FITTED IN SAIL BOAT.

Dock Wheelbarrow for Coaling.

In order to meet the requirements of a good all-round dock barrow, the Lansing Wheelbarrow Company, Lansing, Mich., has just put upon the market the barrow illustrated herewith. Its strength and stability are self-evident. The tray is made large for wheeling coal, and the weights are so arranged that a larger part of the burden shall be directly over the wheel. The tray is placed on a board bottom and is well reinforced at the top and in front. It is made of No. 14 steel, is 18 by 24 in. at the bottom, 18 in. at the front, 8 3-4 in. at the back, length at the top 3 ft. 7 in., width at the wheel end 2 ft. 11 in., width at the handle end 2 ft. 6 in., width over all 3 ft. The capacity of this barrow is about 500 pounds of coal.

STEEL DOCK BARROW.

Four-Cylinder Four-Crank Paine Engines.

The engines here illustrated were designed and built for the new steel passenger steamer for the Woodsum Steamboat Company on Sunapee Lake, New Hampshire, by James H. Paine & Son, of Boston. There are two engines, right and left hand, the boat having twin screws; each engine having two H. P. and two L. P. cylinders. This arrangement of cylinders was adopted for the reason that the engines are handled entirely from the pilot house, levers for operating the throttle valves, and for reversing the engines, being located there. To obviate the difficulty of stopping on "centers" two H. P. cylinders were necessary unless a passover valve was also placed in the pilot house, which latter arrangement seemed undesirable. In order to keep the weights as low down as possible, the forked connecting rod which is usually used in back-acting engines was not used; but the frames were made only high enough to allow the cranks to swing clear, and each pair of cylinders was fitted with two cranks and two connecting rods. In order to occupy as little space as possible fore and aft, the L. P. cylinders were placed above the H. P. cylinders. The framing which connects the H. P. and L. P. cylinders also forms the guides for the crossheads, and the top and bottom ends of these frames serve as the L. P. and H. P. cylinder heads. Piston valves are used on all the cylinders, the valve chests being steam jacketed to ensure equal expansion of valves and chests. The valves are driven by Stephenson links, by means of rockshafts, the valve chests being placed on the side. Each link operates two valves, one H. P. and one L. P. The crankshafts are of forged mild steel, finishing 3 1-4 in. dia. Each crankshaft has five main bearings and four crank pins. The crank pins are 3 1-4 in. dia. and 3 in. long. The cranks are fitted with counterbalance weights, and during the steam test the engines, placed on the shop floor, were run at 210 turns per minute without shake or vibration. The H. P. cylinders are 6 in. dia., L. P. cylinders 12 in. dia., and the stroke is 9 in. These engines will turn a pair of "Paine" speed wheels, R. and L., 52 in. dia. and 6 1-2 ft. pitch.

Electric Cargo Cranes, S.S. Bremen.

The steamship Bremen of the North German Lloyd line, which recently made her first transatlantic trip, is, perhaps, more fully equipped electrically than any other vessel of the merchant marine in the world. Aside from the usual electric lighting plant, she has a very complete and most novel power plant.

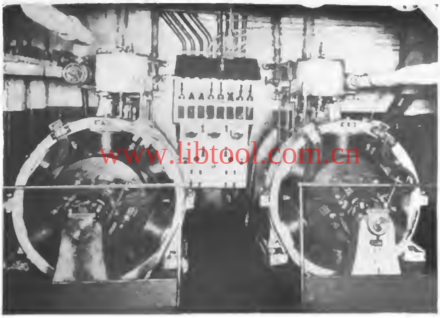
The first power installations on the steamers of the North German Lloyd were made by the Union Electricitats Gesellschaft of Berlin, the German ally of the General Electric Company of Schenectady, N. Y., on the steamships Darmstadt and Prinz Heinrich; in these two cases the familiar and noisy donkey engines were superseded by electrically operated winches, and it was the successful operation of these that determined the North German Lloyd to extend the use of electricity to the Bremen. In this case, however, in lieu of winches, a full equipment of electric cranes was installed. These cranes are sixteen in number, eight on the starboard side of the vessel and eight on the port side. Four of these have a capacity of 3,000 kilograms, or 6,614 lb., and twelve of 1,500 kilograms, or 3,307 lb., and have a total swing outboard of 20 1-2 ft.

The power generating plant is located in the after portion of the engine room and consists of four dynamos, each directly connected to its own engine. Two of these are placed on the starboard side and two on the port side. The dynamos have each a capacity of 75 kilowatts, or 100 H. P., and run at a speed of 210 revolutions, delivering current at a pressure of 105 volts. The output of two dynamos is used for the cranes; one is used for the lighting of the ship, and the fourth dynamo is held in reserve in case of accident or other emergency. The engines are of the triple expansion type and were built by Schichau, of Elbing, the port of Danzig.

The most notable feature of the electrical equipment is the cranes, the lighting installation conforming to the standard practice. In designing the cranes, the principal requirements specified and obtained were: The load should be lifted smoothly; the resistance should be so arranged that the various speeds of the motors should be obtained without too apparent and sudden change; the control of the different motions should be instantaneous and positive, these motions to be effected in the smallest possible space; the cranes to be compact and contain the smallest possible number of parts; the controlling mechanism to be of the simplest to suit the class of operators likely to handle them; and the electrical apparatus to be absolutely protected against changes of weather, inroads of dust and sea water, and to be of such a nature as to withstand rough handling. In addition, all conductors were to be carefully protected and the last consideration, but by no means the least, on a passenger carrying steamer destined

CONTROLLER WITH UNIVERSAL GEAR.

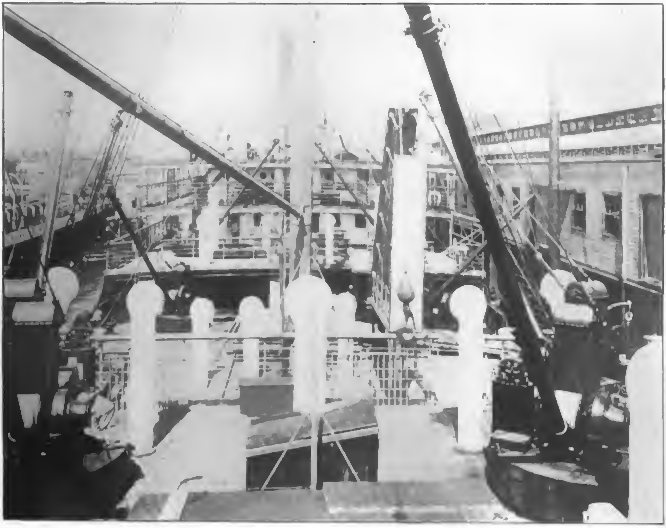
CRANES SHOWING OPERATING HANDLE.



DIRECT CONNECTED GENERATING SETS, S.S. BREMEN.

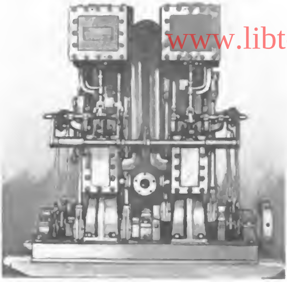
to be constantly loading and unloading, the operation of the cranes was to be noiseless. In conforming to these requirements, the Union Electricitats Gesellschaft has produced what is the latest and an innovation in a ship's equipment.

The cranes, motor, and controlling mechanism



AFT DECK, NORTH GERMAN LLOYD S.S. BREMEN, SHOWING EIGHT CRANES.

are mounted upon a circular iron platform which revolves upon a pivot. This is turned by a motor of 7 H. P. running at 700 revolutions per minute, directly coupled to a worm gear, which in turn meshes in a gearing bolted to the deck. The loads are raised by a 25 H. P. series motor, running at a speed of 900 revolutions, and driving a special worm gear meshing into the gear of the drum. On the gear end of the drum shaft is fitted a winch head. The controllers resemble a double street car controller about 2 ft. high. They are fitted with magnetic blow out, any spark being immediately extinguished in a magnetic field. The contact cylinders are operated by a special mechanism actuated by a simple handle or lever, the movements of which correspond to the movements of the load. Raising the handle raises the load, depressing the handle lowers the load, and movement of the crane to the right or left is obtained by corresponding movements at the lever. Raising and swinging movements can be effected simultaneously. The dullest stevedore can handle these cranes with ease. Motors and controllers are water tight and dust tight, but the cases of both can readily be opened when necessary. To give a more perfect control both motors are provided with band brakes operated by the foot. These brakes are attached to an extension of the motor shaft.



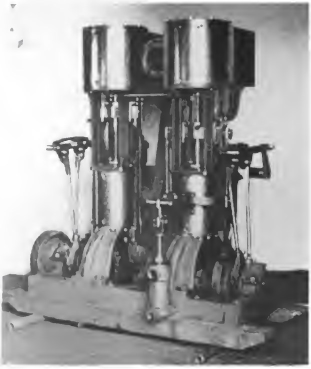
BACK VIEW, PAINE ENGINE.

The difference between the large and small cranes lies in the hoisting speed. Practically both cranes are identical in electrical equipment, but the hoisting speed of the 3,000 kilogram crane at full load—60 ft. per minute—is only half that of the 1,500 kilogram crane at full load—120 ft. per minute. The movement of the jib of the cranes is 13 ft. per second.

The most remarkable feature of the cranes, however, is the absolute noiselessness of their operation. While the whole eight starboard cranes, four on the aft and four on the forward deck, were engaged in discharging cargo during a recent test, had the operation of hoisting and lowering not been witnessed, it would have been difficult to detect the fact by the ear unaided.

Electric Marine Lantern.

The signal lamp here shown represents one of the latest style of electric marine signals. It is made by Wm. Porter's Sons, of 271 Pearl street, New York. The lamp is fitted with a cast metal cap on top so arranged as to turn or revolve and thereby admit the throwing into focus of either or both electric light bulbs with which it is provided. Stuffing boxes with rubber glands are attached to the cap to prevent moisture from entering the lamp and the electric wires lead through the stuffing box and into brass tubes which support the electric lamp sockets. By this device the lights are applicable to the system of wiring the running lights in connection with an electric indicator, or tell tale. Should one incandescent lamp go out, a corresponding signal lamp in the pilot house will be lit and a bell started, and at the same time the relief lamp set aglow in the lantern, which would remain alight until the trouble would be adjusted. The inside of these lanterns is lined with corrugated metal nickled which makes a strong reflector. When these lanterns are ordered with doors, cast door frames are used, the doors fitting snugly against rubber packing and held tight by thumb screws. Lamps of this pattern are used on the American liners, St. Louis and St. Paul, and on vessels on the Red Star line and also on the "Creole" of the Cromwell line.



FRONT VIEW, PAINE ENGINE.

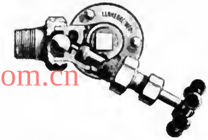
New Gas Motor for Marine Work.

One of the most recent gas or gasoline motors for use on launches and for kindred purposes, is the one illustrated herewith. It is made in several sizes from three-quarters of a horse power to two-and-a-half horse power, and is furnished complete, or in castings accompanied with working drawings enabling any expert to finish it himself. The engine is provided with a pump to circulate water in the water-jacket. These motors are built on the two-cycle compression system, with an impulse at each revolution of the crank. The charge is received through a cylinder port opened and closed by the movement of the piston, and the exhaust is effected in a like manner. A suitable valve regulates the charge received from the closed crank chamber in which the mixture is compressed by the downward stroke of the piston. Vapor and air are drawn into the crank case by the upward stroke of the piston and mixed by the motion of the crank. The one-horse power engine is seventeen inches high and weighs about 135 pounds. The compactness of the engine is self-evident. It is manufactured by the Mianus Electric Co., Mianus, Conn.

PORTER ELECTRIC LANTERN.

Lunkenheimer Water Gage.

This gage is so constructed that should the glass break the water will be shut off automatically. The illustration shows the construction and its operation will be readily understood. When the valves are full open and the gage glass is filled with water the pressure on both sides of the ball valves will be equal and they will remain off their seats, but if the glass breaks the sudden rush of water through the gages will cause the balls to close against their seats, thereby shutting off water and steam.



AUTOMATIC WATER GAGE.

The valves are placed at an offset to the body, thus placing them out of the way, which permits of renewing glasses under full steam pressure. Another feature is the method of making the gage either right or left hand, as may be desired. This is done by reversing the plugs at top and bottom of the gages, when their position can be easily changed.

While steam pressure is on, to preserve the automatic feature the valve stems of both gages should be screwed back as far as they will go, so as to allow the ball valves to act promptly when occasion requires.

MIANUS GAS AND GASOLINE ENGINE.

The Lunkenheimer Co., Cincinnati, Ohio, is the manufacturer.

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Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

Whether or not the fast transatlantic mail service between Canada and the mother country, which has lately been arranged for, will materialize seems to be an open question. It will be remembered a contract was closed on behalf of both Governments with the firm of Peterson and Tate, of Newcastle-on-Tyne, England, for the equipment of the line with steamships of not less than 10,000 tons displacement, and having an average speed of at least 500 knots in 24 hours. This, of course, is a big order for any firm to carry out, and especially for one which does not appear to have had any previous connection with the management of large fast mail boats. It is estimated that the cost of four such vessels would be between nine and ten millions of dollars. The firm is interested in a fleet of freight steamers sailing out of Newcastle-on-Tyne, built upon what is known as the "turret" system. This design is said to be that which will be adopted in the construction of the new ships. Plans for vessels 530 ft. long, 64 ft. beam and of 14,000 tons displacement are said to have been considered favorably. In these the application of the turret method of construction gives a bottle-necked cross section in which the top is about 40 ft. wide and the shoulders on each side, extending the length of the vessel, 12 ft. wide. The promenade and boat decks would probably extend beyond the width of the "turret" to the sides of the hull, which would certainly be a very flimsy arrangement for vessels built to withstand North Atlantic gales. But this is assuming that the ships will be built and put in service. Some influential English critics express a disbelief in any such outcome of the present negotiations. They produce figures to show that even with the aid of the subsidies granted by the Dominion and British Governments, amounting to about $800,000, such a line would not be profitable to the stockholders. It is possible, however, that these utterances are inspired by vested interests, for existing lines can hardly view such competition with complacency.

"We knew how it would be." This is the opening sentence in a paragraph which appeared in a recent issue of the London Engineer, stating: "It was not to be supposed that the United States press would admit that England could produce a faster vessel than America." This is the same paper, we believe, which took elaborate pains to demonstrate that American locomotives could not do what they were really doing every hour in the twenty-four. In the paragraph referred to the Engineer proceeds to quote the "St. Louis Journal," to the effect that the Mosher steam launch Ellide, tried on the Hudson recently, is "faster than any vessel afloat in the world and eclipses the speed record of the Turbinia." It is remarkable that our London contemporary did not quote what the Brattleboro Holstein-Friesian Register had to say about the comparative speeds of the boats. So far as we know, neither the designer of the Ellide nor a single authoritative paper in this country made any such assertion. On the contrary, the technical press generally and many of the daily newspapers gave full recognition to the performances of the Turbinia. We do not know what the Ellide is capable of doing for the official trial trip has not taken place, and possibly she can wash the Turbinia on a measured mile run. The profession and practice of engineering is worldwide and all the talent and skill which makes for progress is not confined to England or America, or any one other nation. In no country is this better appreciated than here, and in no country is genius, whether of home or foreign origin, accorded quicker or more proper recognition. Regarding this splenetic paragraph, we should like to be informed whether the London Engineer read the article it quotes from in the St. Louis Woman's Farm "Journal" or the "Journal" of Surgery and Gynæcology.

The Marine Journal wants to know why papers use the term "pleasure yacht" in describing what our contemporary considers is just a plain "yacht" One reason probably is that a newspaper is published for the information of its readers and not for the perpetuation of any strictly technical modes of expression. Anyhow, there are yachts and yachts. Would any person call the Defender or Valkyrie III. a "pleasure yacht"? We think not, unless one of those peculiarly constituted persons who in this age of power prefer to sail in a roundabout way to their destination rather than steam direct. There are hundreds of such vessels, large and small, in existence all over the world where yachting is understood, and they are generally known as "racing yachts." Only the very barest accommodations are fitted in them for the use of the crews. As to steam yachts there is a class of vessels abroad known as "Royal yachts." These in some notable instances are used as despatch vessels or ferryboats. In other instances they are built from designs which represent a cross between a liner and cruiser, and are intended to be used offensively in time of war. It seems to us that, everything considered, the use of the term "pleasure yacht" is quite admissable, just as proper, indeed, as saddle-horse or pack-mule.

What could the "enterprising" daily newspapers of the country have been thinking about in letting the loss of the Russian ironclad Gangout pass without extended comment. Had an American warship fouled a can-buoy, for instance, it would surely have formed the text for a library of "news" articles. The loss of one of Russia's powerful warships called for an obscure paragraph only. The Gangout was built in St. Petersburg in 1890. She displaced 6,592 metric tons and with 8,300 horse power attained a speed of 14.7 knots. She was strongly armored and powerfully armed. She was supposed to have been lost by striking on an uncharted reef in the Gulf of Finland. Later reports, however, indicate a mysterious cause of disaster, as her navigating officers are credited with saying the shock was so slight as to be almost imperceptible, and she kept afloat for several hours afterwards. She is said to have been structurally weak. The loss will be about $5,000,000, but a private company has offered to raise her. She lies in only fifteen fathoms of water. The estimate for the work is $1,500,000.

ON THE USE OF A DECIMAL SYSTEM IN ENGINEERING PRACTICE.

The substitution of a decimal system of measurement in engineering practice for the present standard measures is a subject of frequent discussion both here and in the United Kingdom. The advocates and opponents of a change usually express opinions rather than state facts. Consequently the actual experiences gained in a shop where the change has been made are of especial interest. These are embodied in a paper read by H. R. Sankey, M.I.C.E., before the recent conference at the Institution of Civil Engineers in London. The works referred to is that of Willans & Robinson, which has always been noted for exact work. Broadly speaking, says Mr. Sankey, the decimal system is used in engineering in the United Kingdom whenever calculations other than mere checking have to be made, or when very accurate dimensions have to be expressed; and in either case, in mechanical engineering, the decimals are generally those of the inch, its square or its cube. The reason of this is fairly obvious. As regards calculations, decimals are, on the whole, far simpler than vulgar fractions, and they allow of the ready use of the slide rule or tables of logarithms.

It is true that occasionally simple vulgar fractions have to be dealt with, as, for instance, 1-6 in the case of the formula for the strength of a rectangular beam. In such cases the vulgar fraction would obviously be used; to convert to decimals would correspond to using a slide rule or a book of logarithms to multiply 6 by 5, or some such simple sum.

In the case of accurate dimensions in mechanical engineering, 1-64 in. is far from being a sufficiently small dimension; hence the use of the terms bare and full; and as, for interchangeable work, such vague dimensions are very unsuitable, recourse is naturally had to the use of 1-100 in. and 1-1000 in. The writing down of accurate dimensions is also very cumbrous, even when they can be expressed by 1-64 in.

Compare, for instance, 11 in. + 15-16 + 1-32 + 1-64 in. bare with its decimal equivalent 11.98 in. No doubt the same dimension may be more briefly expressed at 11 63-64 in., but this form is not generally used in practice, and there are obvious reasons why this should be so.

It will be observed that the decimal expression has only been carried to the second place, and this is because the uncertainty in 1-64 in. "bare" is of the order of 1-100 in. If the decimal expression is extended to the third place, an order of accuracy is reached, expressed by 1-1024 in. on the binary scale, fractions which are not practically workable.

When dimensions of no special accuracy have to be stated, the natural tendency to successively divide the unit by two gains the upper hand. Notwithstanding this tendency and the prevailing custom, it can scarcely be doubted that it would be preferable to state all such dimensions in decimals of an inch.

If decimals of an inch are adopted, the system is still incomplete, owing to there being 12 in. to the foot, 3 ft. to a yard, and so on.

It is here that the metric system has a great advantage; it is a decimal system throughout. As experience in such a matter has more value than mere theory, a statement of the results of introducing the metric system of linear measurements into the works of Messrs. Willans and Robinson may be of interest.

In the first place, it is desirable to say a few words about the class of work and method of manufacture carried out at the works in question.

The Willans central-valve engine and the Niclausse water-tube boiler are manufactured each in certain definite standard sizes, and the parts required are made to gauge and template in large batches and have to conform to fixed dimensions within specified limits of accuracy, in order that strict adherence to the interchangeable system may be maintained.

In the machining and examination of the parts gauges and templates are used, as far as possible, to the exclusion of the measuring rule. Whether inches or millimeters are used is, therefore, not a matter of much importance.

At the marking-off table the measuring rule is, of course, more used, and the question of convenience in the unit of measurement, and its divisions, is of greater importance; the parts are, however, dealt with in batches, and the convenience or otherwise of the unit of measurement, and its divisions, tells once only for each dimension for the whole batch.

The circumstances that led to the adoption of metric linear measurements are not of general interest, and for reasons which need not be entered into here they were only applied to the Niclausse boiler, and to certain sizes of the engine; the earlier sizes being still made to drawings figured in feet and inches. Thus the two systems are concurrently at work in the same shop.

There would have been no advantage in re-figuring these drawings with equivalent millimeters, and to make new parts to millimeters to interchange with old parts made to inches would be impossible without going to several places of decimals. The old gauges and templates were marked with the millimeter equivalent to the third place of decimals, but this was merely to accustom the men to sizes expressed in the new system. It may be mentioned that the men were supplied with rules marked with millimeters on one side and inches on the other.

The expense involved consisted principally in providing a complete set of gauges. New templates and jigs had also to be made, but only a portion of their cost is properly chargeable to the introduction of the new unit, as the greater number of them would have been required in any case.

The only difficulty met with has been in connection with the screw threads. Hitherto, the ordinary Whitworth and gas threads have been retained, but, for reasons connected with the manufacture of the engines abroad, the body of the bolt or stud is turned larger than usual, the excess being 0.3 millimeter for 1-2 in. Whitworth, and 2 millimeters for 1 1-2 in. Whitworth. Intermediate sizes are in proportion, all being brought up to even millimeters. The bored holes are then able to take the corresponding screw cut to the standard used by the French makers of the engine, who use the thread of the Société d'Encouragement, which is slightly larger than the Whitworth, and which, it is stated, promises to become universal in France; it is now adopted by the French navy and railways.

The metric dimensions were introduced in May, 1893, and, after four years' working, the following is the result:

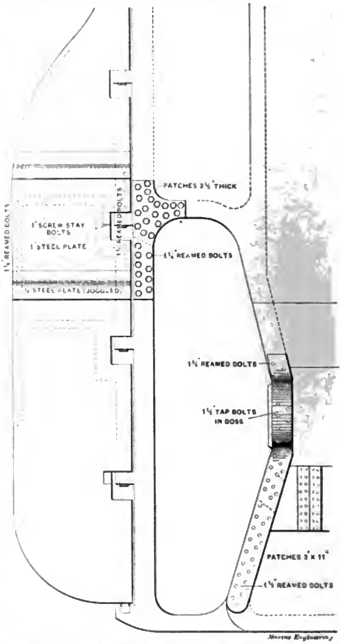
No difficulty has been experienced in getting draughtsmen to use the new measures. No serious mistakes have been traceable to the change, and very few minor ones. The draughtsmen are practically unanimous in favor of metric measures, finding it easier to design, to check, and to read millimeter drawings. Taking all fractions in account, little more than half the number of figures formerly used are now required to express a dimension. An average case would be 3 ft. 1 3-8 in., which, on a millimeter drawing, would be figured 949, and an extreme though possible case is 3 ft. 1 3-32 + 1 1-64 in. bare, which becomes 942.4.

The need to use decimals of a millimeter is very infrequent, but in the case of inches the use of fractions is, of course, the rule. A cylinder, for example, might be figured 2 ft. 6 in. on an inch drawing, and 770 on a millimeter drawing. The piston body must have a certain clearance, say 1-32 in. in one case, or 1 millimeter in the other, in which case it must be figured 2 ft. 5 15-16 in. on the inch drawing; whereas, on the millimeter drawing, the dimension becomes simply 768, and the use of fractions is wholly avoided.

The proportions between dimensions are more readily appreciated when expressed in millimeters. Thus the ratio between 27 millimeters and 49 millimeters is much more easily apprehended than between 1 1-16 in. and 1 15-16 in.

A point of some importance is that the ordinary foot and inch ticks or marks are not required, and with them disappears the possibility of having 2 in. added to each 10 in., or deducted from each foot in a dimension. A case of this kind occurred in which two 13 in. flanges intended to come together were shown on different drawings; in one of them a tick was introduced after the one, and that flange was made 1 ft. 3 in.

With millimeters a cipher might possibly be put in or omitted, but a dimension ten times too big or too small would at once be noticed as absurd.



REPAIRS TO STERN FRAME AND RUDDER, S.S BARBARA.

In the drawings, scales 1, 1-2, 1-5, 1-10, and occasionally of 1-25, 1-50, are used. It is found that this number of scales is amply sufficient.

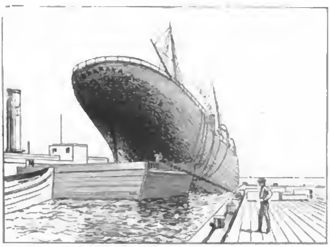
In the works manager's opinion, the metric system would prove even more advantageous in shops where measurements are taken from the rule than where gauges are used. He considers it easier to teach men the use of the rule with the metric than with English measures.

MISHAPS AND REPAIRS.

Repairs to Stern Frame and Rudder.

New Orleans marine interests are very proud of the success of a heavy repair job to the British steamship Barbara, recently executed by the Schwartz Foundry Co. The Barbara is a steel vessel of 3,740 tons gross and is 340 ft. long, 47 ft. wide, and 19 ft. deep. When leaving fully loaded she ran aground at the head of the Jetties, and her stern swinging round came into contact with a pile of rock. The stern frame, rudder, and abutting skin plates were broken and badly twisted, the rudder bent to an angle of about 30 deg. She was hauled off by tugs and towed back to New Orleans. There was a good deal of hesitation about undertaking the repairs at the port, owing to lack of a dry dock. George Brew, the Boston representative of the owners, who had been telegraphed for, decided to attempt repairs by using a floating stern dry dock which was borrowed from the Morgan line. This was too small for a vessel of the full lines of the Barbara, and consequently divers were sent down and templates made of the cross section near the stern. The ends of the floating dock were cut to suit, and when the water was pumped out, a fairly tight fit was the result. Bids for the work were called for and a contract let to the Schwartz Foundry Co. The broken frame, which weighed 17 tons, was removed and taken to the shops of the contractors, and there with the other damaged portions bent back to shape again. The breaks are shown in the accompanying drawing, together with the scheme of repair. These fractures were covered with steel plates and riveted in place. The rudder was also strengthened in a similar way, and new plates were riveted on the bottom to replace those damaged. Work was carried on night and day and it was greatly expedited by the use of electric drills, the current being taken from a neighboring trolley line. When completed the job was thoroughly satisfactory and the steamer loaded a cargo of grain for a British port. Joseph Blackett, of London, a marine surveyor, who was sent over by the owners to superintend the work, expressed his entire satisfaction, both with the quality and cost of the job, which occupied just 19 days.

DAMAGED RUDDER, S.S. BARBARA.



S.S. BARBARA IN STERN DRY DOCK.

Smash-up of Beam Engine.

An unusually bad smash up occurred recently on the lake steamer State of Ohio, the results of which are here illustrated. The vessel is 1,200 tons gross, and 225 ft. long. The engine is of the ordinary beam type with cylinder 50 in. dia. and 132 in. stroke, working at about 50 lbs. pressure and making about 27 revolutions per minute. The smash-up was caused by the breaking of the main connecting rod at a point about 5 ft. below the center. In an instant the engine was a wreck, the parts which were smashed including the beam skeleton, beam pillow blocks, front links, cylinder and heads, condenser and bed plate, piston rod, cross head and guides, air pump and hot well, and the air pump bucket and crossheads. The cranks were also started on the shafts, one wheel was shaken loose, and the crank pin sprung. Repairs in the ordinary sense could not be carried out, so the engine was practically rebuilt. The only parts used again were the shafts, wheels, and cranks, with their pillow blocks. The work was done by the Detroit Dry Dock Co., under the direction of Frank E. Kirby, and with such speed that only 29 days elapsed from the time the steamer arrived at the yard until she was again in commission. Not only were the new parts speedily made in the shops, but the time occupied in erecting the engine in the boat was only 8 days and 8 hours.

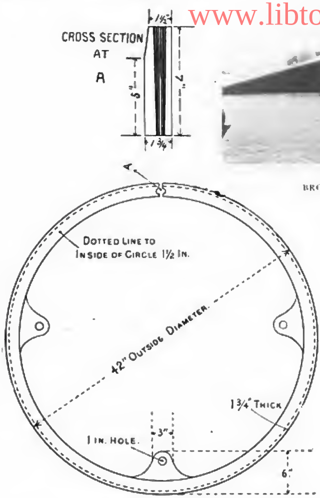
BROKEN CYLINDER, S.S. STATE OF OHIO.

CORRESPONDENCE.

[*We do not assume responsibility for the opinions expressed by correspondents.*]

Handy Tool for Marine Boiler Shops.

I saw a device recently in the boiler shop at the Brooklyn Navy Yard which struck me as a very simple and efficient addition to the shop tools. I send you a sketch of it which makes the construction clear. Rings of this sort are used to true up the furnace mouths in boiler ends and from the samples of work I saw they are very effective. After the end is flanged for the furnace mouths, it is of course badly buckled and is put in the annealing furnace so as to heat all parts evenly. These rings are slung, by the lugs cast on the bottom, over the block at the mouth of the furnace. Then the plate is hauled out and leveled with mauls. When it is squared up the rings are lowered by tackle into the flanged furnace mouths in the plate and an iron pin is driven into the hole in each cast iron ring, so that the ring fits the opening snugly. Then the boiler end is left to cool and the flanged mouths contracting around the metal rings make true circles. When cold the pins are driven out of the holes in the rings and the rings are lifted out easily. It makes a nice job and saves a lot of trouble and possible reheating. I learned that the scheme originated with the foreman of the boiler shop, John O'Rourke. The rings can be cheaply made in the foundry and have only to be turned true on the outside, and they are practically indestructible.

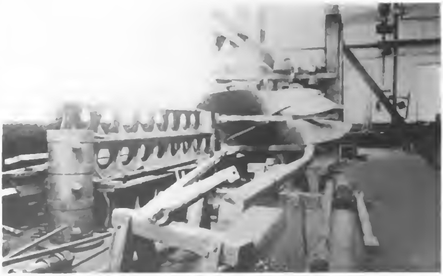


BROKEN AIR-PUMP AND FRAME, S.S. STATE OF OHIO.

Scotch Boiler.

A Question of Boiler Economy.

I have heard it stated that the water-tube boiler only requires a small consumption of fuel to raise steam, but that when running it is not so economical as the Scotch boiler. Now, what I should like to know is why a water-tube boiler is more economical than a Scotch boiler in generating steam, but less economical in maintaining it. I understand that in the former there is less water to be heated, but if this is an advantage at the beginning of a trip, why isn't it a disadvantage at the end? That is, I should think the water-tube boiler would need firing up to the last minute of service, whereas the Scotch boiler, if slow to heat, should be equally slow to cool, and it would seem could furnish steam for a long time without additional firing at the end of a run. **J. H. P.**



BROKEN CONNECTING ROD, S.S. STATE OF OHIO.

Disposal of Excess Feed-Water.

I recently came across the June number of your publication, and becoming interested, have subscribed and purchased the back numbers. In the correspondence column of the April issue I notice a communication signed "E." regarding the disposal of excess salt water which finds its way into the hot-well through leaks in the condenser tubes. Two methods of disposing of the excess are proposed: First, putting the whole quantity into the boilers and blowing off to get rid of it, and, second, allowing the excess to escape from the hot-well. In either case a certain amount of salt gets into the boilers, but it is admitted that the increased density due to this may be disregarded as not being dangerous. It is supposed that the excess water leaking into the condenser is 5 per cent of the total amount of water fed to the boilers. In this case, I do not believe that there would be any great excess to dispose of, as the leakage here and there from stuffing boxes, joints, etc., is probably about 5 per cent of the original amount of feed. However, we will assume that the actual excess is 5 per cent of the total boiler feed. It seems to me that the proper method is to use a compromise of the two methods mentioned, and as the boilers must be blown off occasionally, to feed enough of this excess to make up the amount blown off and to allow the balance to escape from the hot-well. It hardly seems advisable to heat all of this excess up to boiler temperature and then blow it off simply to get rid of it.

Let us assume that we have 6,000 horse power of engines using 15 pounds of steam per horse power per hour at 160 pounds gage pressure. Then we will require for our engines 6,000 × 15 = 90,000 pounds of steam per hour, and allowing about 10,000 pounds per hour for all the auxiliaries, we will require in all 100,000 pounds of steam (or feed water) per hour. Five per cent of this is 5,000 pounds per hour. In one pound of the water of steam at 160 pounds pressure there are 343 heat units above 32° Fah. We will assume that the temperature of our hot-well is 122° Fah., or 90° above the freezing point. Then to bring one pound of this excess water up to gage pressure we must supply 343 minus 90 = 253 heat units and for the total excess of 5,000 pounds we must supply 5,000 × 253 = 1,265,000 heat units per hour. In one pound of coal there are about 13,000 heat units, and assuming the efficiency of the boilers at 65 per cent, there are available for each pound of coal burned 13,000 × .65 = 8,450 heat units. Then the amount of coal required to bring 5,000 pounds of water at 120° Fah. up to the temperature of steam at 160 pounds pressure equals $\frac{1,265,000 \text{ B. T. U.}}{8,450 \text{ B. T. U.}}$ = about 150 pounds per hour. In a ten-day run we have 240 hours, and we would use for this purpose 240 × 150 = 36,000 pounds of coal in heating this 5 per cent excess feed water. If the amount of water wasted in blowing off is 2 per cent of the total feed, and we supplied this from our excess, we would still be heating unnecessarily 5 per cent minus 2 per cent = 3 per cent of our feed water and in doing so, we would use 3-5 of 36,000 pounds of coal, 21,600 pounds, or about a ton per day. This assumes that none of this excess is evaporated into steam, but is only heated up to boiler temperature. While this is not a large amount it is certainly an appreciable unnecessary waste. I would be pleased to hear from other engineers on the subject. Wish you the success which your paper merits.

H. R. J.

Another rumor that China is soon to purchase a new navy has been started by the foreign press.

Contracts for the construction of the three new torpedo boat destroyers for the navy have been let by the Secretary of the Navy. These firms will build one each: Harlan & Hollingsworth Company, Wilmington, Del.; Gas Engine & Power Company, Morris Heights, N. Y.; Wolff & Zwicker, Seattle, Wash.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—II.

BY WM. BAXTER, JR.

In all the figures given, so far, to illustrate the action of magnetism, the force has been shown as acting along curved lines. Some persons find it difficult to understand the real meaning of these lines owing to the fact that they are accustomed to see magnets draw pieces of iron in a direction nearly perpendicular to the surface of the bar at the particular point where the object is attracted, and therefore do not understand how the curved lines can represent the direction in which the magnetic force acts. To be able to interpret this apparent discrepancy it is necessary to take into consideration the fact that when the magnet acts upon a piece of iron that is free to move in any direction it will be drawn toward the magnet by the combined action of the attraction from both ends. The curved lines represent the direction in which a small magnet needle will be directed if it is held so as to swing freely around its center, but at the same time so as to not be drawn bodily into the magnet. This method of representing magnetic force by curves came into use from the fact that the action of the force along such curves can be demonstrated by very simple experiments. If you place a sheet of card board over a magnet, and sprinkle upon it some iron filings, you will find that if the card is jarred gently for a few moments, the particles of iron will begin to arrange themselves in curved lines extending from one pole of the magnet to the other. If a wire carrying an electric current is passed through the card, the latter being in a horizontal position, the filings will arrange themselves in circles concentric with the wire.

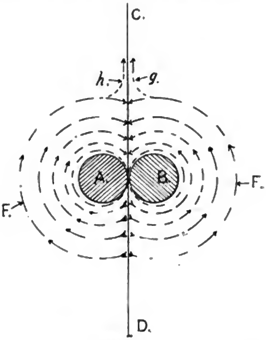


FIG. 9.

These lines along which magnetism acts are called magnetic lines of force. The total strength of a magnet is spoken of as the total number of lines of force, or the magnetic flux. The region in which the force acts is called the magnetic field. Theoretically, the field of any magnet is unlimited, if not neutralized by a counter-acting field, but in practice the field is regarded as the space immediately surrounding the magnet, or electric current, except in the case of telephones and telegraphs, where, under some conditions, the effects of the magnetic field can be detected at distances of several hundred feet.

Although magnetism is a static force, it acts in many respects as if it flowed in currents, and on that account the terms magnetic current, magnetic circuit, magnetic flow, etc., have come into extensive use, but it should be remembered that their use is only a convenience. If the path traversed by the lines of force is long and contracted in cross section, it will offer a greater resistance to their passage than if short and of abundant cross section. In this respect the action of magnetism resembles the action of water flowing in a pipe, the longer and smaller the pipe the greater the resistance the water encounters. With a given pressure to force the water through the pipe, the quantity forced through will be dependent upon the length and diameter of the pipe. Shortening it will increase the flow and increasing the diameter will accomplish the same result. This is also the case with magnetism, if we have a given magnetizing force the strength of the magnetism developed or number of lines of force will depend upon the length and cross section of the magnetic circuit. If the length is reduced and the cross section is increased the lines of force will be increased. If water is forced through a pipe having a rough surface, it will not flow as freely as if through a highly polished pipe. If magnetism is forced to pass through air it will not pass as freely as through iron.

From the foregoing comparisons we can see that there is a great similarity between water flowing in a pipe and magnetic action in a magnetic circuit. The flow of water with a given pressure is dependent upon the length of the pipe, its diameter and the character of its surface. The magnetic force developed by a given magnetizing force is dependent upon the length of the magnetic circuit, its cross section and the character of the medium through which the lines of force pass.

With the assistance of these explanations we can proceed to show how, under certain conditions, electric currents may traverse wires and not be surrounded by a magnetic field, as was stated in the first article. In Fig. 8, of that article, the lines of force are shown around two wires running parallel with each other and traversed by currents flowing in opposite directions. As the current in the two wires runs in opposite directions, the lines of force around them must be oppositely directed, but from this fact the flow of the lines in the space between the two wires will be in the same direction, just as two gear wheels roll together although the shafts revolve in opposite directions. As the lines of force are in the same direction, they will not counteract each other, but the cross section of the space through which they must pass is restricted by the distance between the wires, and if this is made very small, the contraction will greatly increase the resistance the magnetism has to overcome, the consequence being, that the number of lines of force will be reduced. Suppose the wires are brought as close together as possible without actually coming in contact, as shown in Fig. 9, then, as there will be practically no space between them, there will be no way for the lines of force to get through, and, therefore, there will be no magnetism circulating around them, so far as that passing through the space between the wires is concerned. From the direction in which the arrow heads point, in the figure, it will be seen that the balance of the lines check each other where they meet, at the line CD. If, when the lines meet head on, at this line, those marked E should endeavor to curve up, as at G, and thus get by the barrier, they would find that those from the opposite side were endeavoring to do the same thing, as indicated at h. The condition above explained can be brought about practically by arranging a wire as shown in Fig. 10. As can be seen from the figure, the current in the two parts of the wire will run in opposite directions, as in the region between the lines CD and EF there will be no magnetic field practically. Above C the wires will be surrounded by magnetic lines of force owing to the fact that there is a space formed by the loops through which they may pass. The greatest density of lines will be along the line A. Magnetic fields will also be developed around the wires between the lines D E as there is also an opening at this point. At D and E the field will be very weak and will increase gradually toward the line B where it will be the strongest.

Since lines of force surround a wire in which a current flows, and are not present when there is no current, we must naturally conceive the lines as expanding out from the wire, when the current starts, and to continue to expand as long as it is increasing. When it reaches its normal strength, the lines will become stationary, and remain so until the current begins to die out. Then they will begin to contract upon the wire and disappear, the last one vanishing when the current stops entirely.

If passing a current through a wire develops a magnetic field around it, it may naturally be asked: What would be the result if we moved a wire in which there is no current, into a magnetic field? Since a wire carrying an electric current is surrounded by a magnetic field we would infer that a wire surrounded by a magnetic field would be traversed by a current, and therefore, that if we move a wire into a magnetic field the effect will be to develop in it an electric current. This influence is perfectly true, providing the position of the wire is such that the lines of force can surround it, and not run parallel with it.

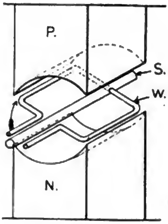


FIG. 11.

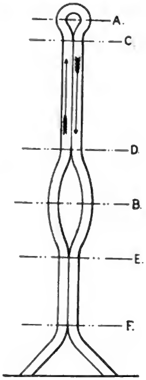


FIG. 10.

By passing an electric current through a wire a magnetic field is developed, and by moving a wire across a magnetic field an electric current is developed. The movement of the wire across the field may be effected either by an actual movement of the wire, by mechanical means, or by a movement of the lines of force, produced by increasing and decreasing the current in the wire.

Fig. 11 shows, in an elementary way, the manner in which the mechanical movement of the wire across the field is effected in all the various types of electrical machinery. P and N represent the poles of a magnet. From what has already been said it will be understood that the space between them in which the shaft S, carrying the wire loop W is located, is traversed by lines of force. The rotation of the shaft, in the direction indicated by the arrow, will cause the loop W to cut through these lines and thus a current will be developed in it. When the loop is at right angles with the poles its sides will move in a direction nearly parallel with the lines of force, as is more clearly shown in Fig. 12, and when it is in line with the poles its sides will cut across the lines of force at right angles. In the first position little or no current will be developed, because the wire moves with the lines and does not cut them. In the second position the greatest current will be developed, because the wire cuts square across the lines of force. The direction of the current developed in the wire by the rotation of the loop will be reversed if the direction of rotation is reversed; that is, if the loop is turned half-way around the circle and then back to its original position, the current during the first movement will be in the opposite direction to that during the second movement. If the movement is continued in the same direction, the part of the loop that passes across the upper half of the field will have a current developed in the same direction in space, say up from the paper; the part passing across the lower half will also have a current developed in it in the same direction in space, which will be down through the paper. As at each half revolution the sides of the loop change their position from top to bottom, it follows that twice in each revolution the direction of the current in the wire will be reversed. As many minds become badly tangled up in endeavoring to trace out this point, it will be explained more fully in the next article, in which will also be shown the devices by which the reverse currents are caused to flow in the same direction in the wire outside the loop.

It has been discovered that the use of fireproof wood on the ships of the Navy causes a corrosive action destructive to surrounding metals. This is said to be owing to the presence of some chemical substance used in the process of fireproofing.

HOME AND FOREIGN EXCHANGES.

Method of Loading Coal at Lake Docks.

The summer meeting of the Ohio Institute of Mining Engineers, June 15-18, took the form of an excursion that carried the Institute over 600 miles by rail and boat, the particular line of inquiry being into the methods of loading coal at various Lake Erie docks. The Ohio Institute had invited the members of the Western Pennsylvania Central Mining Institute to go on this tour of inspection. Leaving Columbus at 11.35 A. M., June 15, the party arrived at the docks of the Short Line Railroad on Sandusky Bay, at 3 P. M. Here they examined the old method of loading vessels with buckets and cranes, the plant being interesting because it was the first to eliminate shoveling. The Thornburgh rapid loader now in course of construction was seen, but owing to its being incomplete the railroad company has not as yet begun to load for its Northwestern trade. At the B. & O. docks, which were next visited, vessels were also being loaded by buckets and cranes. On invitation from an elevator company the visitors next saw the rapid transit method of handling grain, whereby through the use of an endless belt some 7,000 bushels of wheat are moved per hour. The wheat is carried on the flat belt at a rapid rate without spilling, and when the turn of the belt is reached it pours into the funnel without the loss of a single grain.

FIG. 1—B. & O. DOCKS, SANDUSKY, O. CRANE AND BUCKET SYSTEM, THE FIRST TO DISPENSE WITH SHOVELING.

Wednesday morning the excursionists boarded the Maud Preston for Huron, where the operations of the McMyler unloading machine, there used for handling the mountains of iron ore piled up along the docks, were watched with interest. The speed with which this work is carried on is surprising, as is also the saving of manual labor. The buckets being placed near the bottom of an ore-pile are filled with very little shoveling. At Huron the excursionists also examined the Brown hoist for loading coal, which is said to have a guarantee of 3,000 tons. Some of the party timed the machine while it loaded 30 tons in 7 minutes and 18 seconds. But 40 seconds elapsed from the time the railroad car was taken until the coal was dumped into the six buckets ready for loading. These buckets each hold five tons. The apparent ease and rapidity with which these immense masses of heavy material are moved and transferred excited great wonder among those not accustomed to such sights. This machine is very much complicated, from a mechanical standpoint, but saves the coal from breakage as well as or better than any of the other types.

At Lorain the party was taken in charge by S. M. Smythe and others of the Johnson Co., being greeted also by a large delegation from the Engineers' Club of Cleveland. Electric cars took them to the Johnson Co.'s steel works, situated about four miles from the landing. The inspection of the steel works occupied most of the afternoon. It should be noticed that this plant holds the world's record for making steel in shortest time after beginning to build plant. A visit was also made to the site for the docks to be built by the steel company and the proposed site for the furnace plant.

FIG. 2—MINNESOTA DOCK, ASHTABULA HARBOR, O. BROWN SIDE-DUMP UNLOADER, WITH BUCKET TRANSFER SYSTEM.

On Thursday morning the Maud Preston was towed about the river at Cleveland to various points of interest. The first visit was to the Cuddy-Mullen plant on the outside of the harbor, situated on the Cleveland and Pittsburg Railroad tracks. The McMyler side dump is used. The party next visited the Brown hoist on the C. & P. R. R. dock, located in the old river bed. This plant is of the same design as the one at Huron. Then they were taken to the Long[1] car unloader built by the Excelsior Iron Works, of Cleveland, and located on the Erie Railway tracks. Passing up the river, the party was shown a machine being erected on the Valley Terminal Railroad of the McMyler pattern, in many ways similar to the Long machine, the chief difference being that under the spout a drop bucket is used which will lower the coal into vessels, thus reducing the breakage, as the spout is kept full, and the coal slides gradually to its destination without a sudden crash and fall.

For the afternoon a trip was made to Ashtabula Harbor, where the party first examined the Brown hoist, which was engaged in loading the steamer Yuma, a 4,000 ton boat. It is said that this machine can unload 118 cars in 12 hours. This is about the latest system of transfer without shoveling, see Fig. 2, as that at the B. & O. docks at Sandusky, shown in Fig. 1, is the earliest. A visit was paid to the lake shore to examine the first car-unloader ever erected at lake ports. It is the McMyler car-dumper, end-dump type, and works on the cantilever principle. It is said to have an unloading capacity of 16 cars an hour. The machine is the first successfully to load vessels in record-breaking time. The one on the C. C. & S. docks, Cleveland, preceded it in date, but has not approached it in speed, nor in continuous working. Fig. 3 is a view of this machine as in use at the docks of M. A. Hanna & Co., Ashtabula, O.

The foregoing description is taken from the Iron Trade Review, Cleveland, to which we are indebted also for the excellent illustrations of the apparatuses.

A Good Deal About Steam.

This very interesting and simple dissertation was written for the American Machinist by Prof. De Volson Wood, shortly before his death. It was accompanied by this memorandum:

"I intended to say much more about steam, but feared I might be too technical and too lengthy, so I let my thoughts run freely about and closed 'early.'

"De V. W."

Heat can be compared with work, and if a pound of water could fall 778 ft. in a vacuum, and all the energy thus acquired could be transformed into heat, it would raise the temperature of the water 1 deg. F. The heat necessary to raise the temperature of 1 lb. of water 1 deg. F. whatever that amount be, is called a British thermal unit with which all other quantities of heat may be compared, and the equivalent value in foot-pounds will be 778 times the number of thermal units.

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[1] This apparatus was fully described in our July issue, p. 35.

The latter, in some simple operations, is frequently immense.

For instance suppose that 1 lb. of water at 51 deg. F., is placed on a stove, or furnace, and subjected to a steady heat, and that in ten minutes the water boils at 212 deg. F. The temperature has been raised 212 — 51 = 161 deg. Suppose, now, that the water continues to boil with constant heat from the furnace and that in 60 minutes 1 lb. has boiled away, passing off as steam. It will be observed that the boiling water has continually the temperature of 212 deg. According to our supposition it required six times as much heat to vaporize the pound as it did to raise its temperature 161 deg. or six times 161 thermal units, or 966 thermal units. The experiment of Regnault, whose methods were perfect compared with the crude method here indicated, gave 966 thermal units to the nearest whole number required to vaporize 1 lb. of water under the pressure of one atmosphere. This is equivalent to 966 × 778 = 751,548 foot-pounds.

FIG. 3—M. A. HANNA CO'S DOCKS, ASHTABULA HARBOR, O. M'MYLER CAR DUMPER, END-DUMP TYPE.

One appreciates the magnitude of this quantity better by making some comparisons. It is sufficient to raise 1 ton 375 ft. or 100 tons 3.75 ft. The energy of ordinary gunpowder is generally assumed to be 250,000 foot-pounds per pound of powder; according to which, it requires more than three times the energy to vaporize 1 lb. of water under atmospheric pressure than is developed by the explosion of 1 lb. of ordinary gunpowder. The former is done quietly in the course of a few minutes, while the latter is done in a small fraction of a second. This, however, is not all the heat in a pound of water above ordinary temperatures. If the water originally was at 60 degrees F., there were 212 — 60 = 152 thermal units imparted to the water before it boils; and this must be added to 966, giving 1,118 thermal units, giving nearly 870,000 foot-pounds; and if this heat were imparted in 26½ minutes, or 2.26 lbs. so heated every hour, it would equal the energy of 1 horse power. We need not say that 2.26 lbs. of steam, however high the temperature, do not, in practice, produce a horse power; indeed, it is only very recently that a horse power has been produced with so small a weight of steam as 10 lbs. per horse power per hour, and very many engines require from 25 to 40 lbs. One reason for this is, an engine utilizes only a fraction of the heat imparted to it; the very best utilizing scarcely one-fifth of the heat, many good common engines one-tenth, and many one-twentieth, or even less.

Every change of state of aggregation involves a large expenditure of energy. If 1 lb. of ice be melted in 10 lbs. of water at 60 deg. F. it will reduce the temperature of the water about 14½ deg., and if this value were correct it would follow that it requires 14½ × 10 = 145 thermal units to melt a pound of ice. Careful experiments show that it requires 144 British thermal units to melt a pound of ice, and this is equivalent to 144 × 778 = 112,000 foot-pounds of energy. Hence, the energy required to melt or freeze 1 lb., of ice is little less than half the energy in a pound of common powder. When it melts, energy is absorbed by the ice, and when it freezes, energy goes out of the ice into surrounding objects. The energy of melting the pound is equivalent to raising 56 tons weight 1 ft. or of 3.4 horse power to melt a pound per minute. In view of this, it is not surprising that the effects resulting from freezing and thawing water in the earth and in crevices of rocks produces such marked effects as is frequently observed.

The total amount of heat in any given body is unknown. If a gas were perfect, the amount could be computed; but no known gas is perfect. All the so-called perfect gases have been liquefied. Air is a convenient type of a gas. If air be expanded without supplying it with heat, its temperature will fall; and if it were a perfect gas and the expansion infinite, all the energy in it would be changed into work, and the final temperature would be absolute zero, or 461 deg. F. below the zero of Fahrenheit's thermometer. In this way we have computed the total energy in a pound of air at 32 deg. F., the temperature of melting ice, supposing it to be a perfect gas, and found it to be about 64,000 foot-pounds, or about one-fourth the energy in a pound of common powder. A pound of air at that temperature and under ordinary pressure, occupies nearly 12 1-2 cu. ft. hence 4 lb. would occupy about 50 cu. ft. Hence, the air in a room 2 × 3 × 8 1-3 ft. under ordinary conditions, will contain about as much energy as there is in a pound of common powder. If the speed of a cannon ball be 2,000 ft. per second, the kinetic energy of a pound of it will be about 62,000 foot-pounds, or a little less than the total energy in a pound of air under ordinary conditions.

One does not realize the enormous amount of energy stored in bodies about us, as in air, vapors and solids, so long as it is restrained. One may carry powder with impunity if kept from fire, but a spark may make it destructive. Steam boilers are splendid servants, but destructive masters.

The volume of a pound of steam under different pressures is found with considerable difficulty; but at atmospheric pressure, a pound of dry steam is found to occupy just about 26 1-2 cu. ft. the temperature being 212 deg. F. And a pound of dry air at that temperature will occupy just about 16.6 cu. ft., the pressure being the same; hence, under such conditions, air is heavier than the steam, the steam being about five-eighths as dense as the air.

Plans have been made, and are now being executed, for utilizing some 100,000 horse power of the Falls of Niagara, much of which is to be transmitted to 'distant points by electrical transmission. It is a grand engineering scheme; but it is put into the shade by the engineering feat displayed in recent Atlantic liners. The former is on and in solid rock, the latter on a floating ship; and the latter carries engines of 30,000 horse-power, together with furnaces, boilers, and fuel. If the work of 8 men equaled 1 horse power, and if there were three shifts in 24 hours, it would require 720,000 men to do the work of the engines on one of these gigantic steamers; and if one steamer could carry the 240,000 necessary for each shift, it would require three vessels to carry the men to do the work on one. This is an illustration of the fact that steam power may accomplish what hand power cannot.

Capt. Ericsson made hot air engines to drive his steamer the Ericsson, which were very economical of fuel; but the four engines, with cylinders 14 ft. dia., developed only 300 horse power, and to develop 30,000 horse power would require 400 such engines, and would make two rows, each more than 2,800 ft. long, or more than half a mile long; while the triple expansion engines of the Majestic, the boilers, furnaces, and fuel are practically hidden in the hold of the ship. Steam is king!

Immense New Floating Dock at Hamburg.

The shipbuilding yard and machine shops of Messrs. Blohm & Voss, at Hamburg, which for years have had in operation a large floating dock known as the Elbdock, have just completed a new dry dock, which is the largest of its kind in existence. So writes W. Henry Robertson, Consul at Hamburg, in the United States Government Consular reports for the month of July.

This new floating dock has a carrying capacity of 17,500 tons. Its length, with pontoons, is 624 ft. 4 in., and its width 118 ft. 1 in. It is able to raise the largest merchant vessels that have thus far been built, and even the heaviest men-of-war, and consists of seven separate pontoons with high and strong side pieces. These seven pontoons can be joined together, so as to form one connected system. Each side piece contains an engine and boiler room for the pumps and electric and hydraulic machines. These two machines have condensers and 700 indicated horse power each. They drive 14 pumps, which are capable of pumping out the dock in 45 minutes, and thus of raising the largest vessel in this short space of time. In order to regulate the raising and the lowering of the dock, it was necessary to divide each pontoon into several water tight compartments, which are closed by means of stop valves. All these stop valves can be moved from one point by means of hydraulic power, and the depth of water in all compartments is indicated by special apparatus. By this arrangement it is possible for one person to manage all the stop valves and to direct the pumping.

The blocks upon which the vessel rests are easily movable by machinery from the side pieces. Altogether, this new dock is supplied with the most modern improvements, some of which were especially constructed. The dock harbor behind the shipyard has a depth of 26 ft. 2 in. below 0, so that, at ordinary high tide vessels drawing as much as 26 ft. can be docked. A bridge 118 ft. long connects the dock pontoon with the shore, from which the dock is, therefore, quite accessible. Next to the pontoon and on the quay of the shipyard, there is a huge crane, which, when projected 65 ft., can raise 150 tons, and 45 tons when projected 106 ft. By means of this crane heavy loads can be transferred directly from the shore into the dock across the largest vessels.

Owing to its peculiar construction this great dock can, in cases of emergency or in time of war, be transferred to Brunsbüttel, at the opening of the Kaiser Wilhelm Canal, to dock vessels which have sustained heavy damages or whose draft is great. As a matter of fact, it is capable of docking vessels with a draft of 29 ft. 6 1-2 in. No vessel with a greater draft than 27 1-2 ft. has thus far succeeded in coming up to the port of Hamburg.

Upon applying to the owners of the dock I was informed that no fixed schedule of charges for the use of the same had been or would likely be determined. It was believed to be more profitable to make special arrangements in each case. I was given to understand that not even the German Government had been furnished with any tariff of docking charges, and that for the docking of foreign vessels of war it was probable that there would be charged about $975 for the first day and $250 to $500 for each following day. Messrs. Blohm & Voss desire it to be expressly understood, however, that they do not bind themselves to these figures.

LARGE HOME AND FOREIGN DOCKS.

Docks.	Length Feet.	Docks.	Length Feet.
Belfast	825	Havre	535
Birkenhead:		Marseilles	593
No. 1	750	Genoa	720
No. 2	930	Baltimore (Simpson's)	504
Cardiff	600	Brooklyn:	
Liverpool	768	Erie No. 1	620
London (Tilbury)	875	Erie No. 2	510
Newcastle (Wallsend.)	520	Newport News:	
Southampton	750	At top	609
Antwerp	429	At bottom	560
Cherbourg	508	Norfolk, Va.	500

There is little doubt that this capable and energetic firm, by the construction of the new dock, have met a long-felt want in Hamburg, whose docking facilities have of late years by no means kept pace with its shipbuilding. The Hamburg-American Line, especially, will have reason to look with favor upon the new enterprise, as it will enable them to dock their express steamers and large freight boats in their home port, instead of having to send them to English or American docks. The North German Lloyd, of Bremen, which also has some very large boats, and is building more, will (as well as the German Imperial navy) doubtless be glad to avail itself of these excellent facilities.

Although it is easy for persons connected with shipping to look them up in Lloyd's Register, I deem it not uninteresting to give, by way of comparison, the lengths of the largest graving docks in the world:

It will be noticed that a large proportion of these graving docks are longer than Messrs. Blohm & Voss's new floating dock, which latter, however, far exceeds the dimensions of other floating docks in existence, the length of which is seldom more than 300 to 400 ft. It seems the builders desired a dock which could be transported to almost any part of the river below this port, and also one which they considered superior to any graving dock for the safe handling of large and long vessels.

NEW PUBLICATIONS.

ANNUAL REPORT OF THE OPERATIONS OF THE UNITED STATES LIFE-SAVING SERVICE, for fiscal year ending June 30, 1896. Washington, Government Printing Office, 1897, pp. 533.

Departmental reports are not usually the most interesting books for other than the reader who seeks figures on some particular subject. This report, however, is an exception, containing as it does a year's record of hazardous work bravely done by the efficient members of this most important branch of the civil service. The services of crews for the fiscal year set out in diary form fill many pages, and contain many an interesting story of adventure and heroic work. Besides the saving of lives, however, there is the brief record of the prevention of destruction of hundreds of thousands of dollars' worth of property by prompt work of the various crews, in warning vessels of approaching dangers and in rescuing vessels from perilous positions. There are 256 stations on the lake and sea coasts, and the work performed during the year is thus reported by General Superintendent Sumner I. Kimball: "The number of disasters to documented vessels within the field of station observations during the year was 437, and there were on board these vessels 4,608 persons, of whom 13 were lost. The estimated value of the vessels was $8,880,140, and that of their cargoes $3,846,380, making a total value of property involved $12,726,520. Of this amount $11,293,770 was saved to the owners and $1,432,750 lost. The number of vessels totally lost was 67." These figures do not take any account of the numerous cases of aid rendered to small pleasure craft. There is a very interesting entry under the head of "Vessels warned by night signals," dated January 25, 1896. This was the memorable night when the St. Paul went ashore at Long Branch, and an unknown steamer followed her example. The entry regarding the unnamed vessel reads in part, "She appeared to be a large trans-Atlantic vessel, almost broadside to the shore, and looked to be stranded, but while preparations were being made to get the beach apparatus ready for use she backed out of her perilous position." The name of this mysterious vessel seems to be as unobtainable as that of Billy Patterson's assailant. Other matters contained in the report are a fine collection of letters acknowledging the services of crews; awards of medals since 1876, with brief narrative of rescues; table of casualties, giving very complete details; statement of appropriations and expenditures; instructions to mariners in case of shipwreck; list of districts and exhaustive tables of wrecks and casualties at home and abroad. There is also a report of the board on life-saving appliances.

INVESTIGATION INTO THE ACTION OF A SCREW PROPELLER, with special reference to the comparison of actual trial data with formula representing model experimental results. Printed for private circulation. By Bernhard A. Sinn, M. E., New York, pp. 59. With many drawings.

This work is an extensive investigation into the theory and modern practice of screw propulsion. Its main purpose was to compare about 250 actual trials with a formula derived from Froude's experiments and modified by Prof. W. F. Durand, of Cornell University, to allow of differences in area and shape. The investigations show some very great peculiarities in propeller design, and also show that the formula modified as above agrees in 60 per cent of the cases with the actual trials. The work is very completely illustrated with charts and drawings of screw propellers. The tables and information contained therein are based on 250 trial trips, and the tables contain complete dimensions of vessels and propellers, and finally a complete analysis of the performance of each propeller. The vessels are representative, ranging in size from a 58 ft. tug to a 512 ft. ocean liner, and propellers from 4 ft. to 28 ft. dia.; single, twin, and triple screw vessels from 8 to 24 knot speed. Over 70 different shaped propellers are shown, and the results show an efficiency for the scientifically designed greatly in excess of what might be termed the hit or miss design of propeller. Of all the vessels treated the United States cruiser Marblehead shows the maximum efficiency of propeller.

BLUE BOOK OF AMERICAN SHIPPING. Marine Review, 409 Perry-Payne Building, Cleveland, O., pp. 447. With Illustrations. Price $5.00.

This book is fitly termed by the publishers a Marine Business Directory of the United States, as it covers both the sea coast and lake interests. It contains the lists of vessels usual in such works, and besides lists of owners' and officers' names and addresses, statistics of lake commerce, and many pages of information regarding deep sea interests. The illustrations are numerous and interesting.

The twenty-second annual review of the Daily Commercial News, of San Francisco, issued during July, is one of the best all-round publications of the sort we have ever seen. Not only is it an exceptionally fine specimen of good printing, but its arrangement and diversity of interesting contents show good judgment and care. The statistics are carefully worked up into tables of convenient reference, covering all the exports of grain, lumber, and salmon from the coast. There is a very complete chapter of marine mishaps, and a great variety of articles of interest to the merchant and shipping classes of the coast. The illustrations are numerous and good. Copies of the Review can be had by forwarding 25 cents to the Commercial Publishing Company, 34 California street, San Francisco, Cal.

CATALOGUES.

The series of bulletins which is being published by the Bullock Electric Manufacturing Company, St. Paul Building, New York, and Cincinnati, Ohio, contain a great deal of matter of much value to every man who has to do with the generating or utilizing of electricity. Some of the text may refer more particularly to the operation of machine tools, or other machinery by the use of electric motors direct-connected, but the principle is the same that it would be in a hoist ventilator or other apparatus which might be used in any branch of engineering in the marine field. The Bullock motors are made of different speeds, and can be adapted to all uses, from operating machinery in a shipyard to doing various kinds of work on the dock or on board ship. The bulletins are published from time to time as occasion demands, and readers of Marine Engineering who are interested in studying up the practical uses of electricity should send to one or the other offices of this company for copies.

One of the handsomest catalogues of the season is just received from the Deane Steam Pump Company, Holyoke, Mass. It comprises 132 handsomely printed and profusely illustrated pages, devoted to pumping machinery. Each type of pump is shown in a half-tone engraving, and in many instances sectional views are also given. The cover of the catalogue is flexible black board, and the printing upon it in gold. Under the heading of machine pumps will be found full detailed description of light service pumps, surface condenser with vacuum and circulating pumps, combined single vacuum and water pumps, independent condensing apparatus, boiler feed pumps, vertical and horizontal piston pumps for general service, ballast pumps, etc. In addition there is a great deal of general information of much value to engineers regarding pumping apparatus. Copies of the catalogue can be had upon application to the company by mentioning Marine Engineering.

An artistic little book is that entitled "Testimonial Wonders; Songs of Praise about Patent Elastic Felt Mattress," received from Astermoor & Co., 116 Elizabeth street, New York. It is printed on coated paper, in black, and has marginal notes, headings, etc., in red. Several testimonials testify to the extensive and very successful use of these mattresses in the navy and in Government vessels, as well as in the merchant marine. This booklet is devoted entirely to testimonials, but another, entitled "The Test of Time," illustrates and gives in detail the manner of making the mattresses and the various uses to which they are adapted. Copies of either booklet can be had upon application.

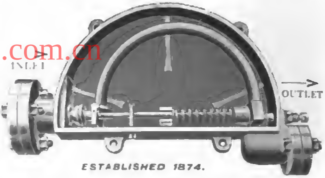
Duval metallic packing is fully illustrated and described in a catalogue just received, and many pages of testimonials are added, showing the value of this packing for all uses, especially in marine work, for piston rod, stuffing boxes, valve rod boxes, air pump buckets, feed pumps, bilge pumps, etc. The cover is very neatly printed in three colors, and the body of the catalogue is correspondingly well printed. B. J. Carroll, 43 John st., New York, is agent for this packing.

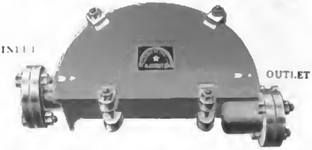
The gas engine catalogue issued by the Westinghouse Machine Company, Pittsburg, Pa., like all the publications of this company, is a beautiful specimen of the printers' art. The illustrations are full size of the page, 7 by 9 in., of very light quality, and the press work is in keeping. Very few catalogues have such concise detailed descriptive matter as this. In short, it is a model catalogue.

J. M. Hayden & Co., Grand Rapids, Mich., have just issued a little book of testimonials regarding their Globe box metal. The book is circular, about three inches in diameter, the cover being of red paper, printed upon with silver bronze, reproducing the color of the metal. Users of box metal will find it well worth looking over this book.

The catalogue at hand from the Power & Launch Company, Bridgeport, Ct., illustrates a variety of boats, from small yawls and dinghys to large naphtha and steam yachts. The illustrations are large and comprehensive, and the descriptive matter as complete as could be desired. Every person interested in such craft should send for one of these catalogues.

Engineers interested in posting themselves on the various kinds and types of lubricators, oil cups, safety valves, and injectors, should send to the Swift Lubricator Company, Elmira, N. Y., for its new catalogue. It is well illustrated and describes in some detail the various specialties referred to.





FOR MARINE ENGINEERS.

A Chief Engineer has something to say concerning Dixon's Pure Flake-Graphite that is worth the reading.

I can highly recommend Dixon's Pure Flake-Graphite as a lubricant for external parts, such as hot pins, journals, etc. We had the High Pressure and Low Pressure connecting-rod brasses run hot in leaving Galveston. These brasses had been adjusted when in port by applying the Flake-Graphite mixed with oil. It entirely cooled them without causing us to stop and ease nuts back. It is an exceedingly good lubricant for slide valves and pistons. We had some heavy weather between Galveston and Norfolk, with engine racing heavy at times. The boilers are inclined to prime a little with racing, causing the H. P. slide valve and gear to work very heavily, and by giving the slide valve a little Flake-Graphite mixed with water it entirely does away with all the bad jarring and rough working of the gear, and I find that one-half of an ounce of Flake-Graphite is equal to one pint of good cylinder oil for causing valve and gear to run smoothly.

I can with the utmost confidence recommend it for either internal or external parts for lubrication.

JAMES STEPHENSON,
Chief Engineer, S. S. Llanthony Abbey.

Any Engineer who is not familiar with this wonderful material will receive sample and pamphlet free of charge.

JOSEPH DIXON,
Crucible Co., Jersey City, N. J.

ALCO VAPOR

Hunting Launch.

Sportsman's Floating Camp. Motor controlled from bow. Valve movement, 12 to 1. 16 to 60 ft. Launches. Twin Screws a specialty. 1, 2, 3, 5, 7, 12, 14, and 20 h. p. No licensed engineer or pilot required. Speed and Safety guaranteed. **No dangerous Naphtha or Gasoline used.** No disagreeable vibration. SEND TEN CENTS IN STAMPS FOR 1897 CATALOGUE.

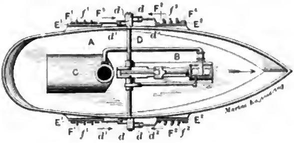
MARINE VAPOR ENGINE CO., Foot Jersey Ave., Jersey City, N. J.

SINTZ GAS ENGINE COMPANY,
GRAND RAPIDS, MICHIGAN, U. S. A.,
Manufacturers of
Marine and Stationary Gas and Gasoline
ENGINES.
Also Yachts and Launches.

SELECTED PATENTS.

586,390—MEANS FOR PROPELLING SHIPS. *Jean B. Pinchard, San Francisco, Cal. Filed July 22, 1896.*

In an apparatus for propelling vessels, suitable guides secured to the side of the vessel, reciprocating frames moving in guides, and a mechanism for reciprocating the frames, combined with two sets of wings, one for propelling and the other for backing the vessel, hinged to the frames; hooks for locking each set of wings in a closed position, a slide for each frame, and to which the two sets of hooks are secured, and means for adjusting each slide so that either set of hooks can be brought into use. In an apparatus for propelling vessels, suitable guides, a sliding frame, and two sets of wings, which operate in opposite directions, combined with an endwise-moving slide carrying hooks for each set of wings, an operating mechanism for moving the slides, located inside of the vessel, and connecting with the slides through the sides of the vessel, a sliding frame provided with stops f^1 f^2 f^3 f^4, two sets of hinged wings F^1 F^2 F^3 F^4, which operate in opposite directions; and two sets of hooks turned in opposite directions, for locking either sets of wings, combined with slides to which the hooks are secured; the pins projecting from the inner sides of the slides, the sliding bolts having outwardly-turned ends, and the levers H, and pins h^1 h^2, for reciprocating the bolts, the combination of a sliding frame having two sets of oppositely-hinged wings, a locking-bar provided with oppositely-pointed hooks arranged to slide respectively and alternately over one set of the wings and lock the same, a lever, and suitable connections, whereby the lever is made to shift the bar and the hooks.



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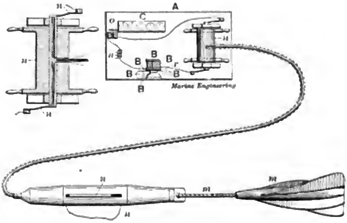


584,095—SPEED INDICATOR FOR SHIPS. *Warren H. McCurdy, Boston, Mass. Filed Feb. 10, 1896.*

A ship's log, having a chamber for the reception of an insulating plug, and open at its end for the reception of an electric cable, combined with the cable provided with strength-giving wires and electric wires wrapped together within an insulating protector, and having its strength-giving wires fixed to the log, and the electric wires inside the log being separated from these wires, and arranged to coöperate with a push button. The combination with an electric cable, of a ship's log composed of a hollow divided shell, containing an independent frame having opposite heads packed water tight and inserted in the shell, and containing a cam and means to move it to actuate a push button to effect the closing of an electric circuit. In a ship's log, a head having a projection, and a slide rod having a collar, combined with a piece of tubing surrounding the rod, and connected to the head and collar to form a water-tight joint. A ship's log composed of a hollow divided shell having at one end a rotating driving shaft, and having within the shell a train of mechanism, and a shaft extended outwardly from one of the heads to be engaged and driven by the driving shaft, combined with a stuffing box, through which the shaft driven by the driving shaft is extended. A ship's log, a rotator, a driving shaft mounted in the former and connected to and to be rotated by the latter, and a driven shaft within the log, the two shafts being connected together end to end by disks and pins. In combination with a ship's log, an electric cable containing electric wires, and strength-giving wires, nested together in a compact bunch and bound together by a protecting covering, the latter wires being secured to the log.

BUSINESS NOTES.

THE NEW YORK MARITIME REGISTER has in preparation an International Domestic and Export Edition, which promises to be a very valuable medium through which to reach commercial houses in all parts of the world.

A POLICE BOAT.—The Marine Vapor Engine Co., Jersey City, N. J., has been awarded contract for a police boat for the City of Brooklyn, in competition with leading launch builders. It will be equipped with the well known alco vapor engine.

GREENFIELD ENGINES.—With a reputation of years' standing for their simple engine, W. G. & G. Greenfield, East Newark, N. J., are finding considerable enquiry for their new compound. Many of their simple engines are in use for operating electric plants on well-known yachts.

A COMPOUND ENGINE.—John E. Thropp & Sons, Trenton, N. J., are distributing folders descriptive of their well known compound engine for yachts, tow boats, etc. It is a fore and aft engine, very solid of construction, designed for pressures up to 300 pounds. Copies of the folder are sent to all asking for them.

THE VIADUCT REDUCING VALVE.—The success attained on the lakes by the balanced piston pressure reducing valve made by the Viaduct Brass Works, Cleveland, Ohio, has been of much value in introducing them on the Atlantic coast. The Eastern agent is Mr. C. H. Tucker, 135 Greenwich Street, New York.

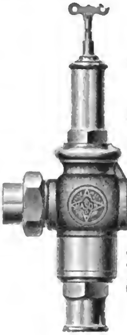
BIG BARROW MAKING.—The volume of business done by the Lansing Wheelbarrow Co., Lansing, Mich., which devotes itself exclusively to barrow making, will surprise many people when they learn that it exceeds seventy-five thousand barrows a year. One of the types of dock barrows is illustrated elsewhere in these columns.

MARINE STEAM TRAPS.—One of the most extensively used steam traps in the world is the "Heintz," which has a great reputation abroad, and which is now being introduced in this country by William S. Haines, 136 South Fourth street, Philadelphia. The latest circular states that over 50,000 of these traps were in use up to last March. Copies of this circular and full detail regarding the trap can be had upon application.

GRAPHITE LUBRICATION.—The following is an extract from a letter which has been received by the Jos. Dixon Crucible Co., Jersey City, N. J. "I have used Dixon's Pure Flake-Graphite on all the main rubbing surfaces, H. P. Valve included, and have much pleasure in recommending it to any one who wishes to improve valve or cylinder faces, combined with a saving of oil." D. Ranken, Chief Engineer S.S. Britannia, Galveston, Texas.

SAMPLES OF PACKING GIVEN AWAY.—If the representations made by Jas. L. Robertson & Sons in their advertisement can be carried out by them, it ought to pay every engineer operating high pressure engines to send for a sample of their indestructible packing. There is a great demand for such a packing, and the manufacturers claim that they have been testing it for nearly three years, and have some strong testimonials.

PACKING FOR HIGH PRESSURES.—The asbesto-metallic packing now being manufactured by The American Steam Packing Co., 60 Federal street, Boston, Mass., is reported as



MARINE ENGINEERING.

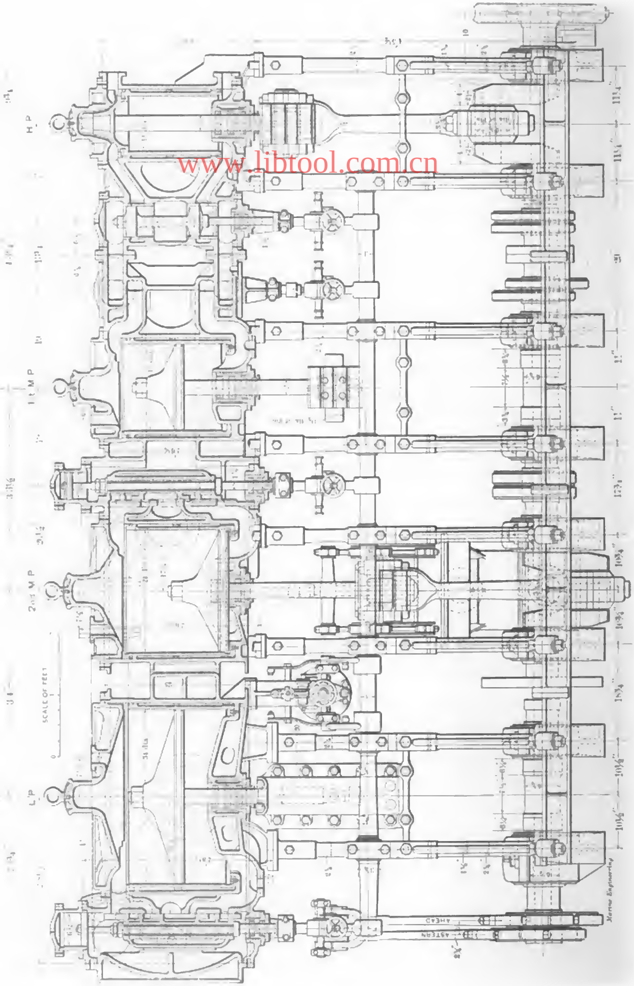
Vol. I. NEW YORK, SEPTEMBER, 1897. No. 6.

U. S. TWIN-SCREW GUNBOAT NASHVILLE FOR SERVICE IN ASIATIC WATERS.

One of the most interesting of the smaller vessels which have recently been added to the Navy is the steel twin-screw gunboat Nashville, built by the Newport News Shipbuilding and Dry Dock Co., at Newport News, Va. To the engineer especially her machinery equipment is of more than usual interest, in that it consists not only of a combination of quadruple and triple expansion engines, but of Scotch and water-tube boilers. From the exterior views here presented it will be seen that the Nashville is a very handsome vessel, clean cut and trim. Her funnels are unusually long and consequently slender looking, but this is offset by the two pole masts, so that a very smart boat is the result. Her general dimensions are: Length between perpendiculars 220 ft., over all 233 ft. 8 in., beam 38 ft., depth of hold 15 ft. 10 in. On a draught of 11 ft. her displacement is 1,372 tons. The contract for the construction of the Nashville, ready for sea, exclusive of armament, was $280,000, and on her trial trip, when her corrected speed was 16.29 knots, she earned a bonus of $45,980 for her builders. She recently went into commission at the Norfolk Navy Yard, to do patrol duty in Key West waters, on the lookout for Cuban filibusters. Before long, however, she will likely be ordered to the China station.

U. S. TWIN-SCREW GUNBOAT NASHVILLE GETTING READY FOR SEA.

The interior arrangements can readily be seen in the longitudinal section published herewith. The Nashville has three decks, and almost straight back, with the upper deck flush right fore and aft. On this deck there are four 4-in., rapid-fire guns, protected by shields, and it is used for working the

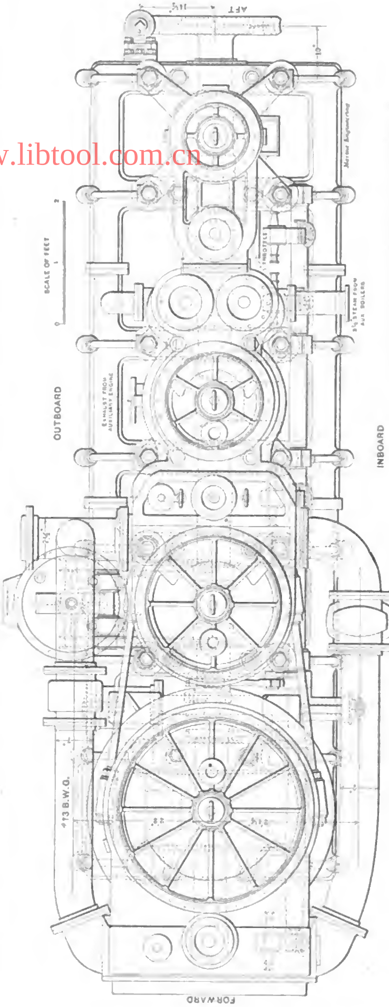


TWIN-SCREW QUADRUPLE-EXPANSION ENGINES U.S. GUNBOAT NASHVILLE.
(*Starboard Engine.*)

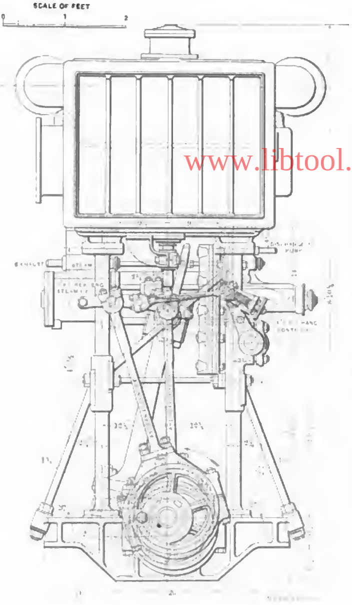
ship. The main deck contains the officers' rooms and executive offices, and also the galley and pantries. On the main deck there are four 4-in., rapid-fire guns in sponsons, protected by 2 1-4 in. nickel steel armor. There are also four 6-pounder quick-fire guns in sponsons on this deck. Two 1-pounders and two machine guns are carried on carriages for fitting in boats or use ashore. Below on the berth deck the crew are housed forward. The bunkers are carried up alongside the machinery spaces on this deck. Below, the engine rooms extend to the inner bottom in this part of the ship, which is carried up to the water-tight sloping deck, and the spaces between the skins are used for fresh-water tanks. On the berth deck the dynamo room, and machine shop, and wash rooms for firemen and machinists, are located between the smoke pipes. Forward and aft of the machinery spaces there are crew's and petty officers' quarters and various store rooms. Below this deck there are ammunition and store rooms and the trimming tanks at the ends. The Nashville is equipped with nine boats, including a 30 ft. steam cutter. It was originally intended that she should carry torpedoes, and a bow port was fitted, but when she was equipped the gear was not put aboard. Below the main deck and including the double bottom under the machinery spaces there are 53 water-tight compartments in the ship.

The machinery consists of two sets of vertical four-cylinder quadruple expansion engines, together with all necessary auxiliaries, and four main boilers of the Yarrow type, and two auxiliary single-ended, single-furnace Scotch boilers. Drawings of the main engines are here given.

When steaming at full speed with quadruple expansion, the main engines run at 300 revolutions per minute taking steam at 250 lbs. pressure per sq. in. in the high pressure valve chest, from the Yarrow boilers, and steam at 160 lbs. pressure per sq. in. in the 1st I. P. receiver, from the Scotch boilers. The engines are fitted with the low pressure cylinder forward, with disconnecting couplings between the L. P. and 2d I. P. cranks. By this arrangement, when cruising at low speeds the L. P. cranks can be disconnected, and the engines run triple expansion by turning steam from the Scotch boilers into the high pressure valve chest. The piping is arranged so that a check valve in position prevents the possibility of the higher pressure steam from the Yarrow boilers under any circumstances flowing into the Scotch boilers. In design the engines are very strong and compact as will be noticed in the engravings, and in workmanship they are beautiful



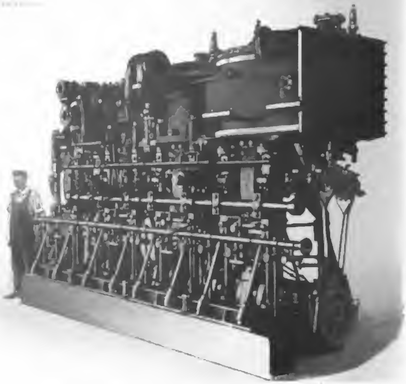
PLAN OF STARBOARD ENGINES U.S.S. NASHVILLE.



END ELEVATION L. P. ENGINE

specimens of mechanical skill. They are rights and lefts with cylinders 11 in., 17 in., 24 in., and 34 in. and 18 in. stroke. The cranks are set 90 deg. apart, the H. P. leading and the others following in regular sequence. Each engine is fitted with one high pressure piston valve 6 in. dia., two 1st I. P. piston valves 6 in. dia., one 2d I. P. double-ported slide valve 26 in. by 24 in., and one low pressure double ported slide valve 37 in. by 24 in. The cylinders are of fine cast iron, with barrels 11-16 in. thick, fitted with liners of close grained cast iron 5-8 in. thick bored vertically in place.

All except the high-pressure are fitted with jackets on lower heads and bodies. The linear clearance in each cylinder is about 5-8-in., divided between the two ends. The piston valve chests are also fitted with liners, and relief valves are fitted on the intermediate and low-pressure chests. The valves are of cast iron, and balance pistons are fitted to the 2d I. P. and L. P. valves. The cylinders are supported by wrought steel flanged columns, carrying the crosshead guides and stiffened with steel tie rods, as shown in the photograph. Composition relief valves, 2 in. dia., are fitted on all cylinders, with casings and drain pipes. The main cylinders and valve chests are clothed with magnesia and lagged with black walnut, secured with brass bands, making a very artistic job. The bed plates are steel castings of I section, in four parts, bolted together and stiffened with ribs, and secured to the engine keelsons by 1 in. forged steel bolts. The pistons are of cast steel dished, each having one packing ring, 1 1-8 in. by 1-2 in., of cast iron sprung into position. The rods are oil-tempered forged steel, 3-in. dia., and are ground true. They work in composition lined stuffing boxes fitted with Watson's metallic packing, which is also used for the valve stem boxes. The H. P. and 1st I. P. valve stems are 1 1-2 in. dia., reduced to 1 1-8 where they pass through the valves, and the 2d I. P. and L. P. are 1 7-8 in. dia., reduced to 1 1-2 in. The crossheads are fitted with manganese bronze slippers, working against white metal on the ahead slides, which measure 10 1-2 in. by 8 in. The pins are 3 1-2 in. dia. by 4 in. long. The crosshead guides are of cast iron, bolted at the top to lugs cast on the bottoms of the cylinders and at the bottom to forged steel cross bars, secured to the engine columns. They are single slides, with metal lips to take the thrust when backing. They



INBOARD VIEW PORT ENGINES U.S.S. NASHVILLE.

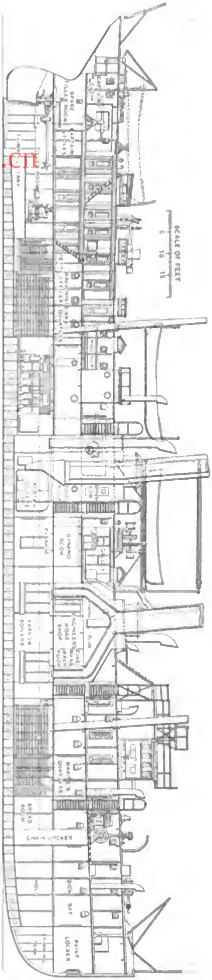
BOW VIEW U.S. TWIN-SCREW GUNBOAT NASHVILLE.

STERN VIEW U.S. TWIN-SCREW GUNBOAT NASHVILLE.

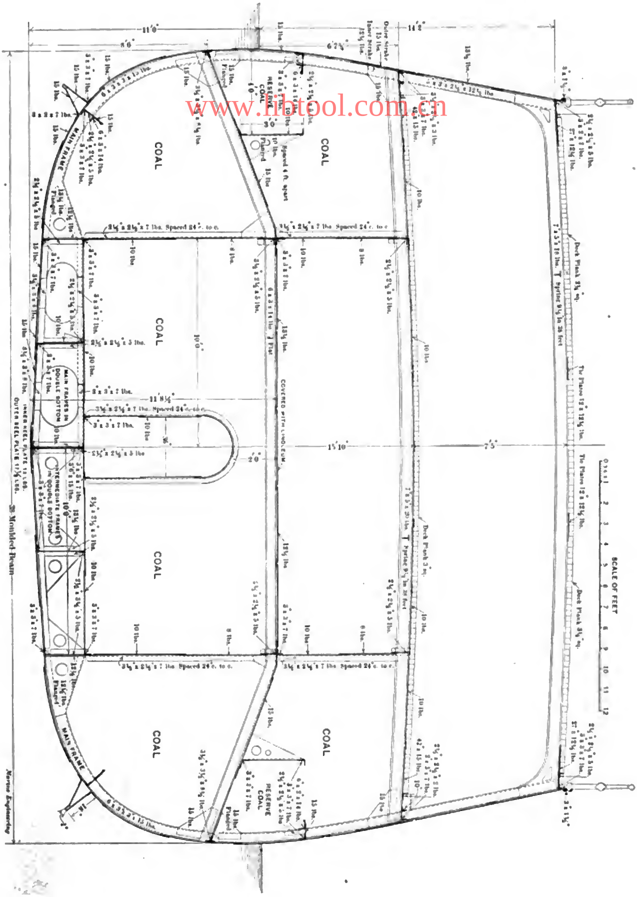
(From Photographs by Rusk & Shaw, Newport News, Va.)

are cast hollow for water circulation. The connecting rods are oil-tempered, forged steel, finished all over, 40 in. between centers, turned 3 3-4 in. at the big end and 3 in. at the neck, with a 1 1-2 in. hole bored through lengthwise. They are secured to the crank pin brasses by 2 in. bolts. Composition distance pieces are fitted between the butt and crown brasses and are removable without taking out the cap bolts. The crank shafts are in three sections, the forward and after sections having each one crank and the middle section two cranks. They are 15 ft. long by 6 1-4 dia. and are bored axially with a 3 1-4 in. hole. The pins are 6 3-4 in. dia. and 7 1-2 in long, with a 3 1-2 in. axial hole. The webs are 7 1-4 in. wide and vary in thickness, thus: H. P. 4 in., 1st I. P. 3 3-4 in., 2d I. P. 3 1-2 in., H. P. 3 1-4 in. The ends are chamfered. Coupling disks are 13 in. dia. and 1 5-8 in. thick, each held together by six 1 5-8-in. forged steel bolts. Valve gear is of the Stephenson, double-bar link pattern, the 1st I. P. valve stems being carried by a crosshead. The eccentrics are cast iron with an eccentricity of 2 in. The backing eccentrics are keyed on the shaft and the go-ahead eccentrics fastened to them by through bolts. The H.P. and 1st I.P. eccentrics have a 2 in. face and the 2d I.P. and L.P. have a 2 3-4 in. face. The straps are composition, finished all over, and lined with white metal. Forged steel is used for the rods, the distance from center of eccentrics to center of link pins being 3 ft. 7 1-4 in. The main links, link blocks, and suspension links are all of forged steel also. Eccentric rod pins are forged on the main links, 11 in. between centers. Composition, lined with white metal, is used for crank shaft bearings. These are turned cylindrical, so that the bottom brasses can be slipped out without taking out the crank shaft. The cap bolts are 1 5-8 in. dia. The reversing shaft for each engine is forged steel, and the link arms are made with a slot fitted with a cast steel block, adjustable by a screw and hand wheel, permitting a variation of cut-off, from about 0.5 to 0.7 of the stroke. The reversing gear consists of a steam cylinder and a hydraulic controlling cylinder acting directly on an arm fixed on the reversing shaft. The working levers are on the inboard side of each engine between the H.P. and I.P. cylinders. An elaborate system of lubrication is provided. Each engine is fitted with a 5-gallon tank overhead connected to lubricators on the engine by 1-2 in. pipe. There is also an additional tank from which oil can be run into the crank shaft bearings under a head, if necessary. A sight feed oil cup is attached to each steam main at the H.P. valve chest, and globe cups are fitted to the piston and balance valves. Water pipes are also fitted to all moving parts.

The exhaust passages from the H.P. steam chest to the 1st I.P. steam chest and from the latter to the 2d I.P. are cast in the cylinder casings. From the 2d I.P. to the L.P. steam chest two



LONGITUDINAL SECTION U.S. TWIN-SCREW GUNBOAT NASHVILLE.

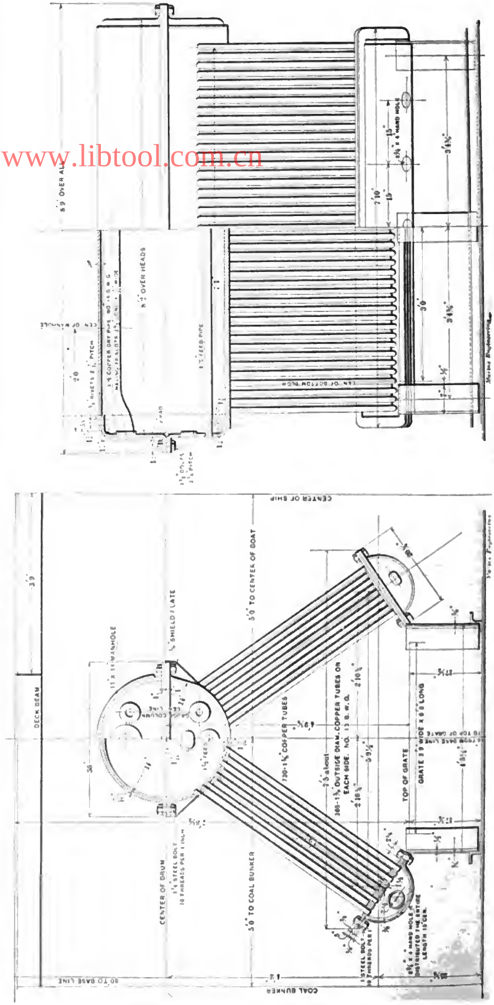


MIDSHIP SECTION U. S. TWIN-SCREW GUNBOAT NASHVILLE.

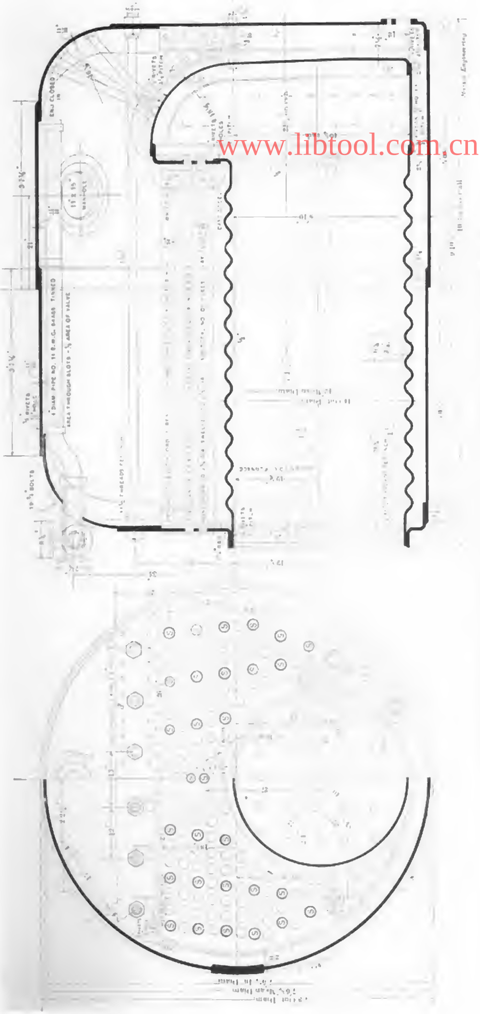
BUILT BY NEWPORT NEWS SHIPBUILDING AND DRY DOCK CO.

copper pipes, one on each side, carry the exhaust. That in the inboard side is 7 in. inside and is fitted with a straight way valve, which is shut when running triple expansion. On the outboard side the exhaust pipe connects with both the L.P. steam chest and the condenser. The branch to the condenser is 7 1-2 in. dia. The live steam pipe from the Yarrow boilers is 6 1-2 in. bore, reduced to 5 in. in the branches at the engines which connect with the throttle valve. The branches from the two auxiliary boilers are 4 in. bore feeding a 5 in. main reduced to 3 1-2 in. in the branches which connect with the 1st I.P. valve chests. Each engine has a double poppet throttle valve 4 in. dia. bolted to the high-pressure cylinder casing.

To run triple expansion the disconnecting coupling between the 2d I.P. and L.P. cranks is uncoupled, the exhaust from the 2d I.P. to the L.P. valve chests shut off and the valve between the 2d I.P. and condenser opened. The Yarrow boilers are shut down, as is also the valve on the 5 in. steam main of the auxiliary boilers leading from the boiler room to the engines. The stop valves on the auxiliary boilers are then opened and the live steam flows from the branch pipes of the two Scotch boilers to the T which leads out to the engine room. A junction is made with this T by the main from the water-tube boilers, between the single 5 in. main leading to the engines and the branches to the Scotch boilers. Close to this junction is the check valve before referred to. The steam from the Scotch boilers meets with no resistance here



YARROW WATER-TUBE BOILERS U.S. TWIN-SCREW GUNBOAT NASHVILLE.



SINGLE-FURNACE RETURN-TUBE BOILERS U.S. TWIN-SCREW GUNBOAT NASHVILLE.

when the Yarrow boilers are shut down, and consequently it lifts the check and flows into the 6 1-2 in. main which leads to the H.P. valve chests.

The thrust shafts are 12 ft. 6 in. long, 5 7-8 in. dia. bored with a 2 7-8 in. axial hole. Each has 9 collars 8 7-8 in. dia. and 1 1-8 in. thick. The bearings are fitted with the usual oil and water cooling arrangements. The propeller shafting for each engine is 46 ft. 2 in. over all, 6 1-8 in. dia. and bored with a 3 in. axial hole.

The propellers are manganese bronze, three-bladed, 6 ft. 8 in. dia., 7 ft. pitch, a true screw. The starboard propeller is right and the port left handed.

The condensers which are fitted outboard are cylindrical, with composition shells and seamless drawn brass tubes. The dimensions are: Dia. of condenser 3 ft., length between tube sheets 8 ft. The number of tubes is 946, giving a cooling surface of 1,238 sq. ft. and for both a ratio of cooling surface to total heating surface of 1 to 2.16. Each propelling engine is fitted with an air pump, 14 3-4 in. dia., secured to the back frame and worked by arms and a rock shaft from the 2d I.P. crosshead. Centrifugal pumps are used for circulation, with 22 in. fliers, 7 in. suction and 6 in. discharge pipes, each driven by a single vertical engine 6 in. by 5 in. An auxiliary air pump is driven by each of these engines by arms from the crosshead. These pumps are 6 in. dia., with 4 in. stroke and suction pipes 2 3-4 in. dia. and delivery 2 1-2 in. dia. The delivery pipe discharges into the delivery pipe for the main air pump and the suction pipe is fitted with a branch for discharge from the evaporator trap. No auxiliary condenser is fitted, the auxiliaries exhausting into a main condenser, or into the 1st I. P. valve chest as desired. There is a very complete installation of auxiliaries, including a number of Blake vertical duplex pumps with composition water ends. The main feed pumps have 7 in. steam and 4 in. water ends with 7 in. stroke. There is also a fire and bilge pump, with steam cylinder 7 1-2 in. and water cylinder 4 1-2 in. by 8 in. stroke, also bilge and sanitary pump with steam cylinder 6 in. dia. and 7 in. stroke, and water cylinder 4 in. dia., and a distiller pump with steam cylinder 6 in. dia. and water cylinder 4 in. dia. and 7 in. stroke. The distilling apparatus includes a Baird evaporator and two double-coil Baird distillers, and a combined fresh and salt water pump, with 3 1-2 in. steam cylinder and 2 1-8 in. water ends by 4 in. stroke. In each fire room there is an auxiliary feed pump.

The weight of both main engines complete is slightly in excess of 28 1-2 tons.

There are four main boilers of the Yarrow type, located in the forward fireroom. Drawings of these published herewith show the details of design. They are fitted in a fore and aft position, one on each side of the keel line; facing in a common fire room athwartship. Each boiler occupies a space 8 ft. 9 in. long, 7 ft. 5 in. wide, and 7 ft. 6 in. high, and weighs with fittings about 6 1-2 tons. The weight of water in each is approximately 1 1-3 tons. The grates are 3 ft. 9 in. wide by 6 ft. 8 in. long. Each boiler has 730 1 3-8 in. O. D. Copper tubes, 13 B. W. G. thick. The grate surface is 25 sq. ft., and heating surface 1,000 sq. ft., a ratio of heating surface to grate surface of 40. All of the material subject to pressure, except the tubes, is open hearth steel. The edges of the water and steam drum sections are planed true and grooved and joined with red lead. The tubes are spaced zig zag, in 9 in. rows 2 1-8 in. centers longitudinally, and 1 7-8 in. diagonally. Each boiler is fitted with a Thornycroft automatic feed regulator.

The auxiliary boilers are two single-ended, single-furnace, Scotch boilers, 9 ft. 10 7-8 in. long by 7 ft. 6 5-8 in. dia. Dimensioned drawings of these boilers are also here given. Each is fitted with one corrugated flue, 40 in. dia., with grate 6 ft. long, and has 98 ordinary tubes of 10 B. W. G. and 30 stay tubes of 6 B. W. G. The heating surface for each is: Tubes, 544.27 sq. ft.; furnace, 47 sq. ft.; combustion chamber, 83.74 sq. ft.; a total of 675.01 sq. ft. The grate surface is 21 sq. ft., giving a ratio of grate surface to heating surface of 32.14. Each boiler weighs with fittings about 11 1-4 tons, and contains about 5 1-2 tons of water. Open hearth steel is used for the plates, and Clapp Griffith for the rivets.

The specifications for plates called for steel containing not more than .035 of 1 per cent of prosphorus and not more than .04 of 1 per cent of sulphur. Transverse specimens of shell plates were required to show a tensile strength of between 58,000 and 67,000 lbs., and an elongation of not less than 22 per cent in 8 in. Longitudinal specimens of the same tensile strength had an elongation of at least 25 per cent in 8 in. The elastic limit was required to be at least 29,000 lbs. For furnace and flange plates the tensile strength required was between 50,000 and 58,000 lbs., and an elongation of 26 per cent, either longitudinally or transversely. Very severe tests were also applied to the rivets, and all boiler tubes were required to stand a hydrostatic pressure of at least 500 lbs.

The boilers were built of two courses of sheets each with curved top sections. The shells are 11-16 in. thick; back plates, 5-8 in., combustion chamber 1-2 in. and furnaces 1-2 in. thick. The inner butt straps are 9-16 in. thick, and outer butt straps 5-8 in. thick, treble riveted with 13-16 in. rivets.

There are two smoke pipes, with tops 80 ft. above the grates. For the main boilers the pipe is 5 ft. dia., and for the auxiliary boilers 3 ft. dia., both finished to an outside dia. of 5 ft. 6 in. They are fitted with ladders on the forward sides. Ash hoists are fitted in each boiler room, and a See ash ejector in the forward fire room. Water for the ejector is supplied with an auxiliary pump, of which there are two, one in each fire room.

Forced draft is provided by three Sturtevant blowers. There are two 36 in. blowers in the forward fire room, with double engines 3 1-2 by 2 1-2 in., with cranks set opposite; and one 48 in. blower in the after fire room with cylinders 4 in. by 3 in. Each blower takes air from the fire room, which insures a good down draught of fresh air, and delivers it to ducts leading to the ash pits. There are also seven fans, driven by electric motors at various points on the berth deck and below, to secure good ventilation in the living quarters.

The electric plant consists of two General Electric direct connected sets, supplying current on the lighting circuits to 240 incandescent lamps, one search light and the usual signal lamps.

There are sixteen coal bunkers with a total capacity of 400 tons, sufficient for a distance of about 7,000 miles at cruising speed.

Severe tests were imposed before acceptance of the finished machinery. The auxiliary boilers were filled full and heated until a pressure of 250 lbs. was reached, and the main boilers and all connections were tested in the same manner to 360 lbs. per sq. in. After being put aboard the main boilers were tested by steam pressure up to 300 lbs., and the auxiliary boilers to 200 lbs. per sq. in. The cylinders, jackets and valve chests of the main engines were subjected to hydrostatic tests, as follows: H. P., 360 lbs.; 1st I. P., 225 lbs.; 2d I. P., 150 lbs., and I. P. to 100 lbs. per sq. in. The exhaust side of the I. P. chests and the condensers were tested to 30 lbs. All pumps, valve boxes and all fittings of feed pumps were tested to 450 lbs., and fire and bilge pumps to 300 lbs. per sq. in.

Plans for the hull were drawn by the Bureau of Construction and Repair, under the supervision of Chief Constructor Philip Hichborn, U. S. N., and for the machinery under the supervision of Commodore George W. Melville, U. S. N., Chief of Bureau of Steam Engineering.

The contract trial over a 30 knot course off the New England coast was conducted by Passed Assistant Engineers W. Strother Smith and C. B. Price, U. S. N., whose report of the trial is here reproduced from the Journal of the American Society of Naval Engineers.

Trial Trip Data.

The trial passed off without a hitch of any kind, the engines were remarkably free from vibration, the bearings were cool without the use of water on them, the boilers steamed steadily, the Yarrow boilers carrying steam almost as steadily as the Scotch type. Live steam was frequently admitted from the main steam pipe into the first receiver, and at times live steam was admitted also into the second receiver. The coal used was Nuttalberg, put up in bags of 112 pounds net.

The trial crew numbered 83 officers and men, including pilots and draftsmen. The engine room force, 44 in number, was directed by Chief Engineer John A. Williams, connected with the Newport News Co., and was divided as follows: chief engineers, 2; engineers, 2; machinists (special), 4; oilers, 12; boiler makers, 2; water tenders, 3; firemen, 8; coal passers, 4; boys, 4; yeoman, 1, and storekeepers, 2. The water tenders and oilers were machinists who had worked on the erection of the machinery.

Draught of water, beginning of trial, forward, ft. and in.	9-10½
beginning of trial, aft, ft. and in.	12- 2
end of trial, forward, ft. and in.	9- 9
end of trial, aft, ft. and in.	12- 0
mean, forward, ft and in.	9- 9¾
mean aft, ft. and in	12- 1
average on trial, ft. and in.	10-11⅜
Displacement (mean), tons	1,364
Area of immersed midship section	370
Wetted surface, square feet	8,881
Speed, mean, knots	16.299
Slip (mean of both screws) per cent	23.5
Speed^3 × area immersed midship section ÷ I.H.P. (*A*)	640.4
Speed^3 × displacement$^{\frac{2}{3}}$ ÷ I.H.P. (*A*)	212.84
I. H. P. (*A*) per 100 sq. ft. wetted surface	28.17

SYNOPSIS OF STEAM LOG.

	Starboard.	*Port.*
Revolutions of main engine, per minute	308.53	308.3
Piston speed, ft. per minute	925.59	924.9
Steam pressure, in boilers, per gauge Yarrow,	252	aux., 154
at engine, per gauge	249	249
1st receiver, absolute	146	144
2d receiver, absolute	72	73
3d receiver, absolute	28	28
Vacuum in condenser, inches	25	25
Throttle valve opening	wide.	wide.
Double strokes of circulating pump, per minute	354	332
Double strokes of feed pump, per min., main	28.5	aux., 29.5
Temperature in degrees Fahrenheit:		
Engine room	103	103
Injection	52	82
Discharge	116	112
Feed, in tank	136	136
Fire rooms	131	105
Air pressure in ducts, mean, inches of water.	1.96	
Revolutions of forced draft blowers, average, per minute	662	
Mean pressure in cylinders, H.P.	71.95	77.18
1st I.P.	45.38	45.57
2d I.P.	26.82	26.87
L.P.	17.50	17.47
Aggregate equivalent pressure referred to L.P. piston	49.74	50.33
I. H. P.:		
H.P. cylinder	184.67	197.88
1st I. P. cylinder	275.23	288.64
2d I.P. cylinder	337.59	338.13
L.P. cylinder	444.11	422.14
Collective, main engine	1,241.60	1,246.79
Circulating pump	7.03	7.03
Three feed pumps	21.74	
Three forced draft blowers	9.54	
Other auxiliaries	2.12	
Collective, main engine and circulating pumps (*A*)	2,502.45	
Total all machinery in use	2,535.85	
Indicated thrust (main engine only), lbs	18,971	19,065
Indicated thrust per sq. ft. of developed blade area, lbs	1,457.07	1,464.28
Indicated thrust per sq. in. of thrust bearing.	6.06	6.09
Cubic ft. swept per minute by L. P. piston per I.H.P.	4.65	4.66
Sq. ft. cooling surface per I.H.P. (*A*)	.99	
Sq. ft. of H.S. per total I.H.P.	2.11	
I.H.P. per sq. ft. grate surface, total	17.86	
heating surface, total.	.474	
ton machinery (penalty weight)	15.37	

Coal.—Kind and quality, Nuttalberg, hand-picked and bagged. Pounds per hour, 7,593; auxiliary boilers, 1,940, Yarrow, 5,653.

On the run from Newport News to Bridgeport, a trial was conducted by Passed Assistant Engineer W. Strother Smith, U. S. Navy, with the engines working triple expansion and the two Scotch boilers under forced draft. The following results were obtained:

Distance run during trial, nautical miles	51
Elapsed time, hours, minutes, seconds	4:33:16
Average speed, knots	11.199
Slip, per cent	10.24
Wind, points from ahead	16
force, navy standard	4 to 6
Steam pressure, average	114.6

		Starboard.	*Port.*
Revolutions, average		180.7	181.52
I.H.P., main engines	H.P.	66.61	67.36
	I.P.	49.21	49.15
	L.P.	93.41	95.12
total		209.23	211.63
collective, both engines		420.86	
all machinery in operation		448.61	
Coal per I H.P., per hour		2.84	
consumed per hour, lbs		1,273.3	
Equivalent consumption, tons per day		13.687	

On this run the coal used was New River steam coal.

The Hon. Theo. Roosevelt, Assistant Secretary of the Navy, delivered a patriotic address at the formal opening of the Naval War College, at Newport, R. I., June 1, in the course of which he said:

"This nation cannot stand still if it is to retain its self-respect, and to keep undimmed the honorable traditions inherited from the men who with the sword founded it and by the sword preserved it. We ask that the work of upbuilding the navy and of putting the United States where it should be put among maritime powers go forward without a break. We ask this not in the interest of war, but in the interest of peace. No nation should ever wage war wantonly, but no nation should ever avoid it at the cost of the loss of national honor. A nation should never fight unless forced to; but it should always be ready to fight. The mere fact that it is ready will generally spare it the necessity of fighting. If this country now had a fleet of twenty battle ships their existence would make it all the more likely that we should not have war."

METHOD OF SECURING AN AUTOGRAPHIC RECORD OF STEAMSHIP VIBRATIONS.

BY PROF. W. F. DURAND.

The purpose of a vibration recorder, the use of which in recording the vibrations of ships has been illustrated in the June issue of this journal, is obviously to record in some autographic manner, relative to the earth or to the mean position of the ship as a whole, the vibratory motion of the ship at the point of application. At any instant a given portion of the ship is necessarily moving simply in one direction. This direction, however, will continually change so that the motion as a whole may become very complex. In all instruments for recording such movements it is therefore customary to analyze the motion into two or three components at right angles to each other. Thus a part of the ship may be describing a more or less irregular oval path situated in a transverse plane, or not even restricted to any one plane. The only manner in which such a motion can be autographically recorded in such way as to show its relation to time is by means of a decomposition into components (1) vertical and (2) horizontal transverse if the motion is in one plane, or (1) vertical (2) horizontal transverse and (3) horizontal longitudinal if it is not restricted to one plane. The vertical component thus shows simply the vertical part of the motion relative to time, or as we may term it, the time history of the vertical part of the motion as a whole. Similarly, the other components give time histories of the other parts of the motion. From such components the motion as a whole may be reconstructed if desired, though this is usually not necessary, as the investigation of the motion and its various characteristics may usually be more advantageously studied from the components, as recorded, than from such a reconstruction of the complete movement.

Taking now the horizontal component for example, we note that its chief characteristic is its more or less irregularly recurrent nature. The maximum displacement goes from extreme right to extreme left and to extreme right again, in general once for each revolution of the engine. This part constitutes the fundamental period or cycle. Within this cycle the history may be either smooth or irregular, as may be seen from numerous examples of vertical vibrations in the curves above referred to.

FIG. 1.

Now, in order to effect the autographic record of a horizontal vibratory motion of this character, a well known principle of mechanics is made use of. This may be illustrated in Fig. 1. P A represents a simple pendulum with weight A supported at P. Now, suppose that the natural period of vibration of this pendulum is 1 sec. and suppose the point P to receive a small horizontal vibratory motion in direction as indicated by the arrows. If such disturbances are timed so as to correspond with the natural period of the pendulum, or one per second, the weight A will gradually acquire a large oscillation far exceeding in amplitude that of the displacement applied. The same phenomenon is familiarly illustrated by the impact of the feet in walking on a bridge where the natural period of vibration of the latter corresponds to the period of the step. A comparatively trivial impact may in such cases give rise to an extremely violent oscillation. If, on the other hand, the disturbances applied at P (Fig. 1) are very much more rapid than the natural period of oscillation, it can be shown mathematically, and results experimentally, that the weight A suffers no appreciable displacement. In such a case the point P and the supporting frame really vibrate about A, which for the time remains practically at rest. Suppose next that we attach to A a marking pen, and to the frame work supporting P a strip of paper moved by clockwork steadily upward relative to the frame. The paper would then oscillate relative to A, and as it moved upward, there would by the combination of motions be traced upon it a curve showing the time history of the horizontal motion of the frame relative to A, or, vice versa, of A relative to the frame. The point to be borne in mind is that in the instrument as ideally constructed for the utilization of this principle the ship and with it the frame of the instrument and the paper itself must all be considered as vibrating relative to the weight A, the latter being the point really at rest so far as the vibratory motion is concerned. In the actual instrument it may be more convenient to attach the marking pen at some point other than A, in the line A P, or its extension. This may be done in order to magnify for record the actual motion of the frame relative to the point A, and is thus merely a geometrical device not otherwise affecting the theory or operation of the instrument. In the actual construction, however, it is not convenient or necessary to carry out these principles to the ideal extent indicated above. The reasons for this departure will be briefly referred to at a later point.

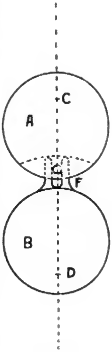


FIG. 2.

It thus appears that the fundamental requirement is a form of pendulum in which the period is somewhat longer than that of the vibration to be recorded. Now on board ship the period of the principal vibration will be that of the engines, which may be taken usually at from 60 revolutions per min. upward. It follows that the pendulum should be such that the period for a double swing should be less than 1 sec., and that of the period as usually stated should be less than 1-2 sec. If a simple pendulum such as P A were to be employed its length would in such case be necessarily greater than 9 in. It is well known, however, that compound pendulums, or vibrating systems, may be arranged in which the time of vibration is much increased without an undue extension of the dimensions. That made use of in the instrument here described is shown in Fig. 2. A and B are cylinders with axes horizontal pivotted at C and D. A fork F attached to B reaches up and engages with a pin attached to A as shown. Now, in order that such a system may oscillate due to the force of gravity, the proportions must be such that a slight lateral disturbance shall involve a rise in the center of gravity of the system as a whole, and, other things being equal, the less such rise the less the return force and the longer the period. Now it is readily seen that such a disturbance will tend to raise the center of gravity of A and to lower that of B. Hence by a proper proportion and arrangement of parts the resultant elevation of the center of gravity may be made as small and the period as long as may be desired. The practical limit arises from the fact that, with a very small return force, the less able is the system to overcome such resistances as friction in the pivots and joints, and between the recording pen and the paper. Hence a compromise is necessary, and for such purposes as we are now considering and with such a vibrating system, a period of 1-2 sec. is not unsuitable, though one of greater length might be preferable. The shorter period is moreover the more permissible from the fact that the slight friction of the system, while not sufficient to disturb the action of the instrument for the purpose desired, is yet enough to exert a restraining influence on cumulative vibration, and also on an irregular continuance of the oscillation after the disturbing impulse has changed its character.

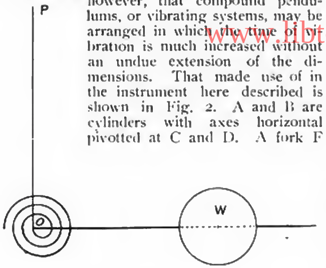


FIG. 3.

The form which this construction takes is shown in Fig. 4. The tracing pen is attached to B (Fig. 2), and reaches upward some little distance so that the record magnifies the actual motion about two and one-half times.

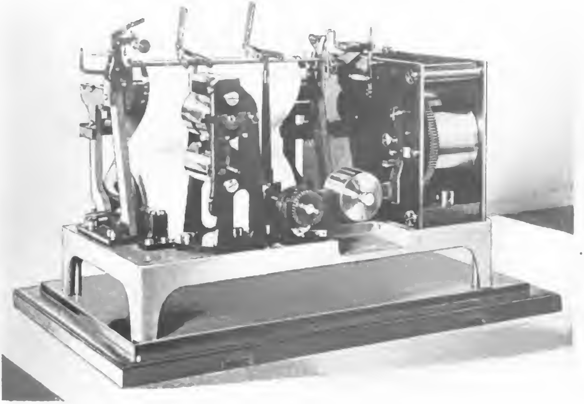


FIG. 4.—INSTRUMENT FOR AUTOMATICALLY RECORDING VIBRATIONS.

Turning now to the vertical component, we find a somewhat different disposition necessary. The displacement is here vertical, and we cannot make use of the ordinary pendulum, as in such case the disturbance would give rise to no return force. Among other means, however, the necessary force may be provided by a coiled spring connected with a horizontal arm and weight, as illustrated in Fig. 3. The tension of the spring may be adjusted, as well as the location of the weight, on the arm, so that for any given position of the latter the spring can be made to furnish the necessary support with the arm horizontal. It is then evident that if in such condition the weight be displaced vertically in either direction, the spring will exert a return force, and the combination will oscillate at a rate depending on the proportions of the system. By choosing these properly any desired period within limits may be obtained. Practically it may be taken about the same as for the horizontal system. Now, in the same manner as in the preceding case, if with such a system the point O be subjected to a periodic vertical disturbance of higher period than the natural rate of the system, the weight W will remain practically undisturbed and the point O and supporting frame work will oscillate about it. The vertical motion is then, by means of the arm O P transferred into the horizontal direction, magnified and recorded by a pen at P on the paper strip, in the same manner as for the other component. The manner in which these principles are carried out may be seen from the construction shown in Fig. 4.

The strip of paper is drawn by clockwork from one roll to another under the pens in the manner common in instruments of this character. A fan with adjustable vanes is provided for controlling the speed, and once the corresponding speed attained, it remains practically constant. A pencil is provided, as shown on the top of the instrument to the left, for marking, if desired, the strip of paper at equal time intervals as determined from a watch held in the hand of the observer. If desired, such pencil might be placed under the control of a magnet energized by a current controlled by a clock marking seconds. Usually, however, the time record is of secondary importance, as the known revolutions of the engine suffice to determine the fundamental periodicity of the record.

For the interpretation of the record, a calibration or comparison of a disturbance of known periodicity and amplitude with its record on the instrument is desirable. With a series of such comparisons at different rates of vibration, it becomes a simple matter to interpret any given record as to the amplitude of the actual vibration, and as to its distinguishing characteristics.

With the instrument shown in Fig. 4, two components, one vertical and one horizontal, may be simultaneously recorded. For the latter, of course, the instrument must be so placed that the plane of vibration of the pendulum is in the direction of the component desired.

The instrument, was designed by Prof. Milne, of the Imperial University of Tokio.

DANISH STEAM RAILWAY FERRIES AND ICE-BREAKING STEAMERS.*

BY CAPTAIN I. C. TUXEN, ROYAL DANISH NAVY.

Denmark, besides the Peninsula of Jutland, consists of a great number of islands, separated from one another by sounds or belts. Most of these waters are shallow, at least near the harbors; only the larger of them may at times be rough. During the winter they are often filled with ice for one or more months; in some cases the ice covers the whole surface, but in other cases the ice is drifting. Across these waters there is a considerable traffic, and great efforts have been made by the State and private firms to continue this traffic uninterruptedly during the whole year. The State railways have provided a floating material, consisting of steam railway ferries and ice-breaking steamers specially adapted for the purpose.

Steam Railway Ferries.

Formerly the traffic was carried across the water in ordinary paddle steamers, but the trouble of transhipment of the goods at each crossing led to the construction of steam ferries. The first steam railway ferry was a paddle steamer, built in 1872 in Newcastle, capable of carrying five freight cars on a single line of rails. The next ferry—similar to the first—was built in 1877. Four larger ferries were built in 1883, and the development has continued, so that the State railways now possess fifteen steam ferries, besides one building.

Table I annexed gives the principal data of these ferries.

Ten of the ferries have a single line of rails, but the five largest have double lines. Twelve of the ferries have paddle wheels, and only three have screw propellers. Two of the latter, fitted with twin screws, are running across a narrow channel, and can work better through ice than paddle steamers could do. The single-screw ferry is really an ice-breaking ferry, and will be described further on.

Detailed description of the ferries is unnecessary, as they are much like ordinary passenger steamers and ferries. Some special features of the class may be mentioned, and a short description of one of the largest ferries will suffice. The first ferries were constructed to take freight cars only, and thus to avoid the transhipments of goods. This principle has been followed throughout the development. Passenger coaches, as a rule, are not taken on board. In some cases a few through coaches are taken, the bulk of the passengers leaving their coaches at the ferries. Comfortable saloons for passenger accommodation are fitted underneath the deck in all the ferries, being well heated and ventilated, and in the later ferries lighted by electricity.

All the ferries have heavy timber fenders round

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* Read before the International Congress of Naval Architects and Marine Engineers, London, 1897.

the outside from end to end, at the height of the deck. The shape of this fender at the ship's ends is exactly the same for all the ferries, so that they may all fit in the different ferry harbors belonging to the seven crossings at which railway ferries are used.

The piers of the ferry harbors are constructed of timber and shaped to the form of the ferry; this goes end on into the berth and is stopped by buffers. A hinged bridge is lowered to the end of the ferry, which is arranged to receive the bridge, over which the cars roll on board or ashore. As there are no great variations in the water level, such as occur in tidal harbors, the difficulties are much reduced.

The lines of rails pass through the whole length of the deck of the ferries, and the cars can be shipped or unshipped at either end, these being alike. The rails are placed directly on the plating of the deck and bolted to it. Underneath the deck beams heavy longitudinal girders are built, one for each rail in the small ferries, and one for each line of rails in the large ferries, to take the weight of the freight cars. The girders are again supported by a number of pillars. The paddle ferries have a rudder at each end, and steam practically as well astern as ahead; they vibrate, however, rather more when going astern.

The arrangements and installations are very similar in all the ferries, and a general idea of them may be had from the sectional drawing of the largest ferry, the Kjöbenhvn, (see supplement), built in 1895, which needs no further explanation. The engines of this vessel are compound, with the cylinders placed diagonally.

TABLE II.—DANISH ICE-BREAKING STEAMERS.

Name.	Built	Builder.	Single or twin screw.	Length between perpendiculars.	Breadth at water line.	Depth moulded.	Draught, forward, ordinary trim.	Draught, aft, ordinary trim.	Displacement.	Draught, aft, with tanks aft filled.	I.H.P. on four hours' full power trials.	Speed.	Cost of building.
				Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Tons.	Ft. In.		Knots.	
Staerkodder.	1883	Burmeister & Wain, Copenhagen..................	Twin	150 0	27 6	14 0	—	10 6	625	11 2	800	—	$122,500
Bryderen....	1884	Kockrun, Malmö...........	Single	131 0	31 8	15 2	11 7	13 0	—	—	—	—	114,500
Mjolner	1890	Elsinore Shipbuilding Co....	Single	135 0	32 8	15 7	10 9	12 9	728	16 0	1350	12.2	116,000
Thor.........	1890	Motala & Lindholm, Sweden.	Single	135 0	32 8	15 7	10 9	12 9	728	16 0	1350	12.2	112,750
Tyr.	1894	Elsinore Shipbuilding Co....	Single	136 0	33 11	15 7	10 9	12 9	735	16 0	1350	12.2	112,750
Sleipner.	1896	Burmeister & Wain, Copenhagen......	Single	161 5	39 0	18 6	12 9	17 9	1450	22 3	2600	12.75	166,500

TABLE I.—DANISH STEAM RAILWAY FERRIES.

Name.	Built.	Builder.	No. of lines of rails.	Paddle or screw steamer.	Length between perpendiculars.	Breadth, moulded.	Depth, moulded.	Full power trial.					No. of cars to be carried.	Cost of building.
								Draught, forward.	Draught, aft.	Displacement.	I.H.P.	Speed knots.		
					Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Tons				
Lille Belt........	1872	Wigham Richardson and Co., Newcastle	Single	Paddle	140 0	26 0	—	7 3	7 3	—	340	8·0	5	$49,500
Fredericia........	1877	Schichau, Elbing.........	Single	Paddle	140 0	26 0	—	7 8	7 3	—	300	8·0	5	47,000
Korsör..........	1883	Kockrun, Malmö.	Double	Paddle	250 0	34 0	16 0	8 10	9 0	1220	1700	13·0	16	156,500
Nyborg..........	1883	Kockrun, Malmö........	Double	Paddle	250 0	34 0	16 0	8 10	9 0	1220	1700	13·0	16	156,500
Hjalmar	1883	Schichau, Elbing.........	Single	Paddle	166 0	26 0	12 0	7 0	7 0	440	600	10·0	6	63,000
Ingeborg.	1883	Schichau. Elbing........	Single	Paddle	166 0	26 0	12 0	7 0	7 0	440	600	10·0	6	63,000
Valdemar..	1886	Burmeister & Wain, Copenhagen ...	Single	Twin screw	140 0	31 6	13 0	7 0	8 0	540	700	11·0	5	69,000
Sjalland..........	1887	Burmeister & Wain Copenhagen ...	Double	Paddle	274 0	34 0	16 0	9 2	9 2	1445	2055	13·4	16	197,000
Dagmar..........	1889	Burmeister & Wain, Copenhagen ...	Single	Paddle	166 0	26 0	12 6	7 9	7 9	495	470	10.2	6	73,500
Marie..........	1890	Burmeister & Wain, Copenhagen ...	Single	Twin screw	140 0	31 6	13 0	7 0	8 0	540	700	11·0	5	76,000
Krprs.-Louise ...	1891	Elsinore Shipbuilding Co.	Single	Paddle	166 0	26 0	12 6	7 11	7 11	570	710	11 0	6	85,500
Alexandra.	1892	Burmeister & Wain, Copenhagen ...	Single	Paddle	177 0	26 0	12 9	7 10	7 11	582	634	10·8	6	86,500
Thyra.......	1893	Burmeister & Wain, Copenhagen.....	Single	Paddle	177 0	26 0	12 9	7 10	7 11	582	600	10·2	6	83,000
Jylland.........	1894	Burmeister & Wain, Copenhagen ...	Double	Single screw	171 0	36 0	19 2	10 9	12 2	1015	1210	12·2	10	135,500
Kjöbenhvn.	1895	Burmeister & Wain, Copenhagen ...	Double	Paddle	274 0	34 0	16 6	8 10	9 1	1392	2155	14·4	18	207,500

There are two high-pressure cylinders, 34 in. dia., and two low-pressure cylinders 62 in. dia.; the stroke is 54 in. There are four cylindrical boilers, with a steam pressure of 85 lb. per square inch. The ordinary full-power speed of the vessel at 9 ft. draught is 12.9 knots ahead or astern, with 1,400 indicated horse power. On the measured mile the vessel has, at the same draught, made 14.4 knots, with 2,155 indicated horse power.

Ice Breaking Steamers.

Formerly, when the sounds and belts were filled with ice, the traffic was carried across in open boats with huge bilge keels, on which the boats could slide on the ice. This was, however, a primitive way, and it was consequently found necessary to build ice-breaking steamers.

Table II gives particulars of the ice-breaking steamers now existing. The five first-named are used for carrying the traffic across the sounds and belts when the steam ferries cannot work on account of ice. The Bryderen belongs to a private company, the four others belonging to the State railways. The fifth, the Sleipner, is used for keeping open the free port of Copenhagen during ice winters, and to assist merchant vessels in getting through the Sound to or from the free port.

The first ice-breaker, the Staerkodder, did not quite answer the purpose. The reason for this was that she was intended to be a good passenger and cargo steamer at the same time as an ice-breaker, and that she was given a very small draught on account of the shallowness of the water where she has to work. As seen from Table II, the length is large relatively to the breadth and draught, which has proved to be a drawback. Further, the vessel has twin screws, and these are too close to the water line, as the tanks aft are not large enough to put the vessel well down by the stern. Consequently the propellers are much exposed, and the blades often break off. At first the propeller blades were of gun-metal, but now they are of cast steel, which stands better against the ice. The engine power also proved to be insufficient for the work, the total indicated horse power being only 800. Experience gained with the Staerkodder was profited by in the construction of the next ice-breakers, and these have all proved to be very successful, both for working through water filled with drifting ice and through a thick layer of ice covering the water. Comparing the Staerkodder with some of the late ice-breakers—for instance, the Mjólner and Thor—it will be seen from Table II what alterations have been made to secure ice-breaking qualities. These vessels are made 15 ft. shorter, 5 ft. broader, and have 2 ft. 3 in. more draught. The draught can be much increased, as the water tanks aft are considerably larger, and the longitudinal stability smaller than in the Staerkodder. The later vessels have a single-screw propeller, and this can be brought well down underneath the water, and is thus better protected than the twin screws of the Staerkodder. The engine power has been much increased, being 1,350 indicated horse power on the full-power trial of two hours' duration.

A short description of the largest and newest ice-breaker, the Sleipner, of which a drawing is published in the supplement with this issue, will serve for all the class. The principal dimensions of the Sleipner are given in Table II. The hull is very strongly built, to be able to resist the enormous pressure of the ice. The frames are placed much closer together than usual, the frame space being 15 in. in the fore body, and 18 in. in the after body, while Lloyd's require 23 in. for a vessel of this size. The plating is further stiffened by six transverse watertight bulkheads, and five web frames in engine and boiler rooms. The outside plating is unusually thick, being 7-8 in. below the main deck in the fore body and 10-16 in. to 11-16 in. amidship and aft. This thickness is, on the average, 50 per cent greater than required by Lloyd's rules for a vessel of that size. The plating is worked flush-jointed, with internal butt and edge straps, to form a smooth surface, on which the ice can take no hold. The longitudinal ties inside the vessel—side keelsons and deck stringer plates—are also well strengthened, and carried through the whole length of the vessel. The shape of the bow is specially designed for breaking the ice. The "water-lines" are very full, and the "bow-lines" fine, the forefoot being cut away. When the vessel is trimmed by the stern for ice-breaking, and steams ahead, the bow presses the ice downward and breaks it. The shape of the bow is like a "spoon;" only that the stem projects somewhat further out than usual in steamers, forming an edge, which facilitates steering in open water. Two water-ballast tanks are built in each end of the vessel for trimming. By filling the two tanks aft, the draught aft is increased 4 ft. 2 in., whereby the propeller comes well below the water surface. The two forward tanks when filled increase the draught forward 4 ft. 11 in. The tanks are filled and emptied through a large centrifugal pump placed in the engine-room. It takes about six minutes to fill or empty each tank. The air pipes of the tanks have the same sectional area as the water-supply pipes, to avoid any undue pressure on the walls and top of the tanks if the pump is not stopped in the moment they are filled.

The machinery consists of a vertical compound engine, with two cylinders of 40 in. and 70 in. dia., by 36 in. stroke. To resist the strain brought on the machinery through shocks of the propeller against the ice, all parts are made extra strong—the shaft, for instance, is 20 per cent stronger than required by Lloyd's rules. A compound engine was chosen in preference to triple-expansion. This was done for the sake of the boilers. When the vessel has to break heavy ice by ramming, going forwards and backwards alternately at full speed, the steam pressure is very fluctuating, which would be trying to the boilers if the high pressure required by triple-expansion engines were used. On the other hand, the saving of fuel gained by triple expansion would not be great for the kind of service required by this ice-breaker. To get a low consumption the boilers are designed with large heating surface to a steam pressure of 100 lb. per square inch. For the same reason the engine is fitted with expansion slide.

The screw propeller is made very heavy, of cast steel, with loose blades that can be shifted while afloat. This is done by the following device, patented by Mr. Olsen, of Elsinore, and indicated in longitudinal section in the supplement. A well is built in the vessel right above the propeller, the top and sides can be shut air-tight. Access to the well is through a hatch in the upper deck. Through a large hole in the bottom of the well works a vertical tube, which can slide down to the boss round a propeller blade. Air is pumped into the well, which thus forms a diving bell. Spare propeller blades are stowed in the well. When the tube is hauled up, the lower opening in the vessel for the well is closed by a steel plate.

When the vessel is working in ice it is difficult to get the necessary cooling water for the surface condenser. There are three sea valves for the entrance of this water; namely, two in the engine-room, placed somewhat apart and at different heights, and a third in the foremost ballast tank aft, which can be opened and shut from the engine-room. When there is much ice, the valves are apt to get choked. The cooling water is then taken from the ballast tank and returned to this again. Now and then the water in the tank is renewed from the sea. If necessary the vessel is stopped to free the sea-valve of ice, as it is not so apt to choke then as when the vessel is moving. In this way it is possible to keep a good vacuum.

The vessel can carry 250 tons of coal. Loaded with 40 tons of coal and all four ballast tanks filled, the vessel easily maintains a speed of 12.75 knots, which requires 2,000 indicated horse power. The engines are able to develop 2,000 indicated horse power, which gives a speed of 13.4 knots when loaded as mentioned.

Probably no more ordinary ice-breaking steamers will be built for the Danish State railways, as ice-breaking railway ferries will be preferred. The first of these, the Jylland, given in Table I, has been built and proved successful. Her main features resemble those of the ordinary ice-breakers, but the length is relatively greater. Experience gained with existing ice-breakers shows that they work in ice as well going astern as ahead, and for this reason it is under consideration to build the next ice-breaking ferry with a propeller at each end, like those in America. The advantage gained is smaller draught; the only fear is, that the vessels being small compared to the American, each of the two engines may be rather small for the work.

PROGRESS OF WORK ON THE NEW BATTLESHIPS KEARSARGE, KENTUCKY AND ILLINOIS.

Work on the three new 11,500 ton battleships, Kearsarge, Kentucky, and Illinois is going forward rapidly at the yard of the Newport News Shipbuilding & Dry Dock Co., at Newport News, Va., and although work on the two first named ships was only commenced a year ago they are nearly one-half completed. Every department in this big yard is making a special effort to get the ships ready for sea. Work on the Illinois was only commenced a few months ago, but the hull plating is already up sufficiently to get a good idea of the finished ship. The illustration on the next page shows the Kearsarge and Kentucky as they now appear, almost hidden from view by the staging.

It has been the practice of this yard, and especially so under the present management, to introduce every possible labor saving device, and from pneumatic hand tools to giant electric traveling cranes this is very noticeable throughout. The structural material for the ships is handled by overhead cantilever-cranes, which will hoist a 13-ton load at the middle of the arm. One is driven by steam, the other by electricity.

Nearly all of the skin plating of the Kearsarge and Kentucky is in place, and the main decks are laid, and the protective decks well in hand. All the steel frame castings are in place, and on the Kearsarge the work of boring out the stern tubes and A frames is progressing. The heavy forged iron rudder frames are due soon at the works, when they will be speedily machined and shipped in place. The new ships are fitted with both bilge and docking keels. The latter extend fore and aft about two-thirds of the ship's length. Incandescent lights are placed at convenient intervals within the hull, so that 'tween deck work can go on in as good light as though the men were at work outside.

Work on the machinery has kept pace with the hulls. When the contracts for these ships were secured the company entered on a series of extensions which has not yet been completed. The original machine shop, 300 ft. long, was increased by a 200 ft. addition, now used as an erecting shop. In this much of the material for the engines of the battleships Kearsarge and Kentucky is ready, as shown in the illustrations. The old and new shops together are a splendid stretch of 500 ft. by 100 ft. floor space, with a height of 70 ft. to the peak of the roof. Both shops are served by electric traveling cranes, which can handle weights up to 100,000 pounds. Down the center of the shop a standard gauge railroad line, connecting with the system in the yard, permits the taking in of any work, direct from the railroad, alongside the machines it is intended for. Both the old and new shops have galleries, under which the small machine tools are arranged, and served by overhead electric jib cranes. The Kearsarge and Kentucky will each have two sets of triple-expansion engines of 10,000 I. H. P., propelling twin screws. The crank shafts and tail shafts are 14 3-4 in. dia., and the line shafts 14 in. The propellers are 16 ft. 9 in. dia. and 17 ft. pitch, each having 3 blades. The steel bed plates for the Kearsarge and Kentucky are laid out on blocking, with the crank shafts and bearings in place ready for the frames and cylinders and motions, as shown in the engraving. There is so much head room that the use of pits in the erecting shop is unnecessary. (The cylinders for each engine are first put top down on blocks and the frames, which are of forged steel, are fitted.) When this work, which is now going on, is finished the frames will be taken down and set up on the bed plates in their proper positions and the cylinders also hoisted on top. Six such engines as the battleships will carry make a very considerable showing of finished work in the erecting shop. On every side there are piles of piston and connecting rods, pistons, big ends, finished covers and valve gear, while the long lengths of finished shafting give a touch of resemblance to a gun factory. The machine and tool work is apparently of the very finest quality. In every detail a carefulness of finish is observable that in commercial work would be considered "impossible." Propeller hubs which are of manganese bronze, are a good example. These are machined as accurately as the bore of a cannon and even the curved outside portions between the blade seats are filed to a finished surface. In the boiler shop there is great activity and much of the work for the new ships is completed. The heavy machinery in this shop handles the work with ease. As the boilers are completed they are grouped in the yard, a recent view taken by our photographer showing the present accumulation. The Kearsarge and Kentucky will each have three double ended boilers and two single ended, all to work at a pressure of 180 pounds per square inch.

BATTLESHIPS ON THE STOCKS AT NEWPORT NEWS SHIPYARD.

Among the improvements and additions before mentioned, which are taking shape, is a more extended use of compressed air. For some time the yard has done much small tool work, such as riveting chipping and caulking, by compressed air. This has been supplied by a compressor with a capacity of 560 cubic feet a minute. A new machine has been installed very recently with a capacity of 1,600 cubic feet, and a considerable extension of the application of this power is planned. In the boiler shop, for example, compressed air will be used exclusively for expanding tubes, tapping stay holes, and dressing plates. For the work of portable machines compressed air is preferred to electricity in the yard as a result of past experience. Another application will be the more novel one of driving by compressed air a large band saw mill now going up. The air will be converted into power by an ordinary steam engine, which will exhaust into an apparatus for ejecting the sawdust of the mill into the adjacent river; a use to which exhaust steam or electricity could not be put. Heretofore the company has bought its lumber dressed, but when the mill is in operation shipments of logs will be made by water alongside the mill and every foot used in the yards will be sawed there. All the wood which is used in the battleships is fire proofed with the exception of teak wood. The fire proofing is carried on in special apparatus capable of handling about 30,000 ft. of lumber a week. This consists primarily of a horizontal cylindrical pickling tank open at

GENERAL VIEW OF ERECTING SHOP STAGING AROUND ENGINES IN BACKGROUND.

GROUP OF DOUBLE-ENDED SCOTCH BOILERS FOR BATTLESHIPS.

TEMPLATES FOR FORWARD ENDS OF ARMOR BELT, IN MOULD LOFT.

BED PLATE AND CRANK SHAFT OF BATTLESHIP ENGINE.

(Views taken for Marine Engineering in Newport News shipyard by Rusk & Shaw, Photographers.

one end and fitted inside with rails, on which carriages which carry the lumber are rolled in and out. The tank is closed with a water tight door, and is tapped by pipes leading from vacuum and pressure pumps handling various chemical solutions. Another new apparatus, work upon which has commenced in the shops, is a 140 ton jib crane, which will be operated entirely by electricity. This will be one of the most powerful of its kind anywhere.

The shops of the outfitting department are filled with work for the ships. Valves innumerable are ready for use, and besides there are many auxiliaries nearing completion and fittings for the plumbing and the sanitary and drainage systems of the vessels. The electrical apparatuses which will be used in the operation of the turrets and guns of the Kearsarge and Kentucky, will be furnished by outside contractors. This also will be the case with the hydraulic pumps which will do similar duty in the Illinois.

With the additions which have recently been made this yard is one of the best and most modernly equipped in existence, not excluding the best of the European establishments. The general superintendent is Sommers N. Smith, who is assisted by George Clarke, who was formerly and for many years the superintending engineer of the American line. To these gentlemen and to C. B. Orcutt, president, we are indebted for facilities afforded in inspecting the work and taking the photographs presented herewith.

Submarine Boat Plunger Launched.

The United States submarine torpedo boat Plunger was launched at the Columbian Iron Works, Baltimore, August 6. This is the second vessel built from the plans of John P. Holland which has been put in the water recently. The other boat, the Holland, built by the Holland Torpedo Boat Co., at Nixon's yard, for private account, was illustrated and described in our June issue.

Although the Plunger was built under the supervision of John P. Holland and under his patents, certain modifications of design were imposed by the Navy Department, and thus in many ways, the boat differs from the Holland. The Plunger is of the familiar model, as will be seen in illustrations, being not unlike a gigantic Whitehead torpedo. She is 85 ft. long, over all; 11 1-2 ft. extreme dia., and has a total displacement of 168 tons, and light displacement of 154 tons. She is propelled on the surface by 3 independent sets of triple expansion steam engines, developing 1,625 I. H. P., and taking steam from a water-tube boiler, fitted with fuel oil burners. Submerged she is driven by an electric motor of 70 horse power. The armament consists of 2 under water torpedo tubes and a supply of 5 Whitehead torpedoes. At full speed when awash the Plunger is expected to have an endurance of 12 hours, and at slow speed a radius of action of 1,000 miles. Submerged she will have an endurance of 10 hours, at 6 knots speed.

When running awash the hull will be 3 feet below the surface, and the only portion visible will be the steel armor turret, 4½ ft. high, protecting both the smoke pipe and the pilot. When about to dive, the fuel supply is cut off, and the furnace sealed; at the same time an electric device lowers the smoke pipe and air shaft, and closes the turret opening with a sliding valve. Water is simultaneously admitted to the ballast tank, and in less than a minute the boat can be 3 fathoms down, running at the submerged speed. In the interior the machinery and appliances are very snugly fitted. In the forward end the torpedo gear is fitted, and aft of this comes the boiler clothed in asbestos, and then the engines, auxiliaries and the dynamo and switchboard. Still further aft there is an air compressor. There are ballast tanks forward and aft and in the double bottom which can be emptied either by ejectors, power, or hand pumps. Her position axially in the water is regulated by automatic apparatus, and she can be steered in both vertical and horizontal planes, simultaneously, by the navigating officer. For the views of the launching and for particulars of the boat we are indebted to the courtesy of C. A. Morris, of the company.

STEEL CONSIDERED AS A MATERIAL FOR SHIP CONSTRUCTION AND MACHINERY.

BY C. A. McALLISTER, FIRST ASST. ENGINEER, R.C.S.

In shipbuilding, probably more than in any art of construction, the selecting and testing of materials to be used is of prime importance. Now that steel has supplanted both wood and iron in this field, it is naturally the material which should be given the most attention. The first use of this metal for shipbuilding in this country is of comparatively recent date, as it was not until 1884 that the first all steel vessel was completed. Since that time great improvements have been made in the manufacture of steel, until now it is not only far superior to the best wrought iron, but of still more importance, a great deal cheaper. When first used in the construction of marine boilers, it was not only very expensive, but somewhat unsatisfactory as well. Many boiler makers were prejudiced against it, claiming that it was too unreliable for flanging and that it would not stand the great variations in temperature without cracking. At the present time it is safe to say that there are no marine boilers being built of wrought iron; thus demonstrating how these prejudices have been overcome, and what rapid advances have been made by the manufacturers of this material. In the construction of the new Navy, the Government has set the standard for the requirements under which steel has been manufactured for both hulls and boilers. These requirements have often been the subject of criticism and complaint, but the fact remains, as will be admitted by the manufacturers themselves, that these severe restrictions have spurred them on to raise the quality of their output; with a result that has been beneficial not only to shipbuilders, but to the makers as well. At the present time our mills are turning out the very finest grades of steel obtainable, and at a price which effectually bars competition from foreign countries.

As is well known, steel made by the Bessemer process is totally unfitted for use in marine construction on account of its lack of homogeneity, although instances may be cited where it has been used for hull plating. Steel made by the open hearth process is now almost universally adopted. Whether basic open hearth or acid open hearth steel is the better is an open question. Both processes have staunch adherents, but from such tests as I have seen of the products of the two systems, I would prefer acid steel, especially for plates which are to be flanged. For hull plating and shapes the usual requirements are a tensile strength varying from 55,000 to 65,000 lbs. per sq. in., and an elongation of not less than 25 per cent in a uniform length of 8 in. It is also customary to require specimens cut from the transverse edges of the plates to be bent over cold, flat on themselves, without showing signs of fracture. These requirements are very easily fulfilled and give a metal which is very ductile. It is not advisable to use steel of a high tensile strength for hull construction on account of its liability to fracture should the ship run aground or come in collision with another vessel. In ordering hull plating and shapes it is well to restrict the mill in regard to the limit of weights that will be permissable. Ordinarily plates as turned out from the mill will vary from 5 to 10 per cent below the calculated weights, to as high as 15 per cent in excess, due to negligence on account of the roller or in some cases to a desire of the men to increase their wages by turning out a large tonnage, where they are paid on that basis. This increase in weight of plating, it will readily be seen, will often result in increased draught and displacement of the vessel, to the discredit of the designer. If plates are rejected when they are more than 3 per cent in excess of the calculated weight or less than 5 per cent short, it will be found that the actual weight of the plating is surprisingly close to the original estimate. In an order embracing about 350 tons of hull plates I have seen the actual weight but 600 pounds less than the calculated. In such close restrictions on weights it should be borne in mind that the designed thickness is not always obtained. Many of the smaller patterns in an order are cut from large plates, which, owing to the spring of the rolls, are considerably thicker at the middle than at the edges. Thus, while fulfilling the requirements as to weight, it will be found that patterns cut from the edges of the plate are thinner than those cut from the center. In ordering hull plating another important point is to specify that tensile test pieces should not be cut from plates which are less than 1-4 in. in thickness. Plates which are rolled thinner than that always show a higher tensile strength and a correspondingly lower elongation, owing to the greater amount of rolling which they receive.

The rapid increase in the working pressure of steam used in connection with triple and quadruple expansion engines has called for higher tensile strength of boiler plates. As the thickness of the shells of large marine boilers has now almost reached the practical limit, a still higher tensile strength is demanded. With the advent of nickel steel the desired increased strength, and consequent decrease in thickness, seems to have been obtained. Thus far the use of nickel steel has been somewhat delayed on account of its expense and the seeming impossibility of getting smooth surfaces on the plates. This latter difficulty I am informed is being gradually overcome by one of the leading mills at Pittsburg, where a series of experiments has been conducted with various devices for the removal of the scale while the plates are being rolled. Carbon steel plates with a tensile strength as high as 80,000 lbs. have been made and used, but it is the opinion of many steel makers that such plates are liable to crack when subjected to the varying temperatures experienced in every day use. The ordinary requirements for shell plate now are a tensile strength of 60,000 to 68,000 lbs. per sq. in., and an elongation of not less than 25 per cent in a length of 8 in. Transverse samples cut from the plates are required to be bent over a curve whose diameter is equal to the thickness of the plate, after being heated to a cherry red and quenched in water at a mild temperature. For flange plates and plates coming in contact with the fire, the usual requirements are a tensile strength of not less than 50,000 to 52,000 lbs. per sq. in. and not greater than 58,000 to 60,000 lbs. The elongations usually called for are equivalent to a stretch of not less than 28 per cent in a length of 8 in. The bending requirements are usually the same as those for the hull plates, although no difficulty is experienced in hammering such test pieces down flat on themselves, without fracture. All of the foregoing requirements are easily complied with by the first-class steel makers, and results far in excess are daily obtained.

In order to do away with the central circumferential seam in single ended Scotch boilers, many are now designed with the entire shell in two plates. At first the manufacturers did not take kindly to rolling such enormous plates, but after some experience they are now willing to roll plates weighing as high as 10,000 lbs. each, and shearing to so great a width as 119 in. The advantages of such wide plates, with the consequent omission of one circumferential steam, are too apparent to need mentioning here.

In order to avoid excess of weight in marine boilers, some restrictions should be put on the thicknesses of the plates. In no case should the shell plates be rolled with the thickness at any point less than that for which it is designed. With the rolls in their ordinary condition it will be found in rolling a plate 110 in. or more in width that the thickness at the center is often as high as 1-8 in. in excess of that at the edges. With newly turned rolls and great care on the part of the roller this variance can be considerably reduced. The following allowances represent a fair limit of variation between the desired and the extreme thicknesses at any part of the plates. Plates under 60 in. in width not more than .04 in.; from 60 to 90 in. in width, not more than .05 in.; from 90 to 110 in., not more than .07 in., and for plates over 110 in. in width, not more than .09 in. thicker at any point than that specified.

In the manufacture of cast steel, as well as plate steel, the improvements have been rapid. While the first vessels of the new Navy were building it was almost impossible to obtain steel castings for cylinder heads and pistons which were not full of blow holes and unfitted for use. In many instances nine or ten castings were made before a sound one could be obtained. For a time it seemed as if no cast steel would be used for marine work. In the last four or five years, however, cast steel is coming in use to a greater extent than was at first anticipated. It is of rare occurrence that sound castings are not obtained at the first or possibly the second attempts. Pistons, cylinder heads, cross heads and slippers, propellers, and even crank shafts are being made from cast steel, with excellent results. The usual physical requirements for this material are a tensile strength of not less than 60,000 lbs. per sq. in. and an elongation of not less than 15 per cent in a length of 8 in. for all castings for moving parts of the machinery, and at least 10 per cent for other castings. Samples cut from castings for moving parts of machinery are required to bend through an angle of 120 deg. without showing cracks or flaws, and through an angle of 90 deg. for other castings. These requirements are very lenient, and are almost always exceeded, as all castings are annealed before they leave the foundry. One sample in particular, I remember, would have fulfilled the requirements for boiler shell plates, as it gave a tensile strength of 63,000 lbs. and an elongation of 27.5 per cent in 8 in., while the bending piece was hammered over so that the ends were parallel without breaking. For shaft struts, stems, stern posts and rudder frames cast steel has no equal.

CRANK AND OTHER SHAFTS USED IN THE MERCANTILE MARINE.*

BY G. W. MANUEL, R.N.R.

I have selected this subject, as the failure and breakage of shafting in the mercantile marine, though not so frequent, still goes on, as recorded in the newspapers, causing loss and detention to the shipowner, and anxiety to all concerned. Papers have been read and discussed, here and elsewhere, connected with this subject, chiefly dealing with the calculations relating to the twisting and bending moments, effects of the angles of cranks, etc. It is not my intention to trouble you with calculations on this, your Jubilee trip, but rather to give you the results of experience of the working of these shafts, under the calculations already made for us by the Board of Trade and Lloyd's Register of Shipping, which govern the minimum dimensions of all these shafts in the mercantile marine of this country. I will begin by allowing that all shafts fitted in new steamers are likely to be in line, and fair with one another from crank to propeller shaft, when the completion of coupling-up is done after the steamer is launched and is water-borne, therefore I do not take fitting of this description into account. After the bearings are adjusted, engines set to work, and the voyage begins, and the power to give the required full speed exerted, then, owing to insufficient bearing surface, the oil for lubrication gets squeezed out, and the metal of the shaft and bearings gets too close together, causing excessive friction; hot bearings commence, and it may be one or two bearing nuts are slacked back, and salt water as well as oil, used for the rest of the voyage, causing the bearings to get rough. The shaft is strained by alternate bending, heating, and cooling suddenly, and when continued, it gets out of line; fractures begin, until the shaft breaks at sea, or has to be taken out on arrival in

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*Read at the International Congress of Naval Architects and Marine Engineers, at the Imperial Institute, London, 1897.

port. I have known the crank pin bearings under such circumstances to require renewal after a voyage of only 6,000 miles, in spite of many gallons of oil wasted, and the main bearing to require to be lined up after running half that distance. The failure in this case is due to the engine builder, who also may have had pressure put on by the owner to get the engines into as little space and made as light as possible, added to the rivalry due to competition with other builders.

Allowing that the bearing surfaces are of good proportion, damage to shafts occurs from want of proper lubrication, or dirt and grit getting into the bearings, and the engine not being slowed down or stopped in time, before the heat becomes excessive so as to melt the bearing metal. Cold sea water is suddenly applied while the surface of the shaft is expanded by heat, causing the surface flaws to commence by sudden contraction locally, or hidden flaws to open out, especially where the shaft is made of non-homogeneous material, which may eventually cause it to give way, or to be renewed in harbor. The failure in this case is primarily due to want of judgment, or neglect on the part of the engineer or men in charge.

It has sometimes occurred when loading vacant parts of holds adjacent to the engines, that hundreds of tons of metal blocks or bars have been put in a short space, with ordinary light cargo in the same hold. The steamer's hull becomes locally deflected with such treatment, also the shaft, and under the influence of heavy weather combined, the shaft is strained and flaws commence, ending as before. This failure is due to want of consideration by those in charge of the storage of the vessel. I would here mention that weak engine seatings, defective bearings, brittle steel bedplates and framings supporting the engines, have caused the breakage and failure of shafts. These failures are due to ship and engine-builders' designs.

It is well known that engines in twin screw steamers, originally designed to lessen the danger of accident, have not lessened the breakages of their shafts, though they have been able, after the shaft of one engine has given way, to make their port with the other engine. I refer more particularly to the large class of ocean steamers and also smaller class, both having large horse-power. In some cases the shafts have been insufficiently supported by the ship's hull, at a considerable distance from the center of the vessel, their bearings far apart, and the screw shaft unprotected and exposed to shocks of the sea in bad weather, added to the continual strains due to vibration of the ships themselves, which is in some cases considerable, causing alternate elongation and compression in the direction of the length of the shaft, and creating flaws on the surface circumferentially close to couplings and bearings, which eventually cause the destruction of the shaft. These failures are due to inefficient design of hull and bearings at the stern part of the vessel.

Hollow crank and screw shafts have been seldom used in ocean-going steamers of the mercantile marine; and except a test hole bored in the center of steel shafts forged from the ingot to ascertain if there is any cavity in the center, or what is termed piping, which hole does not exceed 2 1-2 in. dia. in large shafts, made by the manufacturer, these shafts are generally solid shafts. Shafts generally give way from flaws near the surface, and would give way earlier at sea if they were hollow and not supported by the metal next the center. I have seen several solid shafts with serious flaws extending inwards 3 in. from the circumference bring the vessel full speed into port, whereas if made hollow they would have broken at sea. In cases where hollow shafts were used they gave out at sea. Failures in these cases are through design. Where improvements have been made to remedy the defects I have mentioned, ocean-going steamers are now driven at full speed on a voyage of 12,000 miles with no salt water on the bearings for years, and free from mishaps. I may here say that the use of triple and quadruple engines, by reducing vibration as compared with the irregular motion of the two-crank engines, tends to increase the life of these shafts, and that part of the power formerly wasted in vibrating the vessel is now utilized in propelling it. In spite of all these improvements relating to design, there remains the serious question of defective and variety of quality of the material which these shafts are composed of, and many have given way at sea and also been condemned through no other cause than original defects in material and process of construction.

Iron is now less used, especially for crank shafts; steel is gradually taking its place in ocean-going steamers, except for propeller shafts. Iron shafts are, I may say, made up of thousands of small pieces of selected iron, generally termed scrap, cuttings of old iron boiler plates, good navy ship iron, cuttings off forgings, old bolts, horse shoes, angle iron, all welded together, forged into billets, re-heated, and rolled into bars, cut into lengths, and formed into slabs of suitable size for welding up into the shaft. Before the use of steel generally, considerable improvement on the old method of fagoting, so-called, has been made, more powerful forging hammers used, along with more suitable furnaces and fuel; still, with all this care, I may say there is not an iron shaft without flaws or defects more or less, and when these flaws became placed during the construction of the shaft, in proximity to the greatest strain, and though there was no hot bearing—which no doubt would have made matters worse—they often extended until the shaft became unseaworthy. Even with the best wrought iron that could be made of the finest scrap from the best qualities of selected brands, iron shafts are 60 per cent inferior in strength to the best mild cast steel made on the open-hearth system, cast into ingots, and forged down under the hammer or hydraulic press.

After the introduction of mild steel for the construction of vessels there resulted an accumulation of cuttings from ships' plates, etc., and it was then considered desirable and economical to work this scrap steel into piston rods and shafts. But shafts made in this manner, though stronger than iron, as regards tensile strength, contained similar defects to that of iron, added to inequality of the material, in some parts hard and in others soft; also being made up of thousands of pieces, some of different steels, and the presence of dirt, etc., along with the fact that steel requires more care in welding than wrought iron, the shafts and piston rods made in this manner were found inferior to that made of good homogeneous steel forged from the ingot, or even good wrought iron, and some gave way.

I may here state that in the Peninsular and Oriental Company's service steel was used for crank shafts forged from the ingot as far back as 1863, then manufactured in Prussia by Messrs. Krupp, and generally known as Krupp's steel; the tensile strength was about forty tons per square inch, and, though free from flaws, they broke without warning. This steel was too brittle to withstand the strains of the engines, and its use was discontinued in the service and iron shafts again resorted to. Great improvements have been made by Messrs. Krupp since then, and I am informed that their shafts are now of excellent quality.

Attempts have been made to manufacture crank and other shafts machined direct from the mould after being annealed. The result generally ended in failures, as the material was wanting in that ductility and toughness necessary in crank and other shafts, and I think they are now seldom used.

The term mild steel applied to shafts in a general manner does not in my experience represent the condition of the shaft. I have found there are very great differences in the value and quality of mild steel, even as much as I found in wrought iron, depending largely on the qualities of the iron used and the chemical and moulding operations of converting it into steel. Also the amount and description of mechanical work applied when being forged into shafts. I attach a table showing these differences by actual test—Tables I and II. Mild steel was first used by the Peninsular and Oriental Steam Navigation Company in 1880; the dimensions of the shafts were limited by the same rules as those for wrought iron shafts. The steel was made by the best makers, having a tensile strength of 24 tons per sq. in., it being then considered inadvisable to exceed this limit on account of former experience with high tensile steel. The shafts made were crank shafts, and are still running; have been in use seventeen years; up to the present date no flaws of any description have been seen. The engines have been tripled, using the same shafts and bearings, and the working power increased. The percentage above the Board of Trade and Lloyd's rules, which fix the minimum size, is 24 per cent; a percentage above must be allowed, and has been the experience of all shipowners, varying from their record of mishaps and losses, and condemnation of shafts by the surveyors of the Board of Trade and Lloyd's Registry. Since these shafts were first used the tensile strength of mild steel has been gradually increased, and we are now using it at 32 tons per sq. in. possessing equal, if not more, ductility and toughness, to endure even greater strains than formerly. This has been arrived at by continued improvement in the manufacture by the makers, so that the percentage allowed above the rules is now reduced to only 6 per cent, leaving a very slight margin (Table III). I mention this as there is an opinion that the reason some shafts are so free from mishaps is owing to their dimensions being so much above the rules that regulate those sizes, instead of to the superior quality of the material used (Table II). The table given shows the results of steel tests made from 1880 up to the present time, independent of that done by the Board of Trade and Lloyd's.

TABLE I.—TESTS OF WROUGHT IRON USED FOR SHAFTS.

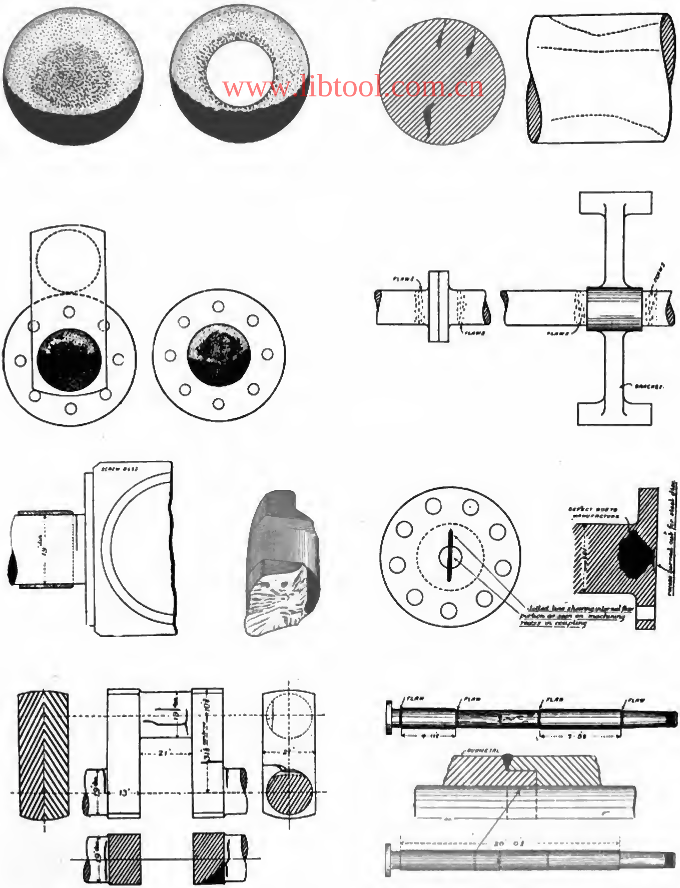
Tensile Tons.	Elongation in 5 in. per cent.	Bend	Fractured Blows.	Broke Blows.	Fall of 10 cwt. in Inches.	
			Ordinary shafts.			
18	22	Good	9	11	13	C
Best	double	rolled	scrap	4½ cwt.	blooms	
18.6	24.3	Good	17	18	12	C
Best iron, three		good	qualities,	rolled	into	flat bars, and
	cut	into	4½ cwt.	blooms		
22	25	Good	21	32	12	C
22.9	21	"	12	14	"	T E ☐
21.9	25.7	"	15	21	"	P
22.3	26.7	"	12	19	"	C
22.4	28.6	"	22	30	"	P
24	27.6	"	20	28	"	Piston rod. 10 in. dia. B ☐

TABLE II.—TESTS OF STEEL.

Tensile Tons.	Elongation in 5 in. per cent.	Bend.	Fractured Blows.	Broke Blows.	Fall of 10 cwt. in inches.	
24	—	Good	52	60	12	
27	25.9	"	76	81	"	
28	21	"	26	32	"	F O
29.1	26.1	"	67	80	"	C ±
29.6	28.4	"	71	78	"	
29.7	27.1	"	70	86	"	D ÷
[1]30.7	25.2	"	75	89	"	A +
32	26	"	70	89	"	
31.2	26	"	74	84	"	

[1] After being nicked all round with a chisel, this piece (A) was broken under a heavy hammer and stood 22 blows.

Propellor shafts, until lately, have mostly been made of good wrought iron; steel, where it has been used in stern tubes and outside, where exposed to the action of sea water, has in many instances been reduced in diameter in a very short time, and in some cases the shafts have given way, and in others had to be taken out through corrosion. There is no doubt that steel, when exposed to sea water, corrodes more rapidly than wrought iron. Where steel is used and protected from the action of sea water it can be used with advantage. Different methods have been adopted to protect the steel. I give you one which has been so far successful. The best method would be to make the gun-metal covering in one piece, but this is an achievement not yet reached in large marine engineering practice. Before explaining the diagrams and tables I would add a few words about nickel steel.



SKETCHES SHOWING DEFECTS IN CRANK AND PROPELLER SHAFTS.

Nickel steel has been lately used for the construction of shafts, and, while possessing a higher tensile strength, about 40 tons, it also possesses increased ductility and toughness. But, as the price of this material is above that of the best mild steel, the shipowner would gain nothing by its use unless a corresponding reduction was allowed in the diameter, and, consequently, the weight of the shafts, for which purposes a modification of the Board of Trade and Lloyd's Rules would be desirable; this should only be granted on condition that a more severe test be applied than those at present, so that good and bad steels may be easily distinguished. In 1881, when mild steel was coming into use for shafts, in order to compare its value with the usual and best wrought iron, I had test pieces cut out of iron and steel shafts, made to the same dimensions, and tested in the same manner; the dimensions were 1 1-4 in. square by 13 in. long.

TABLE III.

Year.	Percentage of Strength above Board of Trade Rules.	Tensile, Tons.	Material.
1879	26	18	Wrought iron
1881	24	21	Steel
1887	14	28	"
1892	11	31	"
1897	6	32	"

No. 1, cut from a rolled bar of best Staffordshire iron, not machined, broke at one blow. No. 2, cut from large chain iron, forged down to size and machined, broke at twenty blows. No. 3, cut from a new best wrought iron crank shaft forging, "machined only," broke at eleven blows. No. 4, cut from a new best mild steel crank shaft forging, and "machined only" stood sixty blows before breaking. These simple tests showed the great superiority of mild forged steel above that of the best forged iron for the construction of shafts.

After an experience of sixteen years, I have neither flaws nor breakages to report, while gradually reducing the margin of safety of these steel shafts from 24 per cent to 6 per cent.

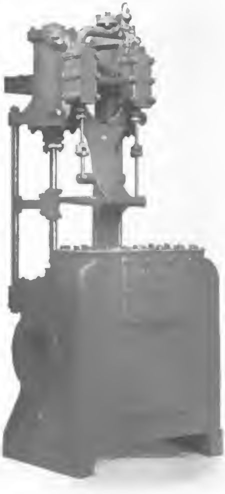
I give Tables I and II with more particulars of these tests of wrought iron and steel. Table III gives the gradual reduction of the factor of safety to present date. I conclude by stating that, amongst the many improvements in marine machinery made during the last sixty years, none has added so much to the safety and efficiency of ocean-going steamers as the manufacture of mild forged steel made by the best English makers.

The German steamship companies are following the example set by America in using nickel steel for propeller shafts. The new North German Lloyd steamships Kaiser Wilhelm der Grosse and Kaiser Friedrich will both be fitted with nickel steel propeller shafts for their twin engines. The shafts for the former will each have a length of 40.80 ft. and will weigh 185,650 lbs., while the Kaiser Friederich will have shafts 42.49 ft. long, which will weigh 155,060 lbs.

IMPROVED APPARATUS.

Deane Water Ballast Pump.

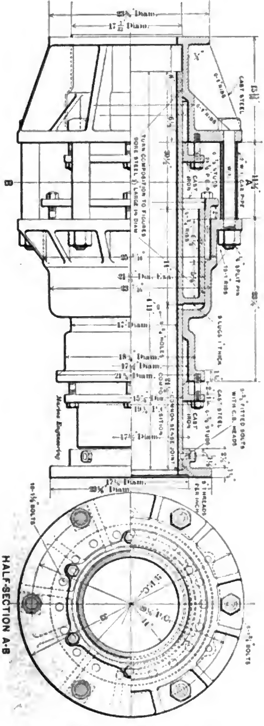
Water ballast has come to be so generally employed in vessels of all classes that there has been an accompanying development in the class of pumping machinery employed for this work. The problem for the inventor has been to design a pump which would be compact and light in weight, yet capable of delivering a large volume of water when necessary. The accompanying illustration shows a pump which fulfills these requirements. It is The Deane, of Holyoke, of the vertical duplex pattern. The material throughout is of the very best quality. Steel and composition are used for all working parts, thus insuring rigidity and strength. The floor space occupied is 3 ft. 2 in. by 3 ft. 9 in., and height 7 ft. 11 in., and the pump illustrated has a pair of 8 in. steam cylinders, a pair of 14 in. water plungers, and 16 in. stroke, and will deliver more than 2,100 gallons per minute when running at fair speed. These machines are built especially for marine service, but are very well suited to any work where maximum capacity is desired with minimum weight and space. Further particulars may be obtained by addressing The Deane Steam Pump Co., 72 Cortlandt street, New York.



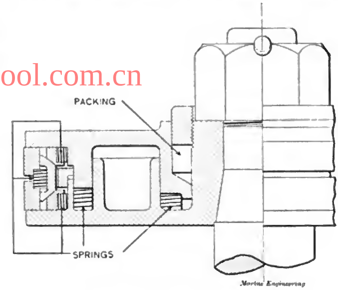
DEANE BALLAST PUMP.

Balanced High-Pressure Expansion Joint.

In the equipment of a new twin-screw vessel at the yard of the Newport News Shipbuilding and Dry Dock Co., recently, it became necessary to make provision for the tremendous pressure which would be exerted in the way of thrust in the steam mains. In each this amounted by calculation to over 20 tons. To take care of this by ordinary expansion joints and some system of bracing was considered impracticable, or at best not good practice. To meet the requirements Sommers N. Smith, the general superintendent of the yard, devised the balanced expansion joint, which is illustrated here. This was fitted in the ship and worked very effectively. On inspection of the sectional drawing it will be noticed that the inner tube has an increased diameter or ring about half way along its length. This forms a shoulder or piston at the end next the bottom of the large stuffing box casting. The other end of this annular piston or ring is open and is steadied by the gland. In the inner tube below this ring there are holes, which admit steam from the main, back of the shoulder. As the exposed area of the shoulder or piston is equal to the area of the steam main the pressure in the main is equalized. Now, as the stuffing box is tied to the other end of the joint by long bolts the entire line of pipe is in a state of equilibrium, so far as the end pressure is concerned. The expansion due to heat is provided for by a liberal space for end play at the cast end of the joint. The advantages of such an appliance are manifest and the designer has made arrangements with H. B. Underwood & Co., 1025 Hamilton street, Philadelphia, for supplying the trade.



SOMMERS SMITH EXPANSION JOINT.



CAMPBELL SAFETY PISTON.

Safety Piston for High Speed Engines.

Mishaps to high speed engines, such as are used in torpedo boats, are frequently caused by water in the cylinders which relief valves cannot take care of. The danger from this cause has indeed seriously increased with the development of the modern fast running engine and it has been the aim of many designers to produce a device which will act as a safeguard. This is the idea carried out in the design of piston prepared by M. P. Campbell, of Portland, Ore. The accompanying sketch is self explanatory. It shows a solid piston at the crank end of the cylinder in a vertical engine, with an elastic top kept in place by packing in a stuffing box around the center of the piston, and held down with a screwed gland against springs, which will compress if under excessive pressure. The other springs and packing rings shown are made to suit the requirements of the cylinder wall packing. This arrangement is applicable to both sides of a piston, if required. The inventor, M. P. Campbell, has applied for a patent.

A New Enamel Rheostat for Marine Plants.

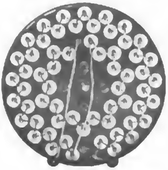


FIG. 1.

FIG. 2.

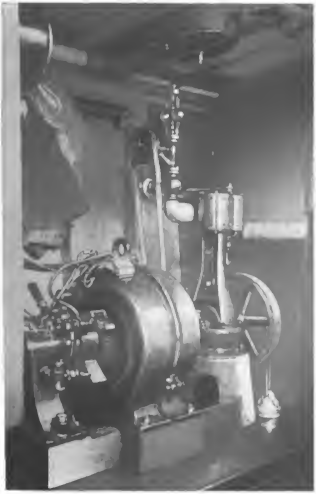
NEW ENAMEL FIELD RHEOSTAT.

Among the essentials for electric appliances on ship board are durability, ease of repair, and compactness. Inasmuch, too, as possible repairs may be required when thousands of miles away from where the article is made, necessary parts should be of small bulk so as to be conveniently carried as extras. The Universal Enamel Field Rheostat, manufactured by the American Electric Heating Corporation of Boston and New York, fulfills these requirements. The rheostat (a back view of which is shown in Fig. 1) consists of a round cast iron plate with a flat surface on the back to which are attached a series of enameled steel disks; projecting from the enamel are suitable copper terminals (which are connected to the resistance sections in the enamel) that provide means for connecting the resistance sections in series, and to the contacts on the front of the rheostat. Round headed brass bolts pass through lava bushings placed in holes in the iron plate, also through holes in the center of the steel enameled disks and holes in the ends of the copper terminals of the resistance embedded in the enamel. Each bolt, when a nut is screwed in place, holds a disk firmly to the plate and furnishes the contact on the front of the plate for the usual movable switch arm (shown in Fig. 2). The binding posts are insulated with lava and the whole is acid, fire, and moisture proof. While enamel rheostats have demonstrated their right to the first place in this class of apparatus by their many points of excellence, they were open to criticism from the marine engineer. Heretofore all the resistance of enamel rheostats had been placed in a single envelope of enamel and a fault anywhere in the circuit required practically a new rheostat, for defective circuits in enamel cannot be repaired. With the form of rheostat here illustrated every section of resistance is a single unit easily removed and replaced. Experience has shown that enamel resistance is sufficiently reliable to justify the claim that a stock of additional resistance sections equal to 10 per cent. of those in use would be ample for repairs for many years; as the disks are but 1 1-4 in. diameter by 1-8 in. in thickness it is clear that, as this is the only possible destructible element except the small insulators, this rheostat meets the requirements previously mentioned. By the use of enamel insulation the resistance element is in intimate contact yet thoroughly insulated from a relatively large radiating surface of a good heat conductor, and the resistance element is also hermetically sealed so that oxidation cannot take place. Because of this, resistance conductors of relatively small section can be operated and the whole made from one-fifth to one-tenth the bulk of the usual coiled wire rheostat. In the latter form air or at best asbestos insulation is depended upon; either of which being poor conductors, the wire must be of comparatively large section to withstand for a reasonable time the rapid oxidation incident to the high temperature, and the large size of wire necessitates greater length, and in consequence more bulk. In the enamel rheostat all of the structure is utilized for radiation when any part is working, while in the other case the supporting structure and idle parts are of little or no value for this purpose, and as but from one-third to one-half of a rheostat resistance is working when in service, it is obvious that much valuable space can be saved by the use of a well-designed enamel rheostat.

COMPONENTS OF STORAGE BATTERY.

Lighting Sets for Small Vessels.

The problem of lighting in yachts, as compared with large mercantile vessels, is complicated often by the necessity for getting the electric plant into an extremely small space. Experience in this class of work, however, as in all other, has enabled designers to get results that at first thought would be considered impossible. Among the concerns which have made it a special study is the Electric Launch Co., of Morris Heights, N. Y. A typical installation is here illustrated and described. Each generating plant consists of a direct coupled engine and dynamo on one base. It is so compact that the set, together with the switchboard, is usually placed on a shelf in the engine room, as shown in the illustration of a recent installation. Steam is supplied from the yacht's boilers reduced to 100 lbs. pressure, if the pressure carried exceeds this. Each separate circuit of the yacht is carried to the switchboard, as shown, and is under the immediate control of the engineer. In all such installations storage batteries are fitted as an auxiliary source of power. Special care has been taken to simplify the methods of charging and maintenance. The battery plant consists of what are known as elements, inclosed in cells of hard rubber, with tight covers to prevent spilling in rough weather. The batteries, the construction of which is shown in the engraving, are usually placed under the flooring in lead-lined trays, so that in case of breakage there will be no danger of hull corrosion. The batteries can always be charged when there is steam on the yacht's boilers, and when charged can be drawn on for a supply at any time. For lighting at night when the machinery is stopped, or while at anchor, the batteries are especially useful, avoiding all vibration from the running of a dynamo. Electric fans too can be switched in circuit. There are also long periods during the day when the number of lights needed is small and the running of the dynamo for lighting is wasteful. The stored energy is then available and will last for days or weeks, if used sparingly, and while the boiler fires are banked or drawn. When occasional extra heavy loads, such as for search lights, projector or band lights, are demanded, the batteries can be used to augment the dynamo current. On the switchboard the volt meter is adjustable to show the E. M. F. of the dynamo or battery at will. The ammeter will also indicate either the current supplied by the dynamo to the lighting circuits, or to the battery while being charged, and will also show the rate of discharge of the battery. With an automatic underload switch in circuit the dynamo is always protected, if for any reason the speed and voltage of the dynamo should fall. This same automatic switch can be adjusted to protect the batteries from an over-load. Provision is also made for the using of lights while the battery is being charged, by the regulation or reduction of the E. M. F. to the normal volts of the incandescent lamps, it being understood that the voltage during the charging of the batteries is from 20 to 25 per cent higher than that required for the lamps. This surplus is absorbed, so to speak, by the regulating rheostat. This rheostat is also used to maintain the voltage at the lamps when supplied with current by the batteries; for, as is well known, the E. M. F., or voltage of storage batteries, falls about 10 per cent during discharge, this fall being allowed for by using enough calls to give the required voltage at the end of the discharge. The instruments are mounted on a marbelized (black or white) switchboard, and are well insulated and are easy of manipulation.



LIGHTING SET IN YACHT.

SWITCH BOARD FOR YACHT SET.

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There is some comfort to be taken from an inspection of the figures of shipbuilding, throughout the world, recently issued by the authoritative Lloyd's Register of British and Foreign Shipping. It shows that the United States had the second largest output of new shipping (iron and steel) during the year 1896. The figures for this country were 174,861 tons, or more than double those of Germany (80,478 tons), the next country on the list. This is the second year in succession in which the United States leads all other nations, excepting of course the United Kingdom, in the total tonnage. In 1895 the total for this country was 97,339 tons, against 80,430 tons for Germany, the third nation on the list. There was also the substantial increase of 77,522 tons for this country in 1896 over the total for 1897, whereas Germany enjoyed an increase of only 48 tons. The figures for the United Kingdom were large, the totals for 1895 footing 956,307 tons, and for 1896, 1,121,505 tons. Although this was a considerable increase, it shows, for the United Kingdom, a falling off in the proportion of tonnage built there, to the total tonnage of the world. The total for all countries in 1895 was 1,211,615 tons, and for 1896 1,478,375, giving the United Kingdom a percentage of 78.9 for the year 1895, and 75.86 for the year 1896. This however might have been caused by a falling off in orders of British shipowners; for during the year 1896 the British yards built 330,095 tons on foreign orders, an increase of 150,859 tons over the total tonnage built for foreign owners in 1895. This calls attention to the fact that the tonnage built by the nations other than the British is no index of the actual increase of tonnage owned by each nation. For instance, while Germany built 80,478 tons in her own yards during 1896, of which several thousand tons were for foreign owners, she had built in British yards a total of 124,193 tons, steam tonnage. The total new tonnage built in 1896 to sail under the German flag was 201,679 tons. Among other nations the only increase of importance is in the totals for France, coming next after Germany. In 1895 the tonnage built was 22,757 tons and in 1896 the total was 33,546 tons, an increase of nearly 50 per cent. These totals will likely be greater this year as the French line has decided to build two new 22-knot liners for the New York-Havre service. The figures here given represent the gross register of steamers and net register of sailing vessels.

The action of the steam yacht Hermione, in running away, after having collided with the Citizen's line steamer Saratoga, in the Hudson river, the night of July 29, has directed attention to the U. S. statute which applies to such cases. The Saratoga at the time had a large number of passengers aboard, and was on her regular trip from New York to Troy. The yacht struck her on the starboard side and wrecked the bar room and adjacent joiner work. Had the blow been delivered below the water line the steamer would in all probability have sunk. According to the most trustworthy of the newspaper reports, the yacht immediately steamed off, leaving her figure head and bowsprit on the steamer, and apparently having no concern whether the passengers sunk or swam. She had two bowplates stove in and put into Erie Basin for repairs, while the steamer continued on her trip to Troy. The Hermione was under charter at the time to a General Thomas, who is said not to have been aboard. The editor of Seaboard, in a recent issue, took notice of this cowardly act, and in a spirited paragraph directed the attention of the authorities to the action of the yacht. With his views we entirely agree. If there is any act within the power of man which is more utterly contemptible and despicable than the desertion of imperiled lives under such circumstances, we cannot even imagine it. In this case it was intensified, too, by the fact that the majority of persons on the Saratoga were passengers who would not be able to swim, or otherwise save themselves, in case the vessel suddenly foundered. So much for the moral side of the case, and now for the legal. September 4, 1890, Congress enacted a law which provided:

> Section 1.—That in every case of collision between two vessels it shall be the duty of the master or person in charge of each vessel, if and so far as he can do so without serious danger to his own vessel, crew and passengers (if any), to stay by the other vessel until he has ascertained that she has no need of further assistance, and to render to the other vessel, her master, crew and passengers (if any), such assistance as may be practicable and as may be necessary in order to save them from any danger caused by the collision, and also to give to the master or person in charge of the other vessel the name of his own vessel and her port of registry, or the port or place to which she belongs, and also the names of the ports and places from which and to which she is bound. If he fails to do so, and no reasonable cause for such failure is shown, the collision shall, in the absence of proof to the contrary, be deemed to have been caused by his wrongful act, neglect or default.
>
> Section 2.—That every master or person in charge of a United States vessel who fails, without reasonable cause, to render such assistance or give such information as aforesaid, shall be deemed guilty of a misdemeanor, and shall be liable to a penalty of one thousand dollars, or imprisonment for a term not exceeding two years; and for the above sum the vessel shall be liable, and may be seized and proceeded against by process in any district court of the United States by any person, one-half such sum to be payable to the informer and the other half to the United States.

An important decision under this law has recently been made in a suit in the U. S. Circuit Court of Appeals for the Fourth Circuit, which was heard by Circuit Judges Goff and Simonton, and District Judge Brawley, by whom the opinion was written. In a libel suit in the lower court, brought by the master of the schooner Morgan against the tug Hercules, to recover damages resulting from a collision, the Court found both vessels in fault and divided the damages. On behalf of the Morgan the appeal was taken. The evidence showed that during a thick fog at night, on the Atlantic, the tug struck the schooner on the port side, tearing such a hole in her side that she sank in seven hours. Both vessels were moving slowly and there was a heavy sea running. There was a conflict of testimony as to the action of the tug after the collision, but the lower court decided that she had run away. A proper lookout, however, had been kept on the tug, but the schooner was found to be at fault in not having a mechanical fog horn as the law directs. There was thus no blame attached to the tug up to the time of the collision, her liability for damages having to be determined solely upon her action in running away. "It would be a violent construction of the statute," said the Court of Appeals, "to hold that by reason of it alone the tug should be held responsible because of an omission of duty after the collision." Then continuing, the Court said: "The case would be different if there had been an absence of proof as to the collision itself; if, for example, the crew of the schooner had not been rescued, as happily they were, and for that or other reasons there was a lack of testimony respecting it, then the failure to stay by, unless explained, would have raised a presumption that the collision was caused by the wrongful act, neglect, or default of the master of the tug. It is in such cases that the statute becomes operative and, in 'absence of proof to the contrary,' fastens the responsibility upon those who, failing in one duty, which was plain, may reasonably be charged with that which was doubtful. When one, disregarding cries for assistance, runs away from the scene of a crime, a strong presumption arises that he has committed it; but where there is positive proof by eye-witnesses that he did not, he cannot be convicted of it simply because he ran away, although he might be convicted of running away, if that were made a penal offense. So we construe this statute to mean that, if a master of a vessel that has been in collision with another fails to stay by her, and shows no reasonable cause for such failure, the law will presume that the collision was caused by some negligent act or omission on his part, and in the absence of proof to the contrary, will fasten upon him the responsibility for the collision. It puts upon him the burden of showing that he was free from fault. It assumes that one who fails to offer assistance to those whose distress is caused by him is presumably at fault in the act which caused the distress, and it denounces pain and penalties against his inhumanity, and holds his ship responsible for the pecuniary fine; but it does not condemn without a hearing. The obligation imposed is not unqualified; it is carefully guarded by conditions; it permits presumptions to be rebutted by proofs, and it is only 'in the absence of proof to the contrary' that his responsibility is made absolute." This reasoning, of course, applied only to the civil proceeding to secure exemption from paying damages (which was granted), but the criminal negligence of the master of the tug is thus commented upon by the Court: "Conceding the correctness of the conclusion of the court below that the master of the tug failed to stay by and render assistance, his conduct is to be gravely reprehended, and in a proper proceeding doubtless he may be made to suffer the penal consequences that follow the violation of the statute." It will be interesting to note if a "proper proceeding" follows the collision between the Hermione and the Saratoga.

International Meeting of the British Institution of Naval Architects.

The International meeting of the British Institution of Naval Architects, held in honor of the Diamond Jubilee of Queen Victoria, appears to have been one of the most successful gatherings of the kind on record. It was a sort of World's Congress in that it brought together prominent representatives of the mercantile and naval services of all maritime nations, and these visitors participated in the discussions of papers, which were read for the most part by British authors. There was a delegation from the United States including direct representatives of the Navy and members of the Society of Naval Architects and Marine Engineers. The American visitors who were received with extreme courtesy, included, among others: Naval Constructor, D. W. Taylor; Passed Assistant Engineer, Walter M. McFarland, U. S. N.; Lt. J. C. Colwell, U. S. N.; General Hyde, Charles Cramp, C. H. Haswell, C. H. Wheeler, and W. H. Shock. The proceedings were opened July 5, by a reception at the Hotel Cecil. Lord Hopetoun, president of the institution and a committee including the Lord Mayor of London, received the guests. On the following day the serious work of the Congress was begun at the Imperial Institute, the Prince of Wales delivering the address of welcome. Many distinguished representatives of the British Government were present. Then the Congress divided into two sections, the Naval Architects gathering in one hall, with Lord Hopetoun in the chair, and the Marine Engineers assembling under the presidency of Sir E. J. Reed.

A paper on "Hardened Plates and Broken Projectiles" was read before the Naval Architects by M. L. E. Bertin, France. In the discussion which followed Sir William White fairly divided the credit for armor plate improvement; France having produced the all steel plate, England the compound plate, America the Harveyised plate, and now Germany is endeavoring to still further improve the manufacture of thick armor plate. "Non-inflammable Wood" was the title of a paper read by Charles Ellis, Sheffield, England, which was entirely favorable to the process of fireproofing lumber used in ships.

In the engineering section a paper entitled "A Review of the History and Progress of Marine Engineering in the Royal Navy and Mercantile Marine," the joint labors of Sir A. J. Durston, Engineer-in-Chief of the British Navy, and J. T. Milton, Chief Engineer Surveyor of Lloyd's, was listened to with much interest. In the portion of this paper devoted to the navy the rise in steam pressure from 10 pounds per square inch, in vessels built in 1844, to 300 pounds, in the Pelorus of 1897, was graphically presented. The same means were used to illustrate the steady increase in piston speed per minute, from a speed of 434 ft. in the warship Warrior in 1861, to a speed of 1221 ft. in the destroyer Starfish at the present time. Also the increase in speed of revolution was noted. The Warrior in 1861 on full power trial gave 54.25 revolutions and the destroyer Boxer, one of the newest vessels, runs up to 410 revolutions. The greater part of this paper was devoted to a comparison of the machinery equipment of war vessels of the British Navy, and very little matter proportionately was given to the no less important subject of the advances made in the merchant marine. J. Leslie Robinson read a paper, for Pierre Sigaudy, France, on "Water tube boilers for high speed ocean steamers." This was a description of a possible instalment of boilers, of the "Normand et Sigaudy" type to give 23,000 H. P. As the paper dealt with one type of boiler only it was not as comprehensive as the title would suggest.

On the second day the most noteworthy paper of the Congress, on "The Advances made in the Mathematical Theory of Naval Architecture," was read by Sir Edward J. Reed, vice-president of the Institution. This was a very masterly exposition of the subject, and covered the period from the founding of the Institution in 1860 to the present time. In succession he discussed the subjects of strains in ships at sea and the necessary strength to withstand them, with the scientific facts which prescribe dimensions, forms and weights, so that vessels shall be possessed of stability under varying conditions of displacement, and also the adaptation of form to fluid resistances so that vessels may be propelled with proper regard for economy and safety. Captain I. C. Tuxen, Director of Naval Construction and Engineering in the Royal Danish Navy contributed a paper on "Danish Steam Ferries and Ice Breaking Steamers." In view of our own experiences with navigation in winter this paper was of special interest to the American visitors. It is reproduced elsewhere in this issue. A paper of a purely technical character describing a "Graphic Aid in Approximating Hull Weights" was read by J. Johnson, Gothenburg. Considerable interest was shown in the paper on "Crank and Other Shafts used in the Mercantile Marine," read by C. W. Manuel of the Peninsular and Oriental Steam Navigation Co. This will also be found in full in this issue. A paper illustrated by lantern slides giving an account of experimental investigation of the "Nature of Surface Resistance on Ships and in Pipes" was read by Professor H. S. Hele Shaw Liverpool. Sydney W. Barnaby read a paper on, "The Formation of Cavities in Water by Screw Propellers at High Speeds."

On the evening of July 7 the members and guests were present at a banquet in the King's Hall, Holborn Restaurant, London, the Earl of Hopetoun presiding. General Hyde of Bath, Maine, spoke for the United States in response to a toast, saying: "My Lords and Gentlemen—My only regret on this happy occasion is that Mr. Griscom, president of our society, is compelled to be absent. He could have responded to this toast so much more worthily. The hearty welcome you have given us, the kind hospitality you have shown us, will long linger in our memories. Our hearts were already warm towards the mother country. We have seen many things to interest us here. Not the least important is to learn how the great heart of England goes out toward her navy and her merchant marine. We have learned how the will of a great people, largely entrusted to members of your society, has produced your magnificent fleet, which by a seeming paradox, may be a promoter of peace while it is an engine of war. We can learn, as Lord Hopetoun so well expressed it, 'that England claims no monopoly in the art and improvement of ship building.' Gentlemen, in behalf of your kindred American society, I thank you."

The programme of festivities which occupied the following days, before the breaking up of the Congress, was carried out very successfully and was pronounced by all the foreign guests to be worthy of the best traditions of British hospitality. A trip was made in a special steamer on the Thames, during which the great bascule bridge at the Tower was examined, and visits paid to some of the great docks. A call was also made at the Thames Iron Works, long famous as the builder of many of the finest warships afloat. Work was progressing on the British battleship Albion, 12,950 tons, and on the Japanese battleship Shikishima, a vessel of 14,900 tons, which is designed to be the most powerful ship in any navy when ready for service. Guide books containing plans of the route were distributed among the visitors. In the evening a grand concert was given at the Queen's Hall, in honor of the foreign guests, at which the orchestra from the Royal College of Music, and the splendidly trained Leeds Festival Choir, which had come to London for the occasion, were present. On the following day an excursion to Portsmouth and Southampton was on the programme. By rail the members and visitors, who included naval officers of many nations, went down to the chief naval port of Britain. The Royal dockyards were opened wide to the visitors, who were permitted to view all of the shops. The only vessel under construction was the battleship Canopus, 12,950 tons, though there was much outfitting and repairing work going on. After looking over the plant the company was taken aboard the liner Mexican for a cruise in the Solent. A landing was made at Southampton where the new graving dock for the London and Southwestern Ry., 750 ft. by 91 ft. was viewed. The harbor improvement works, largely for the accommodation of the trans-Atlantic mail steamers, also created comment on account of their magnitude. The return to London was by train, and in the evening a reception was held at Lord Brassey's house in Park Lane.

On July 10, by special invitation of Queen Victoria the members of the Congress and friends journeyed to Windsor Castle to attend a garden party given in their honor. Every possible courtesy was shown the visitors at the Castle, and during the afternoon the Queen, accompanied by Princess Henry of Battenberg and Prince and Princess Charles of Denmark, drove slowly among the visitors, many of whom were introduced to her Majesty by Lord Hopetoun. Naval Constructor D. W. Taylor, U. S. N. had the honor of an introduction as official representative of the Navy Department. The grounds and apartments of the Castle were free of access to the visitors during the day. On the return journey a stop was made at Richmond where many took a drive through the park. Later dinner was served at the Star and Garter, with the Earl of Hopetoun presiding. The river Thames was lit up with colored fires, and there was a spectacular display of fireworks.

The trip to the North Country shipyards brought out a big delegation who took train for Glasgow. There the Fairfield Shipbuilding Co.'s yard at Govan was the first stop. The yard was specially interesting to the American visitors as birth place of the great Cunard trans-Atlantic record breakers. The work on hand in this yard included 56,300 tons of new shipping and 116,500 indicated horse power of machinery. Dinner was served here in the mould loft to which about 400 sat down. The members then proceeded down the Clyde to the yard of William Denny & Bros. at Dumbarton. Here the famous experimental tank was shown in operation. In the evening the members were entertained by the Lord Provost and Corporation of Glasgow at a conversazione in the City Chambers.

On July 14 the company was taken on a water excursion down the Firth of Clyde round Arran and Ailsa Craig. The day following on the return journey to London, a stop was made at the immense works of the consolidated firms of Sir W. G. Armstrong, Whitworth & Co., Newcastle-on-Tyne. In the shipbuilding department there were 14 vessels, ranging from a torpedo boat destroyer to a 14,800 ton armor clad, in various stages of construction. In the gun works 900 high powered cannon of all sizes up to 12 in. bore were being built. The steel works which can turn out more than 500 tons in a week also attracted attention, especially the heavy hydraulic presses in this department.

The American delegates before separating prepared an open letter addressed to the Secretary of the Institution of Naval Architects.

In this they expressed themselves as profoundly touched by the kindness and hospitality extended to them by the officers and members of the Institution, and desired to place on record their appreciation of the many courtesies they had received. They desired especially to thank the Rt. Hon. the Earl of Hopetoun, president, and Mr. George Holmes, secretary, for their kind attentions. They assured all their kind friends of the Institution that they would carry away the warmest feelings of affection and gratitude.

CORRESPONDENCE.

[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

A Response About Boiler Economy.

In reply to J. H. P., whose inquiry about water tube and Scotch boilers appears in your last issue, I would say that I think he does not thoroughly comprehend the work which a generator of steam for a marine steam engine is called upon to do. Its purpose is to supply steam at a fixed pressure continuously while the engines are running. The water tube boiler carrying comparatively little water is easily started into action, requiring a proportionally small amount of heat to raise steam up to the required pressure. Your correspondent assumes that it does so more economically than a Scotch boiler, but in this I am not prepared to agree. Does he know that bulk for bulk the water in the water tube boiler is heated to the required temperature by a smaller quantity of fuel than the water in the Scotch boiler? The wastefulness of the water tube boiler when running is due rather to imperfections in mechanical construction than to any inherent physical defects in the system. In the water tube boiler there is not that mechanical arrangement of parts which in the Scotch boiler permits of a proper combination and ignition of the gases in the combustion chamber, and provides a subsequent great area of tube surface, over which the gases must travel and give up their heat, before entering the uptake. If he has ever noted the uptake or chimney temperature in vessels fitted respectively with the Scotch boilers and the water tube boilers he will not be in much doubt as to the comparative heat absorbing efficiency of the types. Now as to the saving which might be effected at the end of a run by the use of a Scotch boiler: it is not hot water, or steam of pressure below that needed to develop the power of the engines, that is wanted, but steam of full pressure and plenty of it. So if a vessel had to make a full speed run almost to her destination, as for instance across-channel mail boats have to abroad, there would be no saving possible with any type. In the case of a steamship ending a trip in a port, where there was a necessity for slowing down a good deal, or making frequent stoppages of the engines, the Scotch boiler would apparently have an advantage. The heat stored up in the water would be plus the heat from the furnace, so that the fires in the latter could be slackened. But would not the heat contained in the water of a Scotch boiler, after the signal "finished with the engines," as compared with the smaller amount of water wasted in a water tube boiler, more than offset the small amount of coal saved by early cessation of firing in the Scotch boiler?

NORTH ATLANTIC.

"Practically the Same," with a Difference.

I have read with much interest in a recent issue' your description of the Dublin Packet Company's vessels (new and old), and desire to direct attention to a very important feature developed by the performance of these vessels, which is deserving of serious consideration. I refer to the difference in indicated power. The hulls are practically the same in dimensions, and the speed attained is practically the same, yet the indicated horse power developed is twice as much in the new as in the old vessels. You will observe that the Ireland (of the old type) made the run in two hours and forty-five minutes, indicating 7,000 horse power; while the Leinster (of the new type), which develops 9,000 horse power when making 162 revolutions of the engines, was forced to 172 revolutions while making her fastest run in two hours and twenty-three minutes. The horse power indicated when making 172 revolutions is not stated, neither is the coal consumption per run given; yet I venture the opinion that the coal consumption per indicated horse power will be only one-half as much for the new as for the old vessels, and that the coal consumption per round trip will be about the same in both cases. The reason for this is simple: When steam is being used with moderate expansion the indicated horse power is not much in excess of the actual power. But when steam is used with excessive expansion, the indicated horse power may readily exceed by twice the actual power. There is probably no case on record so rich in object lessons as the record of these vessels. NEW ORLEANS.

For Propeller Sharps with Secret (!) Formula.

We are designing and building steam engines and are now getting considerable custom in marine engines, and we are often asked, "How much power will be required to drive a boat at a given speed?" And also, "What size wheel will give this speed?" We put the matter in the form of queries which we should like to have answered. "Is there any rule for figuring the power required to propel a vessel at any given speed?" Also, "What is the power required to revolve a screw propeller at any given speed?"

M. R.

Another Device for Shipyard Work.

In your August issue I notice a correspondent gives an account of a handy boiler shop tool in use at the Brooklyn navy yard. Well, we have a little labor saving device in use at our yard which I think would interest your readers. It is a plan for handling plates easily while countersinking the rivet holes. The photograph which I send gives a good idea of the device. A table about the height of a billiard table is built under an ordinary radial drill, which is fitted with the usual lever feed. On this table a number of cast iron balls, about 2 1-2 in. dia., are scattered about, and on top the plate to be countersunk is laid. The bed of the table is of wood so that the balls get a good grip on it, and the plate will not move unless lateral pressure is exerted on it. Then it will slide easily, and with this easy way of handling work, and the wide swing of the drill, one man can turn out a lot of work in a day. The advantages of this device are very apparent with heavy work. When the photograph was taken one of the heavy steel plates for the protective deck of one of the new battleships, building here, was on the table. This was a heavy job and would have been awkward to handle in the ordinary way. As you can see in the photograph the driller stood on top of the bed and moved the plate in any direction lengthwise or sidewise with his feet. It costs very little to put this sort of a device in a shop, and it saves lots of time and trouble. NEWPORT NEWS.

DRILLING TABLE FOR SHIPYARD WORK.

The Lake submarine boat Argonaut has been put in the water at the Columbian Iron Works, Baltimore. She is designed to travel on the bottom of rivers and harbors, chiefly for wrecking purposes. The patent specifications of this vessel, together with a sectional view, were published in our June issue. The boat is 36 ft. long and 9 ft. extreme diameter. She is fitted with a gasoline engine of 30 H. P., and storage batteries supplying an electric motor with current. A surface speed of 8 miles an hour is looked for, and it is expected that she will creep along the bottom at a speed of about 5 miles an hour. The boat is fitted with air locks, so that divers can have egress and ingress while she is on the bottom.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—III.

BY WM. BAXTER, JR.

In the last article it was stated that if a wire is moved across a magnetic field an electric current will be developed in it. Strictly speaking, this statement is not correct: the effect of the movement is to develop an electro motive force. An electro motive force is a force that will set an electric current in motion providing there is a complete circuit for it to circulate in. If the circuit is not complete, the force can only develop an electrical pressure, or difference of potential, as it is called. To illustrate this point more clearly, suppose you have a pipe formed into the shape of an endless ring, and that at any point in it a propeller wheel is inserted. If the pipe is filled with water, it will be set in motion as soon as the wheel begins to rotate. If at any point in the pipe a valve is interposed, the shutting of this will cause the flow of water to stop, but if the propeller continues to revolve, it will still develop a pressure, notwithstanding that it cannot impart motion to the water. If the valve is opened slightly, a small amount of water will pass through, and the more it is opened the greater the flow. If you take a wire formed into an endless loop, or ring, and pass one side of it through a magnetic field, an electric current will be developed. The part of the wire that passes through the field develops an electrical pressure just as the propeller does in the case of the water pipe. If the wire is cut at any point, the current will stop, the cut acting in the same way with respect to the wire as the valve does with respect to the pipe. If the two ends of the wire are connected by means of a small wire a current will at once begin to flow. In the case of the pipe, the amount of water that will pass through the valve in a given time will be in proportion to the amount of opening, or, in other words, to the resistance that has to be overcome. With the electric current the action is precisely the same. In the water pipe the resistance is increased by reducing the opening through the valve, and in the wire loop it is increased by increasing the length or reducing the diameter of the wire that connects the two ends.

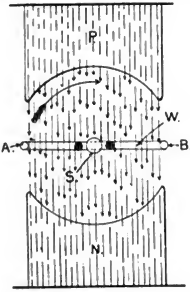


FIG. 12.

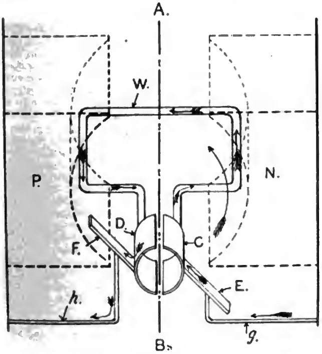


FIG. 13.

The direction in which the electric current will flow in a wire moved across a magnetic field will depend upon the direction in which it is moved with respect to the direction of the lines of force. In Fig. 12, if the loop is rotated in the direction indicated by the arrow the current developed in the side B will flow toward the observer, and in the side A, away from him. If instead of rotating the loop, it is moved bodily to the left, by moving the shaft S in the direction of A, the current in side B will still flow toward the observer. The current in B will have the same direction whether the loop is moved to the left in its central position or is raised close to pole P or depressed close to pole N. From this we can see that the direction of the current is not dependent upon the direction of rotation of the loop, but wholly upon the direction in which the wire moves across the lines of force, and that if it passes from the right to the left side the current will flow up to the observer, regardless of how the motion is obtained. This shows us, at once, that whichever way the loop is rotated, from the position shown in the figure, the current in side B will be the same. This is due to the fact that,

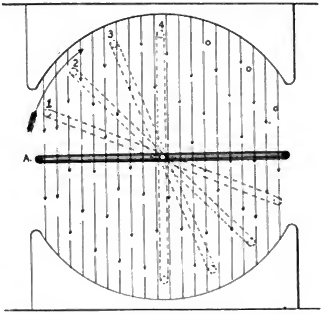


FIG. 14.

as the loop is at right angles with the lines of force, the result of turning it in any direction will be to cause side B to move toward the left. If the loop was placed ninety degrees ahead of its present position, movement in opposite directions would cause the current in side B to be in opposite directions, because then sides A and B would be directly under the poles and in the center of the stream of lines of force; therefor, movement in opposite directions would cut the lines in opposite directions.

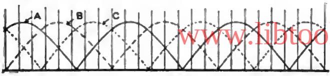


FIG. 17.

By carefully considering the foregoing explanations we can understand how it is that if the loop is rotated continuously in the same direction, the current in the wire will have its direction reversed twice in each revolution. To see this clearly all we have to do is to remember that the wire moving from the position of B toward that of A has a current developed in it, up from the paper, while the wire moving from the position of A to that of B has a current developed in it, down through the paper. The current in B will be up until it reaches the position of A, then it will reverse and flow down during the movement through the next half revolution. Commencing on the second turn the current will be up, through the first half revolution, and then down through the second half.

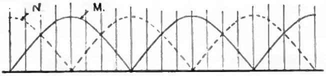


FIG. 16.

Currents of this class which run first in one direction and then in the other, are called alternating, and are used very extensively for the transmission of power on a large scale, but for lighting in cities and aboard ship, and for the operation of small motors, currents that flow continuously in the same direction are required. The generators used to develop such currents are constructed upon the principle illustrated in Figs. 11 and 12, and more fully in Fig. 13. The simplicity of these diagrams is not maintained in the actual machines, but for all that the principles involved in their operation are the same.

From the explanations given of Figs. 11 and 12, it will be noticed that there is no way in which the revolving loop can be moved so as to develop a current that flows in the same direction continuously. This being the case, it is necessary to have some device by means of which the alternating current developed in the loop may be converted into a continuous one in the outside circuit. The device used for that purpose is the part of the machine known as the commutator. The manner in which it accomplishes the rectification of the current can be made quite clear in connection with Fig. 13.

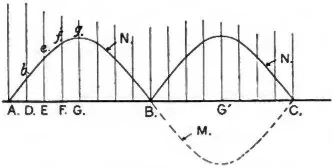


FIG. 15.

The ends of the loop W are attached to two halves, C D, of a cylinder, these halves being electrically insulated from each other, that is, there is no metallic connection between them. If the loop is rotated around the line A B in the direction indicated by the arrow, the current will flow from the end attached to segment C to the end attached to segment D. The brush F, which rests upon D, will convey the current to wire *h*, through which it will pass to the lamps or other apparatus in the circuit and return to wire g, and from here by brush E to segment C and back to the loop. When the loop reaches a position at right angles to the lines of force, the brushes will rest on the spaces between C and D. When the loop passes beyond this point, brush F will be resting on segment C, and E on segment D, which is just the reverse of their present relation. At this point the current in the loop will also reverse, hence the current in wires g h and the outside circuit will remain unchanged.

By this means the current is rectified, but it is not rendered uniform, owing to the fact that as the loop travels through the magnetic field in a circular path, the rate at which it cuts through the lines of force is not uniform, as is clearly shown by means of Fig. 14. In this the lines of force are represented by lines equidistant from each other, and the loop is shown in positions advancing by one-sixteenth of a revolution. If the rotation is uniform, these positions of the loop will represent equal intervals of time, and the lines representing the lines of force, being the same distance apart, will represent a uniform magnetic field. In passing from position A to position 1 the loop will cut one line, but from position 1 to position 2 it will cut two lines, and from 2 to 3 three lines, and from 3 to 4 four lines. The strength of the current developed in passing through each one of these arcs of the circle will be proportional to the number of lines of force cut. We can represent the strength of the current at the various parts of the revolution by means of a curve, such as shown in Fig. 15, in which the distances AD, DE, EF, etc., represent the arcs A-1, 1-2, 2-3, etc., of Fig. 14, and the vertical lines Dd, Ee, Ff, etc., the number of lines of force cut in passing through these arcs. If the curve above the line AC represents current flowing in one direction, a curve below this line will represent a current in the opposite direction, and the two curves, N and M, the latter shown in broken lines, will show the strength and direction of the current in the loop at all points during one revolution. The reverse current, M, is rectified by means of the commutator, and thus the real current is as shown by the curve N. N.

It will be noticed that at A B C the current is nothing, and these are the points where the loop is at right angles with the lines of force, hence the wire is moving parallel with them and there is no cutting. At G and G¹ the current is the strongest, and these are the points where the loop is parallel with the lines of force, in position 4, and therefore cuts them at the highest rate.

The pulsating character of the current, as shown in Fig. 15, can be overcome by using more than one loop and combining the currents generated by them into one. If two loops are used, and placed at right angles with each other, one will be developing the greatest current at the time when the other is doing nothing, as is indicated by the two sets of curves, N M, in Fig. 16. If three loops are used, separated from each other by 60 degrees, the three currents will have the relation shown by the curves A B C in Fig. 17.

These combined curves, shown in Figs. 16 and 17, do not show the real smoothing down of the pulsating currents effected by the use of two and three loops, except in a general way. In the next article the effect of these combinations will be more fully explained.

Another Trans-Atlantic Line of Freight and Passenger Steamers.

Another transatlantic freight and passenger line will come into existence during the month, when the consolidated Wilsons, Furness-Leyland Line will commence operations. The service will be weekly between New York and Boston and London. The five ships, for which orders were placed when the combination of interests was agreed upon, are now nearly ready for sea. They will be known as the Victoria, Cleopatra, Cassandra, Burtecca, and Alexandra. All were built in the United Kingdom, the orders being distributed among East Coast, Belfast, and Clyde builders. A feature of the new line will be the carrying of only one class of passengers at a moderate fare for first-class accommodations. The new vessels are all of large dimensions of the type known as intermediate. This means that they will have large cargo capacity, with passenger trade as a secondary though not unimportant feature, and will be of moderate speed. A description of one of the new vessels is here given in part from the Engineer, London.

On Saturday, July 31, the S.S. Victoria was launched from the shipbuilding yard of Messrs. Furness, Withy and Co., Limited, Middleton, West Hartlepool. This vessel has been built to the order of The Wilsons and Furness-Leyland Line, Limited, and is intended for their Boston and New York passenger, cattle, and cargo trade. Unusual interest was centered in this event, as this vessel is the largest ever built at the port. Her dimensions are as follows: Length over all, 490 ft.; beam, extreme, 52 ft. 3in.; depth moulded, 34 ft. 6 in.; with a deadweight carrying capacity of about 8,450 tons, and a measurement capacity of about 11,900 tons. She is built throughout of Siemens-Martin steel to Lloyd's 100 A1 class, although in many instances the scantlings are far beyond the society's requirements. She is built on the web frame principle, with cellular double bottom for water ballast, with all the latest appliances for filling and discharging the tanks. The hull is divided into nine compartments by means of eight watertight bulkheads. She has three complete steel decks, and in addition a shade deck above with a bridge 130 ft. long on top of it. Arrangements have been made for carrying about 700 head of cattle under the shade deck. The vessel will be rigged as a fore-and-aft four-masted schooner. The accommodation for the crew and cattlemen is placed under the shade deck forward. Accommodation for about 120 first-class passengers is to be fitted in the bridge and large deckhouse.

The engines, which are being constructed by Thomas Richardson and Sons, Limited, are the largest yet built in the Hartlepools, and have been designed to suit the requirements of the heavy Atlantic trade. The diameters of the cylinders are 32 in., 54 in., and 90 in., by 60 in. stroke, on the three crank triple expansion principle, with a steam pressure of 190 lb. per square inch. The high pressure cylinder is fitted with a piston valve and the intermediate and low pressure with double ported slides, the cylinder supports consisting of massive cast iron divided columns. A separate centrifugal pump is employed for circulating water through the condenser, and the air pump is of Edward's design. In lieu of the ordinary feed pumps worked from the main engines a complete set of Weir's engines and pumps will be fitted, and the various auxiliaries in the engine room include large Pulsometer for pumping ballast tanks, Owen's feed donkey and fire pump, Morison's combined evaporator and winch condenser. The propeller is of the variable pitch type, the blades being of manganese bronze. Steam is supplied by two double and two single ended boilers, the latter being in the center and arranged back to back, either serving as an auxiliary in port. The boilers are fitted with Morison's suspension furnaces and Henderson's rocking fire-bars.

Work on the Grande Duchesse.

For several months the Babcock & Wilcox people have been at work on extensive alterations in the boilers of the Grande Duchesse, which has been lying at the shipyard, says the Newport News Daily Commercial. These boilers, it will be remembered, were put in on the order of the owners of the ship and against the best judgment of some of the best mechanics. They never have worked with that degree of satisfaction that has always characterized the work turned out at the shipyard here. At one time it was thought that the boilers would be taken out altogether. The Babcock Company, however, determined to make things satisfactory if possible, and to that end they have been making the extensive alterations necessary in the boilers without removing them from the ship. This work is very nearly completed and the craft will shortly go out on a run to test the repaired boilers.

Salvage Cases Recently Decided.

An award of $25,500 for salvage services has been made by the Admiralty Division of the English Courts in the case of the North German Lloyd steamship Spree, which was towed into Queenstown harbor July 8 by the Atlantic Transport liner Maine. The Spree was bound West, from New York for Bremen, with a large passenger list and full cargo, when her crank shaft broke, the after crank being fractured clear through. As she has no yards, she drifted out of the track of steamships until July 5, when she was sighted by the S.S. Maine, on a voyage from Philadelphia to London. The Maine took her in tow, the anchor cables being passed out through the hawse pipes of the Spree and secured to the towing hawsers. The weather was fine and the vessels made good progress until July 8, when, nearing Queenstown, the captain of the Spree decided to let go one of the hawsers, so as to have an anchor ready when the harbor was reached. This was done, but the remaining hawser soon parted, and a good deal of trouble was occasioned in securing fresh hawsers in position. The distance towed was 500 miles. The values of the vessels and cargoes were: For the Maine $226,425, and the Spree $425,000.

Another interesting salvage case decided was that of the Cunarder Cephalonia, which broke her tail shaft and was towed into Queenstown by the West India & Pacific Company's steamship Floridian. The award was $15,250.

S.S. SPREE IN QUEENSTOWN HARBOR AFTER MISHAP.

An award of $55,000 was made by the same court in case of the Pacific Steam Navigation Company's steamship Oratava, which was hauled off a shoal in the Red Sea, by a vessel of the Perim Coal Company. The value of the Oratava was given as $277,500, and of the cargo $495,000.

DURING THE MONTH.

The Caspian, 2,747 tons, one of the Allan Line steamers built in 1870, was sold for $20,000.

The Chicago Ship Building Co. has booked a contract for a steel tow barge, 376 ft. long, 48 ft. beam, and 28 ft. deep.

The Compagnie Generale Transatlantique, better known as the French Line, has placed orders for two 22 knot steamships to ply between Havre and New York.

The new dry dock at Yokohama measures: Length, 351 ft.; breadth at entrance, 60 ft. on top and 45 ft. at sill, and depth, 35 ft. Another and larger dock is building.

An order for a new ferryboat has been placed with the Delaware River Iron Shipbuilding and Engine Works by the Brooklyn and New York Ferry Co. She will be built of steel and will be nearly 200 ft. long.

William Cramp Ship and Engine Building Co., of Philadelphia, has commenced work on a new steamship for H. M. Flagler. The new vessel will be about 250 ft. long and will run in the West India trade, connecting with the Flagler railroad lines.

An effort is to be made by the Russian Government to keep open the port of Vladivostock, Siberia, during the coming winter by the use of ice-breaking steamers, built on the Danish model. A description of such vessels will be found in this issue.

The Isle of Man paddle steamship Empress-Queen, illustrated and described in our June issue, is now running between Liverpool and Douglas. On her maiden voyage, with the engines making 40 turns, the passage of 80 miles was done in 3 hours and 40 minutes.

A report was started in the daily press that the whaleback Christopher Columbus was to be cut in two and taken to sea for service in the Alaska trade. This has been authoritatively denied, the owners stating that the vessel would continue in the Chicago-Milwaukee passenger trade.

A novel method of removing the propeller of a steamship was tried at Aberdeen recently. The S.S. Ohio was towed into dry dock for repairs, and to speedily remove the propeller charges of dynamite were used. These were very effective, but also damaged the dock floor and walls, and a suit for damages will likely result.

Another twin-hull, self-propelling garbage dumping boat for the city was launched at Nixon's shipyard in Elizabethport August 6. She is a sister vessel to the Cinderella, launched and tested some time ago. The new boat is called the Aschenbroedel and is 140 ft. long, 32 ft. beam, and can carry 300 tons on 8 ft. draught at a speed of 11 miles.

A sum of $1,750 has been divided between the officers and crew of the British S.S. Oceanic by the owners, in recognition of their services in replacing the tail shaft and propeller of the ship while at sea. While on a voyage from South Africa the steamer lost propeller and tail shaft, and the engineers decided to fit the spare one carried aboard. The vessel was tipped and the job done inside of nine days, in water infested with sharks.

The presence of the White Star liner Teutonic at the Jubilee review at Spithead as an armored cruiser occasioned much comment among the foreign naval officers present. Her guns had been put aboard at Liverpool with extraordinary rapidity upon her arrival after a voyage. An extract from the log of this ship shows a remarkable uniformity of speed. Runs made in June, 1895, 1896, and 1897, showed, respectively, average speeds of 20.11, 20.17, and 20.18 knots.

The steam yacht Presto, built from the designs of C. D. Mosher for J. Adolph Mollenhauer, of New York, was launched from the Ayer's shipyard at Nyack. She is 8 ft. 6 in. long and 9 ft. 6 in. beam. Her draught is only 2 ft., as she will be used for cruising in shallow water. Her machinery consists of a quadruple expansion engine with cylinders 6 in., 9 in., 12 in., and 16 in. dia. by 8 in. stroke, and a Mosher water tube boiler having 1,282 sq. ft. heating surface.

It is probable that the unfinished tunnel under the Hudson river will be completed if efforts to secure fresh capital are successful. The western extremity of the tunnel is at the foot of Fifteenth street, Jersey City, and the New York end will be at the foot of Morton street. The total distance is 5,400 ft., of which about 4,300 ft. are completed. The success which has attended the construction of the Blackwall tunnel under the Thames has caused a revival of the Hudson river project, which was originally begun in 1874.

The rush to the Klondike gold fields from Pacific coast points has caused a sudden demand for vessels to carry the mining parties. Every vessel sailing for Alaska recently has been loaded with freight and passengers. There has also sprung up a demand for river boats for inland navigation on the routes to the gold fields, and orders for several such craft have been placed with builders in the States. Some of these are of the knock-down type, and are to be shipped to Alaska in sections and there put into the water.

The progress being made in fast long-distance steaming is exemplified in the new mail carrying contracts made by the British Government with companies carrying to far eastern points. The new contracts come into operation February 1, 1898, and stand thereafter for seven years. The passage to India is to be shortened by two days and to South Australia by 4 1-2 days. The Peninsular and Oriental Steam Navigation Co. will receive $1,650,000 per annum for the services to India, China, and Australia. The Orient line secured a contract for a fortnightly service to Australia, touching at Colombo, for $425,000 per annum.

On July 22 the Monarch, the largest merchant steamship yet built in England, was launched at the yard of Swan and Hunter, Wallsend-on-Tyne, for Elder Demster & Co., of Liverpool, to trade to America. The vessel is 483 ft. long, 56 ft. beam, and 42 ft. 3 in. deep, and is built to the highest class at Lloyds for the 3-deck rule, with shelter deck for cattle. Her cargo capacity measurement is upwards of 18,000 tons, with 700 tons bunker capacity additional. The deadweight cargo capacity is 15,500 tons. She is fitted with a double bottom, in which 3,000 tons of water ballast can be carried. The machinery consists of a set of triple expansion engines with cylinders 28 1-2, 46 1-2, and 60 in. dia., and 54 in. stroke. Three boilers fitted with Howden's draught will supply steam at 180 pounds. Larger steamers have, of course, been built in Ireland and Scotland.

In the paper by P. Sigaudy, France, describing an instalment of water tube boilers to furnish 23,000 horse power, regularly on voyages, read before the International Congress in London, several particulars of interest were given. The installation refers only to one particular type of boiler, the "Normand et Sigaudy," and included 16 double ended boilers, to carry 220 lbs. pressure per square inch. The grate surface for each boiler was 95 sq. ft. or a total for all of 1,520 sq. ft. Rough heating surface for each, 4,600 sq. ft., or a total of 74,400 sq. ft. Each boiler had 1,700 tubes, or 27,200 for all. The volumes of steam and water were: Water, one boiler, 326 cu. ft.; all, 5,216 cu. ft. Steam, one boiler, 172 cu. ft.; all, 2,752 cu. ft. The weights were figured thus: 16 boilers, 590 tons; water in boilers, 146 tons; funnels, 100 tons, and the total, including all fittings, accessories, and spare gear, 938 tons. Figuring the coal consumption at 1 1-2 lb. per I. H. P. the combustion would reach 227 lb. per sq. ft. of grate surface. The weight of cylindrical boilers with 1,520 sq. ft. of grate surface was figured by the author to be about 1,700 tons.

A new set of rolls has been put in Pembroke Dock Yard, England, the machine having a length of 29 ft. 6 in. The rolls are Bessemer steel forgings, and the upper one weighs 25 tons.

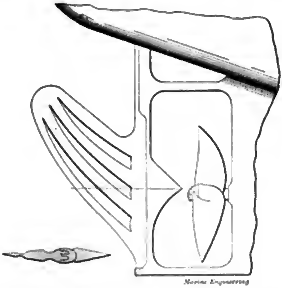
Bids for the construction of a new revenue cutter for the port of New York will shortly be called for by the Revenue Cutter Service. There is an appropriation of $175,000 available.

The firm of Harland & Wolff, the Belfast, Ireland, shipbuilders, is keeping up the record for big tonnage output. The total for this yard for the first six months of the year was 39,000 tons.

OBITUARY.

The death last month of Arthur Lozier, of the Bullock Electric Co., New York, was an exceptionally sad one. He was a man of fine physique, genial, magnetic, with hosts of friends. He was interested in all engineering and mechanical subjects, and thoroughly trained for the work he had undertaken. Upon finishing his education at Stevens Institute, he took up practical engineering subjects and made himself thoroughly conversant with all that goes to make a successful career in those lines. He became a member of the American Institute of Electrical Engineers, joined the New York Naval Militia, and in other ways connected himself with progressive movements. No young man could have been better prepared for a life of much usefulness, nor could one at the age of 23 have given promise of greater success.

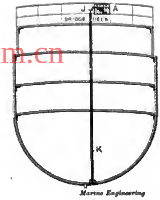
The death of J. K. Kilbourn, at Hartford, Conn., August 14, is announced. He was widely known among shipbuilders and owners as one of the most skilful designers of refrigerating machinery in this country or abroad. Mr. Kilbourn was a native of Connecticut, and in his earlier years of mechanical invention he, in company with his brother, E. E. Kilbourn, produced the Kilbourn knitting loom. In 1873 he went abroad as commissioner from the United States to the Vienna Exposition, and thereafter until 1890 spent much of his time abroad installing refrigerating apparatus on an extensive scale. In 1890 he returned home to supervise the placing of machines on the vessels of the American and Red Star lines on which Kilbourn plants are extensively and successfully used. His son, A. Gray Kilbourn, who was closely associated with deceased in carrying out the various contracts will in future conduct the business.

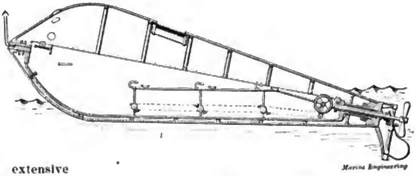


SELECTED PATENTS.

588,248—Speed Recorder. *William J. Smith, Victoria, Canada. Filed Feb. 15, 1895.*

In a speed-recorder for vessels, the combination with the motor-wheel and the power-gearing driven thereby, of register-gearing driven by the power-gearing through the intermediacy of a worm having an adjustable thread and an indicator for the register whereby an adjustment of the thread may be made to establish the correct rate of transmission between the power-gearing and register-gearing and thus standardize or calibrate the register. The motor-wheel being mounted upon a shaft extending fore and aft of the ship and having blades revolving partly within a dead-water chamber or pocket formed in the ship's bottom.





585,903—Life Boat. *Reinhold Bethke and Bernhard Bethke, Milwaukee, Wis. Filed Jan. 28, 1897.*

A life boat comprising a ventilated outer shell of conoidal form having glazed ports and a hatchway that is provided with a suitable closure, a cradle trunnioned in the shell, a rudder having its post hung in arm extensions of the rear cradle-trunnion, a sleeve rotative in the trunnion and geared to the rudder-post, a steering mechanism in gear with the sleeve, a propeller having its shaft rotative in the sleeve, a power-shaft in gear with the propeller-shaft, a frame set in the cradle, pedal-driven crank-shafts mounted in the frame, seats and hand-bars on the frame, and link belt and sprocket-gear connecting the cranks with the power-shaft.

588,512—Rudder. *Albert Viert, Chicago, Ill. Filed July 27, 1896.*

A rudder comprising a blade or tongue, provided with longitudinal grooves or recesses, mounted upon a shaft and extending rearwardly at an upward incline. The combination with a rudder-frame provided with a concave rearward upright having a forwardly-extending triangular projection, of a rudder mounted in the frame as described; the upper edge of the blade being in alignment with the upper edge of the triangular projection.

NEW PUBLICATIONS.

Cassier's Magazine for August is devoted exclusively to articles on marine subjects touching on almost every department of the shipbuilder's art. There are included articles of a descriptive and analytic character. These are written for the most part by well-known masters of their profession, in popular style, which should enable any intelligent reader to easily follow the author. The illustrations, both half-tone and line, are very numerous and of themselves are valuable for reference. The magazine contains 300 pages and includes such articles as: "Specialties of Warship Design," by Sir W. H. White; "Steamers for Shallow Rivers," by John I. Thornycroft; "The Modern Marine Engine," by Charles E. Hyde; "The Coaling of Steamships," by S. Howard Smith, and "The Naval Weakness of England," by Sir Charles W. Dilke. The price is 50c. per copy, and the office of publication, World Building, New York.

"A Chronicle of Books Relating to Steam Navigation, the Navy, and Allied Subjects." This is the title of a little pamphlet issued by Edward Baker, 16 John Bright street, Birmingham, England. To the collector of scientific books, or the head of an educational institution, who desires to complete a set of books on such subjects, this price list is of considerable interest. The oldest book of the lot dates back to 1681. From this to date there is a succession of works, many by famous authors. A brief description is given of each, which the publisher says has not been written "with the view of merely selling a book." The price of the pamphlet is 6 pence, post-paid.

CATALOGUES.

"The Merits of Lead Paints and Dixon's Silica-Graphite Paint Compared" is the title of a pamphlet received from the Dixon Crucible Co., Jersey City, N. J. This pamphlet is written largely because of the extended discussion of late concerning protective coverings for metal. Every user of paints for such purposes should send for a copy. Many striking illustrations are given, showing the advantages of paints other than red lead, an especially striking one being the bridges across the Chicago river.

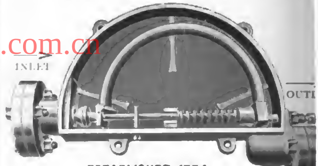
Users of anti-friction metal should send for some of the blotters which the A. W. Cadman Mfg. Co., 63 Water street, Pittsburg, Pa., is sending to its friends and customers.

The lubricators, valves, oil injectors, and other devices manufactured by the Detroit Lubricator Co., Detroit, Mich., are very fully and completely illustrated and described in the 1897 catalogue just received. It comprises about 50 pages and is very fully illustrated, having in most cases from two to four illustrations on each page. The descriptive matter accompanying the cuts is very complete and altogether it is a most useful catalogue. Every user of such devices should send for a copy.

The stamped embossed sheet metal pleasure and ducking boats manufactured by W. H. Mullins, Salem, Ohio, are well illustrated and described in a catalogue just received. These boats are made of manganese bronze, aluminum, or galvanized steel, and each type is fully described.

The pocket size folder of eight pages just being distributed by the Peerless Rubber Mfg. Co., 16 Warren street, New York, has an excellent rainbow effect on the front page, referring especially to the Rainbow packing. The several other kinds of packing also manufactured by this company are well illustrated and fully described. These folders contain interesting matter for all users of packing.

A number of circulars have just been issued by the Lunkenheimer Co., Cincinnati, Ohio, describing and illustrating some of their new devices. These include the Champion rod oil cup, regrinding swing check



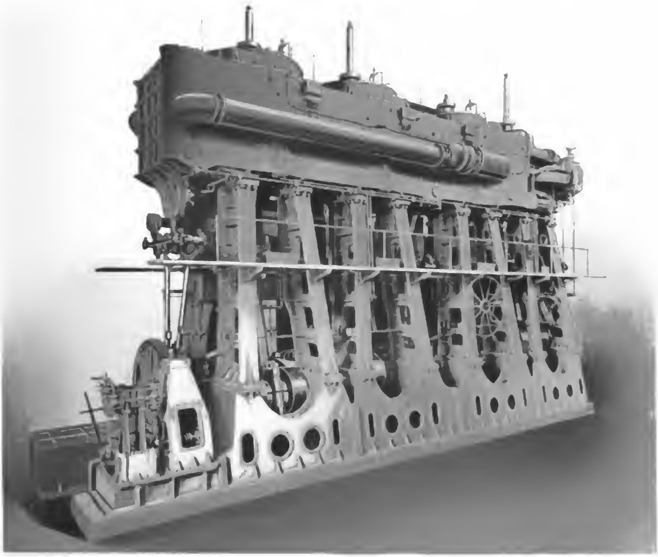
Mass.

MARINE ENGINEERING.

Vol. I. NEW YORK, OCTOBER, 1897. No. 7.

TRANSATLANTIC RECORD BREAKER KAISER WILHELM DER GROSSE.

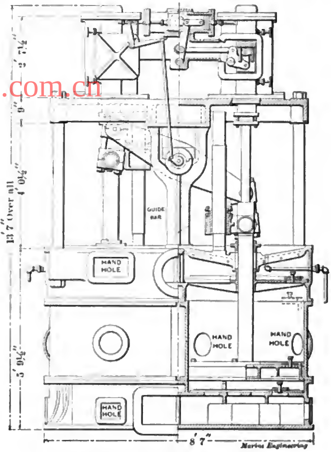
Two transatlantic records were smashed when the new North German Lloyd liner Kaiser Wilhelm der Grosse reached the port of New York, September 26, after a passage of 5 days, 22 hours and 45 minutes, from Southampton. The distance covered was 3,050 knots and the average hourly speed 21.39 knots, which not only establishes a new record on the route, but excelled the maiden trip record, not only for this, but every other route to America. The daily runs were 208, 531, 495, 512, 554, 564 and 186 knots.



FOUR CYLINDER, TRIPLE-EXPANSION ENGINES, T. S. S. KAISER WILHELM DER GROSSE.

This immense vessel, now the largest afloat, is 648 ft. long over all, 66 ft. beam and 43 ft. deep. Her tonnage is 14,000 and displacement 19,684 tons. Until such time as the White Star liner Oceanic, now building at Belfast, is put into the water the Kaiser Wilhelm der Grosse can claim undisputed title to being the largest, and probably fastest, liner afloat. The trip across was also the trial trip, as, owing to low water in the Baltic, she was not sent to sea before the regular day of sailing with a full passenger list. This makes her performance all the more remarkable, as there was no possibility of making any readjustments or special preparations for the trip across, such as would have been possible had a trial trip shown where they were necessary. It will be noticed that the longest day's run was 564 knots, or two knots more than the Lucania's best run of 562 knots. The highest speed attained during the voyage was a fraction less than 23 knots, or rather less than the Lucania showed on her trial trip, when a maximum speed of 23.25 knots was attained by the Cunarder.

As will be noticed in the photographic reproduction of the builders' model, the new vessel is built for speed, with wonderfully fine lines. Her machinery is just as well adapted to the production of speed. The main engines are of very symmetrical design, with not a pound of material wastefully used. They are used solely for driving the ship, all the power needed for auxiliaries being supplied by independent machinery, according to the best modern practice. The vessel is built of mild steel, with a double bottom divided into 22 subdivisions, extending the entire length along the keel line. The hull is also divided into 18 water-tight compartments by 16 transverse bulkheads, extending to the upper deck, and one longitudinal bulkhead in the engine room. The main engines driving the twin screws are of the four cylinder, four crank, triple expansion, vertical type, with cylinders 52 in., 89.75 in. and two 96.5 in. dia. and 68.9 in. stroke. They are balanced on Schlick's system, the cranks being spaced 100 deg. apart, except the H.P. and I.P., which are 60 deg. apart. Stephenson link motion is used, with piston valves for the H.P. and I.P. cylinders, and slide valves for the L.P. The columns and bed plate are cast steel, the former of the girder pattern, giving a very rigid frame with light weight, as shown in the engraving. At 77 revolutions a minute the engines are designed to develop 28,000 horse power. The crank and line shafts are of nickel steel, made by Krupp at the Essen foundry. The tensile strength is 88,580 lbs. Each crank shaft is built up, in four sections, each 11.45 ft. long. The shafts in journals and pins are 23.62 in. dia., with 9.45 in. axial holes. The coupling disks are 40.9 in. dia. and 6.3 in. thick and are held together by 14 bolts. The total weight of each crank shaft is about 81 tons. The propeller shafts are 24 in. dia. and 198 ft. long. Three-bladed propellers are fitted, 22 ft. 3.75 in. dia., with a pitch of 32 ft. 10 in. They are made of bronze and each weighs 26 tons. The propeller shafts are carried inboard and the propeller blades overlap slightly, though not to the same extent as in the White Star fliers. The condensers for the main engines contain 11,060 tubes, and have a cooling surface of 35,522 sq. ft. There is a very complete installation of auxiliaries. In case of damage to the hull, there is a combination of centrifugal and reciprocating pumps available, which can throw 3,600 tons of water an hour. The main air pumps are of the vertical twin beam type, built by the George F. Blake Mfg. Co., of New York. A sectional drawing of one of these pumps is here given. Each has two 8 in. double acting steam cylinders and two 44 in. single acting air cylinders, with 24 in. stroke. The two pumps are so piped that in case of one giving out the other pump can be connected to both condensers. The air cylinders are composition lined, and have buckets and rods also of composition.



BLAKE AIR PUMPS, KAISER W. DER GROSSE.

The boiler equipment of the vessel consists of twelve double-ended Scotch boilers, each fitted with eight furnaces and two double ended, four-furnace boilers. They are arranged in groups, each group connected with one of the four smoke pipes, and each contained in a separate water-tight compartment, so that in case of collision the supply of steam would not be entirely cut off. The stacks are 12 ft. 2 in. dia. and the tops are 106 ft. above the keel line. Steam at 185 lbs. pressure is carried.

There is an extensive electric light plant supplying current to 1,600 incandescent lights of 25 C.P. each. Altogether there are 68 engines aboard the ship, with 124 steam cylinders.

Cabin passenger accommodations on this vessel are really magnificent, not only in the point of decoration, but in spaciousness and convenience. This care has, however, been expended alike in the designing of the accommodations for the passengers of other classes and for the crew. The steerage passengers have been placed in the forward part of the vessel, entirely separated from the amidship portion, which is occupied by the first-cabin passengers, who in their turn are separated from the after part of the vessel, in which the second-cabin passengers are placed. The crew again have their allotted space in the immediate neighborhood of their working stations.

Instead of open gangways on both sides of the upper deck exposed to the weather, such as are on other passenger steamers, the designer, in arranging the upper deck construction, placed the rooms on the upper deck at the sides, the gangways running on the inner side of the rooms. On the older express steamers of the North German Lloyd the space for officers and the engine force is placed in the amidship portion of the deck house, on the upper deck, whereas on the Kaiser Wilhelm der Grosse this space is entirely devoted to rooms for first-cabin passengers. The first-cabin rooms are nearly all placed upon the upper and promenade decks, so passengers are berthed on the upper decks, where no bulkheads hinder the ventilation. This permits, also, of easy access from one part of the vessel to another, and at the same time the rooms being situated high above the water, the port holes can be kept open in almost any weather. The large dining room is situated amidships on the main deck, between the two sets of smoke stacks. On the upper deck above the dining room are the majority of rooms for first-cabin passengers, and on the promenade deck, which is the deck above the upper deck, the drawing room, library and

BUILDERS' MODEL OF THE NORTH GERMAN LLOYD TWIN SCREW EXPRESS STEAMSHIP KAISER WILHELM DER GROSSE.

the smoking room are placed, together with a number of very attractive cabines de luxe and special staterooms. Three staircases lead from the promenade deck to the lower decks. The principal staircase leads into the large dining room, which takes up the entire breadth of the ship, and in which 350 persons can dine at once. On each side of the dining room there are three alcoves, and in the middle of the room is a large skylight. At both ends of the large dining room there are on each side four smaller dining rooms for small parties. A novelty is a vestibule on the upper deck above the dining room, which can be used in bad weather, and from which a view of the dining room can be had. On the promenade deck above this space is the drawing room. This will be the central gathering place for music and social entertainment. The most attractive feature of this drawing room is a large painting, life size, of Emperor William I. On both sides wide gangways lead from the drawing room to the smoking room and to the library.

The library, situated forward of the drawing room, contains a large assortment of international literature in bookcases and is provided with easy chairs, sofas and writing tables.

Four cabines de luxe on the promenade deck are situated on the corridor, from the drawing room to the library, and consist each of a very attractive sitting room, a large bedroom with a brass bed and luxurious bathroom.

There are for the use of the first-cabin passengers 200 staterooms, offering accommodations for 350 passengers, and of these rooms a number are arranged for one person only. The long promenade deck is 400 ft. in length, protected by an awning deck.

The second-cabin passengers are placed aft of the engine room and are accommodated in about 100 rooms, in which 370 persons can be berthed. The second-cabin dining room, extending from side to side of the vessel, is situated on the main deck, immediately aft of the engine hatch. Toilet and bath rooms for cabin passengers of both classes are particularly well arranged. Besides the four bathrooms belonging to the cabines de luxe, there are fourteen large bathrooms for first-cabin passengers distributed throughout the steamer. The second-cabin passengers have six bathrooms.

The steerage passengers are accommodated in the forward part of the vessel in two compartments of the main deck and four compartments of the lower deck, and 800 steerage passengers can be accommodated.

The crew, numbering 450, is very comfortably berthed. The captain's and officers' cabins are on the awning deck close to the bridge. The engineers and firemen are placed on the main deck and lower deck adjoining the engine room, and can reach their work in any weather without inconvenience. The cook's contingent lives near the kitchens, and the stewards of the first cabin are placed amidships and of the second cabin aft. The seamen have their rooms in the forward part of the main deck.

The provision rooms for cabin passengers are amidships aft of the engine room, and those for the steerage passengers forward. Provisions are hoisted from the former by an electric elevator to the first and second cabin kitchens, situated immediately above. These kitchens are furnished with large white porcelain ranges and tiled floors.

The second-cabin kitchen and the rooms for two large bake ovens are on the upper deck, between the engine and boiler hatches. The provision room in the forward part of the vessel contains a cellar cooled by ice, and the kitchen for the steerage passengers is situated above the provision room under the forecastle and is provided with five boilers for steam cooking. The drinking water is kept partly in iron tanks and partly in the double bottom. Three hundred tons of drinking water can be carried, which are pumped into two large collecting tanks on the awning deck, from which the water is distributed by means of pipes into every part of the vessel. The cargo, baggage and provisions are worked through six hatches with four steam winches.

The navigating appliances for the vessel are, of course, of the most improved types. The steering gear is by Brown Bros., of Edinburgh, and is on the orlop deck under the water line. It is operated from the navigating bridge by hydraulic power, the usual hand wheel being fitted. The main bridge is situated above the deck house on the awning deck and contains a large pilot house and chart room. There is also a bridge aft with connecting telegraphs to the main bridge. The steamer is supplied with Hall's stockless anchors.

This grand ocean liner was built by the Vulcan Shipbuilding Co., at Stettin, under the requirements of the German Lloyd's and of the Imperial Navy. In war time she would be fitted with rapid-fire guns and sail as a cruiser under the German flag. She was launched May 4 last. Another vessel of this type, the Kaiser Friedrich, is building for this company at Schichau's yard at Dantzic. She will be somewhat smaller than the Kaiser Wilhelm der Grosse, but will have high speed also.

DIMENSIONS.	St. Paul....	Lucania....	Kaiser W. der Grosse..	Gr. Eastern...
Length over all.	554	620	648	697
Length between perpendiculars..	535	601	625	680
Beam..............................	63	65.2	66	82.6
Depth	50.4	43	43	58
Draught............................	—	—	26	30
Gross tonnage	11,629	12,952	14,000	18,915
Horse power........................	20,000	30,000	28,000	7,652

COMPARATIVE TABLE OF DIMENSIONS.

For assistance received in the preparation of this article we have pleasure in acknowledging the courtesy of Gustav Schwab, of the North German Lloyd Co. in New York.

PITTSBURG AND CINCINNATI PACKET LINE STERN WHEEL STEAMER QUEEN CITY.

BY BERT L. BALDWIN, M.E.

The early settlers in the Western States were not long in discovering that the large rivers formed the "great natural waterways," which could be used most advantageously in the transportation of all heavy goods and supplies to the various settlements that were being located along the river banks. At first the primitive raft was used for this purpose; then came the flat boat, which, with gradual improvements, developed the type of boat which is still in use upon many of the smaller streams, being poled or pushed up stream and floated with the current down stream. The early river men quickly appreciated the value of steam as a power that could be utilized to advantage in handling their boats, as the first river steamer, the Orleans, was launched at Pittsburg during the year 1811; or about four years after Fulton had launched his first steamer, the Clermont, on the Hudson, and proved that it was possible to make the steamboat a commercial success. On the Northern lakes, the Sound and on the Eastern rivers, where the depth of water is practically uniform, where there is little or no current and a wide channel that can be utilized when steering and turning, the finely modeled keel-bottom boats can be used, to the exclusion of almost all other types. In the Western rivers, however, where at certain seasons of the year the current is swift and the channel narrow and tortuous, these keel-bottom boats, if of any size, would be of little use, while the shallow-draught, flat-bottom boats can be handled over sunken sandbars and snags as well as around sharp bends in a manner that would surprise many salt-water pilots. The pilot on a river steamer utilizes the current almost as much as he does the engines in making sharp turns, clearing snags, bridge piers, and in making landings. The most popular boat on the river is the stern wheeler, a most distinctively American type of craft, built to surmount more difficulties of navigation than are ever encountered by deep-water craft. They may look queer to an old "salt," who is sure to call them "wheelbarrows," but they have been gradually developed so as to meet the various conditions and requirements demanded in the river service; and the very fact that many of the best known firms in England, France and Germany are building stern-wheel boats for shallow river navigation, after having tried side wheels and special propellers, shows that the American "wheelbarrow boat" has proved to be all that has been claimed for it. So successful indeed has been this type of boat for shallow river navigation that it is used on all rivers, and is scattered over the world from the Volga, in Russia, to the Magdalena, in South America. On the latter river, so successful have been the American-built boats, that our builders have the preference over all competitors and a practical monopoly of the construction.

The most modern boat that floats upon the Ohio or Mississippi river is the stern-wheel steamer Queen City, which was launched from the ways of the Cincinnati Marine Railway Co. at Cincinnati, June 5 last. This steamer was built expressly for freight and passenger service on the Ohio River, between Pittsburg and Cincinnati.

The Pittsburg & Cincinnati Packet Line, which owns this steamer, has added to its fleet from time to time, and the construction and equipment of each new steamer have been a decided improvement upon the previous ones, so that the steamer Queen City represents the very latest improvements in Western river practice. The company's superintendent, Capt. J. F. Ellison, under whose personal supervision the boat was built and equipped, says, modestly, that there is not a single detail which is actually new, but as far as possible everything has been made strictly up to date, and the good points of many boats have been combined in this one. So this article, which is intended for the many who are not familiar with the river steamer, will describe the steamer Queen City as she is to-day, a representative of the best Western river practice.

The illustration on page 7 shows the steamer complete as she appears on the river, drawn up at the foot of the ways upon which she was built, while the drawings in the supplement in this issue show the steamer in outline only. These drawings have been prepared to show the principal systems of framing and bracing, as well as to show the manner in which the machinery is distributed, it being very important to have the various loads so located that the boat will ride upon a level keel when empty.

The hull is 235 ft. long between perpendiculars, with a breadth of beam of 44 ft. at gunwales, 42 ft. beam at floor of hull and 51 ft. over guards. The half cross section A (see supplement) is taken just forward of the boilers, while cross section B is taken aft of the engine-room bulkhead. The enlarged cross section of hull and boiler deck framing (see supplement) shows more clearly the general arrangement and names by reference to the accompanying table of the various timbers and framing. At the midship section the hold is 5 ft. in depth at the knuckles, with the main deck crowning 10 in. to center. The hull has a shear of 4 ft. 6 in., which increases the head room in the hold, as well as adds very materially to the appearance of the entire vessel. About 60 ft. of the forward portion of the hull, known as the forebody, is modeled to as fine lines as possible, taking into consideration the very shallow depth of the hull as compared with its breadth of beam. The framing and general construction of this forebody are practically the same as would be found in any well-built, keel-bottom, wooden vessel that was designed for deep water, and is finished with a sharp stem, which is protected by a heavy wrought-iron stem band. The main keelson is extended and framed into a massive stem frame, while the moulded frames are shaped to correspond to carefully laid out water lines, and stiffened by the various strakes and keelsons which are carried throughout the entire length of the hull, these longitudinal members having long scarf joints well bolted together. In the bow there are three systems of timber framing, forming massive breast hooks which stiffen the bow so that it is able to resist all of the various strains that may occur in making landing, encountering heavy drift wood, floating ice, shoving barges, grounding upon and sparring over sandbars, which makes it important that this portion of the hull shall be just as strong and rigid as possible. The moulded frames and floor beams are made of clear oak 4 1-2 in. by 5 in. on forebody, 4 in. by 5 in. on dead flats to midship, and 3 1-2 in. by 5 in., aft of this point. They are spaced from 10 in. to 14 in. from center to center, according to location. On the dead flats the floor beams lap 8 ft. on each side of the main keelson, thus doubling the floor beams for a width of 16 ft. through the center of the hull, where the greatest loads and strains are to be resisted. The main and bilge keelsons are let into the flood beams 1 in. and secured with heavy drift bolts properly forelocked. All strakes and clamps are made of Oregon fir, and double bolted on the floor.

By examining the enlarged section of the hull it will be seen that on top of the main keelsons, extending from the breast hooks to the stern planking, is a bulkhead formed of three thicknesses of 1 1-2 in. thick tongue and grooved dressed lumber, the center thickness being made of yellow poplar and run fore and aft, while the outside thicknesses are of yellow pine laid vertically, all thoroughly fastened in place with a top strake made of two thicknesses of 3 in. by 9 in. oak, and with 3 in. by 3 in. side stanchions lapped on main keelson and thoroughly screwed and bolted as well as being further stiffened by a system of double truss rods, forming a veritable backbone for the entire structure.

The forebody is covered on the outside with 4 in. thick selected oak, while the planks under the double floor beams on dead flats are 3 in. thick, and those on either side of this portion of bottom 3 1-2 in. thick. The grub and saddle strakes are also made of oak, while the straight sides, aft of the forebody, are planked with Oregon fir, 3 in. thick, up to the four-foot water line and 2 1-2 in. thick above this point. All seams are thoroughly filled and caulked with hemp payed with red lead, after which the entire forebody and the side planking near the stern are covered with No. 12 wrought iron for the better protection of the planking. The knuckles throughout the entire length of hull are covered with 1-8 in. thick iron, secured by countersunk spikes.

Extending almost the entire length and on each side of the hull is a system of timbers which are known as the hog chain footlines, made out of two thicknesses of 10 in. by 10 in. white pine laid with break joints, scarfed and bolted at joints. These footlines are let into the floor beams 1 in., and bolted through the bottom every 4 ft.

The main deck framing consists of Oregon fir deck beams, supported by the central bulkhead and the various rows of stanchions with their beam strakes. These beams vary in dimensions, being 5 in. by 5 1-2 in. from the stem to forward hatch, where the heaviest freight is handled; 3 1-2 in. by 5 in. from forward hatch to within 40 ft. of main transom and 3 in. by 5 in. aft to the main transom.

The moulded outrigger beams on forebody, which support the overhang of the main deck, are 5 in. by 5 1-2 in. in size, while the remainder of the outriggers are 3 in. by 8 in. in the throat, projecting 3 ft. 6 in. beyond the gunwales, and carrying the guard planks and nosing; the nosing being protected against abrasion by two lines of 1-4 in. by 3 in. wrought iron, with butt strap joints and secured by countersunk spikes.

As will be noticed, the guards extend with a very heavy overhang well toward the stem frame and form a semicircular bow, which space is utilized by the capstan, and is also necessary for the proper handling of the landing stage.

The deck beams and outriggers are covered with a deck of selected stock white pine 2 1-2 in. thick, excepting the portion which comes under the boilers and coal box, where there are longitudinal strips spaced about 18 in. on centers, which carries a 3-16 in. thick steel deck, having butt plates on underside with countersunk rivets at all joints, and an angle iron rim extending entirely around the outer edge, forming one large drip pan, which is properly drained at the low corners. This steel deck is secured in place by suitable wrought iron stirrup bolts, passing under each deck beam. Below this steel deck, and located where they will be most beneficial, are two built-up boiler beams formed of 3-8 in. thick steel web plates stiffened on both sides, top and bottom, by 3 1-2 in. by 5 in. by 1-2 in. steel angles, all properly riveted together. These beams extend from gunwale to gunwale, being straight upon the bottom surface and crowning to the center, where they are 18 1-2 in. in depth. As their name implies, they are intended to carry the weight of the boilers with their furnace settings as well as the weight of the chimneys.

A very important detail in the hull construction is the system of hog chains, which are intended to prevent the steamer from breaking in two in case it grounds centrally upon a snag or sandbar. This bracing is much lighter in weight than the heavy hog frames, which are used upon lake and sound steamers, being in this case simple 10 in. by 10 in. selected white pine braces properly seated on and secured to the footlines, which distribute the strain over a very large area of floor surface. The hog chains are made of refined

PITTSBURG & CINCINNATI PACKET LINE STERN WHEEL STEAMER QUEEN CITY.

Photograph Copyrighted by Marine Engineering.)

wrought iron, 2 in. diam., with solid forged eyes where they are secured to the brace cap castings, anchored securely to the breast hooks in the bow and to the engine timbers and hull at the stern, as indicated on the profile of the steamer.

By examining the cross section of the hull it will be noticed there are diagonal braces with truss rods, shown in dotted lines. These are located under the engine room, where they add greatly to the stiffness of the hull without materially interfering with the handling and storage of freight. The diagonal braces, which are shown in full lines, running from the bilge keelson to the beam strake, are located opposite the central stanchions aft of boilers on main deck, and react against the strain set up by the knuckle chains, which are intended to transfer the strain produced by the weight of freight that may be loaded upon the guards to the central portion of the hull.

Along the strakes and floor beams are 1 1-4 in. white pine boards secured to suitable battens, and laid in sections so that they can be removed without breakage when necessary. This movable floor, or dunnage, extends from the breast hooks to rake of stern, and forms a level surface for the handling and storing of freight. Between the floor and deck of hull there are systems of very heavy strakes, stanchions and diagonal truss rods, forming heavy trusses for supporting the engine timbers as well as resisting the various strains set up by the engines and wheel when in service.

What might be considered a part of the hull construction are the engine timbers, which form the bed plates for the engine as well as project beyond the stern and form the support for the stern wheel. As the name implies, these members are usually made of wood, which has always been a source of trouble on account of shrinking and twisting, making it difficult to keep the cylinders, guides and bearings in proper alignment, as well as to prevent their sliding and slipping while in service, so that in the present steamer these "timbers" were built up in steel, in accordance with modern practice. Each of these engine timbers consists of two built-up box girders with 3-8 in. steel web plates, 3-8 in. by 10 in. top and bottom plates, which are heavily reenforced over the main transom, and have 3 in. by 5 in. by 1-2 in. steel angles at all corners, the two girders being secured to each other by a number of built-up spreaders, arranged so as not to interfere with the working parts of the engine. The outside girder extends a few feet beyond the after end of engine slide plate, while the inner girder projects about 30 ft. or more beyond the stern line, carrying the pillow block and supporting an extension of the guards for the protection of the wheel, as well as forming a very convenient platform for the examination and care of the main bearing and cam. These steel girders are secured in position by heavy foundation rods which extend through the bottom of the hull and are properly forelocked. The overhanging portions are further stiffened by the systems of hog chains and braces, shown on the drawing.

At the stern will be seen the rudder casings, which are arranged to accommodate the rudders, of which there are four of the partially balanced type. The central rudders are known as the main rudders, while the outer ones are the wing rudders. These rudders are massive in construction, with flitch stocks 12 in. by 14 in., having steel plates on the sides extending the full length of the stocks, and each has three sets of rudder irons made of phosphor bronze and secured by heavy strap bolts passing around the stocks and stern posts. The tillers are built up of two thicknesses of oak, size 3 1-2 in. by 12 in., bolted together with distance pieces between and secured to stocks by heavy side strap bolts. The main tillers are about 17 ft. long, while the wing rudders have tillers 8 ft. long. The tillers are all coupled together inboard, while the rudders are also coupled by heavy wrought-iron couplings beyond the rake of the stern. The main tillers have small truck wheels on their under side, centrally located, which run upon semicircular guide tracks supported by framework, known as the elevated circles, which are shown on the deck plan.

On the main deck will be found a central row of stanchions which are also arranged so as to form a truss system, adding greatly to the stiffness of the hull. This is shown clearly upon the profile of the steamer, which was specially drawn to show the various systems of framing and bracing, the cabin and guard stanchions being omitted in this elevation so as to not complicate the drawing. The main deck is divided into certain compartments by the various bulkheads shown. Forward of the boilers will be noticed the main coal box, the front of which is made of 1 1-2 in. tongued and grooved yellow pine, extending up to the boiler deck, although 3 ft. of the upper portion is hinged in such a manner as to drop and allow a free circulation of air to the furnaces when needed. The sides of coal box are only carried to a height of 6 ft. above the main deck. There are bulkheads along the sides of the furnaces, which are hinged for convenience in making repairs. These coal boxes are lined with oak to a height of 5 ft. above the deck. Aft of the boilers the fore and aft bulkheads are carried up solid to within about 30 in. of the boiler deck, and this space is closed by sliding glazed sash in the engine room and by lattice work in the deck room. The other bulkheads are carried up solid to the boiler deck with such window and door openings as are necessary, and all made of tongued and grooved white pine stiffened between stanchions by dressed pine studding and girts which are not more than 1 3-4 in. by 3 1-2 in. in dimensions.

The splash bulkhead at the stern is made of 1 1-2 in. thick white pine tongued and grooved and put together with white lead joints. On the starboard guards, forward of the engine room, is located the cook house, while opposite this, on the

INTERIOR OF PILOT HOUSE OF STEAMER QUEEN CITY.

port guards, is a toilet room, both of which have stairs leading to the boiler deck.

The central line of stanchions, above the main deck, support a continuous white pine ridge pole with scarfed joints 8 ft. long, bolted together with 1-4 in. by 8 in. wrought-iron side plates at these joints, and further stiffened by truss rods and braces where the span between stanchions makes

LADIES' CABIN IN OHIO RIVER STEAMER QUEEN CITY.

this necessary. The forward stanchions are 8 in. by 8 in. at the deck and 8 in. by 6 in. at the cap. The side cabin stanchions are 4 in. by 6 in. at bottom and 4 in. by 4 in. at top.

The carlines are 2 in. by 6 in. dressed poplar, and are carried at their outer ends by a 1 1-2 in. by 9 in. clamp gained into the guard stanchions.

The boiler deck consists of selected stock 7-8 in. thick tongued and grooved white pine in width not exceeding 3 1-2 in. The outer details of this deck are clearly shown by the enlarged section of hull and boiler deck framing, so that it is only necessary to add that the stanchions which come close to the boilers and furnaces are made of iron, and that all exposed corners upon the hog chain braces and stanchions are protected by 1 in. by 1 in. by 1-8 in. single angle iron, carried to a height of 5 ft. above the main deck and properly secured by wood screws.

The guard stanchions, or as they are sometimes called stationary fenders, project above the boiler deck level, and the swinging fenders are made fast to them at this point with 1-4 dia. galvanized wire lashings.

The foregoing describes the portion of the steamer's hull and framing, which differs considerably from deep-water practice. The remainder of the framing, which goes toward forming the cabin, texas and pilot house, is very similar to the usual steamer practice, unless it is that the entire structure is designed so as to be just as light in weight as possible, all parts being placed and tied together in such a manner as to obtain an extraordinary amount of strength considering the small amount of material which enters into its construction. To build a steamer of the size of the Queen City, with a top hamper rising three tiers high above the main deck and only draw 32 in. of water in running order, but without freight, requires the greatest care, skill and experience in proportioning and placing these various parts so as to obtain the desired results.

It is not necessary to enter into a detailed description of the framing of cabin, texas and pilot house, although the dimensions of a few of the members may be of interest, such as the lumber in cabin bulkheads, consisting of 5-16 in. thick white pine; the guard stanchions on upper decks only 1 3-4 in. by 1 3-4 in. oak, and the state room carlines of 1 1-2 in. by 3 in. yellow pine.

A very noticeable feature in this steamer, and one which will meet the approval of nearly every marine architect, is the comparatively small amount of scroll-saw ornamentation used in the vessel, which usually adds to the cost of maintenance as well as to the fire risk. The various guard rails, which are generally composed of light fancy woodwork, are in the present instance made entirely of a heavy galvanized wire netting, having double wires arranged in a diamond mesh measuring 5 in., its greatest dimension, and secured to the base and hand rails.

A very substantial hard-wood stairway leads from the main to the boiler deck, having moulded and polished hand rails on either side and around the well opening, supported by ornamental turned balusters and massive newel posts. The stair tread are completely covered with polished sheet brass. These stairs land upon the forward portion of the boiler deck, which forms an inviting place for the voyager, where he has an unobstructed view ahead and on either side, and is protected from the elements by the hurricane deck above.

Entering the cabin by one of the forward doors the grand saloon extends from the cabin circle to the stern, a distance of 200 ft., without an obstruction, excepting the furniture, to interfere with the view. As one critic has said in discussing this steamer, "up to this point the Queen City can be compared to a number of large steamers that have been built for service on Western rivers, but when you once pass the door of the grand saloon all comparisons must stop. You find before you not a Western steamboat cabin, but a saloon that, taken in detail, will compare most favorably with the finest on lake, sound or even ocean going steamers."

In place of the usual zinc white woodwork the bulkheads, or side walls, are finished in mahogany, with twisted columns, having deeply carved plinths and urn-shaped capitals, forming the jambs of each stateroom door, with carved architraves, mouldings and friezes, all finished in the natural color of the wood and brought up to a high polish with the same care as is used in finishing a piano top. The upper panel of each stateroom door, as well as in the intervening portion of bulkhead, consists of beveled plate glass mirrors, held in place by gold frames, while above each column are gold plated garlands and on the lower door panels are monograms, "Q. C.," entwined around with flowers, which are all in keeping with the lockplates, knobs and other hardware used about the cabin. The upper portion of the side bulkheads, extending the entire length of the cabin, is composed of pivoted sash skylight windows, glazed with chipped glass, which add greatly to the comfort and appearance of the cabin. There are four gangways leading from the cabin to the guards, which are arranged with paneled jambs rounded to about 12 in. radius, and these passage ways are arched by heavy polished brass grills. On each of the rounded panels there are well executed oil paintings, emblematic of the seasons and other appropriate subjects. There are similar panels where the cabin widens to its full width just aft of the cabin circle, and at this point on the starboard side is located the purser's office, while on the port side is the barber's shop, both fitted up in polished brass, hard wood and marble.

The ceiling of the cabin of the Queen City is a decided departure from anything hitherto attempted in steamboat building for the shallow streams in the West. It is made of steel plates that are stamped in a pattern that gives an admixture of the Empire Colonial school of wood carving, each plate being about 18 in. square. These are applied to furring strips, each 1 1-4 in. square, that are first secured to the carlines. The metal cover, extending around the entire cabin, gives the appearance of a semi-arch, which is very effective. This metal is treated after the manner that is in vogue in the treatment of metal house finish, with the exception that greater care was used, made necessary by the jolting and twisting movements of the steamer. The same material has been used in the finishing of walls and ceiling of the ladies' retiring room on the port side near the stern, and also forms the wainscoting in the pilot house. The plates used in the cabin ceiling are made in the raised form, with the configurations brought out on the reverse side, the depth of plate proper being 1 1-4 in., with configurations 5-8 in. The latter is relieved by false beams 7 3-4 in. wide and deep that divide the ceiling into six different large panels. This was done in order to increase the effectiveness of the lighting system, the electric bulbs projecting through these false beams at different points. The cabin ceiling is finished in cream white, while the ladies' retiring room is baby blue. The material is the well-known Sagendorph patent.

There are fifty staterooms, having doors which lead out on the guards, as well as those which communicate with the cabin. They are arranged with comfortable beds and upper berths, fitted out with all the completeness of a Pullman sleeper. Each stateroom has a stationary washstand with nickel-plated water urn, secured to the wall and arranged with a self-closing faucet, in place of the usual bowl and pitcher. On the wall are polished brass clothes hooks, mirrors, and other details which go towards making the stateroom complete and convenient for the passengers.

The furnishing of the saloon is in perfect keeping with the rest of the finish, the carpets and upholstering being the best quality velvet and in patterns and colors which harmonize excellently with the general finish.

Before leaving this portion of the steamer it is well to state that the plumbing in the pantry, toilet rooms, and barber shop is of the most scientific design, including the latest patterns of marble wash stands, flush hopper closets, all furnished with nickel-plated pipes, valves, and trimmings.

Above the cabin on the skylight deck we find the texas, or upper cabin, which is about 100 ft. long, with semi-circular shade decks at forward and after ends. The texas contains handsome and commodious quarters for the officers and crew, as well as a separate cabin for a number of passengers. The staterooms in this portion of the steamer have outside windows with glazed and slat shades, but no outside doors. Above the texas rises the pilot house, which is wainscoted inside to the window sills with pressed steel, and sealed overhead with beaded yellow pine. The sides and after portion of the pilot house are closed in glazed sliding sash, while the front has a system of adjustable weather screens. The most important detail in view is the pilot wheel, which is built with a double circle, the outside circle being 8 ft. dia., and the inner circle about 4 ft. dia., each being built up in hardwood segments carefully joined and finished in natural color, with the outer circle finished with ornamental inlaid work. There are 18 turned radial arms, which project beyond the circle, in the form of handles, and connect the circles as well as couple them to the drum or spool, to which the tiller ropes are connected. The center of this wheel is only a few inches above the floor level, as will be noticed in the engraving, so that nearly half of the wheel comes below the floor. The large dia. of wheel is necessary on account of the tiller ropes being coupled directly to the tillers, without having a series of blocks to multiply the leverage. This is also the reason for making the tillers so long. In the pilot house, on suitable stands, are located the various signal bells, speaking trumpets, search light switches and stearing gear, as well as sounding tubes, which lead from large-mouthed trumpets alongside of the bells in the engine room, to enable the pilot to hear whether his signals are sounded correctly. With reference to the engine room bells there are two large bells of different tones, hung on heavy spiral springs, after the manner of the old-fashioned door bells, as well as a large gong, and a sea-going engineer would be quite at loss to know just what was ordered when the pilot "starts in" jingling his bells. But the river man claims that there is less chance for mistakes with this combination of signals than in the case of the single gong. There is an all-round view from the pilot house, as in steering a river steamer it is just as important to see how the stern is handling as it is to see that the bow is swinging around correctly.

The cabins, skylights, texas and pilot house decks are covered with the W. H. Johns asbestos fireproof roofing material, while the entire boiler or passenger deck is covered with 12 oz. Mt. Vernon duck, lengthwise of the boat, underlaid with heavy felt paper, and finished with several coats of mineral paint.

The engine room, deck room, cook house, laundry, pantry, and all of the woodwork on the under side of the boiler deck are protected by coats of fire-resisting paint of dead white finish. All bulkheads and outside work from the top of pilot house to main deck nosing are painted zinc white, which, although very pleasant to the eye, requires constant attention to keep it in proper condition, on account of the soot and cinders from the soft coal burned in the steamer's furnaces. The only "color" used in the exterior decoration is a little red and gold leaf on the various acorns, which form the top finish to the hog chain braces, mast and derricks, and the raised letter signs on the pilot house.

[*To be continued.*]

STEEL LAKE STEAMSHIP STARRUCCA, OF FIVE THOUSAND TONS DISPLACEMENT.

The launching of a steamer of 5,000 tons in a body of water only as wide as the beam of the vessel was successfully carried out at the yard of the Erie Railroad Co., Union Dry Dock, in Buffalo, in August. The accompanying views show the S.S. Starrucca before, during, and after launching, and the drawings give an exact knowledge of the preparations for launching and the attendant difficulties. The job was carefully planned by Superintendent Edward Gaskin, and nothing was left to chance. By reference to the drawings it will be noticed that the dock into which the Starrucca was launched is 44 ft. wide at a depth of 6 ft. below mean water level, and is 62 ft. 6 in. wide at the top. The moulded beam of the Starrucca is also 44 ft. Before launching the distance from the center of the ship to the end of the launching ways was 35 ft. 1 1-2 in., and the drop from the launching ways to the surface of the water 3 ft. 6 1-2 in. From the bottom of the keel on the blocks the distance to the water, in a horizontal plane, was 9 ft. 4 1-2 in. The vessel was supported on 25 oak logs of sufficient length to extend from the lower bilge to the distance from the keel, shown in the drawing. These logs were about 20 in. square, and were firmly imbedded in the ground, so that they made a solid foundation. The three end ways forward and aft were securely held in position by shores, that were fitted between cleats on the launching ways and piles driven on the bank. Thus the three end ways were firmly held, so that it was possible by means of levers, three aft and two forward, to hold the vessel, after all the blocking and foundations were removed, until such time as it was considered wise to let her go into the water. The inclination of the ways was 1 5-8 in. to the foot. It was necessary to build the heavy barricade on the outer side of the slip, as will be seen in the photograph of the vessel, taken during the launch. Without this barricade, the launch would not have been possible in so narrow a body of water, as all the water displaced by the vessel was forced against it, and the mean level of the slip was consequently raised. At the time of launching the depth of water on the dock sill was 16 ft. 3 1-2 in. The Starrucca was put into the water complete, without water in the boilers and with no fuel aboard. Her launching draught was 8 ft. 4 1-2 in. aft and 2 ft. 1 1-2 in. forward.

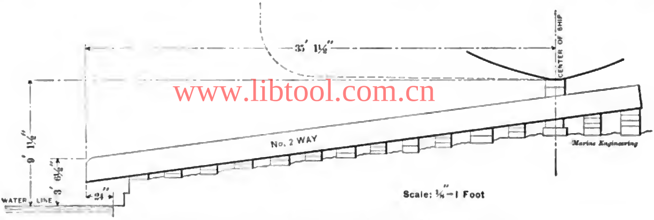
UNION STEAMBOAT LINE S. S. STARRUCCA READY FOR LAUNCHING.

The S.S. Starrucca was built to the order of the Erie Railroad Co., Union Steamboat Line, to carry general cargoes. Her dimensions are: Length over all at rail, 346 ft. 10 in.; moulding length spar deck, 343 ft.; length keel, 325 ft.; depth, 28 ft.; beam, 44 ft.; shear on spar deck, 4 ft. forward, 2 ft. 6 in. aft; shear on gunwale, 5 ft. 3 in. forward, 3 ft. aft. Her decks, main, spar and top-gallant forecastle are entirely of steel, with no wood sheathing. In the main hold there are nine compartments, separated by substantial steel bulkheads, and she is fitted with a water bottom 54 in. deep. The Starrucca was built with channel floors and zee bar frames above the tank, and great care was exercised in determining the size and weight of material used in the construction, the result being an unusually strong steamship. A new feature of the boat is her spars, which are made of steel plate in three courses, riveted with steel rivets. These spars are 100 ft. long, 24 in. dia. at the deck, and are tapered to 6 in. at the truck.

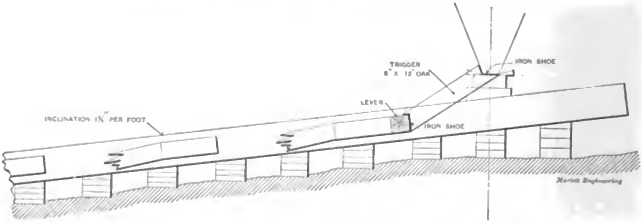
INSTANTANEOUS VIEW DURING LAUNCH.

SHOWING S. S. STARRUCCA AFLOAT IN DRY DOCK.

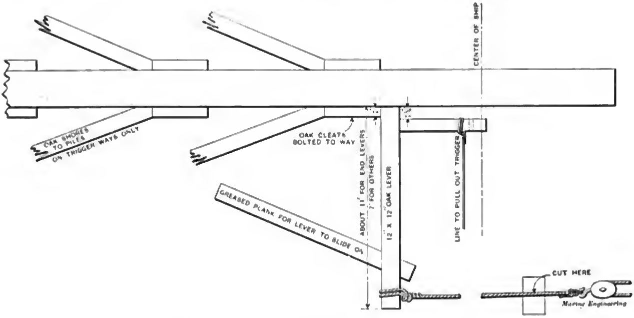
The crew's quarters are located on the spar deck, the deck houses being of wood, with steel coamings of sufficient size to give ample room for all the crew. The quarters are heated throughout by steam and lighted by electricity.



INCLINATION OF WAYS AND DISTANCES FROM WATER LINE.

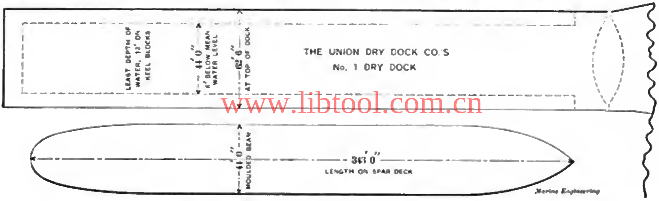


SKETCH SHOWING ARRANGEMENT OF TRIGGERS—ELEVATION.



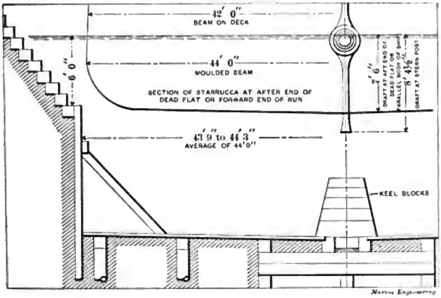
SKETCH SHOWING ARRANGEMENT OF TRIGGERS—PLAN.

The propelling engines, which were built by the King Iron Works, of Buffalo, are of the vertical inverted triple expansion type, with three cranks and cylinders 22 in., 38 1-3 in. and 64 in. dia., and 42 in. stroke, and are up to date in every particular. The high pressure cylinder is fitted with piston valve, and the intermediate and low pressure cylinders with double ported slide valves, all operated by Stephenson link motion. There are 4 Scotch boilers, built by the Lake Erie Boiler Works. Two are 11 ft. 6 in. dia. and 13 ft. long, and the other two are 11 ft. 6 in. dia. and 12 ft. long. Each boiler has two 44 in. Adamson furnaces, and carries a pressure of 175 lb. per sq. in. The stack is 18 1-2 ft. outside dia., and its top is 60 ft. above the grate bars. The boilers are fitted athwartships, two on each side, with the fire room between. Natural draught is relied upon, a small ventilating fan only being fitted.



SKETCH OF OUTLINE OF DRY DOCK, SHOWING S. S. STARRUCCA ON THE STOCKS.

In the engine room there are fitted two vertical duplex ballast pumps, 8 in. and 14 in. by 16 in., of the Deane of Holyoke pattern. To these is attached a single system of piping, with a 10 in. main, and 6 in. suction in each compartment. All valves are operated from the deck. An independent condenser, built by Dean Bros., of Indianapolis, is fitted for the main engines. There are also the usual feed, bilge, and sanitary pumps aboard. The electric light plant consists of two Westinghouse dynamos, each 5 3-4 K. W. 124 volts, direct connected to two Westinghouse junior engines, with 6 in. by 5 in. cylinders. This entire plant was installed by the builders. The steam steering gear is by Williamson Bros. This, with the electric light machinery, is placed in the main engine room, so that it is entirely under the control of the engineer on watch.



SECTION OF DOCK, SHOWING VESSEL AT LAUNCHING DRAUGHT.

Between decks there is a double cylinder vertical hoisting engine with a line shaft operating double drums for all the hatches. There are also fitted steam capstans and steam windlass made by the Providence Windlass Co., and two Dunn Stockless anchors, manufactured by the Standard Steel Casting Co., Thurlow, Pa.

Within a week after the Starrucca was launched she was away on a voyage to Chicago with 4,100 tons of coal in her cargo spaces. With this, and her bunkers full, she displaced 5,610 tons on 16 ft. draught. No trial trip was made, but during the voyage a speed of 14 miles an hour was attained. The construction of this steamer, which was carried out under the direction of Edward Gaskin, superintendent of the yard, gave employment continuously to about 500 men. The launch was carried out without the least hitch or delay of any sort.

New Tidal Dock.

The new Prince's Dock, at Glasgow, christened by Royalty recently, is a tidal basin having a water area of more than 34 acres. It is situated on the south side of the Clyde, at a point which will be very convenient for the shipbuilding interests. It is the largest dock on the Clyde, being greater in extent than the Queen's Dock, on the opposite side of the river. The dock consists of an outer basin and three branch basins, with quay frontage of more than two miles. The outer basin is 1,950 ft. long, with an average width of about 225 ft. The dock will communicate by a gate with the new long graving dock. The tidal dock is fully equipped with hydraulic cranes. One of these can lift 150 tons. The dock is a public enterprise.

THE FORMATION OF CAVITIES IN WATER BY SCREW PROPELLERS AT HIGH SPEEDS.*

BY SYDNEY W. BARNABY, M.I.N.A.

In a paper upon torpedo boat destroyers, read before the Institution of Civil Engineers in 1895 by Mr. Thornycroft and myself, we gave some particulars of the screw trials of the Daring, and described briefly the reasons which led us to conclude that a new phenomenon was manifesting itself. This phenomenon seemingly pointed to the probability that the speed of vessels was approaching a stage at which propulsion by screws would become less efficient, and we said that it appeared inevitable that reduced efficiency must be submitted to as speeds were still further increased.

If a cavity be formed in any manner in the interior of a mass of water it will tend to become filled with water vapor and with any air which might be in solution, since ebullition takes place at ordinary temperatures in a vacuum. We believed that at the speed at which the screws of the Daring began to give trouble such cavities were being formed, and were the source of the great waste of power and of other difficulties which were experienced.

This view met with not a little incredulity at the time, but I believe it to have been perfectly correct. The trials of the Turbinia[1] and the experiments made by the Hon. Charles Parsons afford very strong if not complete confirmation of our contention. Even without this confirmation, the facts that the steps were successful which we took to overcome the difficulty, when we had, as we believed, discovered the cause, afforded strong evidence of the correctness of the diagnosis. As the subject may not have been brought to the attention of many of our foreign friends, I thought a short explanation of the theory of cavitation might be of interest if made as lucidly as its nature will admit and accompanied by a statement of the experience obtained with the Daring, upon which it is based.

Put shortly, the facts were these: With a pair of three-bladed screws 6.16 ft. dia., 9 ft. mean pitch, and 8.92 sq. ft. developed surface, the Daring attained a speed of 24 knots with 3,700 indicated horse power, the screws making 30 per cent slip. With a pair of screws of the same diameter, and practically the same mean pitch, but with a surface of 12.9 sq. ft., an addition of 45 per cent to the surface, the same speed was obtained with 650 less horse power, and with 17 3-4 per cent slip instead of 30 per cent. The number of revolutions required for 24 knots with the screws of small area sufficed to drive the vessel at 28.4 knots, when the blade area was increased. The vibration was unprecedented and dangerous with narrow blades; it was of quite a normal and unimportant character when the blades were widened.

In order to arrive at a clear understanding of what is believed to take place, it is necessary to distinguish between the two cases: Firstly, that of a propeller drawing air from the surface; and secondly, that of the formation of cavities when the propeller is submerged. The effect upon the thrust of a fast running screw when the blades break the surface of the water, or when air penetrates from the surface, is well known. Under such conditions the velocity at which water can flow, due to gravity at a depth below the surface, is equal to $\sqrt{2gh}$, and amounts, for example, to only 8 1-2 knots at a depth of one meter.

If the velocity which has to be imparted to the water in order that it may keep in contact with a portion of the blade situated at a depth is less than $\sqrt{2gh}$, then even if the blade break the surface, there will be no loss of efficiency. This is the case with the slow moving, partially-submerged screws used by Mr. Bancroft to propel barges on the Irish canals, and it also probably explains the good results obtained with the partially-submerged screws of large blade area employed in some shallow-draught tugs on the Continent of Europe. The speed at which water can follow the float of a paddle wheel is limited by the same condition. The particulars of a large paddle steamer, having feathering wheels 20 ft. 6 in. over the floats, which are 9 ft. 9 in. by 3 ft. 6 in. have been supplied to me. I find the slip—i. e., velocity of float in relation to still water—is 11.2 ft. per second. In order that the water should attain this speed it must have a fall of $h = \frac{v^2}{2g} = \frac{11.2^2}{64.4} = 1.95$ ft.; so that, if the top of the float was just awash when at rest, then, considering the action of one float at a time and assuming that at the position of the wheel there was neither a wave crest nor a wave trough due to the motion of the vessel, the water would fall away from the back of the float when in motion for a depth of nearly 2 ft., leaving 1 1-2 ft. only immersed, as it would only be at this depth that the speed of the water due to gravity would equal that of the float. How much the denudation of each float will be affected by the action of those in front of and behind it, is very difficult to say. This might form the subject of very interesting experiments, with models of feathering wheels.

When the screw is sufficiently submerged to exclude air from the surface, the rate at which the water can be accelerated is very much greater. This can be illustrated as follows: water will flow from a tank through an orifice discharging into the open air at a velocity depending upon the depth of the orifice below the surface of the water in the tank. It will flow through the same orifice into the exhausted receiver of an air pump at a much higher velocity

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*Read before International Congress of Naval Architects and Marine Engineers, London, 1897.

[1] See June and July issues of Marine Engineering.

depending upon the degree of exhaustion in the receiver. The velocity in the latter case will be that due to the head of water plus the difference between the pressure of the atmosphere and that in the exhausted receiver. Similarly, the velocity with which water can be made to flow towards a submerged screw is due to the head of water over the screw plus the atmospheric pressure, and there is consequently a definite limit to the speed to which it can attain.

It was not easy to calculate theoretically at what point the breakdown would occur with a given propeller, but a way of attacking the problem suggested by Mr. Thornycroft proved to greatly simplify it, and render its solution easy. His idea was that there must be a definite thrust per square inch of projected screw surface at which cavitation commenced.

A screw propels by putting water in motion sternwards. It effects its object partly by pushing the water with the after face of the blades and partly by pulling it with the forward face. I will ask you to imagine that we have replaced the screw of a ship by a disk of rather less diameter than the screw, and that, instead of revolving the screw shaft, we push the shaft and disk sternwards at such a speed that the disk will momentarily exert the same thrust as the screw. The propelling effect would be the same as that of the screw,[2] and so far as the action between the forward face of the screw blades and the contiguous water is concerned, which is what I wish to illustrate, the action of the disk affords a sufficiently close analogy. As the disk moves sternwards it puts water in motion not only astern of it, but also ahead of it. There being no air between the water and the front face of the disk, a pull can be exerted upon the water, which is forced to follow the disk in the same manner that water is forced to follow the plunger of a pump. But the pull which can thus be exerted by the disk is limited. At a little depth beneath the surface of the water, if the tension exceeds 15 lbs. per square inch (1 atmosphere) the surfaces of the disk and adjacent water are torn asunder, and a cavity is formed between them.

As but a little more than a half of the total acceleration imparted to the water by a screw is estimated to be produced by the suction of the forward surface, it might be supposed that a total thrust approaching to 30 lbs. per square inch (2 atmospheres) might be obtained, but it appears that rupture occurs at parts of the screw surface long before the mean thrust per sq. in. of the whole surface reaches this amount. This is probably accounted for by the fact that the thrust of portions of the screw blade near the circumference is much greater than at portions near the boss.

By plotting the results of a progressive trial carried beyond the speed at which cavitation commenced, we were able to note the point at which the first indications of failure appeared. It is not marked by a sudden change, but by a flexure in the curve of slip, which commences to rise rapidly when the critical speed is reached. The total thrust of the screw at this speed divided by its projected blade area gave a thrust of 11 1-4 lb. per sq. in. (0.75 atmosphere), which is, therefore, about the maximum thrust which can be obtained from a screw working efficiently at a depth below the surface of 11 in., which was the immersion of the tips of the blades in the Daring.[3] For every additional ft. of immersion the total thrust per sq. in. may be increased by 3-8 lb.

By means of the very ingenious expedient of trying a model screw in water heated nearly to boiling point, Mr. Parsons has been able to reproduce and examine the phenomenon of cavitation, and has corroborated our figure of 11 1-4 lbs. as the thrust at which it commences. The difficulty of reproducing analogous conditions with a model lay in the high speed of revolution necessary; but by heating the water, and thus increasing the vapor pressure, lower speeds became possible. Since the tension of the water vapor at boiling point is equal to atmospheric pressure, a screw would cavitate in boiling water at the same speed as it would do if air were admitted to it. In other words, steam would be given off as soon as pressure was reduced. An analogous effect could be obtained by expanding by heat the residue of air in the exhausted receiver before referred to. Then the reduced difference of pressure between the air within and without the receiver would cause the water to flow into the latter from the tank more slowly, and if the temperature of the air were raised sufficiently to cause a pressure inside equal to that of the atmosphere the rate of flow would be that due to the head of water only. The same result would be secured by using a closed tank and exhausting the air in it so that the water would flow from one vacuous region to another, and, I believe, Mr. Parsons has suggested that further experiments might be made in cold water, the surface being relieved from the pressure of the atmosphere.

That cavitation will be the cause of trouble in the future is, I think, certain. Already it is becoming difficult to obtain the requisite area in screws of destroyers without either resorting to an abnormal width of blade or to a larger diameter and pitch ratio than would otherwise have been preferable. The one expedient gives undue surface friction, and the other necessitates a reduction in the rate of revolution, and therefore a heavier engine. The fact that the designer of the Turbinia has been forced—doubtless against his will—to employ nine screws in order to avoid cavitation is an evidence of its influence and a justification of the note of warning we raised in our paper of 1895 after the trials of the Daring.

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[2] This would not be true if the movement of the disk were continued far beyond the stern-post, but is nearly so if the movement is confined to the length of the screw.

[3] The figure should vary slightly with the pitch ratio, being less if the latter is high, since the ratio which the suction thrust bears to the whole thrust varies with pitch ratio, but the variation is so small as to be negligible.

ON NICKEL STEEL AND ALUMINIUM AS MATERIALS FOR SHIP CONSTRUCTION.*—I.

BY J. H. BILES, M.I.C.E.

Improvements in design may be effected by changes in: (1) Arrangements of material; (2) specific strength of material, and (3) specific weight of material. Under the first head are included all changes in structure, which, with a given specific weight of material and a given standard of strength of structure enable a structure to be produced lighter than any previous arrangement. The materials to which attention is called in the present discussion are: (1) Nickel steel; (2) aluminium. Nickel steel has been adopted by the British Admiralty for torpedo boat destroyers. This particular kind has a tensile strength of 37 to 43 tons, with 10 to 15 per cent extension in 8 in. The adoption of some quality of nickel steel for larger vessels, either war or mercantile, or both, is likely to follow. If it were now the same price per ton as mild steel, there seems to be no reason why it should not be at once adopted. But it is not produced at present for much less than three times the price of mild steel. The inducement to adopt it must be an improvement in design. Mr. Beardmore recommends for the shell of torpedo boat destroyers a nickel steel having 52 tons ultimate, 28 tons elastic, and 13 1-2 per cent elongation in 8 in. Mr. Riley, who first made nickel steel in this country, hesitates to adopt as high-tension material as this, on account of the difficulty of making butt connections strong enough.

Two questions are at once opened up: (1) Can advantage be taken of the high tensional strength of this material by reducing scantlings? and (2) If scantlings can be reduced, can good rivet connections be made? It is generally admitted that with uniformly good workmanship and well-designed arrangements throughout, the maximum stresses which come upon a ship are those due to longitudinal bending caused by the passage of waves. When passing over the crest of a wave the deck is in tension, the bottom is in compression. When passing the hollow the reverse is the case. The effect upon the part in tension is dependent upon its sectional area and specific strength. The effect upon the part in compression is dependent on these two things, but also upon the distance between the parts of the material which may be considered to be rigidly fixed, such as the lines of frames or beams. For tensional stresses, any increase of specific strength may be accompanied by a proportional decrease in sectional area. For compressional stresses, the proportional decrease in sectional area can only take place if the distance between the rigid points is reduced also, unless the compression stresses are not severe enough to reach the chosen standard of strength. Generally the maximum tensional strength is greater than the maximum compression stress, the former ranging from 8 to 10 tons, the latter from 4 to 6 tons. This stress is on the ordinary assumptions as to wave heights.

More trouble is found from tensional stresses than from compression, from which it is inferred that the factor of safety for compressive stresses is greater than for tensional. Until an increase of specific strength of material sufficiently great is made to cause reduction in sectional area, and consequently reduction of factor of safety under compression to the point where it equals the factor under tension, it is justifiable to adopt a material of higher specific strength and reduced sectional area. These considerations apply to every detail of the ship, as well as to the ship generally.

In a structure such as a torpedo boat destroyer, or a high-speed light-draught battle steamer, where the compression stresses are much greater than the tensional, and, consequently, the latter are below the standard limit, it is possible that, with the same material and standard of strength, an improvement may be made by reducing the distance between the frames, and accompanying this by a reduction in the sectional area of the parts under compression and tension. The limits of this reduction will be either when the sectional area has been so reduced as to increase the tensional stresses to the chosen standard of strength, or when the reduction in strength of the frames due to the increased number caused by decreased spacings brings on trouble from transverse weakness. If, however, the specific strength of the material be increased, the case is different.

Changes of structure which deserve notice in considering the adoption of nickel are: (1) Reduction of thickness of plating subject to longitudinal tension or compression. (2) Increased local stiffening in this plating. (3) Reduced frame space, and consequent increased number of frames. (4) Reduced weight per frame may be adopted consequent on increased number.

In a recent investigation into the cause of a rupture of a steam main on an English steamer, a board of experts expressed some opinions which are of interest. They said: "In view of the high steam pressure now in use, and which will probably still increase in the near future, lap welded wrought-iron pipes or seamless steel pipes are distinctly preferable to either brazed or copper pipes. Brazed copper steam pipes of 3 1-2 in. internal diameter and over should be examined periodically, with the lagging removed, and should be tested by hydraulic pressure, such tests to be made at intervals not exceeding four years. The test pressure should be such as would subject the material of the pipe to a stress of 2 1-2 tons per sq. in. on the sectional area of the material. The risk of explosion of copper steam pipes would be materially reduced by looping them with wrought-iron bands, or by serving them with wire."

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* Read before Institution of Civil Engineers, London, 1897.

MACHINERY FOR OPERATING LOCKS OF THE ST. MARY'S FALLS SHIP CANAL.

The new lock of the St. Mary's Falls ship canal, opened to commerce August 3, 1896, is the largest in the world, being 800 ft. in length, 100 ft. wide, and about 45 ft. in depth. It is built upon the site of two small locks finished in 1855, which formed the first means of communication between lakes Huron and Superior. Close beside it is the lock of 1881, 515 ft. long and 80 ft. wide, and a short distance to the west the two channels form a Y.

Aside from its size and commercial importance the most interesting feature of the new lock is the mechanism for opening and closing the gates, and for controlling the culverts. Power is derived from the river by means of two 30 horse power turbines located in the basement of the power house, a stone structure which stands between the lower end of the two locks. The turbines are supplied through a large pipe leading from the upper level of the canal, and as the lock has a lift of 18 ft., and the turbines are but little above the lower level, there is always a good head of water. The turbines are geared to overhead shafting, from which three pressure pumps are worked by a rope drive. Each pump has three cylinders. The pumps discharge into three accumulators, which can be weighted as desired, but are usually adjusted to a pressure of 375 lbs. per sq. in. From the accumulators the fluid under pressure is carried out to the lock gates. The gates of the lock are in five sets, known as the upper and lower guard gates, and the upper, intermediate, and lower lock gates. The upper and lower lock gates are at the ends of the lock. The intermediate gates are often used instead of the lower gates when the lock is not crowded to its utmost capacity, and serve to shorten the chamber to 700 ft., reducing the time of filling and emptying. The guard gates are placed in the canal above and below the lock, and are very seldom closed except for repairs. Each set of gates consists of two slightly curved leaves, which swing out from the opposite sides of the lock and meet in the center, forming an arc with the convex side presented to the water pressure and the ends resting against abutments in the masonry. The lower and intermediate lock gates are of course the largest, the leaves being 44 ft. in height, 55 ft. in width, and 3 ft. thick in the center. Each is made of steel, and weighs about 156 tons in air. The gates are opened and closed by submerged wire cables wound upon the drums of six winding machines, three on each side of the lock, opposite the upper, lower, and intermediate gates. A large gear is keyed on the shaft, which carries the winding drum, and this gear engages a pinion which is on the same shaft with a three-cylinder hydraulic engine, driven by the oil piped under pressure. The interior of the drum is provided with a system of gears designed to ease the varying strains to which the machine is subjected as the gate swings around through the water.

LOCKS OF THE ST. MARY'S FALLS SHIP CANAL.—VIEW FROM POWER HOUSE.

For filling the chamber there are six culverts, which start from a well in the forebay, or space between the upper lock gates and the upper guard gates. Passing under the lock gates they run for a long distance beneath the floor, and discharge the water through a number of openings, causing it to rise evenly throughout the entire length of the chamber, and avoiding the dangerous currents which would be set in motion if it was all admitted at one end. The six discharging culverts pass out under the intermediate and lower gates, and empty into a well between the lower gates and the lower guard gates. The culverts are all 8 ft. square, and each is opened and closed by a single leaf valve mounted on trunnions and worked by an engine driven by the oil under pressure. These engines, twelve in number, are placed in the culverts, and are of the simplest design. Each consists of a long cylinder containing a piston, which is driven back and forth as the oil is admitted at either end by valves controlled from above. The piston rod is connected directly with the culvert valve, so that one stroke opens the passage and the reverse stroke closes it. Water is sometimes used in place of oil during warm weather, but it cannot be employed in early spring or late fall when frosts are probable.

By closing the upper and lower guard gates the water can be shut off, not only from the lock, but from the culverts as well, and it is then possible to pump the lock dry. For this purpose an entirely distinct set of machinery has been provided. A passage leads from the culverts to the bottom of a well 50 ft. or more in depth under the power house, and from thence to the canal below the lower guard gates. In this well are located three pumps, each of which discharges a 30 in. stream of water. Each is driven by a vertical shaft reaching up into the basement of the power house, and there connected by bevel gears with a 350 horse power Westinghouse steam engine. There is also a drainage pump, which is sunk still lower in the ground, and is driven by the two turbines. It throws a 10 in. stream, and is intended to keep the lock free of any water which may leak in around the gates. The lock has already been emptied several times. Four to six hours are required for the operation, and the amount of water handled in that time is probably 15,000,000 gallons or more.

The statistics furnished by the canal office show a wonderful growth in the commerce of Lake Superior since 1855, when the canal was first opened. In that year the registered tonnage passing through the locks was 106,296. Last year it amounted, including the traffic through the Canadian canal, to 17,249,418 tons. Inasmuch as both canals have been used by Canadian and American vessels the traffic of both is included in one statement. It is stated elsewhere in the traffic report that the proportion of freight carried in Canadian bottoms in the year 1895 was 3 3-4 per cent, or but little over one-thirtieth of the whole.

No record of the number of passages was kept until the season of 1864, when 1,411 registered craft were locked through, against 17,795 registered and 820 unregistered in 1896. A comparison of the number of passages with the registered tonnage shows that the average vessel has increased in size during the last thirty-two years from about 405 tons to 970 tons. The change that has taken place in motive power is quite as remarkable. In 1864 the steamers were a trifle less than 26 per cent of the whole, and the sailing vessels a trifle over 74 per cent. In 1896 the steamers were over 75 per cent, and the sailing vessels under 25 per cent. It should be remembered, however, that these figures do not represent the actual number of craft on the lakes, but only the number of passages through the canal.

HYDRAULIC WINDING MACHINE.

MECHANICAL EFFICIENCIES OF MARINE ENGINES WITH NUMERICAL ILLUSTRATIONS.

BY BERNHARD A. SINN, M.E.

When determining the power necessary to propel a vessel, it is often desirable to know the mechanical efficiency of the main engines of the vessel in question, and lack of knowledge on this subject is often the cause of large errors in the final result.

The mechanical efficiency of a marine engine is the proportion of power given to the propeller to that indicated by the main engines; or in other words, it is the I.H.P. of the engine, less the friction of all moving parts, stuffing boxes, and bearings. This friction varies with revolutions and power, and is sometimes roughly taken as varying half directly as the revolutions and half directly as the power. As we do not know the exact percentage of friction that is taken up in the various types of engine, we can state at the point neither the quantity nor variation of the frictional forces. The stationary engine has sometimes been taken as a model, as far as frictional wastes are concerned, but the conditions governing the two types are so different that any such comparison is valueless. In the stationary engine we do not have the large lines of shafting, or the constant derangement of the engines due to the twisting and yawing of the vessels. It is thus readily seen that this difference in the two types will cause the mechanical efficiency of the marine engine to fall considerably below that of the stationary type.

Experiments so far made with marine engines to determine their mechanical efficiency, are very few in number, hardly sufficient to form the basis of a calculation. The three most extensive that have come to my notice are those of Isherwood on tug No. 4, Froude on the Greyhound, and Morin on the Pelican. In all three of these cases the developed power was obtained from a transmission dynamometer attached to the propeller shaft, and the friction of the bearings and stuffing boxes was not included in the dynamometric power, although an attempt was made to correct for these additional wastes. These experiments, however, were made before the dynamometer and indicator were as accurate and reliable instruments as they are to-day, and the error that crept into the result is most likely quite considerable.

There are several ways of determining mechanical efficiency, and the means for obtaining it is as follows:

The simplest way, of course, would be to find the developed horse power by means of a dynamometer, but the only practical point of application is inside of the vessel where the friction of the stuffing box and stern bearing cannot be obtained. If we could apply the dynamometer at the end of the tail shaft, between the propeller and the stern bearing, the solution of the problem would be at hand.

We can arrive at the friction of the whole plant when the vessel is in dry dock, by placing a prony brake on the tail shaft in place of the propeller, and finding the difference between the indicated and the developed horse power. But we have not the same conditions here that we have in the actual case, because the vessel in dry dock does not "give" as it would in an ordinary sea.

A third way of finding the mechanical efficiency of a marine engine is to derive the thrust or work, by a method of analysis. If we take a propeller formula, like that of Froude, if necessary modified to permit of a variation in shape and area, other than the ones used in Froude's experiments, we find that, no matter what the form of the expression is, there is always a term which represents work, and the work is I.H.P. multiplied by engine efficiency and propeller efficiency. When we have, therefore, the results of a trial trip complete we can always find the amount of power put into useful work, in other words we can find which portion of the indicated power is wasted and which utilized. Consequently the amount of waste can be found in the marine engine by means of a suitable formula, and of progressive trial data.

At the lowest speed, it can safely be assumed, that all the power that is not given to the screw is used in overcoming the friction of the engine in itself, and not due to the load. Consequently, at the revolutions given for the lowest speed, we know the corresponding friction, neglecting the effect which must of necessity be small when less than 5 per cent of the maximum power is used.

At the next highest speed we find that a different percentage of the power is used in friction. As we can find the amount at this speed and consequently at the revolutions the engines are making in order to attain this speed, we can find the amount of friction caused by the moving parts of the engine, irrespective of load, by simply proportioning the friction found in the first case to the respective revolutions in both cases. Then the residue is load friction. We can now go directly to the highest speed, and by simply proportioning our load friction to power, and primary engine friction to revolutions, find the total friction at the highest speed.

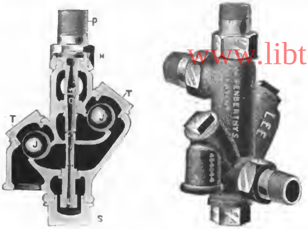
To illustrate numerically. In one engine the maximum power was 1,800 I.H.P., and at the lowest speed given, it was found that but 57 I.H.P. was necessary. Of this 52.2 I.H.P. was used in overcoming the friction of the engines. Now as the power was only about 4 per cent of the maximum, it may be safely assumed that the engine friction took all of this, and the effect of load was nil. At the next lowest power 102 I.H.P. was used in friction. Now, as engine friction is allowed to vary directly as the revolutions, we see that 73 I.H.P. was taken up by this friction, leaving 29 I.H.P. for the effect of load, which at this point was about 15 per cent of the maximum. Now proportioning the load friction to power and going to the highest speed, 128 I.H.P. was used in friction of the load at the maximum power. Similarly we may proportion the friction of the engine itself to revolutions and find at the maximum speed and power 142 I.H.P. utilized in this kind of friction—therefore, we have 270 I.H.P. used in friction. The total power being 1,800, we see that the friction is 15 per cent of the maximum, in other words our mechanical efficiency in this case is about 85 per cent.

The results of an extensive investigation in the course of which this method was used, leads one to form the following general conclusions: For a modern triple or quadruple expansion engine, vertical and built since 1888, about 88 per cent would be the mechanical efficiency. For a modern vertical, triple-expansion engine, built after 1884, about 86 per cent. For a modern horizontal, triple-expansion engine, built after 1885, about 85 per cent. For a modern vertical compound engine built since 1885, about 83 per cent. For a horizontal compound engine built since 1885, about 82 per cent. For a compound engine built since 1875, about 80 per cent. For a beam engine about 70 per cent. For a torpedo boat engine or light yacht engine as high as 90 per cent would be allowable. These values, although derived from particular cases, will in general give consistent results. A great deal, however, depends on the builders, and the care with which the machines are placed on board the ship. Frequently good work in the shops is offset by carelessness in the vessel, as much as 5 per cent. waste from this cause being observed in one vessel.

IMPROVED APPARATUS.

Lee Ball Valve Automatic Injector.

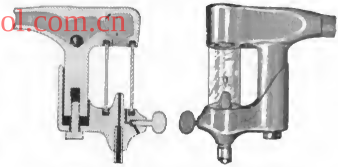
This injector is of the single tube automatic type. Steam entering through the jet W mingles with the water in combining tube O, and the combined steam and water escaping at the space between the combining and delivery tubes lifts the two ball valves J J and is discharged at the overflow. When sufficient velocity has been acquired to send the jet through the delivery tube the upper ball valve seats, the escape through the spills in the delivery tube finding an exit to the overflow by lifting the lower. When sufficient velocity is acquired to send the entire jet through the delivery tube and into the boiler the overflow ceases and the injector is at work. Rubber ball valves are substituted for the usual lifting or swinging overflow metal valves, which are often a source of trouble caused by accumulations of scale. These balls are of vulcanized rubber impervious to liming or corrosion and easily removable by unscrewing the caps T. T. The injector is the invention of W. Penberthy, and is made by the Lee-Penberthy Mfg. Co., 101 Abbott street, Detroit, Mich.



LEE BALL VALVE INJECTOR.

Automatic Positive Feed Lubricator.

A new form of positive feed lubricator is here shown. It is entirely automatic and is operated thus: The adjustable arm is attached to some of the moving parts of the engine, and the pawl attached imparts motion to the back ratchet wheel. An eccentric on the inner hub of the back wheel operates a bell crank having a pawl on the upper end, which moves the top wheel one tooth for each revolution of the back wheel. The face of the piston is provided with a leather cup packing, and an oil outlet running up one side of the piston frame to a pipe connecting with the point to be lubricated. The oil reservoir is drawn on to a stationary piston by means of the feed screw of the top wheel. The oil is thus forced through the outlet and connecting pipe positively and at regular intervals. There is ample provision for adjusting the feed at any desired amount of flow. The back ratchet wheel has three rows of teeth, each row containing a different number of teeth. The adjusting arm and pawl can be set to slip one or more teeth at a time. For high speeds a lubricator can be furnished with means of adjustment, which the manufacturers say will meet every requirement. The action of the lubricator is stopped automatically when empty, and a check valve in the outlet prevents the escape of oil if the removable reservoir is taken out. Many



LUBRICATOR SIGHT FEED ATTACHMENT.

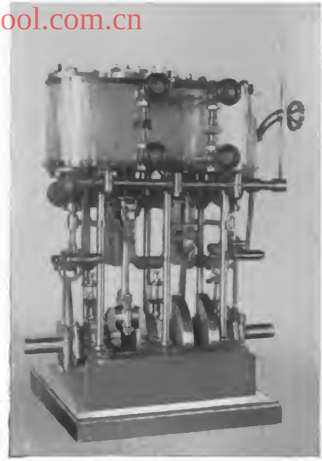
SINGLE AND DUPLEX PATTERNS, AUTOMATIC POSITIVE FEED LUBRICATORS.

lubricators of this pattern have been fitted on engines and the manufacturers report that they work satisfactorily, feeding oil or grease of any consistency to any distance, and being unaffected by changes in temperature. A great convenience with this form of lubricator is that it can be placed in the engine room and connected with the thrust block, or an outboard bearing, with the certainty that lubrication will be regular. For non-condensing engines or where oil in the cylinders is necessary a sight feed attachment is provided, to be used in connection with the National lubricator or as an independent sight feed, as desired. It is, however, not essential to the effective working of the lubricator. The device, as illustrated, is very simple, the glass being of large diameter with an automatic valve which shuts off steam instantly should the glass break. The glass and packing are adjusted with a single adjusting bolt and the glass can be readily removed and cleaned by simply turning a thumb screw. The lubricator is also made in Duplex form, as shown in the illustration on the opposite page. It can be had in a variety of sizes suitable for the work to be done. The manufacturer, the National Lubricator Co., 107 Montgomery St., Albany, New York, will be pleased to answer any inquiries regarding the apparatus.

STANDARD PATTERN, FORBES ENGINE.

Standard Pattern High-Speed Engine.

Every one who has had anything to do with small power yacht engines is aware that their cost is considerable, as they are generally designed to meet particular requirements. This fact has induced W. D. Forbes & Co., of Hoboken, N. J., to put on the market a line of small power yacht engines of sizes which will enable them to be made in numbers, thus materially reducing the cost per engine. The first size of these engines is here illustrated; the cylinder dimensions are 2 3-4 in. and 5 3-4 in. by 4 1-2 in. The cranks are usually set at 180 deg. apart, although the illustration does not show the cranks in this position. All the forgings are made without welds; each crosshead and piston rod is a solid forging and the connecting rods are hollow. The interior of the cylinders are accurately machined on the lower head in order to get as little clearance as possible. The engine runs up to 600 revolutions per minute and will keep on running at this rate of speed provided the lubrication is properly looked after. All parts can be lubricated while the engine is in motion. The link, it will be noticed, is of the double bar type, and the entire design has been given a great deal of thought and care. The engine is highly finished and the material is the best obtainable, and the workmanship very thorough. The weight of the engine, as shown, is 300 pounds.



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Engineers and other officers of steam vessels are cordially invited to call at our office, where will be found the leading marine publications of this country and Great Britain.

Letters and other mail matter can be sent to our care and will be forwarded or held until called for, as desired.

While many of the shipyards of this country are slack of work, or as nearly idle as yards can be and yet keep going, foreign builders, especially British, are busy on vessels for the American trade. Indeed, to keep a complete record of all vessels recently built, or building, or planned, for the purpose of capturing American dollars, would be a difficult task for a statistician. Not to go further back than a year the number of new vessels for this trade, for which orders have been given abroad, is astounding. Taking first the port of New York, not only have single vessels been added to existing lines, but entire fleets of steamers are being prepared for a share of the ever-increasing transatlantic trade. The newest addition to the North German Lloyd service between New York and Bremen, will attract more widespread public attention, of course, than a whole fleet of minor vessels. But such ships are money spenders rather than money makers, when compared with the intermediate type of vessel, which does not attract attention outside of shipping circles, but which nevertheless earns steady dividends for the shareholders. A thousand men could tell the name of the Kaiser Wilhelm der Grosse to one who could correctly name the four great freight and passenger steamers which the North German Lloyd recently added to its fleet, and the company has yet more to come, including the new greyhound, the Kaiser Friedrich. The Hamburg-American line has also largely increased its carrying capacity with the monster Pennsylvania, and it has a few more dollar winners on the stocks, ranging from a sister ship to the Pennsylvania down to a modest 9,000 tonner. Then another Continental line, the Holland-American, appears to be doing pretty well in a business which American capital fears to venture in. In former days it was content to travel along quietly, with second-hand liners, outside of the record class. Now, however, it has moved up a step into the intermediate class with the 8,000 ton Rotterdam, built, and the 10,000 ton Staatendam, building. The White Star has seen the German lines, and gone one better with the 17,000 ton Oceanic, which, according to report, will be able to overhaul a torpedo boat at sea. An immense freighter, too, the Cymric, will soon be added to its splendid cargo fleet. The Cunard line is not talking, but rumor says it has been keeping an eye on the Turbinia. As this line has always had coal to burn, something big may be looked for. French capital, too, seeks an increased share of trade, as the Compagnie Generale Transatlantique is understood to have placed orders for two 22-knot fliers. Next comes the new New York-London service of the Wilsons, Furness-Leyland combination, which will soon announce the sailings of five 8,000 ton vessels. The Atlantic Transport-National line combination has also four big vessels booked for the same route. Another entire fleet has been put in operation by the Prince line, to run between this and Mediterranean ports. With the experience this line has had in Central and South American trade, it ought to be able to correctly judge the trade value of a line here. Then the Allan line has purchased three steamers for the New York service. There is also a movement among West of England interests to establish a line between this port and Milford in connection with the Great Western Railway of England. Now, as to ports other than New York. William Thompson & Co., of St. John's, New Brunswick, have placed orders for four 4,000 ton steamers to trade regularly from that port to Liverpool. Donaldson Brothers, of Glasgow, are adding a 6,200 ton steamer to their Canadian fleet, specially fitted to carry live stock and dairy produce. Elder Dempster & Co. have two 11,500 ton steamers building for their Canadian-Liverpool trade, and also an 8,000 ton cattle and cargo vessel, arranged so that it can be at any time converted into a passenger vessel. They have put larger boats on their line to Bristol, and have a regular line running direct to Manchester. The Warren line, which calls at Canadian ports and Boston, has added an 8,800 ton steamer to its fleet. The Dominion line is also figuring on a new ship. Then the project to establish a fast mail line between Canada and Britain, of which Petersen and Tate are the sponsors, is to be reckoned on. This calls for a fleet of 10,000 ton vessels of top speed, and a subsidy of $800,000 awaits the promoters. A new line is to be established between Philadelphia and English ports, to be operated in connection with the Philadelphia and Reading Railway. This will require the services of several steamers which are under charter. At Newport News the Transatlantic freight carriers are to be added to by two 11,000 ton vessels, orders for which have been placed by Furness, Withy & Co., managers of the Chesapeake line. Going further south, the West India and Pacific Steam Navigation Co., which makes New Orleans a regular port of call, has given orders for two 5,000 ton vessels. Among other projected Gulf lines is one between Bordeaux and New Orleans, and the Hanseatic line is considering the advisability of commencing regular sailings between Galveston and North Sea ports. Pierce, Becker & Ilardi, of Messina, have ordered a 4,500 ton steamer for their fruit line to American ports. On South American routes, several new vessels will soon be carrying cargoes. The German lines are spreading out in this trade, and Lamport & Holt have decided to add a 5,600 ton steamer to their South American fleet. And the contribution of American genius to these grand fleets of ocean vessels consists of a few auxiliaries hidden in engine room recesses.

One of the best things that could have happened to awaken the public mind to a proper appreciation of naval needs was the recent trip of the U. S. S. Indiana to Halifax to be docked. It was calculated to touch the pride of Americans and awaken feelings that no amount of cold explanation could have stirred. That a first-class naval power should have been compelled to borrow the use of a dock in times of peace to execute, not an emergency job, but the very ordinary operation of cleaning and painting the hull, was theatrically ridiculous. More, it was humiliating to every self-respecting American; this spectacle of the millionaire borrowing a utensil from his poor neighbor to cook his victuals in. The fact that the British authorities were extremely courteous only made the position the country was placed in more unbearable. However, it is to be hoped that this incident will be indeed the starting point for very energetic measures to provide the Navy with proper docks. In one way it is fortunate that dock building on an extensive scale was not commenced before this, as in very recent times the size of vessels has increased so enormously that docks of a few years ago are inadequate for all needs now. When the subject of docks is discussed, it is the fashion to speak of the British nation as an ideal. But taking recent advances in naval architecture as a measure of what is to come, the British will also have to do a little excavating. There are only four docks in the British Isles which are big enough to take in the 700 ft. White Star liner Oceanic, now building. Not one of these is owned or controlled by the British Government. The location and dimensions of these docks are of interest: Prince of Wales Dock at Southampton, 750 ft. long, 87 1-2 ft. wide, and 28 1-2 ft. over sill; Mersey Docks and Harbor Board at Birkenhead, 752 ft. long, 85 ft. wide, and 26 3-4 ft. over sill; Clyde Navigation Trust at Govan, 900 ft. long, 85 ft. wide, and 26 ft. over sill, and the Alexandra Dry Dock at Belfast, in three sections, which, over all, measure 825 ft. in length, 80 ft. breadth, and 25 3-4 ft. over sill. Strategically, the disposition of these docks is excellent, but it will be noticed that the depth of water in most is not excessive.

We note with pleasure the following paragraph in a recent issue of Seaboard, which touches on a happening commented on in our last issue:

> In the investigation of the charges brought against Captain Atkinson, of the steam yacht Hermione, which collided with the passenger steamer Saratoga on the Hudson on August 12, the fact was developed that he lowered a boat and offered assistance to the steamboat, but that the Saratoga continued on her way without inquiring the extent of damage done to the yacht. The report was circulated at the time that the Hermione had proceeded on her course without ascertaining the condition of the steamboat, but when the case was brought before the inspectors it was learned that Captain Atkinson had fulfilled his duty, and the charges against him were dismissed. Captain Atkinson has always been known as a careful and trustworthy navigator, and the facts as brought out by the inspectors' investigation prove that he did all he could after the collision.

The finding of the inspectors is entirely creditable to Captain Atkinson and his crew.

Discussion on Breakages of Crank and Propeller Shafts in the Mercantile Marine.

During the recent International Congress of Naval Architects and Marine Engineers in London, one of the most interesting discussions of a practical character followed the reading of the paper on crank and propeller shafts by G. W. Manuel, engineer superintendent of the Peninsular and Oriental Steam Navigation Company. This paper, with the accompanying diagrams, was published in our last issue. The P. and O. Company is, probably, the owner of the largest steam tonnage, held under one ownership, sailing under the British flag. The total tonnage is about 280,000 tons. Under a new contract made with the British Government, the company will receive $1,650,000 annually for carrying the mails to India, China and Australia. In engineering circles the company has been noted for a tenacious adherence to the single-screw type of steamship.

Sir John Durston, Engineer-in-Chief to the British Navy, opened the discussion by referring to Mr. Manuel's statement about twin screw vessels. It was true that twin screws had not lessened the liability to accident, but had made it possible for a vessel to reach port after a mishap to one engine. This advantage justified the adoption of twin screws. As to hollow shafts, the speaker had found them very satisfactory, and in the opinion of the Navy, a better working material was secured by the use of these shafts. The center of an ingot was likely to be the most defective part.

Passed Assistant Engineer Walter M. McFarland, United States Navy, said hollow shafts had given very satisfactory results in U. S. war vessels.

J. T. Milton, of Lloyd's, said that while shafts were made in conformity with rules which prescribed certain factors of safety, yet no rule could provide for the safe working of shafts if they were not properly treated, if out of line or heated at the bearings while at work. To avoid mishaps close observation and prompt remedies for defects were the safeguards. It had been maintained that the three crank engine had given better results than the older types. He favored the built up design of shafts. In these the masses of metal which constituted the component parts are comparatively small and are more likely to be sound forgings than the larger masses which formed the solid shaft, which was machined to shape. Regarding the forging of shafts, he referred to the paper read, in which the author had described the manufacture of shafts from small pieces of scrap iron, cuttings of boiler plate, good ship iron, forge scrap, old bolts, horse shoes and angle iron welded together, forged into billets, reheated, rolled into bars, cut into lengths and forged into convenient sized slabs for welding up into a shaft. In the later days of iron shafts the more powerful hammers and suitable furnaces and fuel made the forgings more reliable. But even with every precaution, every iron shaft contained some flaws or defects, and when these flaws existed in the neighborhood of the greatest strains in work they often extended until the safe limit was passed. The author had also referred in his paper to the forging of steel shafts from scrap, chiefly from ships' plates. The speaker was favorable to this material, as one property of steel scrap was its homogeneity, in which respect it was superior to iron. For a steel shaft he would prefer a tensile strength of 30 tons rather than 33 tons. A high carbon steel in a shaft was unreliable, as, if the shaft once began to go it would break with a snap. As to the reasons for flaws in shafting, such as had been illustrated by the author, one was likely the corrosion that took place between the brass and iron, and another the separation of the molecules in the metal due to longitudinal and not torsional stress. In places where a gun metal liner was shrunk on a rigid point was obtained and a great strain resulted at the end of the liner. Liners might be longer and tapered down so that they would be thick enough only to keep tight. Then, if corrosion took place between the shaft and liner, it would be possible to cut a piece off the liner. Failures of shafts often occurred in tramp steamers which were sent to sea so light that a large part of the propeller was exposed. The blades consequently struck the water a violent blow and the concussion was very hard on the shafting.

John I. Thornycroft said the blows from the propeller blades subjected the shafting to varying stress depending on the number of blows. He favored the tapering of the gun metal liner on a shaft.

A. Holt held that stresses should be calculated in terms of the propeller, and not in terms of the engine. During last winter season twenty-three vessels in the North Atlantic had broken tail shafts. They were tramp steamships for the most part. He favored the use of a propeller of as small diameter as possible.

A. E. Seaton was of opinion that the better framing of engines nowadays, rather than the use of steel, was the cause of fewer shaft failures. The use of white metal was also a contributory cause. Hollow shafts had advantages, as by boring out, the bad metal in the interior was got rid of. Inspection of shafts which did not ignore even microscopic cracks was largely responsible for good results in modern practice. He favored the use of scrap steel in shaft making. In place of liners he would propose the use of white metal bands. In sandy water lignum vitae wore away quickly while white metal bearings would last for years.

Mr. Mudd said most of the shaft failures occurred with tail shafts. Corrosion caused by galvanic action was the chief cause of these failures. A rubber envelope even 1-8 in. thick would preserve a shaft by preventing sea water getting at the metals and causing corrosion at the junction between the liner and the steel shaft. Galvanic action cut a fine nick in the shaft and the stresses acting on this point, it was only a question of time when the shaft would break. He cited cases in which a nick 5-8 in. deep, and extending to a distance of 1 in. from the end of the gun metal, had been observed.

G. W. Manuel, in replying, at the close of the discussion, said that while hollow shafts had been extensively used in naval work they had not been so generally used in mercantile vessels, where more exhaustive tests were possible, and he had concluded that hollow shafts were not as good as solid shafts. In a case in point in which a shaft had been deeply corroded, had the center been removed there would not have been sufficient thickness of metal left to withstand the strains. Speaking of longitudinal strains he could not understand how they would be created if the bearings were properly adjusted. His experience had not paralleled that of Mr. Seaton with respect to the use of Lignum vitae in sandy waters. In ports in China and India there was lots of sharp sand in the water, and the wood strips lasted about seven years.

In England, under the provisions of the Merchants' Shipping Act, stowaways are regarded as part of the crew of a vessel.

During the twelve months ending July 1, 1897, there entered the port of Liverpool, 11,473,421 tons of shipping, an increase of 426,962 tons over the preceding twelve months.

The little torpedo boat Turbinia made a new speed record at the Spithead naval review. She was sent down the lines of warships at top speed, reaching a velocity of 35 knots at times, and this, it is reported, on a steam consumption of 14 lbs. per I. H. P.

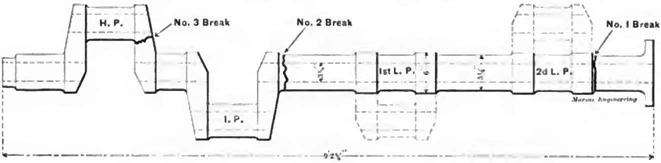
MISHAPS AT SEA.

Failure of Torpedo-Boat Crank Shaft.

During the recent trial of the U. S. torpedo boat Rodgers a bad smash up occurred in the engine room following a break in the after crank of the port engine. At the time the boat was running her speed trial near Annapolis. Everything was going in good order, and those aboard were highly pleased with her behavior, when just as the last stake boat was almost reached, a cloud of steam was observed to rise from the port engine hatch. There is a skylight 7 ft. 9 in. by 2 ft. over each hatch, and fortunately that over the port engine was raised. Steam was instantly shut off by using the levers on the deck. The engine room staff made quick time up the ladders, and Chief Engineer John R. Edwards, U. S. N., who was last to leave the engine room, was not only severely scalded, but badly bruised by the combined efforts of the crew, who had "walked all over him" in their haste to get out. The Rodgers is a twin-screw boat 160 ft. long and 16 ft. beam on the L. W. L., and with the engines indicating 2,000 horse power averages 24 1-2 knots. An examination of the engine showed that it was a complete wreck. The crank shaft was fractured in three places, as shown in the sketch, the H. P. and L. P. cylinders were in scrap, piston and connecting rods were bent, and the bearing bolts of the crank shaft were torn out. The steam main had also been fractured, and had steam not been shut off so promptly from above, deaths might have been reported. The engines have cylinders 12 in., 19 1-4 in. and two 22 in. with 16 in. stroke. When the breakdown occurred the engines were running about 400 revolutions per minute. After a hasty examination the boat was headed for Annapolis with the starboard engine working and Chief Engineer Edwards was sent ashore to hospital.

We are informed that the steel forgings used in the engines were made under lower specifications than those now in force, viz.: 58,000 lbs. tensile strength and 28 per cent. elongation in 2 in. Under the existing specifications such forgings have a tensile strength of 80,000 lbs., an elastic limit of 45,000 lbs. and an elongation of 26 per cent. The crank shaft was 9 ft. 2 3-4 in. over all, 5 1-4 in. dia. in the bearings, and bored with a 3 3-8 in. hole. The first break occurred just aft of the after web of the second L. P. crank. Another break occurred in the same position relatively at the I. P. crank, and the last in the H. P. crank web close to the pin. From the engines aft to the propellers the shafting is solid. Until the vessel is docked and examination is made it will not be known exactly whether the original break was due to inherent weakness in the shaft, interior cracks, for instance, or to something in the water having jammed the port propeller.

A new shaft has been ordered, this time from the Bethlehem Iron Co.



FRACTURED STEEL CRANK SHAFT OF U. S. TWIN-SCREW TORPEDO-BOAT RODGERS.

CORRESPONDENCE.

[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Wants Data About B. T. U.

I should like to know if there are any full data obtainable of the number of B. T. U. per square foot of heating surface in a feed heater, or cooling surface in a condenser, as the case may be, which goes into effective work in heating water or cooling the steam. I should like to have figures giving B. T. U. per square foot for various diameters, thicknesses and materials of tubes. B. T. U.

Regarding Rules for the Propulsion of Ships.

In the last issue a correspondent asks two very vague questions regarding screw propulsion. He wishes to know "a rule for figuring the power necessary to propel a vessel at any given speed," and also "what is the power required to revolve a screw propeller at any given speed?" That no rule can be given for determining the power necessary to drive a ship at any given speed is one of the first propositions made plain to a student of naval architecture. That no rules can be derived at the present time will be seen from the following: The power necessary to propel a vessel is the power necessary to overcome the resistance of the vessel. It is the I. H. P. less the engine friction and the propeller losses. Consequently the whole subject revolves about the resistance of the ship, as this varies with the nature of the vessel's bottom, the shape and the speed. It is a well known fact that up to the present time no formula has been derived which will properly take care of all the different factors involved in the case. The only means we have at hand, except by making model experiments, is to analyze the performance of a ship similar to the one in question, and by the use of experience and the laws of comparison determine the power necessary; but of course it must be kept in mind that this is not an absolute method, merely comparative, and without the original data we are all at sea. As to the second question, there is absolutely no way of determining the power necessary to revolve a propeller at any given speed. In fact the question is so vague that I hardly catch its meaning. What I suppose is meant is the power developed at given revolutions and given slip. As the power varies with pitch, diameter, shape, area, slip, efficiency, etc., it is readily seen that no rational answer can be given. We can, however, determine the thrust de-

veloped by any given propeller, by means of model experiments, but to deduce a formula which will answer all cases is entirely beyond the naval architect to-day. I hope this clearly points out to the correspondent the impossibility at the present time of giving any rules as asked.
B. A. Sinn.

Additional Details of the Turbinia.

In regard to the torpedo boat Turbinia, articles on which I read with great interest in recent issues of your publication, there are a few points on which no information is given. For instance, you do not tell how the boat is driven astern, nor can she be run at low speeds economically, nor whether the type of motor is applicable to bigger vessels. If possible, I would like to get some information on these points.
S. J. McNulty.

(The queries put by our correspondent are best answered by the statements of the inventor, the Hon. Charles Parsons, made at the Institution of Naval Architects, London, in reply to queries put in the discussion which followed the reading of his original paper. How far the speed of the Turbinia could be reduced was a question which could not be answered in a word, said Mr. Parsons, but in ships of larger beam it would be certainly possible to make some reduction in the speed; in fact, the number could be lessened in direct proportion as the diameter of the turbine was increased. Down to 15 knots screws could be driven direct; below that gearing would have to be used, and then the turbine would be applicable to all classes of ships. He looked with distrust on gearing; the small gearing might be made to work, but the application of large geared wheels was a questionable device. The steam pressure could be as high as the boiler would give. It was quite possible to use superheated steam; the difficulty was in getting it. If the superheater were put in the intake, the temperature of which varied widely, according to the state of the fire, etc., or from combustion taking place there, the amount of superheat would also vary greatly. The chief advantage in using the turbine was that by compounding the steam could be expanded down to a lower pressure than ordinarily used; he was able to work down to 1 lb. final pressure, and at the same time could work with very high initial pressure. That gave a very wide range of expansion and consequent economy. If he were to work up to 300 lbs. pressure he would obtain still better results. The boat was driven in a sternward direction by means of a reverse turbine on one of the shafts; the steam was shut off from the ordinary turbine and turned on to the reversing turbine. With regard to steaming at low speeds, there was no difficulty; the engine was small and less steam was put into it. They could go at 11 1-2 knots with 15 lbs. pressure absolute, and could run down to any speed desirable. He had not yet been able to test the most economical speed of steaming. He had been asked if the steam had any cutting action on the blades, to which he would reply there was no such action. By compounding, the difference in pressure was small in any one element of the motor, and the velocity was therefore low; the only deterioration arose from wear, but the clearances were sufficient to put any difficulty from this cause beyond the reach of probability. The engines would develop up to 3,000 horse power without distress. The diameter of the propellers was 18 in. He found that cavitation began when the pressure on the blades of the propeller exceeded 11 1-4 lbs. He used normal screws slightly inclined, and had not gone into the refinement of increasing pitch in any one propeller, or in the propellers relatively to each other. The shafts were slightly inclined, so that the after screws worked partly in the wake of those in front of them, and partly in fresh water.—Ed.)

An immense floating dock built by C. S. Swan and Hunter, Wallsend, England, for the Spanish Government, was towed to Havana by the S.S. Ruapehu. The dock is capable of lifting a dead weight of 10,000 tons, and is 400 ft. long. Very large mercantile vessels can be raised on it. The general dimensions are: Length over all, 450 ft.; width between alters, 82 ft.; extreme width, 109 ft.; depth over side, 27 ft. 6 in. The draught of water when so immersed is 42 ft. 6 in. and the free board 4 ft. 2 in. The material used in construction is mild steel. Structurally, the dock is composed of pontoons, which form the body of the dock and provide the necessary buoyancy, the sides which regulate the raising and lowering of the dock and give it stability, and the movable gates or caissons used when it is necessary to augment the lifting power. There are five pontoons, each 11 ft. 8 in. deep and 85 ft. broad, and the aggregate length is 450 ft. The middle pontoons are rectangular in shape and the end ones are finished off to a point. The motive power for the pumping machinery is electricity, and to raise the dock only requires 2 1-2 hours. The contract for the dock was signed last December and the first plate laid in March.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—IV.

BY WM. BAXTER, JR.

In the last article it was shown that the pulsating current generated by the rotation of one loop in a magnetic field could be improved upon in point of steadiness by combining the currents generated by two, three, or more loops. The figures presented showed how this evening is due to the fact that in the case of two loops, when one is doing nothing the other is doing its utmost, therefore, the average effect of the two is more nearly constant. A little reflection will show that no matter how many loops there may be only one can be doing nothing, and only one can be doing its greatest work at the same time, and all the others will be developing a current intermediate between the maximum and zero. The curve Fig. 18 shows the amount of fluctuation in the current when two loops are used, and Fig. 19 the fluctuation for three loops. As will be seen, in both cases the current does not drop to zero as when one loop is used, but rises above and falls below a line B. This line represents the average value of the current, and is the equivalent of the average pressure line drawn on an indicator card of a steam engine.

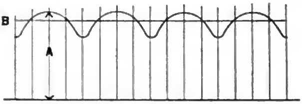


FIG. 18.

The first impression in relation to the effect of combining a number of loops would be, possibly, that the effect being increased as many times as there are loops, the curve drawn to represent the resulting current, would be as many times as high as that representing one loop, as the number of loops used. That is, in Fig. 18 the distance A of the wave above the horizontal line would be twice as high as in Fig. 20, which represents a single loop current. On the same line of reasoning it would be assumed that the line A in Fig. 19 would be three times as high. As a matter of fact such an impression would be entirely wrong for the simple reason that the top of the wave represents the maximum effect, and the result of combining a number of loops is not to multiply the maximum, but the average effect.

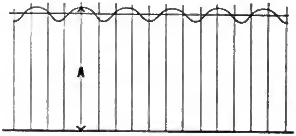


FIG. 19.

In Fig. 20, the line B represents the average effect of a single loop, and is obtained by constructing a parallelogram on the base E F, equal in area to the surface enclosed by this line and the curve. The method is exactly the same as that used to obtain the average pressure line in an indicator card, the peak of the curve which projects above the line enclosing an area equal to that of the two corners of the parallelogram that lap over the curve. In Fig. 21, which represents the current of two loops, the line B is of the same height as in Fig. 18, and is obtained by drawing one parallelogram on top of the other, brickwork fashion. That this construction is perfectly correct can be understood by noting that the two parallelograms are the equivalents of the waves N M of the two currents. Fig. 22 is constructed in the same manner, the three parallelograms being the equivalents of the waves N M P.

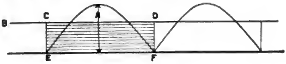


FIG. 20.

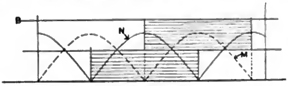


FIG. 21.

As will be seen from Figs. 18 and 19, the increase in uniformity of the current by the use of more than one loop is very decided, the number of waves is increased, and their height is reduced. It is easy to realize from this that by a comparatively small increase in the number of loops the waves can be made so short, and so small, that for all practical purposes the current will be perfectly uniform. In practice a number of loops are not used to accomplish the result, because better mechanical results can be obtained by using another method, which can be explained by the aid of Fig. 23. The principle of this arrangement is the same as that explained in the foregoing, as will be seen presently; it is in fact simply a change in the constructive details.

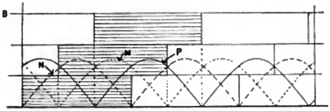


FIG. 22.

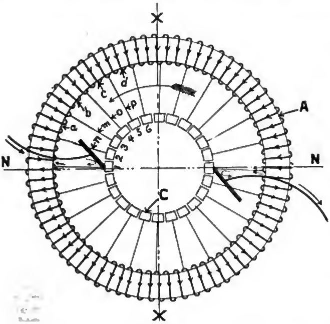


FIG. 23.

Suppose you had ten loops rotating in the field, all equally spaced from each other, then, from what has been explained, it is evident that only one loop would be in a position where it would develop no current, and only one would be in a position to develop the maximum current. In all the others the currents would be intermediate between the two extremes. In the sides of the loops located above the diameter running at right angles with the lines of force, and which we have called the neutral line, the currents would flow in the same direction in space, and in the sides below this line the currents would run in the opposite direction. If each loop were connected with an independent commutator, and the brushes of these were connected with each other so that the B brush of one connected with the A brush of another, the currents generated would pass in succession through all the loops, and the electro motive force developed would be equal to the sum of all the electro motive forces of the ten loops at any particular instant of time. This arrangement, however, would require the use of ten commutators, which would be an objectionable complication. By resorting to the construction shown in Fig. 23, one commutator meets all the requirements. All the armatures of electric machines in general use are constructed upon this principle, although this may not appear to be the case when the form of the armature is considerably changed. The form shown in the figure is what is known as the Gramme ring. The core A of the armature is made of iron and in the shape of a ring; the wire is wound thereon in the same manner as rope on the circular fenders used on tug boats, as shown by the lines upon which the arrow heads are marked. The ends of the wire are joined so as to form an endless wire, and this is divided into sections, which are called coils, as indicated at *a b c d*. These divisions are effected by attaching wires as shown at *n m o p* to points of the wire wound upon the ring. The other end of these wires are connected with the blocks 2 3 4 5 of the circle C, which is the commutator. If a current flows into the brush located on the left side, as indicated by the arrows, it will pass from the block marked 1 to the wire on the ring, and as this wire is endless, it will present two paths leading to the brush on the right side of the commutator. One of these paths is by way of the wire wound on the lower half of the ring, and the other by way of the wire on the upper half. From the direction in which the arrow heads on the wires point, it will be seen that the current in every turn above the line N N will flow toward the center, and in every turn below this line from the center. From this we can see that in the wire lying on the outside surface of the ring, the current will run up from the paper on the upper side, and down through the paper on the lower side. If the line N N is the neutral line of the magnetic field, the lines of force will be at right angles to it and parallel with line X X, and the direction of the current developed by the cutting of the wires on the outside of the ring through the magnetic field would be as stated above. As the brushes are held stationary, the segments 1 2 3, etc., of the commutator slide under them in succession, and thus the point at which the current enters the wire on the armature ring is shifted back coil by coil, as the armature revolves. In actual machines, the coils are wound separate and the ends of adjoining coils are connected with the wires that lead to the commutator segments.

By using a commutator of this type, it will be noticed that there are two points radically different from the arrangement with separate commutators previously explained. One of these is that the current divides at the brushes, and passes through the armature by two separate paths; the other is that the location of the brushes is shifted one-quarter of a circle. As to the first change, a little reflection will show that as the object is to keep the brushes in contact as near as possible, with the points of the wire on the line N N the only way to accomplish it is by cutting off the front and adding to the back of the wire as the ring rotates, and this can only be done by making the wire endless, so as to slip the connections back. But if the wire is endless, there must necessarily be two paths for the current. The position of the brushes is changed simply because the width of the segments is reduced from nearly one-half the circumference to a comparatively small fraction thereof, hence the dividing space when the brushes pass from one segment to the other is but a short distance away from the line N N, instead of ninety degrees, as is the case with a single loop.

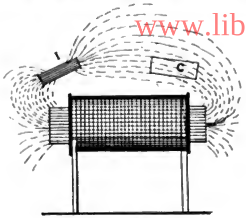


FIG. 25]

If the armature ring A were not made of iron, the action of the machine would be very imperfect. From what has already been said, it will be understood that the lines of force would pass across from one side of the armature to the other in straight lines, and as all the loops of which the winding is composed have both sides on the same side of the center of the shaft, both sides would have currents developed in them that would be in the same direction, in space, that is either up from the paper, or down through it. From this very fact the direction of these currents in the wire itself would be opposite, and therefore the current developed in the outer side of the loop would counteract that developed in the inner side, and the actual current would be the difference betwen these two. When the armature ring is made of iron the conditions are at once changed in the manner indicated in Fig. 24. As iron is a better conductor of magnetism than air, the effect of the ring is to shield the central space. Theoretically, a small portion of the lines of force would pass across the space inside of the ring, but in practice it has been demonstrated that their number is so small as to be unworthy of notice.

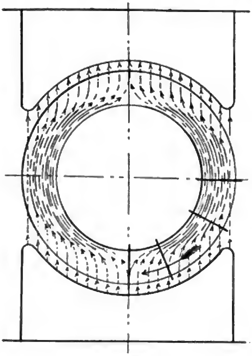


FIG. 24.

In order that electricity may flow along a wire it is necessary that the latter be insulated. If the wire on the ring in Fig. 23 were bare metal, in actual contact with the ring, only a small portion of the current would flow in it; the remainder would pass into the iron ring. Electricity does not follow a wire because it is its nature to run through a long and tortuous path, but because it cannot find a way to get out of the wire, the latter being covered at all points with material through which electricity cannot pass without great difficulty. All known materials are conductors of electricity, but they are divided into conductors and non-conductors, according to their degree of conductivity. Mica, glass and similar substances resist the passage of an electric current to such an extent that only extremely high electric motive forces can pierce them. Other materials, like copper, silver, etc., are such good conductors that the lowest E. M. F. will send a current through them.

Wires through which electric currents are conveyed are made of copper, because it is one of the best conductors. To prevent the current from escaping, it is covered with cotton, which is one of the very poor conductors. The cores of magnets, and other metallic parts of machines, are separated from the wire, and the parts in which the current flows, by means of paper, cloth, mica and other non-conductors, so as to prevent the escape of the current. These poor conductors are called insulators, but there is no known substance that is a perfect insulator of electricity.

There are many substances through which electricity passes with such difficulty, that for all practical purposes they may be regarded as perfect insulators, but there is no form of matter through which the lines of magnetic force will not act in a decidedly energetic manner. Different substances are classified as magnetic or non-magnetic, but this classification is based upon whether they can be made to show magnetic properties or not. A piece of iron placed near a magnet will itself become a magnet. If it is soft iron it will remain a magnet until removed from the vicinity of the magnet by which it is energized. If it is made of hardened steel it will retain its magnetism. A piece of copper placed near a magnet will not become magnetized. The reason for this difference can be understood from Fig. 25. The piece of iron I being a better conductor of magnetism that the surrounding air, concentrates the lines of force upon it, and therefore exhibits polarity just the same as the large magnet; but the copper C being no better conductor of magnetism than the air, does not concentrate the lines of force; hence, the magnetic field at its ends is no stronger than anywhere else. From the foregoing we may say that magnetic substances are those that are better conductors of lines of force than air, and non-magnetic substances, those that are poorer, or at the most no better conductors than air.

The steamer Juanita was launched by the Harlan & Hollingsworth Company in the presence of several thousand persons. She was built for the Merchants' and Miners' Transportation Company, and is 270 ft. long, 42 ft. wide, and 34 ft. deep. Her construction was remarkably speedy, only 4 months and 12 days having elapsed from the time the first frame was raised.

HOME EXCHANGES.

Steamboats on Western American Rivers.

The Ohio river, from Pittsburg to its mouth in the Mississippi, near Cairo, Ill., has a length of about one thousand miles. Its total drainage area is about two hundred and ten thousand square miles. The total population of the cities and towns situated immediately upon the banks of the Ohio and its principal tributaries is about two millions. Hence the importance of the stream as a highway of commerce is great.

During 1896 more than eight million tons of freight and more than five hundred thousand passengers were carried by boats. The freight consisted of coal, iron, manufactured products, and general merchandise, and its value exceeded $250,000,000.

The capital invested in boats is, approximately, $8,500,000. The total amount expended on the improvement of the Ohio for the last seventy years is not more than 2 1-2 per cent. of the value of the freight carried on the river in a single year.

The annual shipments down the Ohio by steamer average more than 7,000,000 tons, and the number of passengers averages more than 1,600,000. Coal shipments are not included in this estimate. Shipments of logs, lumber, and railroad ties towed and rafted amount to 1,000,000 tons. Of corn, oats, hay, apples, potatoes, cabbages, cider, tan bark, hoop poles, lime, etc., sent by flat-boats there are 50,000 tons. Of glass and stoneware, dry goods, groceries, oil, hides, pelts, oil barrels, scrap iron, old rope, etc., sent by trading boats, there are 15,000 tons.

STEAMER HENRY FRANK, WITH 9,226 BALES AND 250 TONS CARGO ABOARD.

The New Orleans was the first steam vessel west of the Alleghanies and was built by Fulton. It was 138 ft. long, and of about 300 tons capacity. This steamer had a stern wheel and two masts—for even Fulton thought sails absolutely indispensable—and one engine. She continued her packet trips between Natchez and New Orleans until July, 1814, when she struck a snag near Baton Rouge and was wrecked. Her average speed was about three miles an hour up stream. She made several trips to Natchez before the merchants would assume the risk of shipping freight on her, perferring the old slow barges or keel boats.

In 1816 a steamer—the first double-decker—was built at Wheeling by Capt. H. M. Shreve. Shreve used French's engines, but placed them in a horizontal position, and gave the vibration to the pitman. He added his great invention, the cam cut-off, and put flues in his boilers, by which three-fifths of the fuel was saved. He named the boat Washington. Leaving Louisville March 12, 1817, she went to New Orleans, discharged and reloaded, and, returning, reached the foot of the Falls in forty-one days. The ascending voyage was made in twenty-five days, including stoppages.

Several boats of queer design were built in the years following, among them the steamer Bazabeel Wells, the greatest curiosity of the age. She was built in 1819, with an engine from a flour mill at Steubenville, boiler from another mill at Pittsburg, and a chimney of brick. The first landing she made knocked down her chimney, whereupon she was provided with a sheet-iron smoke-stack.

In twenty years the genius of the United States made such strides in navigation and transportation that the waterways became almost exclusively the routes of travel. About this time the great system of national highways or turnpikes was introduced and rapidly extended, but the river transit had grown to be so restful, agreeable, and comfortable, and withal so speedy, that everybody who traveled went by steamboat.

From this time until the early fifties steamboats were built in great numbers; the improvement was continuous, and many of the finest steamers ever constructed were built and placed in commission. The decade of 1850-60 was the golden age for steamboats. Daily lines of fast mail steamers were inaugurated.

In the early fifties the Pittsburg and Cincinnati Packet Line consisted of a fleet of fast side-wheel steamers, finely modeled, with big power, but of limited freight capacity, comprising the Buckeye State, Allegheny, Brilliant, Monongahela, Crystal Palace, Pennsylvania, and Pittsburg; while the opposing boats, known as the "Wheeling & Louisville Union," consisted of similar crafts, named the Alvin Adams, David White, Thos. Swan, Baltimore, Falls City, Virginia, and City of Wheeling. To illustrate we give the dimensions of several of these fast clippers—all side wheelers:

The Buckeye State, built at Pittsburg: length, 285 ft.; beam, 30 ft.; floor, 28 ft.; depth of hold, 6 1-2 ft.; capacity, 548 tons; five double-flue 42-in. boilers, 30 ft. long; 30-in. cylinders; stroke, 8 ft. The fastest trip from Cincinnati to Pittsburg credited to the Pittsburg line in 1851 was made by the Buckeye State—490 miles in 40 hours.

The Pittsburg, built at Shousetown, Pa., in 1851: length, 295 ft.; beam, 30 ft.; floor, 29 ft.; hold, 6 1-2 ft.; capacity, 650 tons; five double-flue 42-in. boilers, 30 ft. long; 31 1-2 in. cylinders; stroke, 8 ft. Value, $30,000.

The Alvin Adams, built at McKeesport, Pa., in 1853: length, 281 ft.; beam, 35 1-2 ft.; floor, 33 ft.; hold, 6 2-3 ft.; capacity, 750 tons; six double-flue 42 in. boilers, 28 ft. long; 29 1-2 in. cylinders; stroke, 9 ft. Value, $50,500.

The great low-pressure Jacob Strader, of the Cincinnati & Louisville Mail Line, built at Cincinnati in 1853: length, 332 ft.; beam, 37 ft.; floor, 32 ft.; hold, 7 1-2 ft.; two 16-flue boilers 11 ft. in dia. and 38 ft. long; two poppet-valve engines 5 ft. in dia.; stroke, 10 ft. Value, $120,000. Her boilers, not working well in the muddy water of the Ohio river, were removed, and the old-fashioned double-flue boilers were put in their place. The Strader has the fastest time on record from Louisville to Madison—43 miles in 3 hours and 12 minutes. The Telegraph, of the same line, having made the fastest time from Louisville to Cincinnati the same year—9 hours and 52 minutes

—the Strader was not permitted to beat it, though she could have done so easily. The only steamer that claims to have beaten the Telegraph's time from Louisville to Cincinnati is the new City of Louisville, of the same company, which made the run from port to port in 1896 in 9 hours and 40 minutes.

The fastest trips from New Orleans to Cincinnati—1,513 miles—have been made by the following boats, all side-wheel: 1843, Duke of Orleans, 5 days, 18 hours; 1877, Chas. Morgan, 6 days, 11 hours, making 42 landings and losing 3 1-2 hours passing through the Louisville canal; 1877, Thompson Dean, 6 days, 19 hours, losing 14 hours in the canal and 17 hours at way-landings; 1881, R. R. Springer, 5 days, 12 hours, 45 minutes, running time; 1881, Will S. Hays, 6 days, 17 hours, 10 minutes, port to port, having made 51 landings, and met with other delays.

The Dean and Hays had 30 in. cylinders, with a stroke of 10 ft. The Duke of Orleans, like all boats that passed through the old short Louisville canal, was only 172 ft. long.

With the present enlarged canal, the boats now in use are longer and of lighter draft, with more than double the capacity, enabling the Upper Ohio to compete with the Lower Ohio and Mississippi steamers.

For general freight business, economy, passenger-comfort, and speed, the stern-wheel is fast taking the place of the more expensive side-wheel steamer on the Ohio and Mississippi and their tributaries. They make the same time in all packet trades, and, in comparison with the old side-wheel packets, carry twice the cargo with less power.

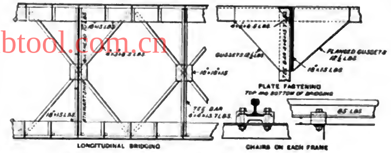
The rapid decline in steamboating on the western American rivers is attributed to the rapid increase in railroads and the diminution of the water supply. The government has awakened to the fact that the waterways must be cherished, and the navigation of prominent streams made continuous and permanent. This is now being done by the construction of the chanoine dam, which can be raised or lowered in a few hours, thus not interfering with the navigation when nature supplies the volume of water, but furnishing a guarantee of steamboat transit, except when ice prevails. Last year Congress appropriated more than $11,000,000 for the maintenance and construction of these betterments. The bill was vetoed by the President, but passed over his head. This improvement established, the Ohio valley must become the coal-producing center of the world. England's coal supply is limited. The almost limitless coal fields of Pennsylvania, West Virginia, Ohio, and Kentucky, being adapted for rehandling and for foreign shipment, can supply the demands of the world for ages.

With the building of the canal from Pittsburg to the Lakes, the locking and damming of the Ohio river, and the construction of the Nicaragua canal, Pittsburg coal can be sold in San Francisco at $4 to $5 per ton, where other and inferior coal is now selling at $7 to $8. American coal could be sold at Callao, on the west coast of South America, at $5 per ton, where it now commands $15. In Valparaiso, where other nations control the coal trade, United States coal could be furnished at $5 to $6, while now the price varies from $12 to $13.

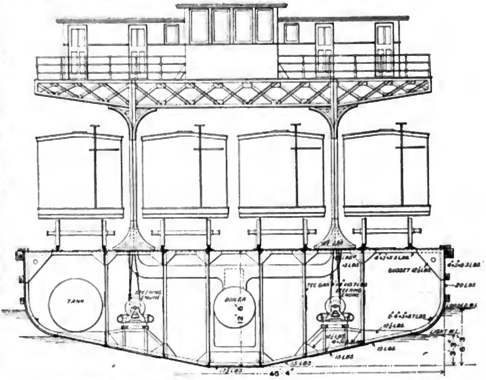
Cons. D. Millar, in the August number of the Engineering Magazine, to which we are indebted also for the use of the illustration.

Car Float for N. Y., Phila. & Norfolk R. R.

A large car float is being built by the Crescent Shipbuilding Company at Elizabethport, N. J., for the New York, Philadelphia & Norfolk Railroad, and through the courtesy of Theo. N. Ely, Chief of Motive Power of the Pennsylvania Railroad, we are enabled to illustrate and describe it. The float is to be one of the largest ever built and will be known as barge No. 5. It is to be used for the transfer of freight cars between Cape Charles and Norfolk, Va. The length is 340 ft., beam over all is 47 ft. 3 in., beam over hull 45 ft. 4 in., and the total depth 12 ft. 6 in. The draft when light will be 3 ft. 3 in., and when loaded 6 ft. 3 in. There are four tracks, which will hold 28 cars, and the equipment and appointments of the boat will be complete and well arranged.



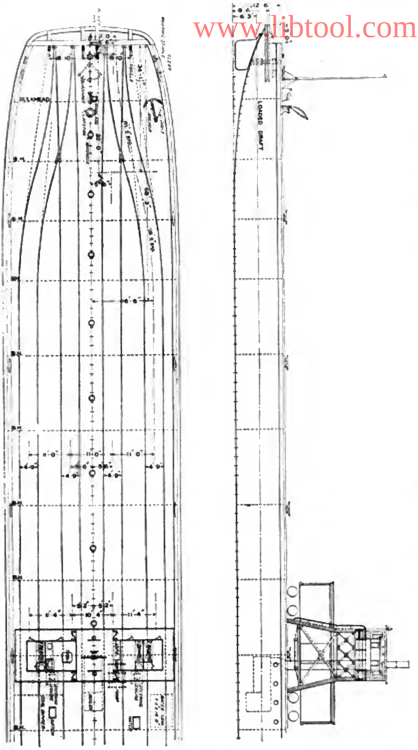
SYSTEM OF LONGITUDINAL BRACING OF CAR FLOAT.



TRANSVERSE SECTION OF CAR FLOAT FOR N. Y., PHILA. AND NORFOLK R. R.

The hull is divided into 18 water-tight compartments by transverse steel bulkheads spaced 20 ft. apart. A 6-in. pipe, which runs the entire length of the float, is provided with valves in each compartment for trimming the float with water ballast. The midship compartment contains the boiler, pumps and steering engines.

The float is being built to drawings prepared by the railroad company and the details have been admirably worked out. The boat has no shear and the deck plating is flush, the seams being made on joint plates upon the under side. The bottom plating is of the usual form with out and in strakes. The keel plate is 7-16 in. thick and is 6 ft. wide, being straight. The plates in transverse section are straight from the keel plate to the bilge, where they turn on a radius of 4 ft., and the sides from there to the deck are vertical, which is not an unusual construction. The bottom plates on both sides of the keel plate are 3-8 in. thick, and 5-16 in. plates are used for the deck. The frames are placed 2 ft. 6 in. apart at the center and 2 ft. at the ends of the boat. They are of angles 4 by 3 in. of 8 1-2 lbs. section. The deck beams are also of the same sized angles and they are gusseted to the frames and to the longitudinal bracing. This longitudinal bracing consists of six trusses which run the entire length of the boat and are virtually keelsons extending from the bottom plating to the deck. The chords of the trusses are 15-lb. plates, 18 in. wide, and the bracing between them is made of 4 by 3 in. 8 1-2 lb. angles. The verticals or struts are T-sections, 4 by 4 in. of 8 1-2 lbs. section. The struts are omitted at the bulkheads and two 4 by 3 in. angles with the 5-16 in. bulkhead plate between them are substituted therefor. The bulkhead plates are joined to the bottom plating by 3 by 3 in. double angles and gusset plates are used in the deck connections. The truss plates are continuous and gussets are used at each frame. The keel plate is braced by vertical transverse plates to which the frames are riveted.



CAR FLOAT FOR NEW YORK, PHILADELPHIA AND NORFOLK RAILROAD, BUILT BY CRESCENT SHIPBUILDING CO.

The deckhouse is carried on a large bridge supported by four posts of channels which have ample gusset bracing at the deck and bridge. In the deckhouse are the pilot-house and cabins for the crew. The float has two rudders, one at each end, which may be worked by two independent Williamson steam-steerers, or by independent hand gear. The rudders are made on spider frames and have no bottom support. All of the machinery is located in the compartment under the bridge. Steam is supplied by a small Scotch boiler 5 ft. 6 in. dia., by 7 ft. long, and 3,500 gallons of fresh water may be carried in a cylindrical tank in this compartment. The pump for trimming the float and for fire purposes is of the Snow duplex pattern, with 8 1-2 by 10 in. cylinders. The 6 in. pipe already referred to connects this pump with all of the compartments, and communication either for emptying or filling them may be made by a valve controlled by a hand-wheel at the deck over each compartment. A Providence brake windlass and a Providence hand-power capstan are provided at each end of the float.

The courtesy of Lewis Nixon, of the Crescent Ship Building Company, and of Theo. N. Ely and H. S. Hayward, of the Pennsylvania Railroad, are acknowledged.

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The Goodrich Co.'s steel twin screw passenger steamship Virginia has finished her season's running between Chicago and Milwaukee, says the Marine Record. The passenger business has been so prosperous during the season that the company intends to spend over $100,000 in remodeling and improving some of its steamers. The most important change will be in the steamer Virginia. She is to be increased in length 50 ft. or 60 ft. and will receive finer lines forward. Two additional boilers will be given the steamer. With the change in her bow and the extra supply of steam it is anticipated that the Virginia will make the run between Chicago and Milwaukee in four hours. The estimated cost of the alterations is $75,000.

NEW PUBLICATIONS.

THEORETICAL AND PRACTICAL GRAPHICS. By Prof. Frederick N. Willson, M. E., Professor of Mechanics, Princeton University. Princeton University Press. pp. 286. With many illustrations.

This is the best contribution yet given on the subject of Descriptive Geometry and Mechanics. The work is primarily for students, but the contents are of such a practical character as to make it a most valued aid to the practical draughtsman and engineer. A thorough knowledge of Descriptive Geometry is the basis in the making of drawings for machinery, for arch work, and for both building and ship construction. Under its method of Projection the stresses in bridges and roof trusses or other engineering construction are graphically determined. This evinces the high industrial utility of the study. In Prof. Willson's work the old method of Projection, or Monge's First Angle Method, is fully explained, in so far as that system is now used, but especial care has been given to an exposition of the Third Angle Method, which is the one chiefly pursued by the best trained constructors of the day. Engineers and draughtsmen will find valued knowledge in the treatment of Gearing, Slide Valves, Screws, Development of Surfaces, and Link Motion Curves. The chapter on the intersection of surfaces will be found of great service in the construction of shafting and piping. Under Warped Surfaces there is given a very lucid and valuable arrangement of a subject that is so useful in treating problems of screws and gearings. Map and Chart Projection is treated in a general way for the instruction of the student. The subject being so broad would require a large-sized work for its full exemplification, but such matter as is given is most useful and fully complies with the requirements of the manual as a text book. In nomenclature he has performed a lasting good for the study. Although the subject has received its greatest attention from other than English writers, yet it seems left to Prof. Willson to unify and give the subject fitting and explicit nomenclature. That portion of the book devoted to Sketching, Lettering, Dimensioning and Conventional Representation of Materials, Use of Instruments, Working Drawings, and similar topics is most complete and of aid to the student. The "make up" of the book is suggestive to publishers of technical works to pattern by it. A well selected paper, a very readable dress of type, and over four hundred illustrations, reproduced by the very best of modern means, constitute no small value of the work. There is no redundant matter given by Prof. Willson. He not only understands his subject, but the plan of the work shows evidence of great care in its arrangement and groupings. His method of exposition is much to be commended. Besides selecting solutions by the best recognized methods he has also given many direct methods of solution of his own. Problems are demonstrated connectedly and clearly and then sensibly applied to constructing or draughting work. The merit of the work justifies the hope that further works by Prof. Willson may follow.

A pamphlet was issued by Assistant Secretary of the Navy Theodore Roosevelt from the Government printing office, entitled "The Naval Policy of America as Outlined in Messages of the Presidents of the United States, from the Beginning to the Present Day." In a preface Mr. Roosevelt explains that the quotations do not at all include all the references to the navy by Presidents of the United States, the selection omitting references to the work of the navy during war times and touching rather upon the necessity for an efficient navy. The most terse of all the many utterances is that of President John Adams, who just 100 years ago said: "Naval power is the natural defense of the United States." The little pamphlet is of interest and is sure to have a widespread effect.

Klondike Edition, Self Help, No. 5, is the title of an extremely interesting pamphlet issued by the Colliery Engineer Co., proprietors of the Correspondence Schools, Scranton, Pa. It is a hand-book compressed into the space of 8 pages, 9 in. by 12 in., which contains about all any one wants to know about the Northwestern gold fields. There is a general chapter on the Yukon gold fields, information as to the best ways of reaching there, the necessary outfit to take along, also a description of life in the gold country, hints on how to preserve health there, and practical points on "how to find gold." There are good reproductions of views of the country and a map of the Yukon region. Although the Klondike is, for most persons who have serious work to do, a very desirable place to keep away from, this pamphlet is well worth the price of a postal card, addressed to the publishers, for the information it contains.

Advices from England report the placing of a contract for a new and enlarged Turbinia with W. Hawthorn, Leslie & Co., of the east coast.

A report was circulated that the old Inman liner City of Chester would be purchased by an English syndicate and sent to Alaska with an expedition bound for the Klondike gold fields.

The documented merchant marine of the United States on June 30 last included 22,633 vessels of 4,769,020 gross tons. To this the Atlantic and Gulf coasts contribute 2,647,296 tons, and the Great Lakes 1,410,103 tons. The steam tonnage amounted to 6,599 vessels of 2,358,558 gross tons.

Thomas McKean, of Philadelphia, one of the directors of the Philadelphia and Reading Railway Co., placed an order with the Cramps for a steel yacht, to be launched and completed by April next. The new yacht will be 213 ft. long and 23 ft. 3 in. beam, with a sea speed of about 16 knots.

The Delaware River Iron Shipbuilding and Engine Co. booked an order for a sister ship to the John Englis of the Maine Steamship Co. The new vessel will have additional passenger room and will carry 1,400 tons cargo and 200 tons coal on a mean draught of 15 ft. 9 in., and will be able to maintain a sea speed of 16 knots.

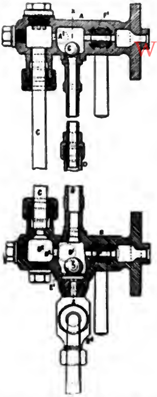
SELECTED PATENTS.

589,259—WATER-GAGE. *Joseph Hopkinson and John Lowis, Huddersfield, England, assignors to J. Hopkinson & Co., Limited, same place. Filed Dec. 19, 1896.*

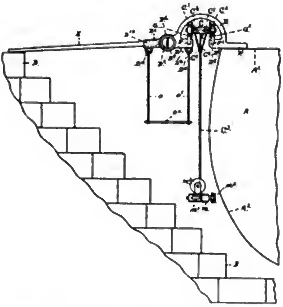
In a safety water-gage the combination of steam and water arms connected by a gage-glass C and a tube D, a try-cock connected to the water-arm, a chamber B' below the tube D, a ball-valve in the chamber, and thoroughfares forming communications between the chamber and the boiler. In a safety water-gage the combination of a steam-arm A and water-arm B connected by a gage-glass C and a tube D, a try-cock B^4 connected to the water-arm, a chamber B' in the water-arm below the tube D, the chamber communicating with the boiler, the tube D, the gage-glass C and the try-cock B^4, a ball E in the chamber B' adapted to close the passage B^3 leading to the gage-glass, the top of said ball when resting on the floor of the chamber being below the level of the passage Bx leading to the boiler, and a ball G in the steam-arm adapted to close the passage A' leading to the gage-glass.

588,933—**Electrically - Operated Ship - Cleaning Device.** *Eddy T. Thomas, New York, N. Y. Filed Apr. 21, 1896.*

Claim.—The arched frame D, supporting the electric conductors G and G', in combination with the truck C, provided with the wheels C' and C², for holding the portable suspended motor M, and tools operated by motor. The arched frame D, supporting the joist F, the electric conductors G and G' forming a track for the truck C to run on, in combination with the truck C. The frame D, having adjustable arm D², pole E, staples D¹¹ and D¹², to support the ropes O O', and scaffolding O², for the purpose described.



HOPKINSON AND LOWIS WATER-GAGE.



THOMAS SHIP-CLEANING APPARATUS.

CATALOGUES.

Very neat folders lithographed in color are being distributed by the Joseph Dixon Crucible Co., Jersey City, N. J., giving detailed information regarding the well-known pencils and crayons made by this company. This folder will be of much use to draughtsmen and other users of pencils who wish to know the various degrees and qualities.

A catalogue has reached us from C. E. Parker, Orange, Texas, descriptive of the Parker safety water tube boiler. Several cuts of the boiler are given, illustrating fully its arrangement and general design, and sufficient reading matter accompanies the cuts to give a comprehensive idea of the special features of this boiler. It has been approved by the Government Supervising Inspector, and is allowed to carry a working pressure of from 200 to 300 lbs.

Owing to the changes in the tariff in the recent Dingley bill the Keuffel & Esser Co., New York, has issued a revised price list. Every user of draughtsmen's instruments and supplies should have a copy of this list, as it is up to date in every respect, and as this list is intended to supplement the general catalogue, it should be used in connection with that. Copies of the catalogue as well as this revised list can be had upon application to the company.

An exceedingly good catalogue is being distributed by the National Lubricator Co., 107 Montgomery street, Albany, N. Y. It is of convenient size to carry in the pocket and is well printed, being in two colors, red and black. Several pictures of the various types of lubricators are given, showing their general design, and their operation is fully explained. Photographs of stationary engines are given, showing the application of the lubricator, and a large beam engine is also shown.

An extremely fine specimen of press work is catalogue No. 96 on steel plate fans just issued by the B. F. Sturtevant Co., Boston, Mass. It comprises 124 pages, 6 1-2 by 9 in size, is printed on coated paper and is very fully illustrated with the various types of fans manufactured by this company. Everybody interested in the subject of ventilation or forced draught, or in other uses, where a blower could be used, will find a great deal of information in this catalogue, as it covers the subject very completely and contains several pages of tables which are valuable for reference.

Users of varnish on marine work will appreciate the catalogue sent to all inquirers by the David B. Crockett Co., Bridgeport, Conn., which gives considerable information regarding the finishing of wood, especially when exposed to the elements, as on vessels, yachts, etc., and in order to emphasize the quality of the varnishes and other wood preservatives manufactured by this company each catalogue is accompanied by a piece of wood finished in the ordinary way. This gives opportunity to test the quality of this work and find out the weather-proof qualities of the varnish.

A copy of the very handsome catalogue published by the Racine Yacht and Boat Works, Racine Junction, Wis., is just received. It is 6 1-2 in. by 10 in. in size, and comprises over 60 very fully illustrated pages devoted to everything connected with yacht and boat work. It illustrates various types of rowboats, combined row and sail boats, dingheys and yacht tenders, schooner and sloop yachts, both cutter and centerboard; canoes of all kinds, racing shells, steam yachts, electric, gas, and steam launches; in short, everything that is necessary for boats and yachts. Every man interested in the subject of designing and constructing boats will find this catalogue particularly valuable.

General Catalogue No. 12, just received from the Electric Appliance Co., 242 Madison street, Chicago, Ill., is a volume of astonishing size and elaborate completeness. It is handsomely bound in red cloth, and comprises 568 pages. Everything that the practical electrician could have use for is fully illustrated and described. Some idea of its completeness can be had when it is stated that the index alone covers 12 pages of two columns each. Every man who has the purchasing of electrical supplies will find it invaluable to have such a complete catalogue as this at hand. Many articles of special design for marine uses will be found fully illustrated and described.

That good printing and press work are a profitable investment is evidently the policy of the Peerless Rubber Mfg. Co., 16 Warren street, New York, judging from Catalogue No. 24, just received. It comprises 120 pages, nearly every one of which contains at least one illustration, and many pages are printed in two colors, showing graphically the appearance of many of the red rubber products of this company. Rainbow packing, of course, occupies the first position, and is very fully described and illustrated, and complimented by letters which have been received from users of it. Other subjects which receive full attention are Rainbow gaskets, various rod and other packings, pump valves, and such manufactures of rubber as hose pipe, buckets, belting, tubing, cement, fire hose, matting, etc. The cover of the catalogue is a rich shade of dark green and the lettering is of gold, giving a very fine effect.

The 1897 catalogue now being distributed by the Boston & Lockport Block Co., Boston, Mass., is of very convenient size, being small enough to put in the pocket, and besides is very complete and has many illustrated pages. Among the special features worthy of more than usual mention in this catalogue are the oval edge yacht blocks which are brass screw riveted, and in other ways up to date so far as strength and economy of operation are concerned. There are many tables and other important information regarding blocks, trucks, pumps and other specialties required in fitting and operating yachts and steam vessels, each subject being illustrated and described. A test recently made at the Watertown arsenal shows that the blocks of this company are of unusual strength. The results of this test are fully given on page 105, and are well worth the consideration of every user of blocks. An unusual feature of this catalogue is the printing of a star in red on each page. This is the trade-mark of the company.

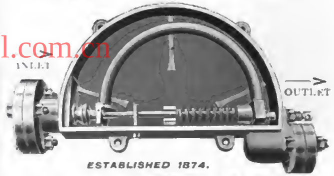
BUSINESS NOTES.

REPAIRS TO TUGS.—The Lockwood Mfg. Co., Boston, Mass., has two tugs undergoing extensive repairs at its yards. Boilers and engines are being overhauled and other improvements made.

A GOOD CLEANSER FOR ENGINEERS.—The India Alkali Works, 75 Broad street, Boston, is meeting with much success among engineers in selling Savogran, a cleanser made especially for the removal of oil and grease.

MARKED ECONOMY.—Regarding the economy resulting from the use of Serve's patent ribbed steel boiler tubes, we have received from Chas. W. Whitney, 11 Broadway, New York, a report of tests made in the Fall River boat Priscilla, showing an economy of not less than 10 per cent. Copies of this report can be had by applying for them.

HIGH PRESSURE STEAM VALVES.—The Coldwell-Wilcox Co., Newburg, N. Y., is getting out steam valves and other specialties where high pressures are required, which will interest every engineer. The catalogue regarding these specialties can be had upon application to the company. This catalogue also illustrates expansion joints, separators, oil filters and other goods.



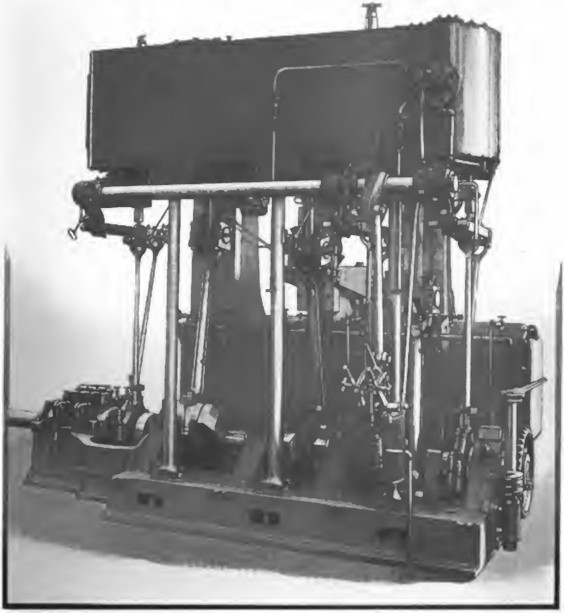
MARINE ENGINEERING.

Vol. 1. NEW YORK, NOVEMBER, 1897. No. 8.

NEWEST AMERICAN BUILT STEAMSHIP FOR HAWAIIAN ISLANDS TRADE.

Recent contracts secured by the Union Iron Works, of San Francisco, Cal., have not been for war vessels alone. The growth of the trans-Pacific trade has created a demand for tonnage which has necessitated the building of numerous ocean-going vessels on the Pacific coast, and has, as a matter of course, stimulated ship building in that section of the country.

The Wilder Steamship Company, of Honolulu, when contemplating the enlargement of its inter-island fleet gave much attention to vessels turned out of British shipyards. It was argued that there was much to be saved in the matter of cost



TRIPLE EXPANSION ENGINE OF THE HAWAIIAN ISLANDS STEAMSHIP HELENE.

by awarding contracts to the shipyards of the United Kingdom. But after careful consideration it was decided to file specifications for two steel steamers of about 450 tons with the Union Iron Works. As a result of the placing of these orders the swift, strong and comfortably-appointed steamer Helene is now engaged in the Island trade, and upon the ways at the Union Iron Works' yard is the frame of a sister ship.

The Helene was built to conform to the rules of the Bureau Veritas. She is schooner rigged, with pole masts made extra heavy to bear the strain they will be subjected to in handling the machinery cargoes required on the sugar plantations of the Hawaiian group. Her length at the water line is 175 ft., beam 30 ft., and depth of hold 15 ft. The hull is divided by five water-tight bulkheads.

The Helene's accommodations on the main deck are as elaborate in design and finish as those of larger and more extensively-advertised liners. There is a steel midship house containing a handsome dining saloon—finished in hardwoods—pantry, galley, engine and boiler rooms, officers' quarters, cooks', waiters' and firemen's apartments, and six passenger staterooms, complete in every detail.

On the upper deck of the midship house is the pilot house, captain's room, two passenger rooms and quarters known as "the President's room," an elegantly-fitted apartment intended for the accommodation of President Dole, or the President of the Wilder Steamship Company, or the corporation's officials, when they travel from island to island of the Hawaiian Republic. Surrounding all these apartments is a shade deck.

On the forecastle deck is a steam windlass. The forecastle is fitted with 18 berths, a large crew being required in the Hawaiian inter-island trade to handle freight in the open roadsteads in ship's boats built especially for the service. On both the forward and after decks there is a double cylinder cargo winch, each capable of handling 4,000 pounds in a whip, and fitted with friction-disengaging gear as well as link-reversing motion. The handling of cargoes from and into boats in the large ocean swells of the island waters necessitates that special provision be made in many details to prevent loss or breakage of packages.

Arrangements are made on deck for carrying cattle and miscellaneous and bulky articles which cannot be stowed in the hold conveniently. Cattle bars and boards are fitted for about 60 head of cattle.

The main engine is of the triple-expansion type, with cylinders 12 3-4 in., 19 in., and 32 in. by 24 in. stroke. The valves are worked by the ordinary Stephenson link motion, fitted with steam reversing gear. Watson's patent metallic packing is used on all rods and valve stems. All bearings are lined with Union white bronze. The air, bilge, and feed pump is worked by levers from the crosshead of I. P. engine. The circulating water is supplied by an independent centrifugal pump, which is fitted with a bilge connection.

The thrust bearing is of the horse-shoe type, lined with Parson's white bronze, and with water circulating through the horse-shoe rings.

UNION IRON WORKS GENERATING SET.

The propeller is right-handed, four-bladed, of manganese bronze, 8 ft. 3 in. dia. and 9 ft. 6 in. pitch.

The main boiler is 12 ft. dia. by 11 ft. 3 in. long, and has two Morison suspension furnaces each 44 in. outside dia. The boiler contains 1,580 sq. ft. heating surface, and the spring-loaded safety valves are adjusted for a working pressure of 165 lbs. per sq. in.

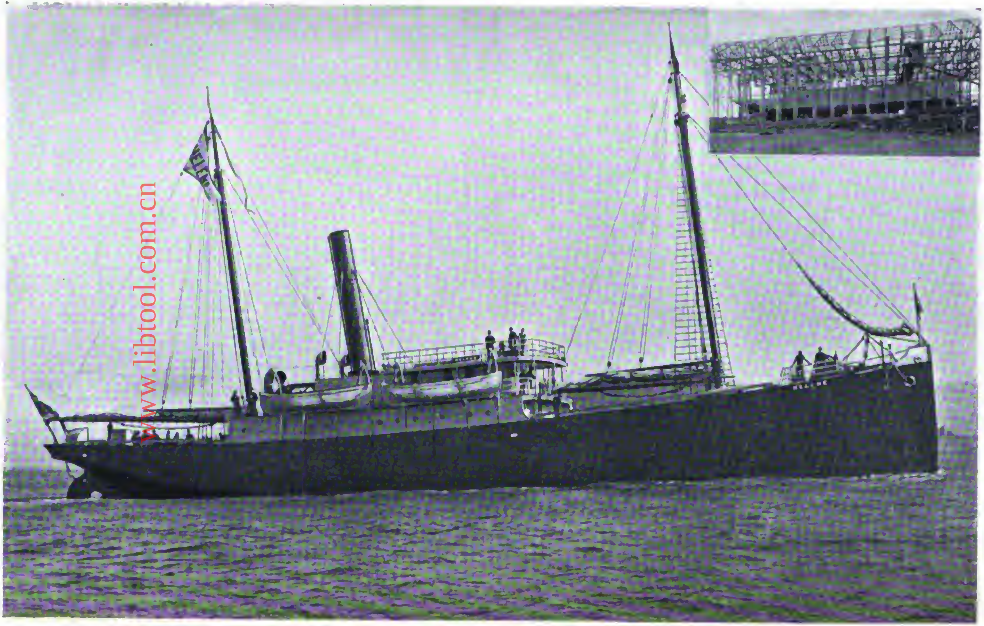
The feed water passes through a live steam coil heater and enters the boiler at a temperature of 212 deg. Additional provision is made for feeding with an injector when in way ports, as well as with the auxiliary steam feed pump.

A donkey boiler is fitted in the upper part of the fire room, having the same steam pressure as the main boilers and connected to winches, windlass, steam pumps, and dynamo engine.

The electric light is supplied by a direct-driven dynamo of 5 K. W., Union Iron Works pattern, making 500 revolutions per minute. It is located close to the starting platform.

The vessel carries 670 tons of sugar in the holds, and averages on her regular service a speed of 10 knots, developing 420 indicated horse power. She has proved to be a very successful investment.

The Union Iron Works is at present busy on a number of new vessels, which include the Fannie Irwin, a sister ship to the Helene, the Japanese cruiser Chitose, the U. S. battleship Wisconsin, and the torpedo boat destroyer Farragut. The company has also orders booked for two coasting steamers and for a large ferryboat.



WILDER STEAMSHIP CO.'S PASSENGER AND CARGO STEAMSHIP HELENE, ENGAGED IN HAWAIIAN ISLANDS TRADE.

(Built and Engined by Union Iron Works, San Francisco, Cal.)

EXPERIMENTAL TANK AS AN AID TO MARINE ENGINEER AND NAVAL ARCHITECT.

BY PROF. W. F. DURAND.

In all branches of engineering work problems are continually arising, the solution of which cannot be found without the aid of experimental investigation. No more ample illustration of this truth can be found than in the field concerned with the design and construction of ships and their propelling machinery. Of the many problems which may thus arise, however, we are, in the present article, concerned only with such as depend on the forces developed by the motion of a solid body through or in a liquid. The problems thus brought before us are those relating to resistance and propulsion as affecting the general problem of marine design and construction.

Now, it is a fact that, notwithstanding the enormous advances made by the science of mathematics, it is still entirely unable to deal, in the general case, with the phenomena attending the motion of a body through a liquid. The forces involved in such case depend on so many variable conditions of the problem and are related to these conditions in such obscure ways that hitherto all attempts at a mathematical discussion of the problem have been futile. Our only recourse in such case is therefore to determine by experimental investigation, such features of the solution as are needed for the purpose in hand.

Such experimental investigation may be either direct or indirect. In the first case the objects involved in the problem are made or represented full size, the conditions of the problem are produced, and the forces involved are measured directly. Thus, for example, the resistance of a torpedo boat might be determined experimentally by building the boat and towing it at a series of speeds and measuring by a traction dynamometer the forces involved. Or, again, the performance of a screw propeller might be investigated by making the propeller full size, producing the conditions of use, and determining the data desired. Where possible, such direct methods are naturally the best, but it is rare that experimental work can be carried on in this way, and, even if it could, the value of the data taken would be comparatively small were its application limited to the case for which it was directly observed. In fact, the broad and fundamentally important principle of experimental work of the kind we are now considering lies in the possibility of applying the data for any one case to an indefinite number of others through accepted laws of relationship and comparison between them. Such laws being accepted as a working basis, it becomes possible to represent the object under investigation by a comparatively small model. The latter is then made the subject of direct examination under a set of conditions connected with the fundamental conditions according to the laws of relationship mentioned above. The data thus found is then used according to these laws, and the desired final results determined. But this is not all. The data having thus served its immediate purpose may than be filed away for future use, and may be made to serve as occasion arises, for an indefinite series of other problems under properly related conditions. We shall not here enter into these laws of relation and comparison. It will be sufficient to note simply that their object is to render as far as possible the investigation independent of size or dimension, so that the series of cases referred to above may consist of an indefinite series of sizes, all of the same form and proportion, and operated under speeds related to that of the original model according to the law of relationship used.

With this general introduction we will now take a nearer view of the application of these principles to the experimental investigation of the resistance of ships and the performance of screw propellers, these being practically the most important parts of the general field of work here brought to our notice.

The ship is represented by a model usually in paraffine, and to such scale as to bring its length from ten to fifteen feet. A block of paraffine is first cast roughly to shape. This block is then placed on the bed of the model forming machine, shown in plan in Fig. 1[1]. The block here passes to and fro under rapidly revolving cutters which are moved by a pantographic connection with a tracing point or disk, the latter being carried by the operator tangent to the water lines of the vessel whose form is to be reproduced. In this way successive water lines are cut out at the proper successive heights on the surface of the future model, the cross sections at the end of this stage resembling series of steps whose inner corners are on the surface desired. The outer corners are then worked off smoothly by hand tools until the inner angle of the path cut by the tool barely remains. The surface is then smoothed and polished and is ready for the trials. The canal or tank in which the trials are made should have a length of from 350 to 500 ft. by 20 or 25 ft. width and 10 or 12 ft depth.

Spanning the tank, as shown in Fig. 2,[2] is a truck or carriage running on rails laid on either side. This truck is connected with a steam engine or other motor through a wire rope or other cable, and winding drum, and by this means a given speed once obtained may be maintained sensibly uniform throughout the remainder of the run. The engines used in the establishments installed in Europe are controlled by a specially sensitive governor designed by the late William Froude, by means of which the slightest variation in speed is met and counteracted, and a very high degree of uniformity is obtained. The truck is also provided with means for holding the model in such way that it shall be free to take whatever trim the conditions of the experiment may tend to give it. The cradle holding the

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[1] Reproduced from the paper by R. E. Froude, published in Transactions of Mechanical Engineers, London, 1893.

[2] Reproduced from the paper by R. E. Froude as above.

model is also connected with a traction dynamometer so that the resistance opposed to the motion is transmitted through the cradle to the dynamometer and there automatically recorded on a drum given motion by connection with the truck. This provides for the determination and record of the resistance.

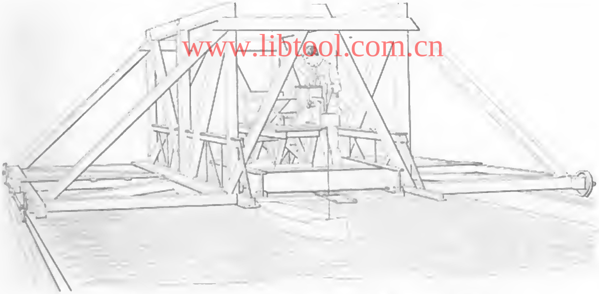


FIG. 2.—CARRIAGE CARRYING CRADLE FOR HOLDING MODEL.

The remaining item, the speed, is determined by electrically recording signals sent by a clock with a make or break in the circuit every second, and also marks denoting equal distances measured along the track, as, for example, every ten feet. As an independent determination of speed through the water, use is often made also of a small carefully calibrated propeller wheel mounted on the truck and immersed in the water, the revolutions of which are counted and electrically recorded also on the revolving drum.

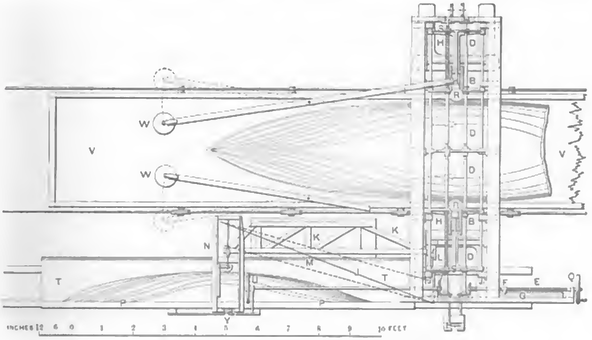


FIG. 1.—PLAN OF SHIP MODEL SHAPING MACHINE.

These various items furnish the necessary data from which the resistance of the model at a given speed may be determined. Such models are usually tried at a large number of speeds and at three or more immersions varied by adding or subtracting ballast, and also at two or more sets of trims, varied also by shifting the ballast.

The data thus derived may then by appropriate laws of relationship be used in connection with the determination of the resistance of a ship of any size having the same form, and moving at a properly related speed. It may be well to note here that there seems to be no simple relation between the total resistance of the model and that of the ship, so that of the total resistance considered as of two kinds, skin resistance and wave-making or residual resistance, the former is usually computed both for the model and for the ship by accepted empirical formulæ, and the latter from the model by the law of relationship for this part of the resistance.

These operations naturally give simply the tow-rope or natural resistance. Due to the interaction between a ship and her propeller, the actual resistance in the case of the combination is quite different from the resistance found as described above. For the determination of the resistance of a model combined with screw propeller, an additional separate truck is required carrying the latter and provided with means for running the propeller steadily at any speed in definite proportion to the speed of the truck. The propeller truck is also provided with means for measuring the thrust developed by the propeller as well as the power required to run it. These items as well as the revolutions are recorded on a drum or otherwise, so that a complete record may be determined of the items involved in the performance of the propeller as well as in the resistance of the ship. The two trucks are then attached together in such a position as to bring the propeller under the stern of the model and in the location it would occupy were it used as the means of propulsion. The propeller is nevertheless entirely unconnected with the model and can only influence it through the water about the stern. The two trucks with model and propeller are then moved at a given speed through the water, and the revolutions of the propeller are so adjusted that the thrust developed shall equal the resistance now shown by the model. The model and propeller are then, as nearly as may be, in the relation they would have, were the latter used for driving the former at the given speed in the usual way. The resistance thus shown by the model will be considerably greater than when towed alone, but whatever it may be, the thrust developed by the propeller can be made to equal it, and thus the conditions above noted can be obtained. Naturally these experiments will be repeated at varying speeds, and often with propellers situated variously relative to the model, and also of varying diameter, pitch, or surface.

For the investigation of propellers alone, the propeller truck only is used and the propellers are operated at a constant speed of advance and varying revolutions, thus giving varying slip. The thrust developed, the power absorbed, the revolutions and speed, are then determined and furnish the data for determining the performance of the propeller, including the useful work and the efficiency.

There are naturally many details of operation and refinements of manipulation which cannot be referred to in a brief article like the present, but these outlines will serve to show the nature of the problems involved, and the general way in which their solution is undertaken.

As already noted the data derived for any one case may by appropriate means be made applicable to an indefinite series of others, differing only in size and operated at properly related speeds. This is a most valuable feature of such investigations, for with the gradual accumulation of available data there is less and less need for independent experimentation concerning any given or proposed case. In the English Government experimental tank at Haslar there has been accumulated such a mass of data that most questions relating to cases likely to arise in common practice can be answered by interpolation from existing data without the need of individual experimentation, and the same in varying degrees is likewise true of the various other experimental establishments. There is, in fact, on file in the archives of these various establishments an amount of data which, if massed together, properly analyzed and reduced to common standards of measurement, would render unnecessary a vast amount of work which is currently carried on in the various places individually. The causes of this duplication are commercial and well known, and need not be here discussed, but emphasis may properly be laid on the resulting waste of effort arising from this continual working over of similar fields in different places, when by a combination of effort a large amount of such work might be saved.

Having available the store of data which such a combination would give, it would doubtless be possible to add notably to our scientific understanding of the general problem of resistance and propulsion. From the present state of our knowledge it seems unlikely that any purely analytical solution can be derived for these problems, and that we shall always be dependent on empirical formulæ derived from and expressing the results of experimental research such as we have here described. It is obvious then that the more complete the experiments as regards variety of form and conditions, the more satisfactory will be the formulæ developed, and the more will the future scientific study of the problem be furthered. While this combination of existing data is not likely to occur, at least at present, it has seemed desirable to point out the possibilities inherent in such a common storehouse, as well as the waste of energy which results from its segmentation as at present.

The lines of experimental research which we have thus far noted are those directly connected with commercial questions. There is in addition a large field of work of the very highest importance and which has been but imperfectly worked over. This consists of the more fundamental problems connected with the forces acting on bodies of elementary forms under varying conditions. Such, for example, are planes of varying size and form moved at varying speeds, immersions, and angles of obliquity with the course. Likewise bodies of elementary form such as the section of a propeller blade moved under varying conditions. There is in these and allied problems a vast field of work not related to any one commercial problem, but related to them all and to the whole subject in a very important and fundamental way. From the scientific standpoint, therefore, no work is at present more needed than a thorough and comprehensive examination of many of these questions, and no great advance in our theories of hydrodynamics as applied to such problems is likely to be made until the results of such investigations become available.

Practical Applications.

Many examples might be given of the value of the information determined by such experimental research. Of these, one mentioned in a recent paper read by Archibald Denny before the Institution of Civil Engineers in London and abstracted in Number 5 of this journal may be noted. In 1887 his firm, by the use of model experiments, was able to guarantee for side-wheel steamers for the Ostend-Dover route a speed of 20.5 knots or 1 knot in excess of the speeds previously obtained under like conditions. The firm thus obtained the contract, and in the result the vessels maintained a sea speed of about 21 knots.

Looked at in another way the value of this information may be seen by noting that, if content with 19.5 knots instead of 20.5, the former speed could have been obtained with a saving of perhaps 15 per cent of the power, which, in such case, might be toward 1,000 I. H. P.

FIG. 3.—EXCAVATION FOR EXPERIMENTAL CANAL AT CORNELL UNIVERSITY.

Experiments on the models of the Italian battle-ships Duilio and Dandolo, made long after their construction, showed that slight changes of model would have rendered the realization of the same speed and other conditions possible, with the saving of a considerable fraction of the power, or with a saving of nearly or quite enough money to build and equip an entire experimental establishment of the character previously described.

In this country during the early building of the new navy, premiums were paid amounting to over $3,000,000. The commercial value of these as an incentive to builders is not denied, but from the scientific standpoint it must be remembered that a considerable part of these sums might have been saved with the information available which an experimental tank could have furnished, and it is not too much to say that by the aid of such experiments the splendid results already achieved might have been even improved, or might have been obtained with a saving sufficient to have paid many times over the cost of the building and equipping of the experimental establishment necessary for their prosecution.

Of the possible and probable value of the information thus obtainable, there seems little room for doubt, and it may be hoped that as such possibilities are better realized larger sums than at present may be devoted to such purposes, and thus stores of information determined which shall be of still further and wider aid in these obscure features of the general art of marine construction.

Historical.

For many years in England and on the Continent the experimental investigation of models and general work along the lines here discussed has been held in high favor.

Between 1793 and 1798 Colonel Beaufoy made in the Greenland Docks in London his celebrated experiments in one part of the general scientific field, as noted above. In more recent years, between 1870 and 1880, the late William Froude carried on the same line of work, including his famous experiments on skin friction. He also first instituted in their present form the experiments on models, the first experimental tank being privately constructed at Torquay. The same line of work is worthily carried on by his son, R. E. Froude, in an establishment built by the British government at the Haslar gunboat yard, near Portsmouth.

Nearly contemporaneous with the elder Froude, Tidman, at Amsterdam, also conducted a notable series of experiments on skin friction and independently covered much of the same general field of investigation.

In more recent times experimental tanks have been established by the governments of Italy and Russia, while the French have long made use of similar experiments, carried on in a flooded dry dock or basin.

Still more recently the United States Government has appropriated money for such an establishment, which, as planned, will be the largest of any yet built, being about 500 ft. long by 50 ft. wide and 14 ft. deep. Of private establishments, Denny Bros., at Dumbarton, are alone in having instituted and maintained an experimental establishment of this character, and the success which has attended their efforts and the enviable reputation which they enjoy in the shipbuilding world are no doubt due in large measure to the information thus obtained.

Hitherto there has been no such experimental establishment in connection with an educational institution. There is, however, in process of present construction at Cornell University a general hydraulic laboratory, to be under the charge of the College of Civil Engineering. One feature of this laboratory will be an experimental tank or canal about 350 ft. long by 16 ft. wide and 10 ft. deep. In Fig. 3 is shown a general view of the excavation with stakes outlining the section of the canal. This, presumably, will be the only experimental establishment of its kind equipped for the prosecution of the lines of research discussed in the present paper, and without specific commercial relationships. The field of usefulness of such an establishment would seem to be wide and important, and it may be hoped that as a part of its work some of the many fundamental problems previously mentioned may be taken up, as well as those having a more definite commercial aspect and of more apparent present-day interest.

THE UNITED STATES COMPOSITE ELECTRIC LIGHT VESSELS, NOS. 68 and 69.

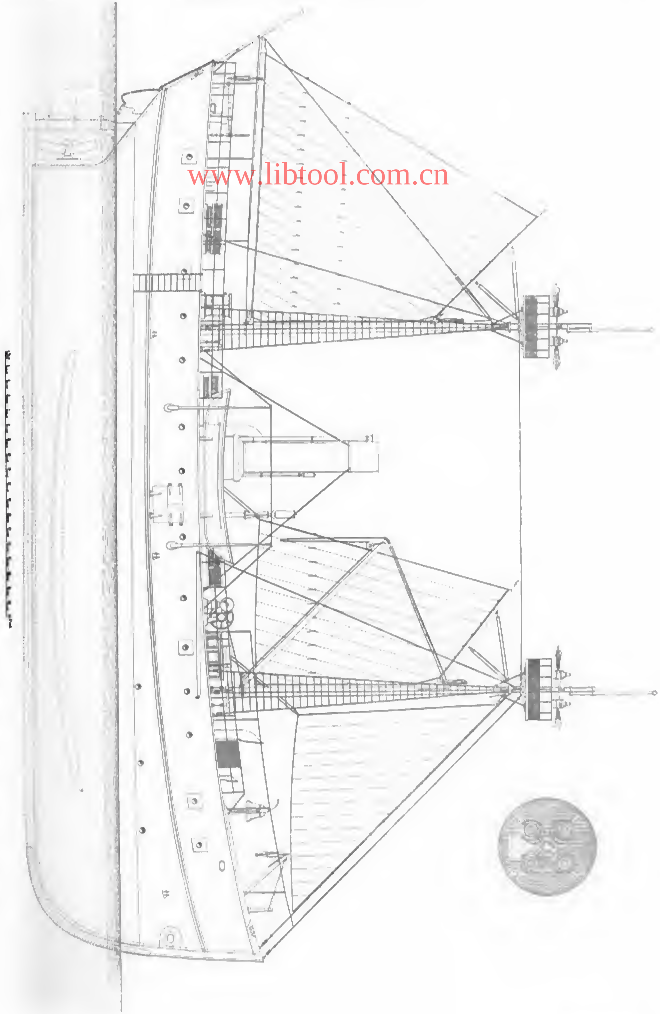
Two interesting light vessels have just been completed by the Bath Iron Works, of Bath, Maine. The contract for the construction of these vessels was signed about the middle of January last, and the vessels were delivered to the Light House Board early in August, having thus been only about six months building. These vessels are by far the best light vessels afloat, and although very similar in general appearance to the new South Shore Light vessel—constructed last year by the same firm—they have many modifications, the principle points of difference being increased headroom in the living spaces, greater freeboard, better accommodation and superior arrangement of machinery. The contract price for the vessels was $74,500 each, to be delivered within nine months, and it will thus be seen that the contractors completed the vessels two months before the expiration of the specified contract time—a very creditable performance.

These vessels occupy the most important stations anywhere on the coasts. No. 68 is stationed at Fire Island, and No. 69 guards the Diamond Shoal off Cape Hatteras, one of the most dangerous spots in existence.

The dimensions of the vessels are as follows:

Length over all	122 ft.	10¼ in.
Length load water line	113 ft.	1½ in.
Beam moulded	23 ft.	6 in.
Beam extreme to outside plank	29 ft.	5 in.
Mean draught with all weights, stores, coal, water, etc., aboard	12 ft.	6 in.
Depth of hold	13 ft.	3 in.
Depth moulded	22 ft.	1½ in.
Least freeboard t main deck	3 ft.	4½ in.
Least freeboard to spar deck	11 ft.	4 in.
Freeboard forward	19 ft.	3 in.
Freeboard aft	13 ft.	4¼ in.
Overhang forward	1 ft.	8 in.
Overhang aft	8 ft.	5 in.
Tumble home to main deck		3 in.
Tumble home to spar deck	1 ft.	8½ in.
Proportion length to beam	3.85	
Proportion length to depth	5.11	
Proportion length to draught	9.05	
Proportion beam to depth	1.33	
Proportion beam to draught	2.35	
Displacement to load water line	590 tons.	
Co-efficient of displacement, about	.5	
Area immersed midship section	279 sq. ft.	
Co-efficient of area of midship section	.76	
Area of load water plane	2,520 sq. ft.	
Co-efficient of load water plane	.76	
Tons per inch at load water plane	6	
Area of wetted surface	4,095 sq. ft.	
Area of immersed longitudinal section	1,345 sq. ft.	
Rudder area	44.6 sq. ft.	
Ratio of rudder area to immersed longitudinal section	1 to 30	

These light vessels are of composite construction, the scantlings being very heavy and the structure unusually strong. The frames are composed of steel angle bars 4 1-2 in. by 3 in. by 9 lbs., spaced 18 in. from center to center. The floor plates are 18 in. in the center and are composed of plate 15 lb. per sq. ft., the reverse bars being 3 in. by 3 in. by 7 lb., run alternately to 3 1-2 in. above the main deck, and to 12 in. above the upper turn of bilge. Extra stiffening is afforded by four belt frames on each side, 12 in. wide with double 2 1-2 in. by 2 1-2 in. by 5 lb. angles on the inside, the plates being 12 1-2 lbs.

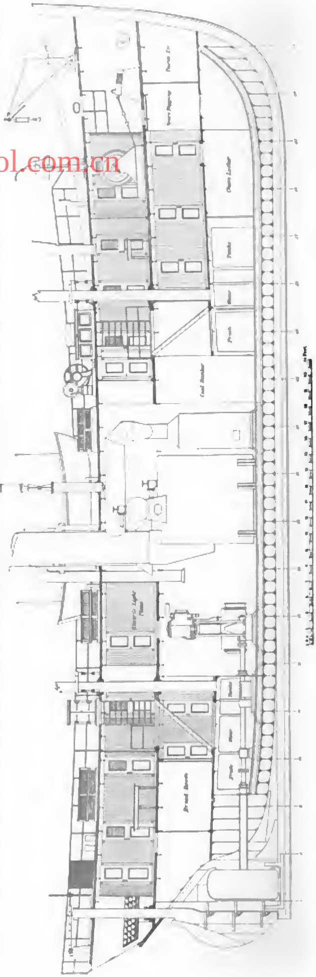


U. S. GOVERNMENT COMPOSITE ELECTRIC LIGHT VESSELS NOS. 68 AND 69, STATIONED AT FIRE ISLAND AND DIAMOND SHOAL.

(Constructed by the Bath Iron Works, Bath, Me.)

per sq. ft. above the floors. There is a steel flat plate keel 36 in. by 20 lb., and connected to this is a yellow pine keel 12 in. by 12 in., with two white oak false keels secured to it, one being 3 in. by 12 in., and the other 2 in. by 12 in. The vessels are planked with yellow pine to about 2 ft. above the main deck. The plank diminishes in thickness from 5 in. at the keel to 4 in. on the sides, the width of strake amidship varying from 15 in. garboard to 10 in. and 8 1-2 in. bottom and bilge strake, and 6 in. on the side. The vessels are then sheathed with 1 1-2 in. of white oak to the 14 ft. water line, and sheathed with copper to about the 13 ft. 6 in. water line. The sides of the vessels are plated with steel 12 1-2 lb. plates from 3 ft. below the main deck to the upper deck. The vertical keel or backbone of the vessel rests on the floors, and is 11 in. by 20 lb. riveted to the floors and to a horizontal flat keel or rider plate which is 24 in. by 20 lb., by double 3 1-2 in. by 3 1-2 in. by 9 lb. angle bars. On the upper part of the vertical keel are also a couple of angle bars 3 in. by 3 in. by 7 lb., and to these are riveted a 6 3-4 in. by 15 lb. plate. There are two side keelsons composed of 15 lb. intercostal plates riveted to a shell tie plate by 3 in. by 3 in. by 7 lb. angles, and to a 7 in. by 3 in. by 16 1-4 lb. angle bulb and a 3 1-2 in. by 3 in. by 7 1-2 lb. angle bar on the inboard edge. Additional fore and aft stiffening is afforded by two keelsons composed of 3 1-2 in. by 3 in. by 7 1-2 lb. angle bars riveted back to back, which are located one above and one below the main deck and about four feet from it. The main deck beams are composed of angle bulbs 7 in. by 3 in. by 18 1-2 lb., and spaced 36 in. apart. They have a camber of 7 in. in 28 ft., and are securely fastened to the frames by 18 in. by 18 in. by 17 1-2 lb. brackets or gusset plates. The spar or upper deck beams are formed of 6 in. by 3 in. by 13 3-4 lb. angle bulbs alternately spaced 36 in. apart and secured at ends to the frames by 15 in. by 15 in. by 15 lb. bracket plates. Both the main and spar decks have a metal waterway about 10 in. wide. Both decks have steel stringers and tie plates, the main deck stringer being 32 in. by 15 lb., and the spar deck 21 in. by 15 lb. Bilge keels are worked for a length of 60 ft. amidship. They are of white oak 20 in. deep and 6 in. wide at the outboard end. The main deck plank is 3 1-2 in. white pine and the spar deck plank is 3 in. by 3 in. yellow pine. A lower deck is worked forward and aft of the machinery spaces. The beams are 4 in. by 3 in. by 7 1-2 lb. angle bars, without any camber, and the deck plank 2 1-2 in. by 3 1-2 in. yellow pine. The bulkheads are all composed of 12 and 10 lb. plates stiffened vertically and horizontally with 3 in. by 2 in. by 5 lb. angle bars.

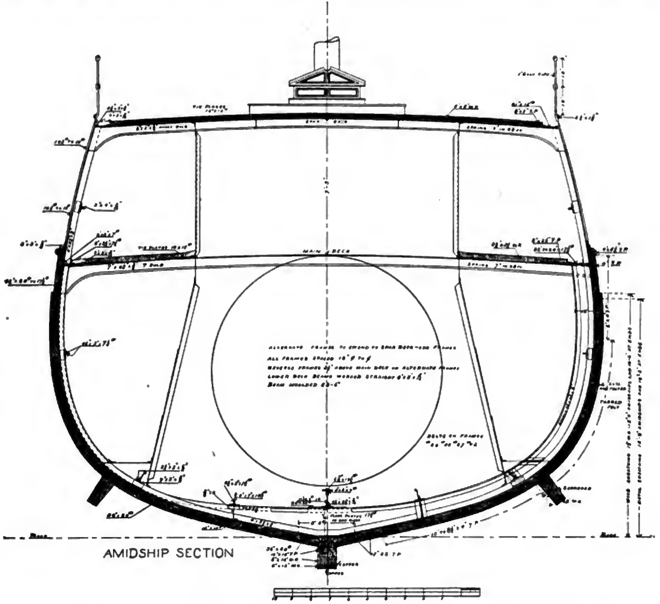
The stem, stern post, deadwood and rudder are all of white oak and extra heavy. The foregoing particulars are sufficient to show that the hull of



LONGITUDINAL SECTION OF U. S. GOVERNMENT COMPOSITE ELECTRIC LIGHT VESSELS NOS. 68 AND 69.

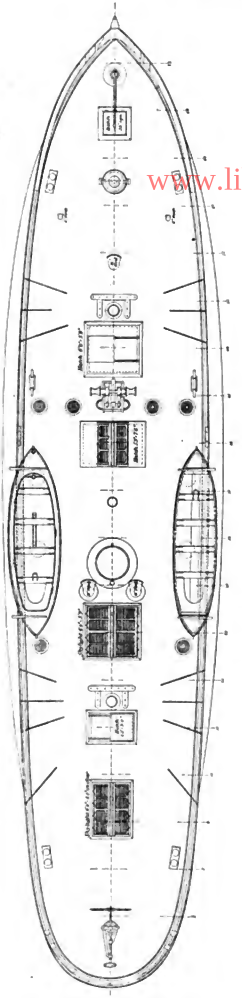
the vessel is very heavy, and the weight is judiciously located, so that the structure is unusually strong. The steel in the hull weighs about 200 tons and the launching weights of these boats was about 275 tons, the draught being nearly 8 ft. mean.

The officers and crew are all accommodated on the main deck. Forward is located the windlass with a lamp room and pantry on the starboard side, whilst the crew's wash room and W. C. is on the port side. Then comes the crew's quarters, and their accommodation is very fine and greatly superior to that enjoyed by the ordinary sailor. There are five spacious state-rooms with double pipe berths 6 ft. 3 in. by 2 ft. 6 in. in each room. The galley is on the starboard side. It contains a range with a capacity for 20 men, a large wooden lead-lined sink, with a 4 in. brass pump connected with fresh water tanks, shelving, drawers, sacks, hooks, tables, coal box and all desirable fittings. The crew's mess room is quite large and airy, finished in white pine with hardwood trimmings, the mess table being 8 ft. by 3 ft., surrounded with substantial ash dining chairs. The engine and boiler casings take up considerable room amidships on the deck, the dynamo room being at the after end. Ten 18 in. coal scuttles lead to the bunkers, thereby enabling them to coal either from the main deck through the cargo side ports or from the spar deck by means of canvas chutes (there being scuttles in the spar deck over those in the main deck). Aft on this deck is the officers' accommodation, all partitions being of well-seasoned white pine. There are four state rooms, two on each side, furnished with hardwood, each state room having one berth with drawers underneath, a wardrobe, washstand and racks. The captain's room, forward on the starboard side, and also the engineers' room on the port side, have each a hard wood desk. On the port side aft is the pantry, and on the starboard side a chart and signal room, whilst the officers'

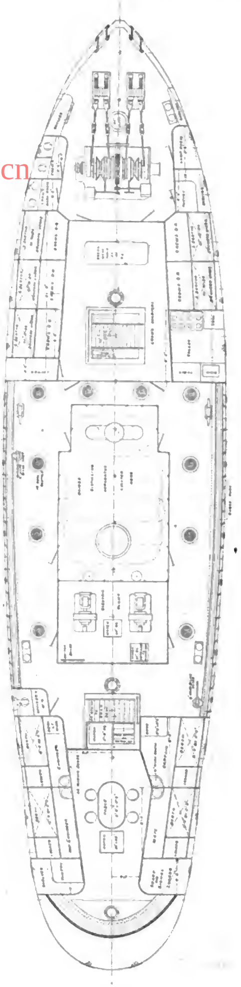


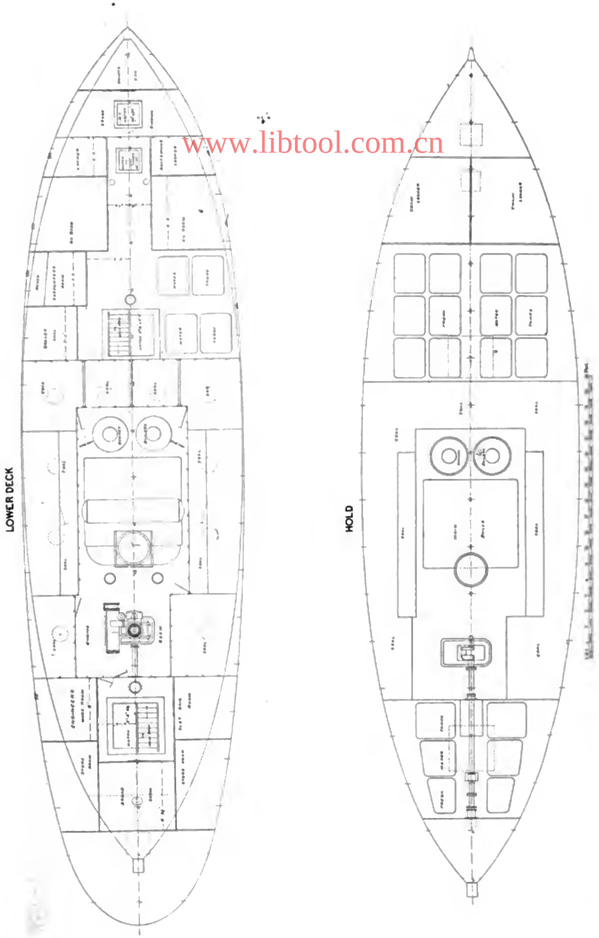
CROSS SECTION OF U. S. GOVERNMENT COMPOSITE LIGHT VESSELS NOS. 68 AND 69.

SPAR DECK



MAIN DECK



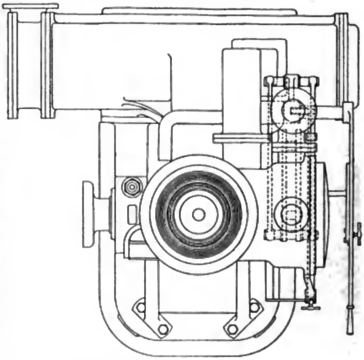


PLANS OF THE U. S. GOVERNMENT COMPOSITE ELECTRIC LIGHT VESSELS NOS. 68 AND 69, STATIONED AT FIRE ISLAND AND DIAMOND SHOAL.

W. C. is forward of the engineers' room. A transom seat is worked around the stern. The floors are covered with linoleum and rugs, and all the fittings are very tastefully and neatly arranged. The officers' mess table is 6 ft. by 3 1-2 ft., and four leather-covered dining chairs have been furnished, together with a sideboard of artistic design. The lower deck is principally devoted to stores. Forward are the rooms for paints, oils, spare rigging and boatswain's gear. The carpenter has also a commodious work room with bench, whilst a space 7 ft. sq. on the port side is used for the stowage of galley coal. On the starboard side four large fresh water tanks are situated. Aft of the machinery spaces come the engineers' work room, which is entered from the engine room, a sail room, bread room, and two store rooms for miscellaneous stores. In the hold forward are twelve fresh water tanks, whilst aft six more large tanks are located. The entire hold space (excluding machinery and chain locker spaces) is devoted to the fresh water tanks. One of the best features of these boats is the fact that they are fitted with propelling machinery and power sufficient to take them to and from their respective stations, and in case the anchor cable breaks, they are not helpless.

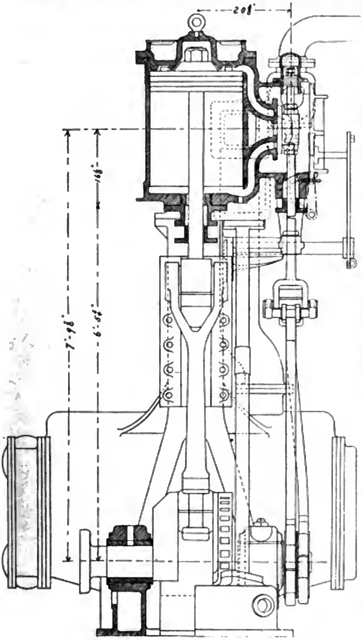
The propelling machinery on these boats, although not used very much, is very complete. Economy is not essential, but initial cost, weight and space occupied. Especially the cost has had to be considered. The main engine is of the vertical inverted direct-acting single cylinder type. The steam cylinder is 20 in. dia., with 22 in. stroke, combined in one casting with the valve chest. It is supported upon two solid wrought-iron columns in front and one hollow box column extending from the top of the condenser, and forming part of the condenser casting at the back. The main distribution steam valve is an ordinary D slide, operated by a double bar Stephenson link, and a link block connected to the valve rod, which is guided by a bearing in an arm bolted to the valve chest. The engine is reversed by a hand lever. The condenser is of box form, and contains 700 sq. ft. of cooling surface. It is served by independent air and circulation pumps, which have circulating sea and bilge sections. This engine will develop 350 indicated horse power at 150 revolutions. It occupies a space about 6 ft. 6 in. sq., and the engine room is 10 ft. 6 in. long and 12 ft. wide. The propeller is four bladed and of manganese bronze, cast in one piece, right handed, and is 7 ft. 10 in. dia., and a pitch varying from 9 ft. 6 in. to 10 ft. The blade area is about 28 sq. ft., and the weight a little less than 1,700 lbs., the maximum width of the blades being 30 in. Steam for the main engine is supplied by a single ended steel Scotch boiler at a working pressure of 100 lbs. The diameter of this boiler is 12 ft. 2 in. and the length 11 ft. 3 in. It has three 39 in. dia. corrugated Madden furnaces. The combustion chamber is 28 in. wide, with 5 in. water space between it and the back of the boiler. There are 320 2 1-2 in. tubes 8 ft. 5 in. long, spaced 3 1-4 in. vertically and 3 1-2 in. horizontally. There is one combustion chamber common to all three furnaces. There are eighteen stay rods about 2 in. dia., fourteen of which are about 11 ft. 7in. long, and the remainder about 8 ft. 4 in. long. The shell of the boiler is 5-8 in. thick, tube plates 9-16 in., back of combustion chamber 1-2 in., and furnaces 1-2 in. The total tube surface is 1,765 sq. ft.; total heating surface is 2,045 sq. ft.; calorimeter 10.91 sq. ft.; grate surface, 63 sq. ft.; ratio of grate surface to heating surface 1 to 32.43; ratio calorimeter to grate surface, 1 to 5.77.

There are also fitted two vertical tubular donkey boilers, which are capable of supplying all the steam necessary to work the steam windlass, electric plant, donkey pumps, fog signals, and also for heating purposes, or for all purposes except for supplying the main engine. A See patent ash ejector has been fitted, also a Crosby chime fog whistle with a 12 in. dia. bell fitted with Crosby improved balance valve. There is also a 6 in. dia. whistle for use while under weigh. A Hyde improved Robinson steering gear is fitted aft with a 60 in. mahogany wheel. A steam winch is located on the spar deck forward capable of lifting about 3,000 lbs. A large clear-sounding bell of 1,000 lbs. weight has also been furnished, and this is mounted in a large belfry on the forward spar deck. The windlass is a steam pump brake Hyde windlass, with two Hyde double spring riding stoppers. The vessels are each equipped with the following anchors and chains: One mushroom anchor weighing 5,100 lbs.; one bower anchor, 2,000 lbs.; one kedge, 335 lbs., and two



PLAN OF LIGHT VESSEL ENGINE.

stud link chain cables, 120 fathoms each, 1 5-8 in. dia. The windlass on these vessels is placed in the center of the deck, and the hawse pipes (which are 11 in. dia.) are in the line of the direct lead from the wildcats, and in this respect they differ from their predecessors, which had a large hawse pipe in the stern resembling a torpedo tube. The ships are drained by 2 1-2 in. and 3 in. pipes, leading from each compartment to a manifold in the engine room, which is connected to a steam pump and also to two Hyde No. 3 deluge hand pumps, located on the main deck amidships. There is also an automatic steam syphon in the engine room.



LIGHT-VESSEL SIMPLE CONDENSING ENGINE.

Two small boats have been supplied. One is a center-board of whaleboat model, 24 ft. long, 6 ft. 7 in. beam and 3 ft. deep. It has two masts 22 ft. 6 in. and 16 ft. 6 in. respectively; the foresail is a lug sail and the main mast carries a boom sail. The other boat is a corrugated steel Ingersoll self-righting, self-bailing and unswampable metallic life boat 27 ft. 6 in. long and 6 ft. beam. Both are carried resting in chocks on the spar deck of the vessel.

The water tanks of these vessels have a capacity of about 16,000 gallons of water, and the bunkers have a capacity of about 150 tons of coal. There are two spars built of steel, the total height of each with flag pole is 73 ft. above the load water line. Excluding the flag pole the height is about 64 1-2 ft. The spars have a diameter of 16 in. at the deck, and they have no rake. At the masthead is fitted on each mast a gallery for day signals to surround the electric lanterns. The frame work is of steel with wood grating floors, gas pipe railing and netting of galvanized wire. A large coaling boom is fitted on the foremast and a boat boom on the starboard side abreast of the forward rigging. The main boom is about 40 ft. long and 11 in. dia., and the fore and main gaffs are about 21 ft. long and 6 in. dia. The total sail area is 1,805 sq. ft.

The electric plant is in duplicate, being composed of two General Electric marine sets, known as M. P. 4-8-650, with 4 1-2 by 4 in. double cylinder General Electric engine. The vessel has forty lights of 100 volts 16 candle power, and eight 100 volts 100 candle power lights at the masthead, four on each mast. Attached to the engine and dynamos is a device for alternately opening and closing, at regular intervals, the circuits at the masthead lights. This device is arranged so that the length of the intervals may be varied from five to twenty seconds at will. There has also been furnished on each vessel an automatic machine for operating the fog signal whistle, also an automatic registering device.

These vessels are excellent sea boats. They roll quite easily and have full buoyant ends. They have good freeboard and an enormous reserve buoyancy. These vessels have had no speed tests, but they have averaged 8 1-2 knots for 20 or 30 hours; steaming at sea with about 275 horse power, and a displacement of about 480 tons.

The Bath Iron Works have just laid the keel of another light vessel, No. 71, for Overfall Shore, New Jersey. This will make the fifth vessel this firm has built for the U. S. Light House establishment in two years, besides doing extensive repairs and alterations on the light-house tenders Armesia, Myrtle and Lilac. The construction of these vessels was carried out under the personal direction of Charles R. Hanscom, naval architect and shipyard superintendent, with the aid of Charles E. Hyde, consulting engineer; John S. Hyde, superintendent engineering department, and William C. Besselievre, assistant superintendent of the ship department.

During the construction of these vessels S. A. Savage represented the Light House Board, and inspected the work as it progressed.

The placing of a light vessel on the Diamond Shoal is largely in the nature of an experiment; and results are awaited with interest.

PITTSBURG AND CINCINNATI PACKET LINE STERN WHEEL STEAMER QUEEN CITY.*

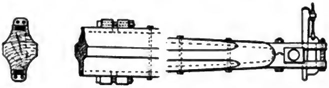
BY BERT L. BALDWIN, M.E.

The machinery which propels the steamer is on the main deck, and is so located as to distribute the weight through the length of hull. Just aft of the main hatches are the boilers which supply steam to the main engines, as well as the various auxiliaries. Dimensions of the boiler are fixed by Government rules, and on account of the great amount of mud in the water, when there is a rise in the river, there must be a space of at least 3 in. between all flues or tubes. In building the boilers for the Queen City, certain concessions were granted, and the steel plates were increased in thickness 2-100 in. over the usual standard, which, together with a high tensile strength, permitted a slight increase in the diameter of the shells, as well as in the steam pressure.

There are four boilers of the horizontal return flue type, externally fired. They are made of Luken's marine steel, having a tensile strength of 70,000 lbs. per sq. in., and an elongation of 30 per cent. in 2 in. Each shell is 47 in. dia. by 26 ft. long, 28-100 in. thick, with all longitudinal seams double riveted, and circumferential seams single riveted. The heads, or flue sheets, are 5-8 in. thick, flanged for shell and flues. These are six in number, lap welded, telescoped in six lengths and made one gauge heavier than the usual standard. These flues are riveted to the flue sheets, and act as braces. The flue sheets are also braced above the upper line of flues by crow foot braces. These flue sheets are re-inforced around all man and hand hole openings. The four boilers are connected together by one 24 in. dia. by 18 ft. long steam drum, having flanged steel connecting legs 16 in. dia., and spacing the boilers so that there is 10 in. flame room between the shells. The boilers are also connected together by two mud drums, which are 16 in. dia. by 18 ft. long, and connected by 8 in. dia. water legs. The boilers are supported by the mud drums, which, in turn, rest upon cast-iron stands, which are secured to the iron deck plates.

Boilers of this type require a setting very similar to the ordinary land boiler, but as the settings must be as light as possible, the brick work is kept down to a single thickness of fire brick, supported by a sheet-iron casing, which incases the boilers up to the water line. The ash pan is of 1-4 in. thick steel plates, with a flanged rim rising 8 in. high above the deck. This is paved with fire brick, laid in Portland cement, and is fitted with a 10 in. dia. ash well, which extends from the surface of the paving directly through the bottom of the boat. The boiler fronts are cast iron, with large fire doors and ash pit openings, and with movable grate bars arranged so that they can be replaced without disturbing the fire to any extent. The grate extends from side wall to side wall under all four boilers, making the grate 20 ft. in width by 4 ft. 6 in. in length. As will be noticed by reference to the boiler settings on page 19, the fire bed at the bridge wall is brought up to within a few inches of the boiler shell, and this distance is increased at the other end, so as to form an easy curve for the gases as they enter the flues. The back arch and all exposed portions of the boiler and drums are covered with asbestos cement to a depth of 3 in. The breeching and chimneys are made of cold rolled iron, and supported under the large elbows by pipe braces, not shown on the drawings, which transmit the weight to the steel boiler beam below deck.

Each boiler is supplied with a 4 in. dia. Government standard lever safety valve. The only known objection to this type of valve is the fact that the lever forms a splendid "roosting place" for a heavy deck hand, when the engineer wants a little higher pressure than the weight and lever is proportioned for. Each boiler is also supplied with fusible plugs screwed in the shell, three Mississippi gauge cocks, in the back flue sheet, where they are convenient for the engineer. There is also a copper float which operates the black hand upon a white 10 in. dial, near the after end of boiler. There are, of course, reliable steam gauges in front of the boilers, as well as in the engine room. The blow-off valves are bronze and heavily protected. The boilers are fed through the top of the shell, the perforatetd brass feed pipe being carried down below the flues and extended well along toward the center of boiler.



DETAIL OF PITMAN OR CONNECTING ROD.

Forward of the main boilers, in the starboard coal box, is located a 48 in. dia. by 8 ft. high vertical fire box donkey boiler, which is used for various purposes when the steamer is in port, and the main boilers cooled down. The entire boiler equipment was built and erected by the McIlvain & Spiegel Boiler & Tank Co., of Cincinnati, who make a specialty of "river work," and deserve credit for the excellence of their work.

From the outlet on the steam drum of the boilers, and extending into the engine room, is an 8 in. steam pipe, having all of its flanges bored and shrunk on to the pipe and properly secured by rivets. This pipe terminates at engine room end in a long radius fire bend, which is coupled to the throttle valve casting near the floor line. This is supported upon a roller stand, allowing for the free expansion and contraction of the steam main, as well as other strains that might be pro-

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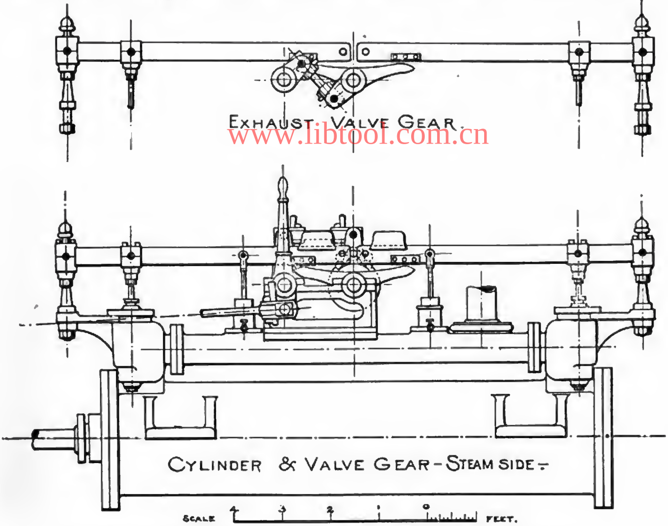
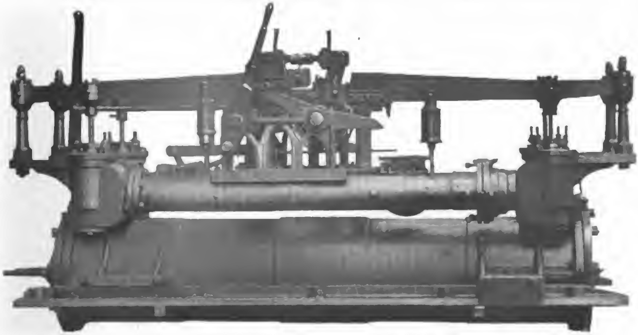
* Commenced in October issue.

duced by the "twisting" of the steamer. The throttle valve is of the angle valve type, arranged so that in opening the valve against the heavy steam pressure a certain amount of lost play in the valve stem opens an auxiliary valve which allows steam to pass under the main valve and form a balance before raising the latter from its seat. Long radius fire bends connect the throttle



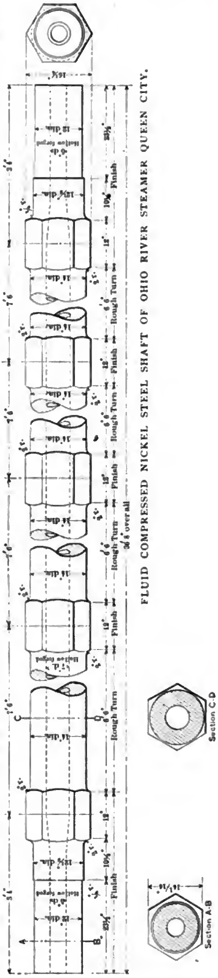
HIGH PRESSURE NON-CONDENSING ENGINES OF OHIO RIVER STEAMER QUEEN CITY.



TYPE OF ENGINE GENERALLY USED IN OHIO RIVER STERN WHEEL STEAMERS.

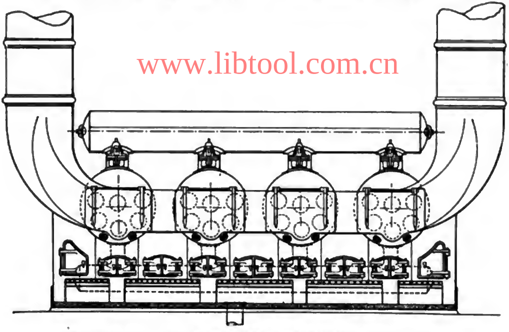
casing with the main engines, and other steam pipes lead away from this casing to supply the electric light engine, water pump, reversing gear and steering gear.

The main engines which propel the boat are two in number, of the simple high pressure type, with cylinders 24 in. dia. and 96 in. stroke, placed close to the guards and overhanging the stern, as shown on the plan. The general design of these engines is about the same as has been used for many years in this service. Certain slight modifications have been made, so that the engines give satisfaction on account of their free action, accessibility, and the ease with which repairs can be made—a very important matter in case of a breakdown miles away from a machine shop. Each engine has a steam cylinder 24 in. dia. by 96 in. stroke, having four double beat poppet valves, designed so as to be practically balanced, and connected to the weighted lifting bars, fitted with suitable "dash pots," as shown in the sketch of valve gear on page 17. The steam valves, with their side pipes, are located on the inboard side, while the exhaust valves are on the outboard side of the cylinder, and are operated by separate rocking cams, which receive their motion, through rockers and connections, from an irregular shaped cam located on the paddle shaft, just inside of the main bearings. The motion transmitted is intermittent, so that the valves have a quick opening and closing action, with a long pause between these periods. The motion upon the exhaust valve is arranged so as to give uniform release and compression, while the steam valves are arranged so as to have a uniform lead, and by means of a releasing gear, a point of cut-off, which can be varied from 1-4 to 7-8 of the stroke. The releasing gear is tripped by a pair of adjustable stops, which receive their motion from the main cross head. This is known as the Rees cut-off gear. It is arranged so that the cut-off stops can be lowered, and not come in contact with the releasing catches, extending the point of cut-off to about 7-8 stroke, which is necessary in making landings or turning the wheel over at a slow speed. The cam rod is connected to a stationary reverse link of very simple construction, while the radial rod, which is connected to the valve rocker on the cylinder, is coupled to the link block, and this link block is shifted or held in any desired position by a small steam cylinder, suspended vertically over the link and coupled by suspension hangers. The valves of the reversing cylinders are controlled by a lever, which, together with the connections that regulate the cut-off stops, are near the throttle valves, so that the engines can be worked to varying points of the cut-off, ahead or astern, without excessive labor on the part of the engineer. The slide plates, as well as the cylinders, are bolted directly to the built-up engine timbers, with their centers as nearly in line with the top plates as possible. The cross heads are similar to the locomotive type, having long brass gibs which bear on top and bottom of the slide plates. The main outboard bearing is formed of heavy cast-iron pedestals let down into the upper surface of the projecting engine timbers, and carrying bronze liners held in position by heavy caps. The engine cranks are wrought-iron forgings well proportioned, smooth finished and painted. The crank and cross-head pins are 6 in. dia. by 6 in. long. The paddle wheel shaft is fluid compressed nickel steel, forged hollow, made by the Bethlehem Iron Co., and is the first one of this material on the Ohio River. It is 14 in. dia. and 12 in. in the bearings, with hexagonal bosses where the five wheel flanges are keyed. The central core is 5 in. dia. through the journals and crank fits, and enlarged to 7 in. through the rest of the shaft. The paddle wheel flanges are cast-iron, heavily ribbed pattern, reinforced by wrought-iron bands shrunk on their hubs and outer circumference. They have hexagon cores through their centers, dressed

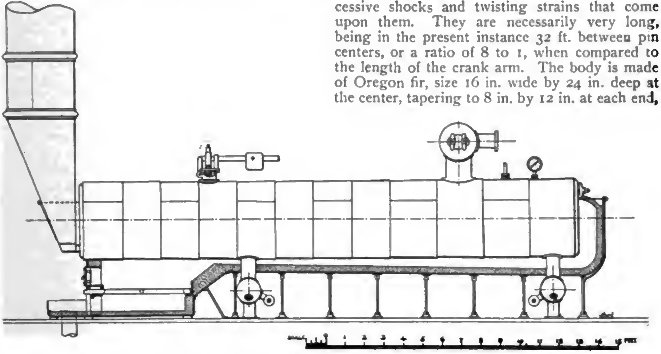


FLUID COMPRESSED NICKEL STEEL SHAFT OF OHIO RIVER STEAMER QUEEN CITY.

true, and each is secured to the shaft by means of 18 steel keys, fitted and driven in place. Four of the wheel flanges have sockets for a single set of arms, while the center flange is doubled and carries a double set of wheel arms. This is because the buckets are divided at the center so that they can be staggered, which greatly reduces the vibration caused by the buckets striking the water.



FRONT ELEVATION OF BOILERS OF STEAMER QUEEN CITY.



SKETCH SHOWING METHOD OF SETTING BOILERS OF STEAMER QUEEN CITY.

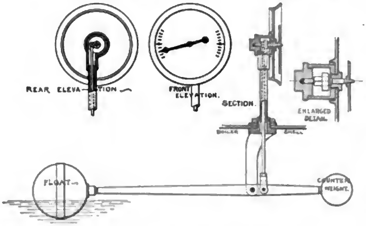
The paddle wheel is 24 ft. 6 in. dia. by 32 ft. long over buckets. The arms are made of clear 3 in. hickory, 7 in. wide where they enter their flanges and 10 in. wide at rim of wheel. These arms are strengthened by the circles and braces, which are bolted to and between them.

The buckets are made of 2 in. oak, 24 in. wide, and arranged to work 4 in. under water, when the steamer is running light. They are secured by 3-4 in. dia. U bolts extending around the wheel arms.

The connecting rods certainly look "antique," on account of their massive wooden bodies, but up to the present time this is the only construction which will satisfactorily withstand the excessive shocks and twisting strains that come upon them. They are necessarily very long, being in the present instance 32 ft. between pin centers, or a ratio of 8 to 1, when compared to the length of the crank arm. The body is made of Oregon fir, size 16 in. wide by 24 in. deep at the center, tapering to 8 in. by 12 in. at each end, lightened by being dressed to the section shown, and reinforced by the wrought-iron straps which are let into the body and through bolted. These straps are 2 1-2 in. by 4 in. sections, with brass pin boxes and steel gibs, keys, keepers and clamp bolts, as shown on the sketch on page 16.

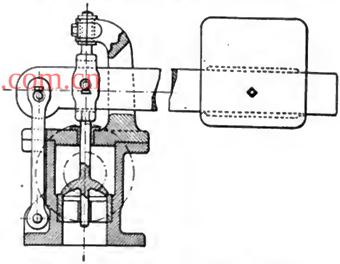
The exhaust from each cylinder is connected to a special three-way valve, by which it can be turned directly through the vertical exhaust pipes to the atmosphere, or through a central exhaust main which branches at the boiler so as to exhaust into and form a blast in the chimneys, or, in cold weather, discharge through stern pipes onto the paddle wheel and bearings, to prevent the formation of ice.

Situated just forward of the throttle valve, in the engine room, are two Lunkenheimer feed water injectors, with separate steam supply pipe, leading directly from the boiler, and each having separate suction and discharge connections. The water from these injectors is forced through a copper feed pipe, about 80 ft. of which is passed through the center of the exhaust main, forming an excellent feed water heater. Using injectors is quite a departure from the usual river practice, where the "doctor" was always considered a most necessary portion of the machinery outfit. This occupied a space about 4 ft. wide and 8 ft. long, with vertical steam cylinders, overhead beam, connecting rod, fly wheel and numerous plunger pumps, which were always giving more or less trouble. As a further precaution, the duplex fire pump, 7 1-2 in. by 4 1-2 in. by 10 in., placed just aft of the boilers, is arranged so that it can be used for feeding them in an emergency. Government regulations also require a hand-power feed pump to be coupled up so that it can be used for both fire and boiler feeding purposes. There is a small duplex pump in the engine room, which has a pump governor connected to its steam pipe, set for 40 lbs. water pressure. This pump supplies water to a pressure tank suspended overhead, and, with the various pipe connections, forms the steamer's water works, maintaining a constant pressure upon the water mains, which supply the fixtures in the various wash and toilet rooms, as well as in the cook house, pantry and laundry.



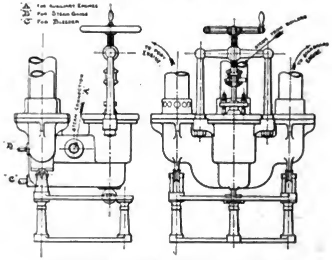
WATER GAUGE AND CONNECTIONS.

The electric lighting plant is also in the engine room, and consists of a slide valve engine, 10 in. by 14 in., with a very sensitive governor. The engine is placed athwartship and is belted direct to a 24 K. W. multipolar shunt wound dynamo, feeding a 120-volt circuit. The switchboard is in the center of the engine room upon a raised platform, and consists of a polished marble panel, held in position by a nickel-plated frame, and is equipped with volt and ammeters, pilot lamps, rheostat, ground detectors, as well as the main and the various circuit switches. The entire steamer from hold to side lights on the chimneys is lit up by electricity, not a single oil lamp being in use on the boat. There are about 300 16 C. P. incandescent lamps in service, the lighting system being divided into five circuits, each of which is controlled by a separate switch.



SECTIONAL SKETCH OF SAFETY VALVE.

The circuits are divided thus: All night circuit, carrying lights on the main deck; staterooms; lights in barber shop; ladies' reception room; toilet rooms and texas; cabin electroliers and light clusters; ladies' cabin; lights in the hold and arc lamps on incandescent circuit. Of these there are two side lamps of 2,000 C. P., one lamp of 2,000 C. P., one 800 C. P. enclosed lamp on the forward deck, and a 4,000 C. P. searchlight on the mast. All of the large arc lamps are under control of the pilot.



THROTTLE VALVE AND CONNECTIONS.

[*To be continued.*]

QUADRUPLE-EXPANSION ENGINE AT FIVE HUNDRED POUNDS PRESSURE.—I.

BY DR. R. H. THURSTON.

Rising steam-pressure has been one of the principal characteristics of progress in marine engineering, as in every other branch of steam engineering, from the first, and our knowledge of the science of thermodynamic energy-conversion shows us that it is the primary principle of economic progress. The extent and the rate of this increase in the intensity of the steam-pressures adopted by our most progressive and successful engine builders have been illustrated by the writer, perhaps most strikingly and most clearly, by a diagram which the ordinates are the pressures taken as standard at dates which are represented by the abscissas of the curve.[1] This diagram—Fig. 1, page 10,[2] in the April issue of Marine Engineering—is useful as indicating most satisfactorily the trend of progress in this respect in the operation of steamships at the moment. It represents probabilities for the immediate future also; although, of course, we have no assurance that some sudden change may not be brought about by the introduction of some new invention or the adoption of some as yet unanticipated improvement in construction, resulting in such sudden changes as characterized this curve when the steamship proprietor, twenty years ago, became convinced of the profitable character of the then comparatively unfamiliar multiple-cylinder engine.

It has long been known that this direction of progress must be adhered to with the steam-engine if we are to continue its improvement in the direction of increased thermodynamic efficiency. The conditions retarding progress are not those related to the theory of the case, but almost wholly those due to difficulties arising in the endeavor to avail ourselves of the promise of gain through the use of high-pressure steam. The two main obstacles to further advance under the old régime were the increasing internal wastes of the engine with increasing ratios of expansion proportional to the rising pressures, and the difficulties attending the construction and operation of boilers subjected to exceptionally great intensity of steam-pressure. The former of these obstacles was removed in large degree by the adaptation of the multiple-expansion engine to the use of the marine engineer, and the latter was evaded, first, by the use of the now almost universally employed "Scotch" boiler, and, recently, by the introduction at sea of the more manageable forms of the "water-tube" boiler. The compound engine brought up pressures from the two or three atmospheres pressure of the last generation to from four to five atmospheres, and the triple-expansion engine raised the figures to six or eight, and sometimes ten, in its earlier history, and to fifteen atmospheres later; while the quadruple-expansion has already made similarly successful pressures exceeding 200 pounds on the square inch, and seems likely, if we are to judge by the results of the experimental work to be here presently described, to make available pressures of from 250 to 500 pounds per sq. in., or upwards of 30 atmospheres.

These higher pressures, to become economically desirable, must be worked expansively throughout the greatest possible range of pressures and temperatures, and this expansion must be as nearly as possible perfectly "adiabatic." A cut-off at such a point as will insure expansion to a minimum terminal pressure—measured by the sum of condenser-pressure, loss of pressure in ports, the pressure equivalent to the mean effective friction-pressure of the unloaded engine, and a quantity determined by the extent of the internal wastes by "cylinder-condensation"—is that best suited to give maximum gain, and the reduction, and if possible extinction, of wastes of heat, internally and externally, by conduction and radiation, are the two primary conditions of maximum physical efficiency of the engine; while maximum net financial gain is still further limited by relative costs of improved apparatus and of fuel saved. General experience, under the conditions familiar to us in transatlantic navigation, has now led to the complete adoption of the triple-expansion engine, and indicates the probable introduction, later, of the quadruple; while the cut-off in the high-pressure cylinder is set, for best effect, to give a terminal pressure in the low-pressure cylinder of not far from eight pounds per square inch. Under such circumstances, the gain by increasing pressures with properly constructed and proportioned machinery is known to be nearly proportional to the increasing values of the logarithms of the total, absolute, pressures employed.[3]

As the writer has elsewhere remarked:[4]

"As pressures have risen throughout the century, the value of the best ratio of expansion has correspondingly increased, and in still higher ratio, and the best work is now done in the best of contemporary engines, as a rule, at a ratio measured by the quotient $p_1 / 8$, or a slightly higher value. The Milwaukee pumping engine, for example, gives $p_1 / 6.5 = 20$, nearly. From what has preceded it is seen that the efficiency, the quantity of work which may be obtained from the unit-weight of steam, may be at least approximately taken as proportional to the logarithm of the ratio of expansion for maximum efficiency, and that consequently the cost of power will be proportional to the quantity

$$W_1 = m / \log p_1,$$

where W_1 is the weight of steam per *I. H. P.* per hour, and p pounds per square inch. The

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[1] "Manual of the Steam-Engine;" Dr. R. H. Thurston; Edition of 1897, Chap. VIII.

[2] "High Steam-Pressures on Sea-Going Ships;" Part 1; Dr. R. H. Thurston.

[3] *Trans.* A. S. M. E., 1896. "Promise and Potency of High-Pressure Steam;" Dr. R. H. Thurston.

[4] Ibidem.

value of this constant, *m*, employing common logarithms, was fifteen years ago about 40, and is now probably not above 30 for good constructions; it has become, in the case of the best class of engines above referred to, about 25, including all wastes. Accepting the last measures as limiting figures for the higher pressures of steam which the engineer is comir.g now rapidly to contemplate and experimentally to investigate, we have approximately the following:

Pressures	100	200	300	500	1000
Expansions	15	30	45	75	150
Steam used per *I. H. P.*	13-15	11-12	10-11	9-10	8-9."

Fig 3, page 9, in the May issue of Marine Engineering shows[5] the facts of history in respect to the progress made, in the better classes of steam engine, from the days of Savery and Smeaton to the present time, and also the basis of the improvement noted, as seen in the corresponding reduction of the internal wastes of the machine. In the earlier days of the steam engine these wastes were the main expenditure of the engine, constituting, sometimes, ninety or even ninety-five per cent of the total expenditure of steam. In our own times, the internal wastes of the engine, by "initial condensation," have been brought down to 20 or 25 per cent and the duty has been raised, partly by increase of pressure, but mainly by decrease of wastes, from about 3,000,000 to over 150,000,000, as measured by the customary methods of builders of steam pumping engines. Otherwise stated: The gain has reduced expenditures of fuel to about one-fiftieth the figures usual before the time of Watt, and a large fraction of this gain is due to improvements affecting reductions of extra-thermodynamic heat-wastes; the remainder has been principally due to rising pressures with provision for proportionally increased expansion.

The method of waste and its effect upon the working of the engine and its influence upon the magnitude of the most suitable ratio of expansion are best shown by a diagram, as in the accompanying Fig. 1, in which the ordinates represent the expenditures of heat or steam or fuel, and the abscissas measure the ratios of expansion at the stated pressure. This diagram, already elsewhere employed for this purpose,[6] is here reproduced as the best possible substitute for pages of text.

In Fig. 1 the lower curve of the diagram represents the variation of costs of power with variation of the ratio of expansion, with the best triple-expansion engines of our day, when employing steam at a pressure of about 150 pounds, absolute, and where, as in the purely thermodynamic case, only thermodynamic energy-transfers and transformations are occurring. At the limit, thirty expansions, the cost of power is about 9,000 *B. T. U.*, or in the neighborhood of eight and one-half pounds of steam per *I. H. P.* per hour. Friction adds a fifth to these figures, and internal wastes, in the case of the simple engine, reduce the ratio of expansion giving best effect to eight or ten, and the expenditure becomes nearly twenty-five pounds per *I. H. P.* per hour, or about 24,000 *B. T. U.* Compounding cuts the wastes in half, and these figures become $r = 10$; $W = 16$; $H = 17{,}500$. The triple-expansion engine drops the cost to 14,000 *B. T. U.*, or about thirteen pounds of steam, and the ratio of expansion becomes, at best effect, about fifteen. Finally, the quadruple-expansion engine gives, for the same pressure—which is, however, too low for its best working—12,000 *B. T. U.* and eleven pounds of steam per *I. H. P.* per hour, and raises the ratio of expansion for best effect to twenty, or more, in this particular case.

Next, adding the equivalent cost on investment account, the dotted lines show that, in the case of the stationary engine, at least as here taken, the highest financial returns are secured by still more moderate ratios of expansion, and the diagram indicates the results, measured as before. The costs of adaptation to the thermodynamic requirements, in order to make the "duty" of the machine a maximum, are such as to restrict the extent to which it will pay to seek economic gain, and to a much greater extent than is commonly realized by even the best designers and builders. In the cases here illustrated the maximum net financial return is secured when the simple engine is proportioned for a ratio of expansion of about five, the compound for ten, the triple-expansion for thirteen, and the quadruple for about sixteen. These figures are, of course, modified by every variation in costs of construction and of operation, as well as of fuel and supplies, and of wages. The point to be here brought out clearly, if possible, however, is simply that an engine, if properly adapted to business purposes, is designed, not to give maximum duty—minimum expenditure of steam and of fuel—but maximum financial returns, the largest possible economy in capital expended or employed to produce the demanded power, and that this last measure of a true economy may dictate a very different proportion of engine, and often a much less economy as measured in heat, steam and fuel consumed than that giving highest duty. Notwithstanding this fact, however, it is none the less important to ascertain what are the proportions which insure best thermodynamic effect, as well as the extent to which these conditions are affected by considerations of extra-thermodynamic expenditures and financial costs. Experience indicates that we may hope to make our work with high-pressure steam at least as nearly perfect as hitherto at low pressures, and, knowing the theoretical, purely thermodynamic performance of the steam engine under stated pressures, we may deduce with some degree of confidence a probable actual efficiency and the rate of gain to be anticipated with increasing pressures, far beyond past practice or experience.

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[5] "High Steam-Pressures on Sea-Going Ships;" Part II.

[6] *Trans.* A. S. M. E., 1896; "Manual of the Steam-Engine;" Chap. VIII.

Comparatively little is known of the actual working economy of steam engines at pressures exceeding 150 to 200 pounds per square inch; although some work has been done in the direction of making such pressures available, with a view to gain of economy in costs of power, both at sea and on shore. Taking the quantity of power obtainable from a stated weight of steam as varying with the logarithm of the pressure, and the wastes as reducible to a minimum and the same amount, proportionally, for all pressures, as the writer has elsewhere remarked, we are evidently not to expect a gain by simple increase of pressure from, say, 100 to 1,000 pounds, of more than about fifty per cent; the ratios of the logarithms of the two pressures presenting that relation.[7] Taking the best work of our time as averaging about 12,000 *B. T. U.* per *I. H. P.*, this gives promise of about 8,000 *B. T. U.* at the higher tension of steam; and these figures represent an efficiency approximating seventy per cent of that of the Carnot cycle at the same pressures. Perkins and Albans, employing, experimentally, a half century ago and more, pressures of from 800 to 1,500, perhaps in some cases 2,000 pounds per square inch, proved to their own satisfaction the practicability of handling such tensions safely and the "promise and potency" of maximum pressures, but their efficiencies of engine have been often and greatly exceeded by later builders with what are now common pressures, and the thermodynamic defects of their machines were so great as to make their work useless for our purposes to-day. The successors of Jacob Perkins, Messrs. A. M. Perkins & Sons, of London, in the steamer "Anthracite," secured an economy at 350 pounds pressure, and with a comparatively small engine, of 1.7 pounds of fuel, 1.6 pounds of combustible, 17.8 pounds of feed-water and 20,000 *B. T. U.*, per horse power per hour, with a triple-expansion engine; the "cylinder-condensation" being about 30 per cent in the high-pressure engine-cylinder.

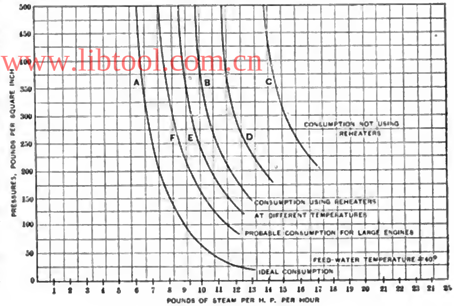

FIG. 1.—ENGINE EFFICIENCIES.

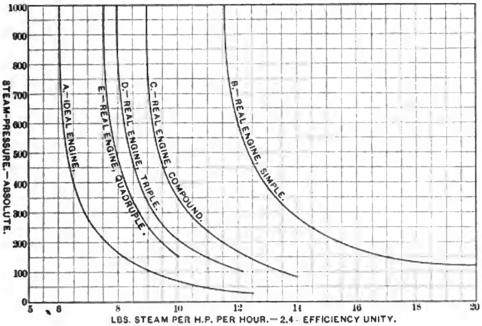

FIG. 2.—PROMISE OF HIGH PRESSURE STEAM.

The case about to be discussed is one in which 500 pounds pressure was provisionally adopted and the engine, a quadruple-expansion, was proportioned for that figure. Experience to date, however, shows, it would seem, that the machine, although performing remarkably well for so small an engine at the higher presssure, does its best work at more nearly 300 pounds. The promise of gain by increasing pressures is well known, for the case of the large engine, such as gives us to-day our "record-breaking" performances, in Fig. 5 of the articles already referred to, and as illustrated in the issue of this publication of May, 1897, page 11, and here reproduced as Fig. 2, and it shows that it should be practicable to secure as low an expenditure of heat as about 7,000 *B. T. U.*

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[7] Ibidem.

at 1,000 pounds, and 8,000 at 500, when the engine is so constructed as to reduce the extra-thermodynamic wastes to twenty-five per cent. of the ideal requirement. Such could not be the fact with a little engine, of but twenty horse-power, such as is to be described; in which the excessive proportion of cylinder-wall to enclosed steam makes certain a comparatively large amount of initial condensation. In the diagrams, Fig. 2, it is assumed that it will be practicable to secure as high efficiency of boiler at the higher pressures as at those now employed.

The Ideal Case is easily computed for any assumed pressure. Thus, for example, taking the initial pressure as 500 pounds per sq. in., the back-pressure in one case as 5 pounds, in another as 2, and the ratio of expansion as 64, in both cases, we have the following, adopting Rankine's methods of computation:[8]

DATA AND RESULTS.

$p_1 = 500$ lbs.; $p_2 = 6$ lbs.; $p_3 = 5$ lbs.; $r = 64$.

Mean effective pressure	31 lbs.
Efficiency of fluid	0.2575
B. T. U. per I. H. P.	10.200
Steam per I. H. P., per hour	9.25 lbs.
Coal per I. H. P., per hour	1.03 "

Reducing the back pressure to 2 pounds per sq. in., these figures are improved to the extent of ten per cent, and we have:

Efficiency of fluid	0.28
B. T. U. per I. H. P., per hour	9,200
Steam per I. H. P., per hour	8.5 lbs.
Coal per I. H. P., per hour	0.9 "

It is here assumed that 1,100 *B. T. U.* are available per pound of steam with a good boiler and heater system, and that the area of heating surface is ample to insure an evaporation of nine pounds of water per pound of good fuel. For unity efficiency, this would give but 2.3 pounds of steam and 0.26 pounds of fuel per *I. H. P.* per hour.

Assuming the total wastes of heat to be measured by the percentage $w = a\sqrt{r}$, and the value of a for an engine of considerable size to be, as found for large mill engines, about 0.15, we obtain the loss for the simple engine, $w = 0.15 \times 8 = 1.2$, and the total expenditure of feed-water per horse power per hour here becomes, for the two cases respectively, 20 and 18 pounds. Taking the wastes as inversely as the number of cylinders in series, within the limits here observed, we have the following for the computed and probable costs of power in the two cases:

EFFICIENCIES OF MULTIPLE-CYLINDER ENGINES.

Form of engine	$p_3 = 5$.	$p_3 = 2$.	
Ideal case	9.25	8.5 lbs.	steam per I. H. P. per hr.
Simple jacketed	20	18	" " "
Double expansion	14.5	13.5	" " "
Triple expansion	13	11.5	" " "
Quadruple expansion	12	10.5	" " "

Were the same investigation made for steam-pressures approximating 1,000 pounds, the results would exhibit but ten per cent better figures. Compared with the now usual figure, 100 pounds per sq. in. of boiler pressure, the elevation of the pressure 400 per cent would give, as seen already, about 30 per cent gain, and increase to 1,000 per cent about 50 per cent gain. It is further obvious that a well-designed and efficient, yet not excessively expensive, engine could be adapted to the employment of these higher pressures, the gain in efficiency might, in many cases, handsomely repay the costs.

The above figures are at the present moment particularly interesting, in view of the steady rise of pressure, at sea, that we have observed in late years. The comparison of the two columns of the last table suggests, however, another and very important point: The reduction of the back-pressure from five pounds to two has as much effect in the decrease of costs of power as does increase of steam-pressure 50 per cent or more; as, for example, the rise from 100 to 150 or 160 pounds pressure. It is useless to raise the steam-pressure, and to accept all the attendant disadvantages of cost and risk, if the back-pressure cannot be kept down. Tight stuffing boxes and a good condensing system are more important than any ordinary excess of pressure above the normal of the time.

AN ACCOUNT OF THE CONSTRUCTION AND PERFORMANCE OF A "CANOE LAUNCH."

We herewith illustrate a very handsome little motor boat, which the builder, J. H. Rushton, of Canton, N. Y., has called a "canoe launch." Its water lines are those of the "Vesper" sailing canoe, which is 16 ft. by 30 in. One foot has been added to the length, in a neat overhanging stern, and about 3 in. to the width, making the dimensions of the new boat 17 ft. by 32 in.

The keelson is of oak, 7-8 in. thick by 3 in. wide at the center of the boat, tapering to about 1 in. at the bow and stern. The planking is 3-8 in. thick of clear Michigan white cedar, except the sheer strake, which is of Spanish cedar. Red elm is used for the ribs. The deck timbers and inside floors are of white pine, while the deck is of fine figured mahogany 1-4 in. thick. Cherry is used for gunwales, fender rail, coaming and general finish. The boat is double-clinch, fastened with copper and brass, and is finished with best spar varnish throughout. The skin is smooth, the laps being nailed from each side, and all seams laid in spar varnish. The cockpit measures 10 ft. by 19 in., and is pointed with flaring coaming forward, as in a sailing canoe. Close in the bow is a copper air tank, and aft of that, under the forward deck, a gasoline tank of galvanized iron, with a capacity for eight gallons, is provided. On account of the propeller shaft, exhaust pipe and muffler, no air tank could be placed in the stern, and the space there is filled with cork blocks, thus making the boat non-sinkable. The lower rail or fender is grooved on the

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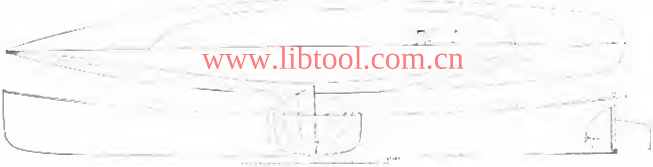
[8] "Hand-Book of Engine and Boiler Trials;" Dr. R. H. Thurston, p. 380. *Vide* the Writer's "Manual of the Steam-Engine;" Vol. I, p 613, for such computations. Also in *Trans.* A. S. M. E., 1896, "Promise and Potency of High-Pressure Steam."

under side, giving a finger hold by which the boat can easily be carried by two men on each side. The propeller wheel is protected by a stout wrought-iron shoe, which is braced from the underside of the counter, and which also carries the foot of the rudder post. The propelling power is a Wolverine, Jr., gasoline motor, rated at 1 H. P., and fitted with a 12 in. two-blade reversing propeller wheel. The exhaust pipe passes aft along the bottom of the boat (inside), under the stern seat, and up to the deck, where it outlets through a nickel-plated mouthpiece on the deck, directly aft of the rudder post. The battery for supplying the electric igniter of the engine is a dry one, containing five cells, which are stowed in a pocket under the deck at one side. On the other side similar pockets hold tools, oil cans and other sundries. Almost any grade of gasoline can be used in the engine. The entire outfit weighs under 500 pounds, and is at its best trim with three persons aboard of, say, 500 pounds total weight, making 1,000 pounds in all.



LINES OF A CANOE LAUNCH DESIGNED BY J. H. RUSHTON.

PHOTOGRAPH OF CANOE LAUNCH WITH THREE PASSENGERS ABOARD.

With regard to the performance of the boat, Mr. Rushton gives this narrative of his recent experiences:

"The canoe launch was hauled to Ogdensburg from Canton, a distance of 18 miles, on an ordinary platform spring wagon, and put on board the steamer Empire State. A friend was with me, and we had intended cruising up to the A. C. A. camp at Grindstone Island. We found the wind blowing directly down the river, almost a gale, and a big sea on, and concluded the dollar asked to carry the two boats (we also had a 15 ft. by 30 in. open Canadian canoe along) to Thousand Island Park, about 45 miles distant, would be money well spent. We were put off at the Park, and as it was then growing dark we remained until morning. Having no convenient place where we could house the boats—where we could feel that they would be safe from the investigations of the inquisitive—we anchored them under the dock on the leeward side and slept in them. At dawn we pulled out for camp, where we ran the boat more or less during the week following, and then ran down to Ogdensburg.

"The run down from Alexandria Bay, about 40 miles by the route we took, was made in six hours with the canoe in tow. There was quite a sea running, and the canoe persisted in taking the opposite side of every big wave, and was constantly twisting the launch off its course. But for this drag we could easily have covered the distance in five hours. We consumed, including evaporation, less than 8 gallons of gasoline on our entire trip. We found our craft a remarkably good sea boat for its size, as was proven by our taking the swell of a large excursion steamer at close quarters, and that without taking a drop of water into the cockpit."

The new transatlantic liner Kaiser Friedrich, building at Schichau's yard at Dantzig for the North German Lloyd Co., will, in many respects, be a departure from the practice which has hitherto been followed in the fastest vessels. Her general dimensions are 600 ft. length over all; 64 ft. beam and 41 ft. depth from the keel to the upper deck. Her gross tonnage is 12,000 tons, and when loaded to 28 ft. draught her displacement will be 17,000 tons. She has a double bottom throughout, and is divided into eighteen water-tight compartments, so arranged that any three adjoining compartments could be filled without risk of disaster. The engines for the twin screws will together indicate 25,000 horse power. They are quadruple expansion, with cylinders 43.25 in., 64.25 in., 92.125 in. and two 93.25 in. The engines have five cylinders working on three cranks. They are placed amidships, and consequently there are fire rooms abaft the engine room as well as forward. Steam will be supplied by nine double ended boilers and one single ended boiler, at a working pressure of 225 lbs. per sq. in. Three funnels will be fitted and two pole masts. The boilers will be worked with Howden's system forced draft. As the builder has had a very extensive experience with high speed steamers, the Kaiser Friedrich should turn out to be a flier.

The double screw ferryboat Chebucto, which was built at Glasgow recently to ply between Dartmouth and Halifax, N. S., does not seem to be a very good sea boat. She left the Clyde for Halifax August 15, and, after being out about 260 miles, returned, nearly a week later. The excuse given was that she had experienced such severe weather, and had labored and strained so much, that the crew insisted that the vessel return to port. The vessel is built in imitation of an American ferryboat, and is 140 ft. long, 50 ft. broad, and 13.7 ft. deep moulded. She has a screw propeller and rudder at each end driven by two pairs of compound surface condensing engines fitted on one bed plate. During her trial trip she attained a speed of 10 knots, her draught at the time being 9 ft. forward and aft.

RESULTS OF AN INVESTIGATION INTO THE CAUSES OF TAIL SHAFT BREAKAGES.

A very thorough investigation into the causes of breakages of tail shafts has been undertaken by John Gravell for the British Committee of the Bureau Veritas. His report reads as follows:

With reference to the corrosion and rupture which so often occur in tail-end shafts, there appears to be considerable difference of opinion, both as to the cause of, and the best means of preventing these accidents, but all are agreed that one of the chief causes is the galvanic action which takes place when liners of brass or similar metal are fitted to work in lignum vitae bushes in the stern tube or stern bracket.

Among the causes to which the breakage of tail-end shafts is attributed by various engineers are these: (1) Defects in the structure or working of the material of which the shafts are made. (2) Defects of design and proportion. (3) Bending stresses set up by the shafting getting out of line through unequal wear of bearings, or yielding of the vessel under different conditions of loading. (4) Vibration in after part of vessel. (5) Hammering produced by the sea acting on the propeller, when the latter is overhung, if the after bearing has been allowed to wear too slack. (6) Corrosion near ends of brass liners. Any one of these acting alone, or in combination with some of the others, will tend to shorten the life of the shaft, and may so reduce its strength as to make it give way unexpectedly.

Defects in material.—In some cases of broken shafts examination by the microscope has shown a very irregular structure of the metal, this irregularity differing sometimes considerably in different parts of the shaft. This is specially liable to occur in shafts made from scrap. When a shaft is made from iron scrap it is very difficult to obtain this unmixed with steel scrap, which will naturally spoil the homogeneity of the metal, and cause weakness. When made from steel scrap, it is equally impossible to secure its being all of the same quality and tensile strength, so that a shaft forged of such material can in no way be homogeneous. Shafts made from ingot steel, however, if not of too high a tensile strength and hardness, may be perfectly homogeneous if carefully forged—especially if forged under a hydraulic press. Shafts have also been made of cast steel without forging, and have given great satisfaction both in locomotive and marine work.

Defective Design.—Sometimes shafts have been made too light to allow not only for the strains which may come upon them, but also for corrosion, and sudden changes in diameter are also sometimes made which prevent the equalization of stresses throughout the length of the shaft, and cause them to be localized, thus tending to weaken the shaft.

Bending Stresses.—When bearings wear unequally, or when, owing to the weakness of the vessel, it yields under different conditions of loading, the shafting gets out of line, bringing heavy stresses upon the shafting—stresses which constantly vary in direction as the shaft revolves—thus tending greatly to shorten its life and produce rupture.

Vibration.—When a vessel is lightly built, or when she has powerful machinery, there may be an amount of vibration in the after part which will tend to produce molecular changes in the metal and make the shaft brittle.

Hammering.—When propellers are overhung, as is nowadays generally the case, and when the after-bearing is allowed to wear very loose, not only are bending stresses set up, but the action of the waves on the propeller, especially in a rough sea, causes the shaft to knock about in the bearing with a hammering action, which is liable to upset the molecular condition of the metal and lead to rupture.

Corrosion.—The majority of vessels have their tail-end shafts fitted with brass or gun-metal liners, working in bushes lined with strips of lignum-vitæ, sea water being freely admitted to act as a lubricant. When this is the case a galvanic action is set up between the iron or steel of the shaft and the brass or gun-metal of the liners through the salt water, and the iron or steel is eaten away at the point where the two metals meet, a groove, sometimes very deep, being formed round the shaft, weakening it suddenly in one place and making it liable to break under any extra strain. In order to get as much light as possible on this subject I have obtained opinions from some of our surveyors, and Lewis Evans, engineer to the North of England Iron Steamship Insurance Association, has kindly sent me a report on the subject, together with some interesting photographs of broken shafts. The ideas expressed in his report are practically the same of those of our surveyors. Thos. Mudd, of Hartlepool, has also been kind enough to send a wooden model showing the method of applying his patent protective sleeve, and a portion cut from a shaft that had corroded badly at the forward end of after brass liner, after only eighteen months' use, together with a most interesting communication in which he strongly contends that the main cause of corrosion of tail shafts is due to galvanic action. There is, however, no unanimity in the proposals for avoiding corrosion and reducing the liability to rupture.

Amongst the suggestions for curing the defects found to exist may be given the following:

When there are brass liners working in lignum-vitæ. (1) To carry the brass liners the whole way within the stern tube, the joints being either brazed or soldered, or otherwise made watertight. But even with this expensive arrangement water has been known to get through the pores of the metal and corrode the shaft underneath, where such corrosion could not be seen. (2) D. B. Morison's patent, in which the ends of brass liners are made of ziz-zag form where it touches the shaft, so that the line of corrosion, instead of running round the shaft at one part of its length, should take a similar form to the brass liner, and thus be distributed over a greater length of the shaft. (3) To carefully lap the shaft between the liners with marline, well soaked either in Stockholm tar or red lead, covering with canvas and painting well over with red lead paint. This has been found efficient in proportion to the care with which the lapping is done, so as to secure a thick and unbroken coating of tar or red lead; but it has the disadvantage of being troublesome when the shaft has to be examined. (4) The method patented by Thos. Mudd, of Hartlepool, of protecting the shaft between the liners by a tube or sleeve of india rubber, made tight at the ends of the liners. This has proved very successful in many steamers. (5) Filling the space round the shaft, in the stern tube, with tallow, or a mixture of tallow, and either rape or mineral oil, means being provided for adding fresh grease to replace any that may work out, and so keep the space full. This has proved efficient when the tallow has been pure, and free from any trace of sulphuric acid used in its preparation, and when the space has been kept quite full and the shaft protected from contact with sea water. (6) To do away with the brass liners and lignum-vitæ bush, and to let the shaft work on long bushes of white metal. This has worked well when the white metal bushes have been long enough and well lubricated either by water or grease, and has been largely employed in torpedo boats and other small craft. (7) Cedervall's patent protective box, which is bolted to the forward face of the propeller boss, and contains a ring or gland (packed inside and out) pressed out by spiral springs, and running watertight against the after-end of the stern tube. The stern tube is filled with the best olive oil, and grooves are cut to let the oil get to the bearings and air to escape. The oil is prevented from getting out by the ring or gland, so that the consumption of oil is very small; and is made up by a pipe and cock on the watertight bulkhead at the forward end of stern tube. This has worked well on Swedish vessels.

Recommendations.—In view, therefore, of the above considerations, I would offer these suggestions: (a) That tail-end shafts should not be made of scrap either in iron or steel, but that they should be of ingot steel not exceeding thirty tons tensile strength, and that when forged it should preferably be under a hydraulic press, rather than under a steam hammer. Also that whether forged or cast they should be well annealed. (b) That when fitted with brass or gun-metal liners working in lignum-vitæ bushes, all parts of the shaft between and beyond the liners should be thoroughly protected from contact with sea water. (c) That when not fitted with liners as above, either some such arrangement as Cedervall's should be adopted, or if the shafts work in white metal bushes, these should be of ample length and well lubricated by either grease or water.

IMPROVED APPARATUS.

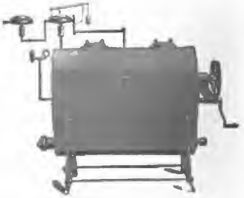
Acetylene Gas Generator and Burner.

ACETYLENE GAS BURNER.

For the purpose of illumination aboard ship acetylene gas is attracting the serious attention of vessel owners. The compactness and cheapness of the generating plant, and the ease with which the manufacture of the gas can be carried on, or stopped, is likely to cause the substitution of acetylene gas for electricity in many cases. The lighting plant is entirely independent of the main or auxiliary machinery on board a vessel, and where electricity is not used for purposes other than illumination it is at a great disadvantage as compared with acetylene gas. The manufacture and use of this gas has, of course, only recently passed the experimental stage, but now forms of apparatus are obtainable which the trained staff of the engineers' department of a steamer can use with absolute safety. A convenient form of apparatus for using this gas is here illustrated. It consist of the "Naphey's" generator and the special burner which is necessary for the production of a smokeless flame. The generator is of the class known as "dry." It consists of a drum of sheet steel, within which is a receptacle for calcium carbide, from which the gas is produced, and a spraying apparatus for supplying the necessary proportion of water. There are two man-holes in the drum, one to supply the carbide and another to remove the waste. There are also three connecting pipes, one an inlet for water, another to give an exit for the gas, and a third as a drain when flushing or cleaning the tank. There is also a mechanism for turning over the carbide while the generator is in use. There are two valves attached to the generator, one to control the water supply, and the other the pressure of the gas. This pressure automatically controls the water supply so that the gas is manufactured as needed. Calcium carbide is a hard bluish-black crystalline substance, which is packed in convenient sized air-tight cannisters. In operation a charge of this carbide is placed in the generator, and the water is turned on slowly. An immediate generation of gas in quantity takes place. By having an excess of carbide and a minimum of water a dry gas is secured, and the operation of the machine is not affected by the rolling of the ship. The gas so generated is piped in the same manner as ordinary water gas, and burned in the special burner shown in the cut. This has two tips, from which gas is emitted and burned in a flat flame. When so burned the gas is intensely brilliant, producing a light which closely resembles daylight. For this reason a very much less quantity of gas is needed for each burner than would be the case with ordinary water gas. The proportions are, acetylene, 1-2 ft. per hour for 25 candle light, and ordinary gas 5 ft. per hour for 16 candle light. In the Naphey generator one pound of the calcium carbide of commerce gives an average of 4.48 cubic ft. of acetylene gas, or nine burner hours per pound of carbide. A generator with a capacity of 1,000 pounds of carbide occupies a space 3 ft. by 6 ft. This will operate 40 to 80 lights, and will give an illuminating value of about 80,000 cubic ft. of ordinary gas. The American agents for the apparatus described are J. B. Colt & Co., 117 Nassau street, New York, who will give any additional particulars needed for special cases.

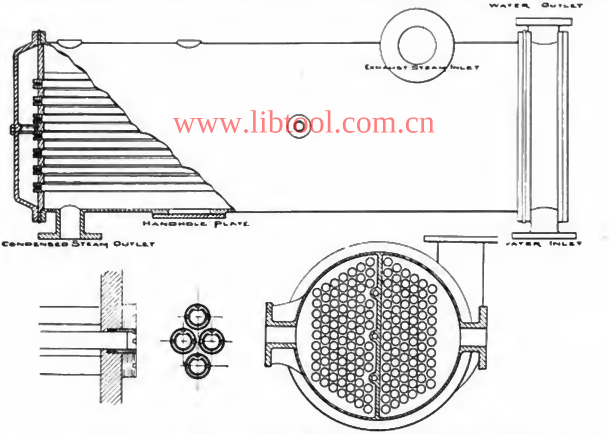
Surface Condenser and Pump Combined.

A surface condenser, combined on one base with air and circulating pumps, is here shown, as made by Dean Bros., of Indianapolis, Ind. The condenser is placed on top of the pumps, forming a self-contained apparatus. They are made in various sizes, from twenty horse power up. All air pumps are provided with sealed chambers to prevent air from leaking at the piston rod, and the valves are arranged so as to be at all times submerged with water. Instead of using cradle bars to connect the cylinders as shown, the cylinders are frequently placed on a bed. The surface condensers manufactured by this concern are made of selected material, with cylindrical shells, as that form combines lightness with strength. They are provided with necessary openings for exhaust steam and water connections; also, for hand holes for cleaning. All air and water pockets are carefully avoided. The tube heads are of solid brass, with brass glands and cord packing of the style adapted by U. S. government engineers. Baffle plates are arranged for distributing the steam and protecting the tubes at the opening. The steam is also diffused over the tubes by traverse plates. The tubes are

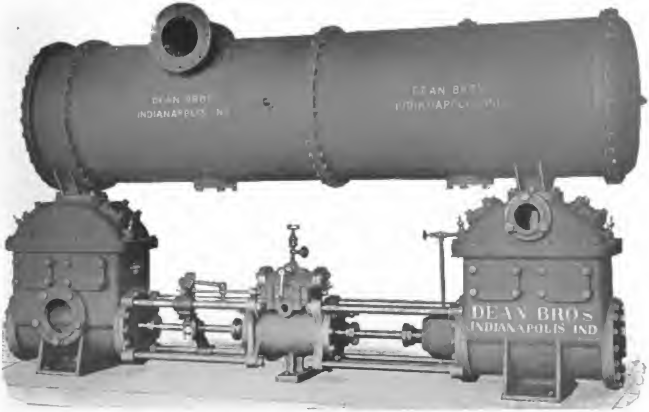


NAPHEY'S ACETYLENE GAS GENERATOR.

supported at their centers to prevent sagging, and stop lugs are provided to prevent the tubes from "creeping." Without such stops the tubes, by contraction and expansion, are liable to be drawn out of the heads. One and a half to two square feet of surface is required for each horse power, depending on the economy of the engine and temperature of the circulating water.



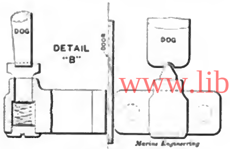
SKETCHES SHOWING CONSTRUCTION OF DEAN SURFACE CONDENSER.



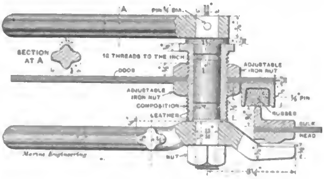
DEAN BROS.' COMBINED SURFACE CONDENSER AND PUMPS.

Cross Adjustable Water-Tight Door.

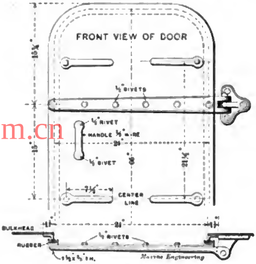
A new adjustable water-tight door, the invention of Frank W. Cross, of Washington, is here illustrated. The design of the door is such that no cutting or alteration of the frame is necessary in putting this door on ships that have the old style door. The clamping dogs are secured to the door, an advantage where a door comes in a passage where there is not room to put them on the bulkhead. A stop is fitted to hold the dog in position, so that there is no chance of a dog dropping down between the door and the frame and being bent or broken. The dogs and hinges are adjustable, allowing the door to be moved in or out so as to bring the angle iron in safe contact with the rubber packing. Wear of the rubber can thus be taken up readily by moving the jam nuts and turning the brass sleeve. This is much less troublesome than taking out the rubber and putting a liner behind it. The tension can be adjusted so nicely that the door will be water-tight without excessive pressure on the packing. It will be noticed that the groove for the rubber packing is the reverse of the usual style. In the old dovetail groove it is necessary to stretch the rubber to get in position, as the widest part of the dovetail is at the bottom of the groove. In the Cross door the rubber is readily slipped in place cut to exact length, and there is no tendency to contract and leave an open space between the ends. The levers on the door are of cast steel, put on the spindle separately, and if broken or bent can be readily replaced. It is claimed for this door that it is a simple and practical construction, one that can easily be repaired on board ship, and that it is durable and inexpensive. It is manufactured by T. C. Basshor & Co., 28 Light street, Baltimore, Md., who will be pleased to give any additional information desired.



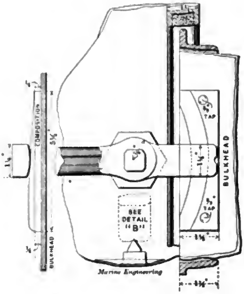
CROSS DOOR—DETAIL "B."



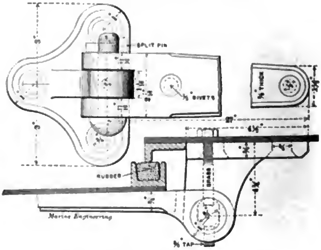
CROSS DOOR—SECTION SHOWING CLAMPS.



CROSS DOOR IN POSITION.



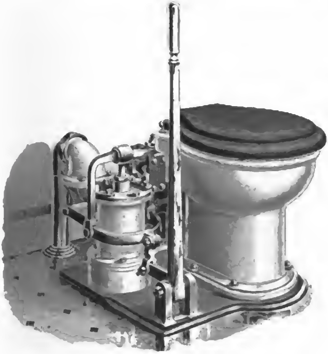
CROSS DOOR—DETAIL OF CLAMP.



CROSS DOOR—DETAIL OF HINGE.

Neptune Closet for War Vessels and Yachts.

The Neptune closet, here illustrated, is designed especially for use in vessels in which the closet must be located either below the water line or at such a slight elevation that a pump is necessary to eject the contents. In this class are included war vessels and yachts. It consists of a galvanized iron base plate upon which is mounted a pedestal bowl of American vitreous porcelain, with hardwood seat and cover attached, and a brass supply pump and inlet valve and discharge pump, operated by a single lever. It is so arranged that the supply valve cannot be opened except by operating the lever, which also controls the discharge pump, so that an overflow is not possible. During the operation of pumping out the closet water is accumulated in a refill chamber, so that the bowl is constantly supplied with water. One great advantage of this closet is that one lever does all the work, and there are no foot treadles or hand pulls to be worked before water can enter the supply pump. It is the invention of Geo. B. Howells. The dimensions are: Length over all, 22 1-2 in.; depth from front of seat to back of discharge coupling, 30 in.; height from deck to top of seat, 17 in.; dia. of supply pipe, 1 1-4 in., and of discharge, 2 in. The closet is manufactured by McCambridge & Co., Ltd., 523-527 Cherry street, Philadelphia, Pa.



NEPTUNE MARINE PUMP WATER CLOSET.

REAGAN CHOPPING GRATE, SHOWING POSITION OF CHOPPERS IN USE AND AT REST.

Reagan Dead Bar Chopping Grate.

An improved form of grate which has been tried with much success under severe conditions of service, is here illustrated. It is named after the inventor, the Reagan Dead Bar Chopping Grate. The general arrangement of the grate can be seen in the accompanying engraving. The dead bars are made very strong, more than 1-2 in. thick at the top, which is pointed round with two rows of air holes opening into larger air cells below on either side of the rib center. This is 5-8 in. thick, and extends the length of the bar. The dead bars can be lifted out or dropped into place between the choppers with ease. They stand about 1-2 in. above the choppers and support the body of the fire. An air space is thus maintained between the choppers and the bottom of the fire, as the fire crusts and arches from bar to bar. As the grate is made in short sections with abundance of air passages there is little tendency to change of form and distortion, which is so troublesome in ordinary grates. It will be noticed that the choppers in the front and back halves of the grate can be operated independently or together, as required. Though the grate looks complicated, it has been found in practice to be really simple, and that it will work effectively under extreme conditions of forced draft. Its strongest point, perhaps, is that by its use the nominal and effective grate areas are identical, a condition which it is impossible to maintain with ordinary grates and heavy firing. It has been used successfully on many ocean vessels, including some of the fast ships of the American Line. The grate was invented by James Reagan, of the Water Circulating Grate Co. of Philadelphia. In New York and Philadelphia the sale is controlled by the James Reilly Repair and Supply Co., 230 West street, New York, and foot of Washington avenue, Philadelphia, Pa.

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The navy estimates for the fiscal year ending June 30, 1899, have been approved by Secretary Long and will be presented later to Congress. The total is $31,991,727.55, or $2,224,208.64 less than last year, for which the total was $34,215,936.19. This is a mere matter of totals, however, and not economies, for the building program only contemplates the construction of one vessel, a practice ship for the naval cadets. This cessation of building may be good politics, but it is poor policy if the nation desires to keep in the procession of naval progress. This is not simply because advances in material and construction are continuously being made by foreign powers, but because American builders have now had sufficient experience in the construction of war vessels to do quicker and better work than ever before. Every yard in which ships of the new navy have been built has learned much about construction which it did not previously know, and good as the first ships were it is certain that better ones could be built now; not stauncher vessels, but vessels in the building of which a thousand and one little modifications which practice has suggested could be used. Then, too, such yards have gathered together forces of trained men, who have become highly skilled in the exact kind of work demanded. These men unless continuously employed will drift away into other lines of work, and any practical manager knows that it is not easy to create such forces out of new material. The estimates include these items of special interest:

Construction and repair of vessels, $1,500,000; repairs to U. S. S. Hartford, $10,000; repairs to U. S. S. Chicago, $125,000; steam tug for Portsmouth, $50,000; improvement of construction plants at Portsmouth, $50,000; Boston, $10,000; New York, $10,000; League Island, $50,000; Norfolk, $50,000; Mare Island, $50,000; Puget Sound, $50,000. For completion repairs and preservation of machinery, $600,000; purchase, handling and preservation of all material, $400,000; improvements in engineering plants at Boston, $15,000; Norfolk, $25,000; Key West, $10,000; Port Orchard, $50,000; experiments with liquid fuel at New York, $5,000; experiments with fuel on two torpedo boats, $10,000.

Construction and machinery on account of hulls and outfits of vessels and steam machinery of vessels already authorized, $3,070,473; armor and armament, $4,254,800; increase Navy equipment, $175,000; for one composite vessel propelled by sail, $125,000

The last item, of $125,000, is presumably additional to the like amount already appropriated by Congress for the construction of this vessel, the original amount being inadequate.

Elsewhere in this issue a reference to the construction of an experimental tank at Cornell University will be found in a description of the uses of such a tank by W. F. Durand, principal of the School of Marine Construction at Sibley College. While this tank is a part of a general hydraulic laboratory installed in charge of the College of Civil Engineering, it is expected that, through the kindness of the director of the college, it will be available for distinctively marine work as well. With characteristic modesty Prof. Durand refers but briefly to the results which will undoubtedly follow the equipment of this station for experimental investigation of those problems which apply to safe and economical navigation of waters. In considering what has been accomplished by the use of similar apparatus abroad, and properly estimating the qualifications of those intrusted with the work of experimentation, the establishment of this tank is the most important undertaking in the history of American marine construction since Ericsson laid the keel of the Monitor. Contrasted with the progress made in other lines of scientific research—even in the abstruse field of astronomy—advancement in marine construction has been very slow in America. We refer particularly to steam propulsion. There has been much latent talent, which in certain lines opportunity has developed beyond competition. Witness the superiority of American designed sailing yachts. But, generally speaking, there have been few opportunities and fewer facilities. How many builders follow certain fixed rules or ideas, the only reason for which being that their ancestors did so, and like as not made money. Now, however, there is a prospect that American genius will have an opportunity to assert itself and in a purely scientific way. This is perhaps the most significant feature of the undertaking, for it is usually charged that progress here is induced by dollars and cents. With the Ithaca tank in operation America will enjoy the distinction of being the only country to possess such opportunities completely removed from all purely commercial or naval purposes. The good results which thus must follow are incalculable, for the results of investigation will not be read in secrecy and padlocked in security, but spread abroad among the profession. Every American builder will be a beneficiary, and it is a safe prophesy to make that the tank at Ithaca will influence not only the build of the noble liner, but even the unnamed barge which carries city garbage. It is a grand work for which the trustees of Cornell University have appropriated money, and it only remains to equip the station with apparatus commensurate with the needs of science and the capabilities of those intrusted with its charge.

We are frequently asked if it is necessary for the owner of a motor boat, using other than steam power, to have an engineer's license or employ a licensed engineer. The law governing the operation of motor boats is of recent date, having been approved January 18 last. It is entitled "An act providing for certain requirements for vessels propelled by gas, fluid, naphtha, or electric motors." By its terms, all such vessels of "above fifteen tons burden, carrying freight or passengers for hire," are subject to the United States statutes relating to the inspection of hulls and machinery and requiring the employment of properly qualified engineers and pilots, and a strict compliance with the navigation laws. Consequently, the law does not apply to motor boats of small capacity used for pleasure only. Owners of such boats, however, who usually act as their own engineer and pilot, should, in justice to themselves, to those whom they may carry, and to the owners of all other craft, make themselves thoroughly familiar with the construction and safe operation of the apparatus used for propelling the boat. The many accidents which happen to such boats are usually due to carelessness or gross ignorance on the part of owners. They should also carefully study the rules of the road, and observe these strictly when running. Any disaster which might result from a breach of the rules would place the owner at a serious legal disadvantage in civil suit, not taking into consideration his moral responsibility.

The fifth general meeting of the Society of Naval Architects and Marine Engineers will be held in New York City during the present month. Through the courtesy of the executive officers of the American Society of Mechanical Engineers, the place of meeting will be in the building 12 West Thirty-first street, the well-known headquarters of engineering societies in New York. The proceedings will be opened by President Clement A. Griscom, Thursday, November 11, at 10 o'clock in the morning, and will continue during the day and on Friday, the day following. The meeting will terminate in a pleasant social gathering, which will take the form of a banquet at Delmonico's on Friday night, commencing at 7 o'clock. An interesting and diversified program has been provided through the efforts of the Secretary-Treasurer Francis T. Bowles. The papers cover a variety of timely topics, and are representative of the widespread marine interests of the country. The list of papers reads:

Thursday, November 11, 1897.

Watertight Bulkhead Doors. The "Long-Arm" System on the U. S. S. Chicago. By William Barnum Cowles, Esq., member.

Regulations for Loading Vessels. By Lewis Nixon, Esq., member.

Torpedo Boat Design. By Assistant Naval Constructor H. G. Gilmor, U. S. Navy, associate.

The Commerce of the Great Lakes. By C. E. Wheeler, Esq., member.

Progressive Trials of the "Guardian." By Prof. C. H. Peabody, member.

An Experimental Study of the Influence of Surface upon the Performance of Screw Propellers. Preliminary Paper. By Prof. W. F. Durand, member.

Friday, November 12, 1897.

Some Notes on the Speed Trials and Experience in Commission of our New Battleships. By Chief Constructor Philip Hichborn, U. S. Navy, vice-president.

Performance of Scotch Boilers and their Durability Under Forced Draft. By Edwin S. Cramp, Esq., member.

Use of Water-Ballast for Colliers in the Pacific Coast Trade. By William P. Frear, Esq., member.

Estimated Weights of Machinery. By Prof. George R. McDermott, member.

Navy Yard Expenses. By Naval Constructor W. J. Baxter, U. S. Navy, member.

Pneumatic Steering Gear, as Applied to the U. S. Monitor Terror. By H. A. Spiller, Esq., member.

Other business to be transacted at the meeting will include the election of officers, disposition of applications for membership, and probably the drafting of a set of resolutions expressing appreciation of the splendid reception accorded the delegates to the recent International Congress of Naval Architects and Marine Engineers in London. Secretary George Holmes, of the Institution of Naval Architects, recently sent to Walter M. McFarland, U. S. N., a very courteous reply to the joint letter of the American visitors, written before their departure from London. As a supplement to this issue we present our readers with a group of portraits of members of the society, representing the science and art of American shipbuilding and marine engineering in various sections of the country.

CORRESPONDENCE.

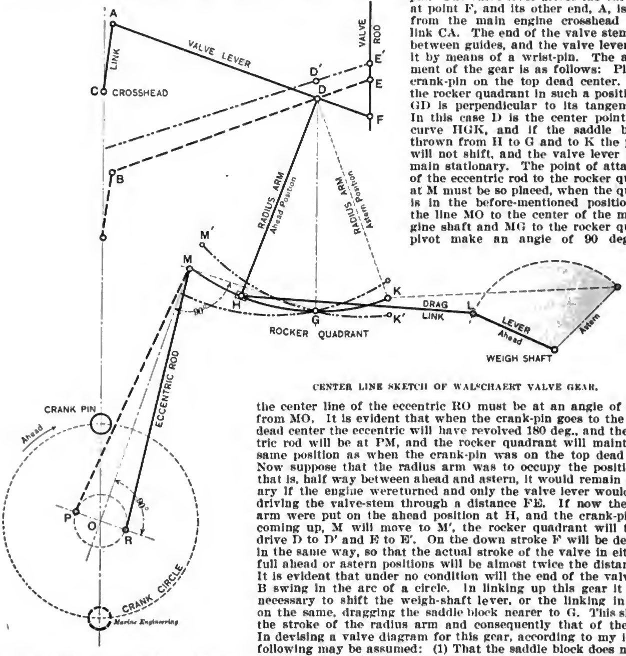
[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Walschaert Valve Diagram Wanted.

I herewith enclose a center line sketch of the Walschaert valve gear as used in marine work. I have been given to understand that this gear is also used in locomotive practice in certain countries in Europe. I have been unable to find any literature dealing with this gear, and as I am anxious to know what the valve diagram looks like, I take the liberty of requesting you to publish the sketch with the hope that some of your subscribers may be able to give the information required, or devise a diagram. The main characteristic of this gear is that only one eccentric is required to go either ahead or astern, and that the valve is placed at the back or front of the cylinder, thus saving space between the different cylinders of an engine, allowing the eccentric to be put close to the crank-cheek. The explanation of this gear may be easily understood by referring to the sketch. A single eccentric and rod oscillates a rocker quadrant which is pivoted at point G. This rocker quadrant has a saddle block sliding in it, and this saddle block can be drawn from one end of the quadrant to the other by means of a drag-link from the weigh-shaft lever, thus putting it in either the ahead or astern position. This saddle block has a radius arm, HD, connected to it by means of a wrist-pin, compelling the bottom end of the radius arm to move with it into the ahead or astern position. The radius of the curve of the rocker quadrant is equal to the length of the radius arm. The radius arm is also connected with a valve lever at point D by a wrist-pin. The valve lever drives the valve stem at point F, and its other end, A, is driven from the main engine crosshead by the link CA. The end of the valve stem works between guides, and the valve lever drives it by means of a wrist-pin. The arrangement of the gear is as follows: Place the crank-pin on the top dead center. Swing the rocker quadrant in such a position that GD is perpendicular to its tangent at G. In this case D is the center point of the curve HGK, and if the saddle block is thrown from H to G and to K the point D will not shift, and the valve lever will remain stationary. The point of attachment of the eccentric rod to the rocker quadrant at M must be so placed, when the quadrant is in the before-mentioned position, that the line MO to the center of the main engine shaft and MG to the rocker quadrant pivot make an angle of 90 deg., also the center line of the eccentric RO must be at an angle of 90 deg. from MO. It is evident that when the crank-pin goes to the bottom dead center the eccentric will have revolved 180 deg., and the eccentric rod will be at PM, and the rocker quadrant will maintain the same position as when the crank-pin was on the top dead center. Now suppose that the radius arm was to occupy the position GD, that is, half way between ahead and astern, it would remain stationary if the engine were turned and only the valve lever would move, driving the valve-stem through a distance FE. If now the radius arm were put on the ahead position at H, and the crank-pin were coming up, M will move to M′, the rocker quadrant will tilt and drive D to D′ and E to E′. On the down stroke F will be depressed in the same way, so that the actual stroke of the valve in either the full ahead or astern positions will be almost twice the distance EF. It is evident that under no condition will the end of the valve lever B swing in the arc of a circle. In linking up this gear it is only necessary to shift the weigh-shaft lever, or the linking in gadget on the same, dragging the saddle block nearer to G. This shortens the stroke of the radius arm and consequently that of the valve. In devising a valve diagram for this gear, according to my idea the following may be assumed: (1) That the saddle block does not slide in the quadrant during one revolution for a fixed position of cut-off. (2) That the eccentric rod is of infinite length, hence its angularity may be neglected. (3) That the radius arm is of infinite length, so that its whole motion may be supposed to be vertical. (4) That the crosshead link is of infinite length, and also that equal divisions of the stroke AB will be proportional between points E and F



CENTER LINE SKETCH OF WALSCHAERT VALVE GEAR.

when the radius arm is at GD. The angularity of the connecting rod, however, must be taken into account, as in marine work the connecting rods are only slightly longer than twice the stroke. In actual practice a line drawn through point D parallel with the valve rod would intersect the rocker quadrant at a point about half way between H and G. This helps to reduce the angularity of the radius arm when the engine is going ahead. From the above description it can be seen that the principal features of this gear are that the leads top and bottom are constant for any position of cut-off, also that it gives a long steam opening and a quick cut-off. In altering the setting of a valve within certain limits on an engine fitted with the Stephenson link motion, it is a simple matter to shift the eccentrics and alter the laps on the valve, but with this gear it would seem that any alteration would entail considerably more work. The eccentric could be shifted, but the leads top and bottom would then not be constant. The throw of the eccentric could be altered by making a new sheave, but this would entail moving point D on the valve lever, so that the valve would have the same stroke as before. In addition, the shifting of point D would put it out of position in reference to the rocker quadrant. If the valve alone were to be altered, for instance, the steam lap were reduced to get a longer cut-off, an excessive lead would be the result. Whatever advantages this gear possesses over the Stephenson link motion, it would seem that it is not as flexible as the latter when alterations are concerned. H.

MISHAPS AT SEA.

Collision Between Newport News and Columbia.

While the passenger steamer Newport News of the Norfolk-Washington line was on a trip to Washington early on the morning of September 7, she ran into the side wheel ferryboat Columbia, during a dense fog. The ferry was on the way to Alexandria, Va., at the time, and when nearly opposite that port she stopped, and the Newport News, which was coming along full speed, struck her almost amidships. Fortunately the blow was delivered at the paddle box and the energy of the ramming vessel was exhausted in crushing the wheel and smashing up the machinery generally. As will be seen in the engraving the steel hull of the Columbia was not damaged, and she was subsequently towed to Baltimore to the yard of James Clark Co., where repairs were made. Both vessels are comparatively new. The Newport News is one of the finest passenger vessels of her type in the country. She was built at the Newport News yard in 1895, and her dimensions are, length 260 ft., beam 46 ft. and depth 14 ft. Her hull is of steel, and she is fitted with quadruple expansion engines which indicate 2,500 horse power. The ferryboat Columbia is a composite vessel, built in 1891 by William E. Woodall & Co., Baltimore. Her dimensions are: length 148 ft., beam 48 ft. and depth 12 ft. Her machinery consists of a beam engine with cylinder 38 in. by 108 in., and one Scotch boiler supplying

FERRYBOAT COLUMBIA AFTER BEING RAMMED BY THE PASSENGER STEAMER NEWPORT NEWS.

steam at 50 lb. per sq. in. The machinery was built and erected by James Clark Co. When she returned to their yard after the collision a survey showed that the damage to machinery consisted of a crushed wheel, bent wheel shaft, both cranks bent and lower end of connecting rod also, one leg of gallows frame broken, main pedestal broken, eccentric cam, eccentric strap and rods sprung, crank pin bent and crank pin brasses broken, all holding down bolts broken, and entire engine moved from its original position. This caused the removal of all the machinery and the substitution of a large amount of new work for parts damaged beyond repair. The wheel was so badly crushed that very little of it was used in the construction of a new wheel. The Columbia reached the Clark yard September 9, and left October 23 under her own steam for Washington, the repaired machinery working very smoothly during the trip.

A novel method for preventing interference with their nonunion workers has been adopted by the Messrs. Yarrow & Co., the torpedo boat builders on the Thames. The shop has been endeavoring to keep going at full capacity since the great strike commenced. As part of the plan the passenger side-wheel steamer Southampton, which formerly ran in connection with an English railroad line in the Channel service, was moored out in the stream and here the men who replaced the strikers are berthed and have their meals. They are ferried to and fro in boats and steam launches. A regular routine was adopted, and the arrangements on the ship placed in charge of a special manager who has provided a number of social features for the entertainment of the workmen. The program includes entertainments of various sorts, and church service on Sundays. In the evenings after work a steam launch conveys them to whatever point on the river they want to go and returns for them again at a certain hour, all having to be aboard by 9.30 o'clock at night. The bell to turn out on weekdays rings at 5.20 o'clock in the morning and hot coffee is served, and shortly before 6 o'clock the men are conveyed ashore. They knock off in time to take breakfast at 8.30 o'clock, dinner at 1 o'clock, and tea at 5 o'clock. The ship's company includes a librarian, pianist, and a doctor, and so far the hundred men aboard this vessel have dwelt in peace and comfort.

The annual report of the American Seaman's Friend Society, just published, recalls attention to the great usefulness of this organization. Reports from the various foreign ports where there are missions aided by the society all tell of great usefulness and missionary zeal with expressions of appreciation from seamen. In the home field, too, the reports show earnest work. The loan library of the society, for example, sent out 295 loan libraries during the year ending March 31, 1897, in which the volumes numbered in all, 12,685. The books have been read with real interest, judging from the expressions of those who enjoyed this feature of the work. Of the regular publications of the society thousands of copies were circulated. The report shows a sound financial condition, a small balance being carried over to the credit of the present fiscal year. The cash receipts from legacies amounted, during the year ending March 31, to $20,673.94, and from other sources of income to $16,608.65 additional, and the disbursements amounted to $31,001.55. The officers of the society are: James Elwell, president; C. A. Stoddard, D.D., vice-president; W. C. Stitt, D.D., secretary, and W. C. Sturges, treasurer. The headquarters of the society are at 76 Wall street, New York. It is supported by membership fees, voluntary contributions and by bequests made by charitably disposed persons and gives aid to chaplains at sixteen foreign and nineteen domestic ports.

EDUCATIONAL.

THE ART OF MAKING MECHANICAL SKETCHES, FOR MARINE ENGINEERS.*—II.

BY PROF. C. W. MAC CORD.

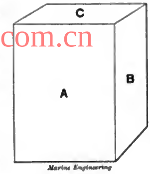


FIG. 1.

It is hoped that the following brief explanations may be of service to such of our readers as are not already familiar with the principles of making "working drawings," as distinguished from pictorial representations.

For illustration: A simple block of wood, such as is shown in Fig. 1, will answer. Three sides are visible, and it is clear that this represents the block as seen from a point not directly in front, but also above and to the right of it. It conveys a perfectly clear idea of the form, which is that of a rectangular prism, and a general idea of the proportions. But as neither the angles nor the edges appear of their true forms or sizes, no measurements could be taken from it, and it would be of no use to a workman if he were required to make a block precisely like the original. This drawing is said to be in *perspective* (which means seen through); since it might be made by looking at the block through a pane of glass, and tracing the edges thereon in their apparent positions, each corner being represented by the point in which a right line from it to the eye would pierce the glass—because light travels in straight lines.

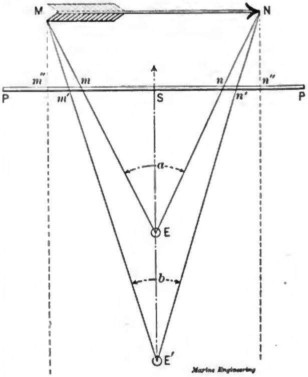


FIG. 2.

Now in Fig. 2, let P P represent the edge of a vertical pane of glass, seen from above; suppose the eye to be placed at E in front of it, and to be looking perpendicularly toward it, in the direction E S; and let M N, parallel to P P, be an object behind the glass.

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* Commenced in July issue.

In this case the rays of light M E, N E (or extreme *visual rays*) include a certain angle a; they pierce the glass at m and n, and m n is the apparent length of M N. But if the eye be removed to E', the extreme visual rays will include a smaller angle b, and the apparent length of the object will be m' n', which is greater than m n. We see then that the farther back the eye is placed, the more nearly parallel the rays will be; if then we suppose the eye to be removed to an infinite distance, those rays will be actually parallel to each other and to the central ray S E. They will then be perpendicular to the glass, and the apparent length m'' n'' will be equal to the actual length M N. This equality exists, however, only because M N is parallel to P P; in Fig. 3 it is not so, and since in any case the visual rays become perpendicular to P P when the eye is infinitely remote, the apparent length m'' n'' is less than the real length, or, as it is technically called, is *foreshortened.* But these two figures show that on this supposition as to the position of the eye, the representation of any point is found by drawing a perpendicular through the point to the plane on which the drawing is made; and this is the distinguishing characteristic of the system of *orthographic projections*, used in making working drawings. The arrow M N was selected for illustration, since, being long and thin, it can easily be imagined to represent an edge of the block shown in Fig. 1.

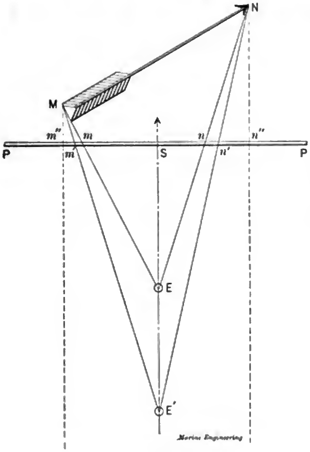


FIG. 3.

Now, suppose that object to be placed in a rectangular glass box, like a show-case with flat sides, the faces of the block being parallel to those of the box. Then standing in front of it, let each visible edge be drawn on the glass, just as M N is represented by m n in Fig. 2; from what precedes it should be clear that the result will be simply a rectangle of the same dimensions as those of the nearer face A. If we then go around and look perpendicularly against the right-hand side of our show-case, we shall in like manner produce a view of the face B, and if we suppose the eye to look vertically downward, we shall have on the top of the show-case a representation of the upper face C; and these will also be rectangles, of the same dimensions as those of the two faces themselves.

Now, suppose the top and the right-hand side of the show-case to be hinged to the front side by their nearer edges; then if the former be swung upward and the latter outward, they may both be made to coincide with the plane of the front face. The three views above described will then be arranged as shown in Fig. 4, in which the three faces of the show-case are represented by the dotted rectangles, E H being the top, E G the right-hand face and E F the front; E K and E L are the hinged edges.

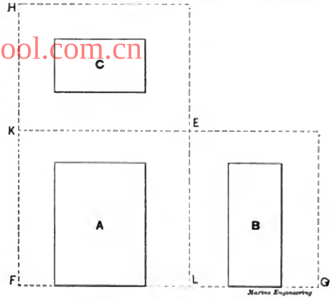


FIG. 4.

Each of these views, then, represents a different face of the prism, in its true form and size—which has given rise to the expression that these projections show an object as it is, while a perspective drawing shows it as it seems. Whether this is strictly true or not, it is certain that Fig. 4 conveys the information which will enable a workman to reproduce the original block, while Fig. 1 as certainly does not.

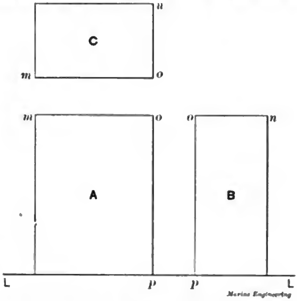


FIG. 5.

But the dotted lines in Fig. 4 are evidently not essential in representing the object; the imaginary show-case, which was introduced merely as an aid in the logical deduction of the method and the arrangement of the different views, may now be dispensed with, and the drawing of our prism made as in Fig. 5: we have here made use of a *base line*, L L, representing a horizontal plane upon which the object may be supposed to rest—which, though not absolutely necessary, is in many cases very useful as indicating the position of the object.

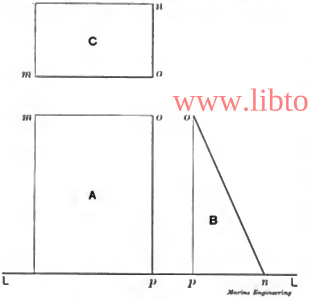


FIG. 6.

Studying these views, we observe three things, viz.:

I.—Each shows two dimensions only: thus
A gives the length and the breadth.
B " " length " " thickness.
C " " breadth " " thickness.

II.—Consequently, one dimension is the same in any two views: thus
The length, *o p*, is the same in A and B;
" breadth, *o m*, " " " " A " C;
" thickness, *o n*, " " " " B " C.

III.—Considering A as the front view, it is noted that the view B, which shows the same object as seen from the right, is placed at the right of A. Had it been desired to make a view as seen from the left, that view would have been placed at the left of A.

And these observations hold good in all cases, whether the object be a simple one like that chosen for illustration, or one of the most complex nature.

The mere fact that each view gives only two dimensions leads at once to the deduction that in general at least three views are necessary to define the object perfectly; and sometimes several more are required. There are cases, of course, in which two will suffice, as, for example, a simple circular cylinder would require only an end view and a side view. But Fig. 6, in which the views A and C are the same as in Fig. 5, will suffice to show that even in very simple cases no less than three may be necessary. It is in the nature of things impossible to lay down a rule by which to determine either what views or how many of them should be made; but there is one axiom which the beginner should fix in his mind at the start, and keep it there to the finish: and that is, that the drawings must be such that by their aid the workman can make what is wanted, and cannot make anything else.

The position of the block chosen as the object to be drawn, in what precedes, is that in which its lines and faces are parallel to the paper in each view; this is clearly the most simple position in which it can be placed, and it is necessary to possess the information conveyed by Fig. 5, in order to proceed intelligently in representing even so simple a thing as this is, in oblique positions, where the lines and angles do not appear in their true forms and sizes, which is sometimes necessary. But it is to be noted that in a working drawing the most simple position should always be selected; and, without waiting for any explanation of more complicated matters, what has previously been explained can be put to very good and practical use in representing minor mechanical details.

In illustration of this, we give in Fig. 7 two views of a small cylinder, with a round flange at one end, and at the other a square one through which are drilled four bolt-holes. When in place, this piece may have had a vertical or an inclined position, but in making a detached sketch of it the drawing will be of more convenient form if the cylinder be laid on its side. In this case two views are sufficient, since a top view, if made, would be exactly the same as the side view. Since the large square flange happens to be at the right, we make an end view from the left, because then the circular flange will not obscure the other; in this view, in fact, the only thing hidden is the outline *m* of the exterior surface of the cylinder, which is indicated in dotted lines; as also is *n*, the interior outline in the side view.

This object is symmetrical about an axis, which is indicated by a fine continuous center line *h h*, drawn through and beyond both views; and short center lines are drawn to represent the axes of the bolt-holes, as at *k k*.

In the end view, a vertical center line, *v v*, is drawn through the center of the cylinder, and the centers of the bolt-holes are likewise located by short cross center lines. Since these lines are imaginary, they ought never to terminate in a boundary line, and they should be made as fine as possible consistently with distinctness.

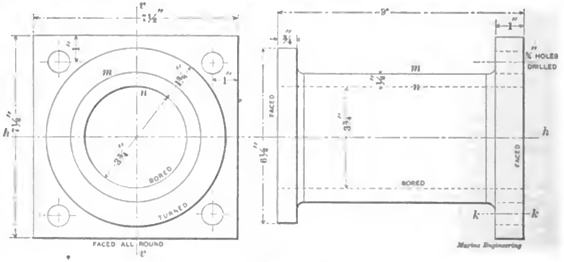


FIG. 7.

These center lines are of the greatest importance in making a finished drawing, being, in fact, always drawn before the circles are struck; but even in a sketch they should always be put in, as a guide to the draughtsman or the machinist, as the case may be.

The sketch must also be complete in respect to the dimensions, as well as in regard to instructions for facing, turning, boring, drilling and the like. And in making a sketch, as well as a finished drawing, the measurements should always be made from center lines or from finished surfaces when practicable, for a rough surface is never perfectly reliable.

Attention is called to the manner in which the figured dimensions are arranged in this example. In the first place, no figure is placed upon a center line; nor are any dimensions written close to the outlines. Had the diameter of the round flange been put in, as we have often seen it done, between the two lines showing its thickness, in the side view, the effect would have been confusing. Each figure should as far as practicable stand in an open space by itself, and be so placed as to be conspicuous and to catch the eye; moreover, each one should be boldly written and carefully formed, in order to avoid any possibility of mistakes in reading them; inattention to this may lead to serious consequences, as an error committed in metal is often an expensive matter.

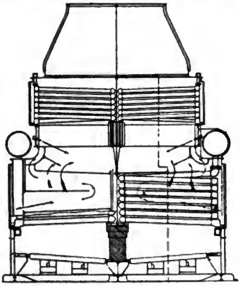
SELECTED PATENTS.

590,829. **Steam Generator.** *Louis Marie Gabriel Delaunay-Belleville, Paris, France. Filed Sept. 24, 1896.*

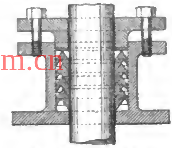
In a steam generator the combination with economizer tubes E, located at the upper part of the generator, of generator tubes D, above the fire chamber, a mixing and combustion chamber F, between the economizer tubes and the generator tubes, vertical hot air pipes G having apertures g for the entrance of outside air, these pipes being near the front portions of the generator tubes, and means for forcing air from the exterior into the mixing and combustion chamber, under pressure, and for heating the air on its way to the combustion chamber.

591,670. **Metallic Packing.** *William H. Law, Brooklyn, N. Y. Filed Apr. 22, 1897.*

A sectional packing, the sections of which are formed of split rings each like or a counterpart of the other sections so as to be interchangeable throughout, each section having a channeled face and a ridge-face, the channels having their edges of unequal length and the channel and ridge of each section having their respective apexes out of alignment with one another, combined with a stuffing-box and a piston-rod or movable part, the packing sections being made to seat their sides against the box and rod while having the ridges partly inserted into the channels.



BELLEVILLE STEAM GENERATOR.



LAW METALLIC PACKING.

BOOK NOTICE.

Books of foreign travel are so numerous and so frequently mere repetitions that the busy business or professional man cannot profitably give time to their perusal. The exceptions are consequently the more valuable, and in this class comes the little work "American and Other Machinery Abroad" by Fred J. Miller, editor of the American Machinist. The sub-title tells the reader that the book is a study of the European field for the introduction of American machinery. It is a clever, clear account of what might be called the machinery conditions in all the foremost countries of Europe, written by an unprejudiced expert. The book is extremely opportune now that manufacturers are wakening up to the possibilities of foreign trade. Allowance will be made by any rational reader for the few discrepancies which appear in it, as the author was apparently on the move during the whole of his stay in Europe. It is specially valuable as representing the American view of the subject, not at long range, but after a careful reconnoissance of the field. Notes on American machinery abroad which appear in technical publications are usually written by foreigners living abroad who, of course, are unconsciously partial to their own country. There is only one serious mistake in the book: an "excuse" for the publication, made by the author. This was entirely unnecessary. Not a single machinery manufacturer in the country could give a valid excuse why he should not read it. The book is issued from the press of the American Machinist, 256 Broadway, New York. Price 50 cents.

The powerful additions to the Italian fleet were launched recently from Italian yards. One was the armored cruiser Garibaldi, and the other the battle ship Emmanuele Filiberto. The Garibaldi is 326 ft. long, 60 ft. beam and 23 ft. mean draught, displacing 6,840 tons. She is protected by armor plate 7 in. thick, 54 in. wide forward, and 47 in. aft. She is fitted with engines of 13,000 horse power, and will have a sea speed of 19 knots. Her offensive battery consists of two 9.75 in., 80 ton guns, six 4.75 in., and ten 5.75 in. The two latter batteries are rapid-fire. There is also an extensive equipment of machine guns and torpedo apparatus. The battleship Emmanuele Filiberto is 342 ft. long, 68.6 ft. beam, and has displacement of 9,800 tons. She is fitted with a protective deck and Harveyized armor, varying from 1 1-2 in. in the gun shields to 7 in. in the turrets. Her gun equipment includes four 9.9 in., two placed in the forward turret and two in the after. Also eight 4.6 in. and eight 2.2 in. with the usual equipment of machine guns.

CATALOGUES.

Users of search lights will be much interested in Catalogue A, that has been issued by The Carlisle & Finch Co., 834 West Sixth street, Cincinnati, Ohio. The catalogue is printed in colors, and comprises eleven pages of matter, devoted exclusively to a fully illustrated description of the several sizes and types of searchlights made by this company.

A leather covered vest pocket memorandum book is being sent to all enquirers by the Boston Belting Co., 268 Devonshire street, Boston. It contains much information regarding hose packing, gasket, and other rubber goods, besides important points regarding steam pressures, a calendar for 1898, etc. There are also fifty or more memorandum pages.

A cloth bound catalogue has just been issued by the United States Metallic Packing Co., 427 North Thirteenth street, Philadelphia, Pa. It is pocket size and comprises in considerable detail, with numerous illustrations, all necessary information regarding the packing manufactured by this company and also regarding pneumatic hammers and drills. These hammers have found very extensive use for calking boilers and flues, cutting off scale, clipping boiler plates, etc.

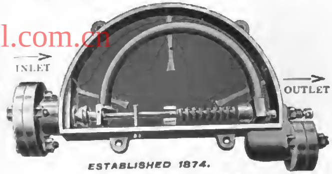
The steam regulating devices and steam pumps manufactured by the Mason Regulator Co., 6 Oliver street, Boston, Mass., are thoroughly illustrated and fully described in a pocket-size price list and catalogue just from the press. The catalogue comprises 40 pages, is supplied with an excellent index and has an illustration on almost every page. A number of diagrams and sectional views are given which add to the value of the text. Copies may be had upon application to the company.

An annex to the twenty-eighth edition of the general catalogue issued by the Keuffel & Esser Co., 127 Fulton street, New York, has been found a necessity, and is just from the press. It is a trade price list of some over 30 pages, and should be on the table in every draughting room for ready reference in connection with the complete catalogue of this company. This pamphlet is made especially complete by a fine index. It is made the same size of the general catalogue for the convenience of filing away with it.

BUSINESS NOTES.

A FIRE ALARM ON SHIP BOARD.—The great danger from fire on board ship has led to the introduction of several systems of giving notice of a fire; one of the latest systems being that of the Marine Union Fire Alarm Co., 925 Chestnut street, Philadelphia. This system is in use on a number of coastwise and other vessels, and was mentioned in connection with the description of the Princess Anne published in the August issue of Marine Engineering. Several serious fires have been prevented lately on vessels using this system.

STEAM MOTORS.—A steam motor of especial value for uses in which compactness is desired is now being put on the market by James T. Halsey, Twenty-sixth and Callowhill streets, Philadelphia. The motor can be placed in any position and is adapted for running launches, electric plants, fans, or almost anything. The motor has no connecting rods, no cross heads, eccentrics, or eccentric rods, and is noiseless, but it is not by any means a rotary engine. These motors have been used for several purposes on board several transatlantic liners as well as on smaller vessels. Every engineer who has interest in such devices should have a copy of Mr. Halsey's circular.



MARINE ENGINEERING.

Vol. 1. NEW YORK, DECEMBER, 1897. No. 9.

STEAMSHIP JUNIATA FOR THE MERCHANTS AND MINERS TRANSPORTATION CO.

The latest addition to the fleet of the Merchants and Miners Transportation Co., the steamship Juniata, is here shown. She was launched recently from the yards of the Harlan & Hollingsworth Co., at Wilmington, Del., and is the fourth vessel built at this yard for the line. The Juniata is a four-deck steamer, 270 ft. long on the water line, 42 ft. moulded beam, and 34 ft. deep. She is fitted with two-pole masts and one funnel, and in design is an unusually handsome boat, not unlike a transatlantic liner. The passenger accommodation is fully in keeping.

MERCHANTS AND MINERS TRANSPORTATION CO'S STEAMSHIP JUNIATA.

On the main deck, the dining saloon is 80 ft. long and 22 ft. wide, with seventeen communicating state rooms. It is fitted with six separate tables, which can be joined together so as to make two long dining tables, and is finished in white and gold. A wide staircase leads up to the social hall, which is covered by a handsome dome fitted with a large ornamental electric light cluster. The social hall is also finished in white and gold, and opening on this are forty state rooms; the open well in the center of the hall lights up the saloon below. Wide berths of modern design are fitted in the state rooms, and the toilet conveniences are of artistically enameled ironware. Accommodations for the second-class passengers are fitted forward on the main deck. Quarters for the crew have been carefully planned for comfort and convenience. The officers are berthed on the upper deck, their quarters communicating with the pilot house, so that they can go to and fro in bad weather without being exposed. Aft of the midship house on this deck the officers' dining room is situated above the galley, which is connected by a dumbwaiter. The room is finished in sycamore and the floor laid in ash. The engineers' rooms are finished in hardwoods and fitted with the usual speaking tubes and accessories. On this deck there is also a smoking room for passengers, finished in sycamore, with cherry and maple wood tile floor. Aft of this room there is a toilet room for men, with marble furnishings and tile floor. From the pilot house on the boat deck a flying bridge extends to the sides. The pilot house is finished in butternut, the ceiling being colored blue, and the floor and grating of polished ash. Power steering wheel and the usual binnacle and telegraph apparatus is fitted, as well as a chart case and flag locker. The captain's room, just aft, contains a folding bed, with a roll top desk, wardrobes, and large book case with French plate mirror panels. A private toilet room connects with the captain's room. A powerful searchlight is in position over the pilot house.

The machinery equipment of the Juniata is quite modern. The engines are of the inverted triple expansion type, with cylinders 28 in., 45 in., and 72 in. dia., and 48 in. stroke. The propeller is 16 ft. dia., 23 ft. pitch, and is made of Manganese bronze. There are four Scotch boilers, 13 ft. 6 in. dia., and 11 ft. 6 in. long, built for a working pressure of 160 lbs. per sq. in. The electric lighting sets are in duplicate furnishing current for lighting the ship with incandescent lamps throughout, and also for the searchlight, and for a system of ventilating fans. On a draft of about 18 ft. of water a sea speed of 15 knots is obtained.

While this issue is in the press the New York meeting of the American Society of Mechanical Engineers will have been opened, at the headquarters, 12 West Thirty-first street, New York, by President Worcester R. Warner. The programme for the technical and social features of the meeting, issued in the form of a little booklet, shows that excellent care has been taken to make the meeting a most enjoyable and profitable reunion. The opening session is set for November 30, when at 9 o'clock in the evening President Warner delivers an address on "The Evolution of the Telescope." Before this hour, however, the rooms are to be opened for the reception of members. Other equally pleasant social occasions are provided, and include invitations to members and guests to luncheon on Wednesday and Thursday, and on Wednesday evening to a reception and conversazione at Sherry's, to which ladies are especially invited. The list of technical papers shows also that Secretary F. R. Hutton has been very successful in adding important papers to the transactions. The papers read at the meeting of special interest to marine engineers are those by Andrew Fletcher, upon "The Stevens Valve Gear for Marine Engines," and George W. Dickie, on "Auxiliary Engines and Transmission of Power on Naval Vessels."

ON THE INFLUENCE OF SURFACE ON THE PERFORMANCE OF SCREW PROPELLERS.[*]

Preliminary Paper.

BY PROF. W. F. DURAND, MEMBER OF COUNCIL.

The performance of a screw propeller involves fundamentally the following features: The work absorbed, the thrust developed, and the useful work returned, together with the ratio of the last to the first as expressing the efficiency of the transformation of which the propeller is the immediate agent. This performance, in turn, depends on the following chief items: (1) The dimensions of the propeller. (2) The conditions of its use. The former includes diameter, pitch, and area or surface. The latter includes revolutions and speed of advance, and slip as resulting from them.

Pitch may be uniform or variable, and if the latter, the variation may be axial or radial, or both, in any degree or with any distribution, no matter how complex.

Area includes two specifications: (1) Amount and (2) Distribution, or shape and number of blades.

The performance depends also on a variety of minor variables, such as: Thickness of blade and its distribution, or the form of the cross-sections of the blade; the material of the blade; the general shape of the blades as resulting from variations in the mode of generation, such as blades bent or curved back from the plane of rotation, blades bent or curved in the plane of rotation, etc. The effects of these variables we shall at present disregard.

The performance of a propeller is also fundamentally dependent on the ship in connection with which it works, or, to state the relation more exactly, the characteristics of the ship will, to a greater or less extent, affect the conditions under which the propeller works, and thus affect the performance through them.

The investigation of propeller performance thus naturally divides itself into two fundamental parts: (1) The performance of the propeller in still or undisturbed water. (2) The modifications due to the interactions between the ship and the propeller in the actual case. In the present paper we are concerned wholly with the first subdivision, the performance of propellers in still or undisturbed water.

The most extended and undoubtedly the most reliable experiments on propellers of which we have the data were those made by R. E. Froude, and reported on in 1886.[1] In these experiments, diameter, speed of advance, and area, both in amount and distribution or shape, were kept constant; the former at .68 ft. and the latter at a disk

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[*] Paper read before the Society of Naval Architects, Marine Engineers, New York, November, 1897.

[1] Transactions Institution of Naval Architects, London, Vol. XXVII, p. 250.

area ratio of about .36, with propellers having four elliptical blades with maximum width .4 the radius. The investigation then covered the ground involved in the variation of the other features as noted above, viz., pitch or pitch ratio, and slip or revolutions. The investigation of the influence due to gradual variation in the area was not one of the fundamental purposes of these experiments, and the information relating to this point was restricted to the results arising from a reduction in the number of blades from 4 to 3 or 2, their shape and size remaining the same throughout.

In the experiments to be hereafter described, an additional variable element—that of the amount of area—is to be introduced. In these experiments, therefore, diameter, speed of advance, and shape of blade as well as number of blades are kept constant; while amount of blade area, pitch or pitch ratio and revolutions or slip are subject to variation. The essential feature of the present investigation is therefore the relation of the amount of area to the performance as a whole. There seems to be reason for believing that the influence due to change of area includes that due to change in number of blades, or, in other words, that with given area and usual proportions the performance is but slightly dependent on the number of blades. This may require further examination at a later point, but in the meantime no serious error will be made by accepting the above proposition as substantially correct.

We shall not here enter into any detailed discussion of the utility or propriety of model experiments. In the last twenty years experiments of this character have steadily advanced in scientific standing, and have won for themselves a secure place in the development of our present knowledge of ship resistance and propulsion. It will be sufficient to note that in the case of propellers of constant area ratio, shape and number of blades, slip and pitch ratio, the assumption is made that the work involved in the performance may be considered as varying directly with the square of the dimensions and with the cube of the speed. This relation may be expressed in a variety of forms, one of the most useful of which is as follows:

$$U = d^2\,(pn)^3\,(aihk),$$

where U = useful work;
d = diameter;
p = pitch;
n = revolutions;
$(aihk)$ = conjointly a coefficient or factor in which—
a = area factor;
i = shape factor;
h = pitch ratio factor;
k = slip factor combined with the necessary factor to provide for the units of measurement used.

These factors are, of course, interdependent, and the chief purpose of writing the equation in this way is to emphasize the leading features upon which the performance as a whole must depend. The experiments of Mr. Froude furnished data from which values of the factors h and k may be derived for one given value of the area, and one given shape as employed. The present experiments are intended to furnish data from which values of the factors a, h and k may be derived for the constant elliptical shape of blade employed.

The problem immediately before us is, therefore, the experimental determination of the data necessary to this end. As already seen, there are three modes of variation—pitch ratio, area ratio, and slip. Of these, the first two belong to the propeller, and the third to the conditions of use. To cover the ground satisfactorily, there will presumably be required from four to six or more determinations for each mode of variation. Thus six or seven pitch ratios, each with five or six area ratios, making about forty propellers, each tried at five or six values of the slip.

Of this work, only that relating to one pitch ratio has as yet been accomplished, and the present paper is written for the purpose of placing before the members of the society a brief description of the experiments as projected and thus far carried out, with a preliminary statement of the results obtained. The completion of the entire series will necessarily require some time, and it is thought that even should the results in their complete form give rise to some modification of the values thus far derived, yet the general trend of these values will not be far from correct, and their interesting and suggestive character may be a sufficient excuse for their presentation without further delay.

Apparatus and Matériel.

The experiments here reported were made on propellers of the following dimensions:

Reference No.	Diameter.	Pitch.	Area ratio.	Max. width of blade ÷ radius.	No. of blades.
2	1'	1'.3	.18	.2	4
3	"	"	.27	.3	"
4	"	"	.36	.4	"
5	"	"	.45	.5	"
6	"	"	.54	.6	"
7	"	"	.63	.7	"
8	"	"	.72	.8	"

The number of the propeller and its pitch ratio serve to identify it, the number corresponding to maximum width ratio and to area ratio, as seen by comparing the first, fourth and fifth columns.

The elements directly to be measured in any given experiment on one of the propellers are as follows: (1) The power absorbed. (2) The thrust developed. (3) The revolutions. (4) The speed of advance in undisturbed water.

The facilities of an experimental tank not being available, it was decided to mount the necessary apparatus on the bow of a small steamboat, the propeller to be tested projecting forward into undisturbed water, and the boat serving as a carriage whereby any desired speed of advance may be obtained.

Arrangement of Propeller Shaft and Fittings.

The arrangement of the propeller and shaft is shown in Figs. 1 and 4. AB is a pipe surrounding the shaft proper, and provided at its forward end with a ball-bearing, shown in detail in Fig. 4. This pipe, at the rear end, passes through the stem of the auxiliary box or false bow, as shown, and is connected with a watertight joint to the forward end of the thrust dynamometer *C*. The water has free entrance to the pipe through the forward ball-bearing, and as far aft as the forward end of the dynamometer *C*. The shaft proper is coupled to the brass plunger-rod of the dynamometer, as shown in Fig. 4, and the fit between this rod and the dynamometer end is so perfect that no water can leak through. Under the conditions of use, in fact, the pressure is greater in the dynamometer than without, and the only leakage would necessarily be from within outward. The pipe is supported at the forward end by iron bands depending from the framework attached to the bow of the boat. These rods are very thin in transverse dimension, and are drawn down to sharp edges fore and aft so as to give rise to the minimum disturbance in passing through the water.

FIG. 4.

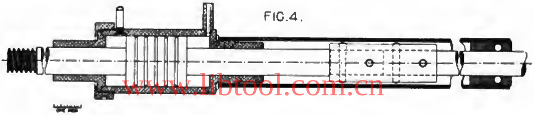


FIG. 1.

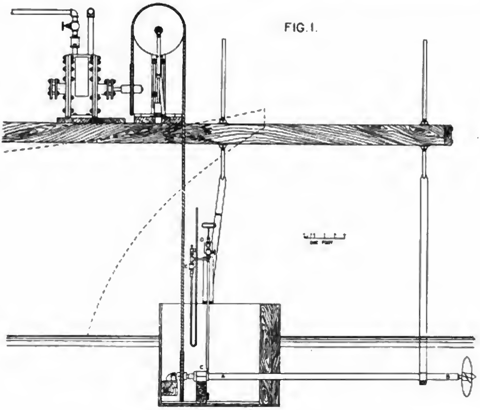
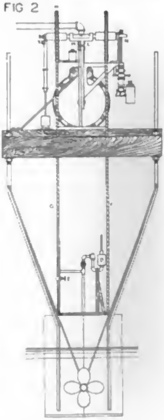


FIG 2

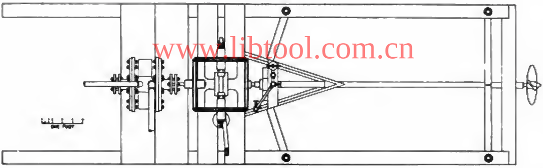


Thrust Dynamometer.

This dynamometer consists of a plunger and oil cylinder, as shown in Fig. 4. They are accurately fitted by grinding and lapping, with a difference of somewhat less than .001" in diameter. This difference is sufficient to insure perfect freedom of movement, and the presence of a definite layer of oil between the plunger and the walls of the cylinder. The plunger and rod are in one piece, and the forward end of the latter is coupled to the shaft as noted above. The after end projects to the rear and carries the driving sheave, and is also fitted with a screw for attaching a counting device. This rod passes through a solid bearing at each end of the cylinder, and is fitted by grinding and lapping, as with the plunger. In the forward end of the cylinder is a pipe leading to the mercury gauge for measuring the pressure. In the after end is an opening giving free escape for such oil as may leak past the plunger. As indicated above, a small leakage was desired in order to insure complete lubrication of all moving parts, and in use the cylinder thus becomes filled with oil on both sides of the plunger, the slight amount lost being made up by a pump connected with a pressure gauge.

The propellers are run at a number of revolutions somewhat greater than would correspond to the speed of the boat, thus giving a sternward acceleration to the water acted on, and a forward reaction. This gives rise to a pull on the shaft, and the oil on the forward side of the plunger then furnishes a ready means for the transmission of the pressure to the mercury column, where it is measured. The fundamentally important point of the dynamometer is, that when the plunger is revolving, all longitudinal friction is eliminated, and the delicacy for the measure of the forces involved becomes very great. The cylinder is bedded in a cast-iron seat attached to the bottom of the box, and the latter is securely stayed longitudinally to the boat, thus securing the necessary longitudinal rigidity.

FIG. 3.



The measurement of the pressure is by means of an open mercury manometer, as shown in Fig. 1. The hand-pump *D* for making up the loss due to leakage has been already referred to. No trouble whatever was experienced in running the course of 1,000 ft., or longer if desired, without replenishing the oil. The stop valve *E* is for the purpose of damping any tendency in the column toward vibration due to periodic fluctuations in the pressure measured. If the valve is wide open, the column shows with great delicacy the fluctuating values of the pressure; but, for purposes of registration, a more accurate mean value may be determined by choking down the fluctuations to a small range. Actually this may be accomplished with great nicety, and in no case, under usual conditions, was the momentary fluctuation more than a small fraction of the total quantity measured. The performance of the thrust dynamometer and pressure manometer was exceedingly satisfactory, and, I believe, leaves little to be desired as to delicacy, accuracy, steadiness, readiness of calibration, and general reliability. The manometer as used in these experiments was not self-registering, but was read by an observer at intervals of a few seconds throughout the run. This gave a very satisfactory value for the mean, but required, of course, the services of an extra observer.

FIG. 5.

FIG. 6.

Transmission Dynamometer.

For the transmission dynamometer the arrangement shown in Figs. 1, 2, and 5 was used, constituting a special form of rope dynamometer. The ropes *F* and *G* lead from the driving sheave on the after end of the propeller shaft, the former being the tight and the latter the loose side.

These pass over sheaves *H* and *I* and then around the sheave on the motor shaft. These sheaves are all of the same diameter, in the present case 15 in. The sheaves *H* and *I* are mounted with ball-bearings on a shaft *K*, which is carried by a block *L M*, the latter being connected to the base by a pair of thin steel plates or springs. This is the well-known Emery support or substitute for a knife edge, and for slight movements is almost perfectly frictionless, at the same time affording rigidity in the directions desired.

The sheaves *H* and *I* and their shaft thus form a balanced rocking system or lever pivoted in the middle, and therefore without deflection, so long as the tension on the two sides of the rope is the same. When running, however, the difference between the tensions on the tight and loose sides will determine a moment which will tend to throw this arm down. This motion is prevented by a strut connected with the arm *N* by a spherical joint, and resting on the bottom of an inverted steam-engine indicator piston. The compression of the indicator spring is then used to measure the moment, and thence, knowing the revolutions, the power transmitted is immediately known. The indicator drum was given continuous and uniform motion in one direction only, by connecting it through a cord with the main drum of the Weaver recorder. The chief points of this dynamometer are the ball-bearings and Emery support, and their influence in reducing friction to a minimum is of great value in reducing the perturbing influences which may affect the operation of the instrument. In order to provide the same relative delicacy of reading for both thrust and work absorbed, a new form of oil-cylinder, mercury-column measuring device for the transmission dynamometer has been designed and built, and will presumably be used in the remainder of the experiments.

Motor.

For driving the propellers a small rotary engine was used as indicated in the figures. This gave a nearly uniform turning moment and proved itself very satisfactory for the purpose in view.

Records of Revolutions, Time, and Distance.

All records relating to revolutions, time, and speed were recorded on a Weaver time and speed recorder, which, it will be remembered, consists essentially of a modified Morse register with a number of pens under electrical control.

The Course.

For the course a distance of 1,000 feet was measured off on a railroad tangent running close to the east shore of Cayuga Lake, where the beach is bluff and deep water extends close to the shore. This distance was divided into ten parts of 100 feet each, and by a surveyor's transit, lines at right angles to the course were determined and marked by ranges, the front row near the water's edge, and the back row some distance in the rear. The conformation of the shore was such that, by going a little to the north of the course, it became possible to lay off by range marks on the distant hills a parallel course through deep water about 200 feet from the shore. The course to be followed became thus definitely determined in direction, location, and extent. A similar course was also laid off on a straight reach of the "Inlet," a channel about 100 feet wide leading from the lake to the city. Most of the work was done on the outer course, the "Inlet" course being used only when the water on the lake was too rough for regular work outside. The observations relating to the ranges were made by an observer holding a circuit-breaker in his hand, which was closed opposite each range, thus furnishing ten series of distances of 100 feet each. This subdivision of the entire course was found advantageous for many reasons. If, due to disturbing influences, the conditions of speed or revolutions were not quite regular during any part of the run, or if, due to other causes, the data from a part of the run might be questioned, such part could be eliminated, and there would still remain a distance of several hundred feet over which the conditions were constant within the requirements of the work. In general, however, the conditions

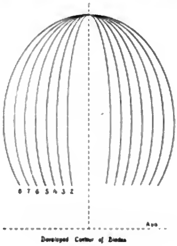


FIG. 8.

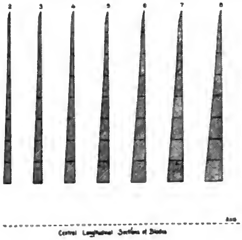


FIG. 9.

were substantially constant throughout, and the data taken related, with few exceptions, to the entire distance of 1,000 feet.

The Clock.

A clock with second's break specially arranged for this work furnished a signal each second, thus giving, in conjunction with the range signals, the speed per minute or per second.

The Revolutions.

By a reducing gear, every tenth revolution of the propeller was recorded on the tape, the marks being at such distances that, by interpolation, the revolutions to a single unit could readily be determined. This furnished the data for the determination of the revolutions per minute or per 100 ft. or per 1,000 ft., and thence, knowing the pitch, for the determination of the slip. The revolutions of the motor direct were indicated by a tachometer, which was merely used as an indication, and not as a measure. By the aid of this indication, the person in charge was able to control the speed of the motor sensibly constant at any desired point.

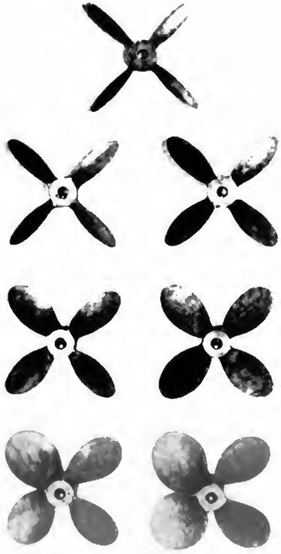


FIG. 7.

Speed of Boat.

The speed of the boat through the water was controlled by the revolutions of the main engine, and also by a weighted rod or pendulum hung over the side and pivoted so that the motion of the boat would cause it to tend aft. A pointer extending from the axis upward swept over an arc, and thus furnished a sensitive indication of variation in the speed through the water. This was, of course, an indication and not a measure, but was quite sufficient to enable the engineer to note instantly the condition of the boat relative to the desired speed. The actual speed itself was taken as the mean of four runs north and south over the course, measured as described above.

The Propellers.

These are shown in Figs. 7, 8, and 9. They are of brass, four-bladed as shown, and the blades are of elliptical contour when developed, with maximum widths as shown by the table above. For making the propellers a wooden pattern was first prepared for No. 8. This propeller being cast, the pattern was reduced in blade width and thickness, and No. 7 was next cast, and so on down to No. 2, but one original pattern being thus required for the entire series. For the measurement of the pitch thus resulting, the device shown in Fig. 10 was used. The propeller in hand was bored, fitted on a mandrel, and swung in a lathe face outward. Fitted on the same mandrel was a drum of diameter, say, .7 that of the propeller. On this drum was secured a strip of paper. A square steel bar was then fitted in the tool post with one edge parallel to the lathe axis. At the end next the propeller the bar was drawn down to a point lying in the upper and inner edge of the bar. Farther back, and opposite the drum, a nick was made in the same edge. Now, it is obvious that if the bar be run in till the edge above referred to is just clear of the drum surface, and if the carriage be so moved longitudinally that the point of the bar rests constantly on

FIG. 10.

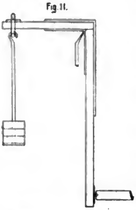


Fig. 11.

the surface, then all points on the bar will trace, relative to the drum, like helices, and hence like that traced by the end of the bar on the driving face of the propeller. A pencil held in the nick of the bar will therefore describe on the paper a copy of the helix on the propeller, and will therefore serve to determine the pitch across the blade at this radius. Four such drums were used at radii .3, .5, .7, and .9 the outer radius, the hub radius being .2 the outer radius. In this way a sufficiently complete knowledge of the history of the variation of pitch over the driving face could be determined. Conversely the same apparatus was used to guide the dressing of the propeller down to the desired degree of constancy as to pitch. To this end a line was laid off on the paper making an angle a with the transverse determined by the equation:—

$$\tan a = \frac{p}{2\pi r},$$

where p is the pitch desired and r the given radius. By comparing the path of the nick as given by the actual surface with that which should be given, the points which are too high may be easily determined. At such points a little hollow was chipped out of a depth sufficient to bring the nick onto the line. A series of such spots being chipped out across the blade, it is evident that the bottoms of such points are on the surface desired. This being repeated on the other radii, similar series of points were determined. The whole surface was then reduced by grinding and filing until the bottoms of the holes were barely removed. The driving face was then taken as a sufficiently close approximation to the form desired. As described later, however, a further measurement at the completion of the experiment gave the data for an additional correction. The blade was then trimmed to the desired contour, the original casting having been made purposely a little larger in all dimensions. Next the back was reduced until the lay-out of the thickness was that called for by the drawings, and the propeller was ready for use.

Mode of Conducting an Experiment.

For the determination of a single point or item of the final data, two single runs were made, one north and one south. The current was very slight; indeed, many times not appreciable, and at other times, due to a surface set of the water caused by winds, it amounted to a few per cent of the speed of the boat. In any event, it was assumed that the mode of operation followed was the best under the circumstances, and such as to eliminate all sensible disturbance due to current or set in the water.

The boat being brought on the course some distance from the first range mark, the motor was started, and the revolutions were brought by tachometer to the desired point. The speed of the boat at the same time was brought to the constant value, and as the boat neared the range marks the counting and recording mechanism was thrown into operation. The indications of the mercury column on the thrust dynamometer were read and recorded at intervals of a few seconds while on the course. The fluctuations were in all cases slow and gentle, and usually from ten to fifteen readings were sufficient to give a closely accurate average of the indications. In the meantime the range observer closed his circuit on passing each range, and the other records were automatically recorded.

The data thus taken consisted of the following: (1) An indicator card from the power dynamometer. (2) A column of readings from the thrust dynamometer. (3) A strip of paper with dots giving time revolution and range marks.

Calibration.

For the purpose of standardization, the apparatus was erected in the laboratory and operated as nearly as possible under the conditions of use. The power dynamometer was standardized by means of a Prony brake applied on a wheel located on the end of the shaft, instead of the propeller. The thrust dynamometer was standardized by applying known thrusts by means of a right angle triangle having a knife-edge bearing, as shown in Fig. 11. The calibrations were made at various speeds, and a large amount of data was taken as the basis of these important determinations. The calibration of the power dynamometer was also determined by measurements and the known theory of its action. The difference would indicate the loss due to friction in the transmission apparatus. As might be expected, this was exceedingly small, and the values given by both methods of calibration seemed mutually consistent. In a similar manner the calibration of the thrust dynamometer was determined from the known area of piston, effective height of column, and specific gravity of mercury. This likewise agreed very closely with the experimental calibration, and indicated only a negligible amount of friction in the apparatus.

Reduction of Observations.

The data obtained as previously described was reduced as follows: The mean ordinate of the indicator card was determined, and from the calibration data the corresponding power was immediately known. Similarly the mean altitude of the mercury column was determined, and by the calibration data the corresponding thrusts were found. The revolutions per minute and per 100 feet for the entire course, as well as the speed per minute, were then determined by counting from the strip of tape. The two sets of results north and south corresponding to a given determination were then averaged and the results thus found were accepted as a series of values of speed revolutions, thrust and power, mutually corresponding the one to the others. This constituted the original reduced data. Naturally in such case the average speeds of the boat would not be exactly the same for all determinations, especially on different days and for different propellers; neither would the sets of revolutions be exactly the same under the dissimilar conditions mentioned. It became necessary, therefore, in order to put the data into form for plotting or investigation, to reduce it to constancy for some one feature. The data was first reduced to constancy of speed, the slip in each case being unchanged. A speed of 100 ft. per minute was chosen for convenience, the actual speeds having been about 270 ft. per minute. The reduction was made by assuming that, slip being constant in any case, all forces relating to the propellers vary at the square of the speed.

A correction was also introduced at this point to allow for such slight departures from the standard pitch ratio of 1.3 as existed in the propellers as actually used. To this end the propellers were again, at the conclusion of the experiments, measured for pitch in detail, as previously explained, and for each one a resultant mean pitch was derived in the following manner: The pitch on each blade at each of the four radial distances corresponding to the drums used in the measurement, and approximately at .3, .5, .7, and .9 the outer radius, was given a weight represented by the product of the width of blade at that point by the square of the corresponding radius. The mean of these was then found by the usual method for a weighted mean. In other words, a weighted mean was used in which the weight was proportional to the moment of inertia of the element of the propeller at the given radial distances, and therefore, as nearly as may be, to the thrust developed at each point, or by each element. The results thus found naturally varied sligthly from the desired value of 1'.3 or 15".6. All forces in the determined value were therefore so corrected as to reduce them to corresponding values for a pitch of 15".6, and therefore for a pitch ratio of 1.3 exactly. These corrections were made by taking the results of R. E. Froude for the relation for given diameter between thrust and pitch at given slip. This relation[2] is expressed approximately by the proposition that for constant slip the thrust varies as the reciprocal of the pitch ratio less the constant .17. Or, if c denote the pitch ratio, then:

$$T \text{ varies as } \left(\frac{1}{c} - .17\right).$$

Using this relation, all thrusts were reduced to the desired pitch ratio, it being assumed that for the very small change in pitch the rule might be extended to all values of the area. It was further assumed that the changes were too slight to sensibly affect the efficiency, and the values of the work absorbed were therefore corrected on the assumption of constant efficiency for the slight change of pitch involved.. In all cases the changes thus made were small and perhaps negligible, but inasmuch as there existed a reasonable method for determining the corrections, it seemed well to make them, even if in most cases they were hardly appreciable in amount. The results of these reductions are shown by the spots plotted in Figs. 12-16.

The data was next reduced to constancy of revolution, the slip in each case remaining the same. Revolutions of 100 per minute were also chosen for convenience, the actual number having been from 200 to 450. This reduction was also made by assuming that for constant slip all forces related to the propellers vary as the square of the revolutions. The results of these reductions are shown in Figs. 19 and 20.

In Figs. 12-16 the curves drawn through and among the spots are not, in all cases, those which would approximate most closely to them, but are such as seemed best to agree with the entire set of observations using the indications furnished by the cross curves in Figs. 21 and 22, and also, as noted below, taking provisionally the lines of Figs. 19 and 20 as rectilinear. The approximation to the actual spots is, however, in general quite satisfactory, and the curves thus drawn are then taken as the data from which the remaining diagrams are reduced.

For the reduction to constant revolutions, the results for each case gave very nearly a straight line. In consequence it was assumed, as referred to above, that such a line might be taken as representing the observations quite as well as any other curve drawn through or among the points. This was done, therefore, for convenience, and without assuming that the loci shown in Figs. 19 and 20 are naturally or necessarily rectilinear in character.

In Fig. 21 are shown curves giving the relation between thrust and area at constant slip, and in Fig. 22, similarly, curves showing the relation between work absorbed and area at constant slip.

The thrust multiplied by the speed gives the useful work, and this divided by the work required will give the efficiency. This will obviously be the same, whether derived from the data before or after reduction to constancy of speed or revolutions. In Fig. 23 are shown the curves of efficiency, collected together and plotted on slip. In Fig. 24 are shown cross curves from Fig. 23 giving the relation between efficiency and area at constant slip. All curves following Figs. 12-16 are derived from the lines of these diagrams, and not from the spots, and hence represent the data in this reduced condition.

The detailed work of the reduction of the observations was performed independently by two assistants, Messrs. Preston and Norton, of Cor-

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[2] Transactions Institution of Naval Architects, London, Vol. XXVII, p. 250.

nell University, and, in part, by the writer, and is believed to be numerically correct.

Discussion of Results.

In Figs. 12-20 it will be observed that the limits of slip have been pushed beyond those actually employed, especially on the lower side. In all cases the slip for zero thrust was specially determined by a set of runs in which, at constant speed, the revolutions were so controlled as to give no thrust. In all cases, except for number two, the slip at which this occurs is seen to be negative, and the thrust at zero slip is positive. This result is well known in a general way, but the present experiments, so far as the author is aware, are the first published in which the point has been made the subject of quantitative determination. The explanation of the apparent anomaly is found in the influence due to the

Fig 12.

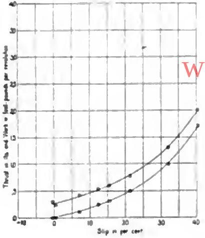


Fig 13.

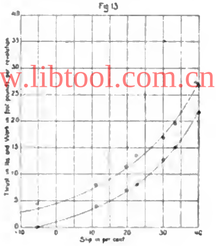


Fig 14.

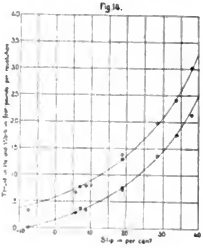


Fig 15.

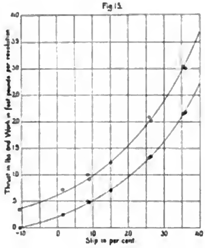


Fig 16.

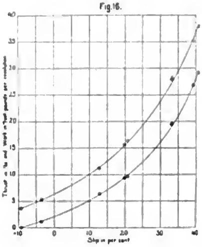


Fig 17.

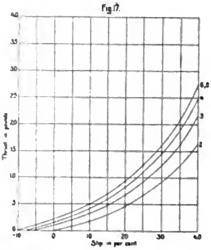


Fig 18.

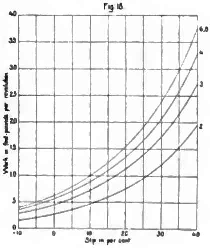


Fig 23.

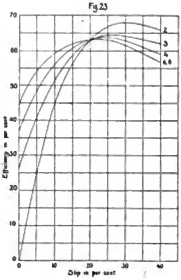
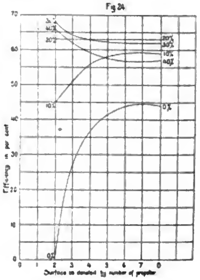


Fig 24.



thickness of the blade. Independent experiments show, for a body of cross-section like a propeller blade near the root, that due to the stream-line distribution about such a body, the resultant force, when the direction of relative motion is parallel to the plane face, is directed from the plane face inward, or at least in such a direction as to give a forward component in the case of a propeller thus moving. It is not, therefore, until a negative slip is reached with a more pronounced pressure on the back that this forward component is overcome and a zero thrust obtained. It is also notable that this effect seems to be the less pronounced the narrower the blade, so that for number two a zero thrust was found at nearly zero slip. It thus results that in Figs. 17 and 19 the lines showing the relations between thrust and slip for successive values of the area lie, successively, completely underneath each other as the area decreases, and do not radiate from any point, at least within the region covered by the limits of the physical problem.

Fig 19

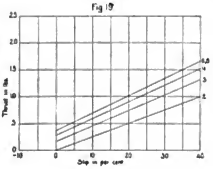


Fig 20.

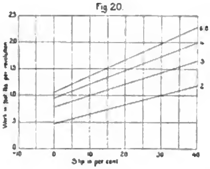


Fig 22

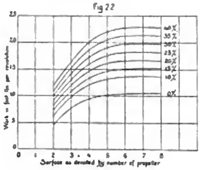
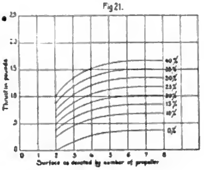


Fig 21.



In Fig. 21 is shown the information especially sought in this series of experiments, the relation of thrust to area. We know that for a given slip there is some maximum thrust beyond which we cannot pass, no matter how much the area. This follows from the fact that, for any given element of the propeller at a given slip, there is a certain maximum acceleration of the water which cannot be exceeded, no matter how much area be employed. By making certain assumptions a value may be assigned to this, and hence a value to the maximum thrust obtainable from any given element of the propeller[3]. By a process of approximate integration this may be summed for the entire propeller, and thus a value of the maximum thrust determined corresponding to the formation of a so-called complete column of water, or, more properly, to the formation of a column completely accelerated in all parts. The influence of the back or thickness, however, is such that these results are by no means entirely reliable. Whatever the value of the maximum, however, it is evident that such a limit will exist, and that after the area necessary to its attainment is reached any further increase will give rise to no additional thrust, and quite possibly to a gradual decline. Passing to the other extreme, it is evident that for no area there will be no thrust. Furthermore, all experimental data on resistance lead us to expect that for very small areas the increase in thrust will be nearly proportional to the increase in area. It follows that starting with zero area the thrust will at first vary nearly with the area, but will gradually increase at a slower and slower rate with further increase, until finally a maximum is reached, after which for increase of area the thrust will either remain sensibly constant or else slowly decline. The curves of Fig. 21 are seen to be of this character. The maximum thrust for all slips is seen to be for a propeller having the area of number seven, or an area ratio of about .63. The change between numbers six and eight, however, is very slight, and, so far as these experiments indicate, the variation is practically inappreciable.

The general or average ratios between the thrusts of two, three, and four bladed propellers given as the result of Froude's experiments are .65, .865, and 1.00 for areas in the ratios .50, .75, and 1.00. The corresponding ratios here found for the particular pitch ratio 1.3 with four blades and area ratios .18, .27, and .36, or with areas the same as those for two, three, and four bladed propellers, as derived from the data shown

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[3] Cotterill, Transactions Institution of Naval Architects, London, Vol. XX, p. 152.

in Fig. 21, are found to vary somewhat with the slip, as shown by the following table:

Slip.	Ratios of Thrusts for Area Ratios.		
	.18	.27	.36
.10	.43	.78	1.00
.15	.51	.80	1.00
.20	.56	.82	1.00
.25	.60	.83	1.00
.30	.63	.85	1.00
.35	.65	.86	1.00
.40	.66	.87	1.00

The data for the relation between work required and area, for various values of the slip, are shown in Fig. 22, and will require no special explanation.

We come next to the efficiency curves of Fig. 23. These are of great interest and highly suggestive. Taking true slips within the usual working range of .20 to .30, corresponding to apparent slips of, let us say, .10 to .20, the efficiency, as we see, increases with the decrease of area, and *vice versa*. For low values of the true slip, however, the reverse is the case, and efficiency increases with increase of area. For a slip of about .20 with this pitch ratio, efficiency seems to be nearly independent of area. Or, viewed from another standpoint, a propeller of small area is comparatively inefficient at low slips, and does not reach its maximum efficiency until a high value of the slip is reached. This maximum value is, however, higher than that reached by propellers of more area. *Vice versa*, a propeller of large area reaches its maximum efficiency at a lower value of the slip than for less area, and such maximum is less than that for the propeller of the smaller area. Again, the variation of maximum efficiency for variation of area ratio from .18 to .72 is only about 5 per cent, so that variation of area ratio within this range has comparatively slight influence on the efficiency.

The maximum efficiencies herein determined are slightly less than the value 69 per cent given by Froude for four blades and area ratio .36. The cause of this difference I am at present unable to explain.

In Fig. 24 the same data relating efficiency to area is differently presented. It results from Fig. 23 that if there be no limit on diameter or revolutions, the conditions likely to give the best efficiency are those of low area ratio and high slip, sufficient size and revolutions being provided, of course, to give the necessary thrust. With electric motors or steam turbines, where the revolutions are naturally high, such a propeller may the more readily be selected, and probably, in such cases, propellers of this character and worked at high values of the slip will be found most efficient so long as the conditions are avoided within which cavitation may be likely to occur.

No attempt will be here made to reduce the data found in the present series of experiments to the most convenient form for purposes of design. The incomplete character of the data relative to the problem as a whole makes such a step inadvisable in advance of the completion of the other series of experiments. Remembering, however, the relation assumed between revolutions, diameter of propeller, and useful work, the data shown in the various curves might be used for the design of propellers of the particular pitch ratio 1.3, but naturally of no other.

In conclusion, it may be well to again point out that the data herein contained relates to pitch ratio 1.3, and the conclusions of the present section must be understood strictly as applying to this value of the pitch ratio only.

Construction and Trial of Knapp Roller Boat.

MONOCYCLE.

N Lake Ontario a "roller boat," the invention of a Canadian named Knapp, had a trial trip recently. In this boat the principle of the monocycle is applied to a vessel floating in water, and by this the inventor, according to report, expected to revolutionize the modern method of water transportation. The boat was built in Polson's shipyard at Toronto, local capitalists furnishing the money. The accompanying photographic reproductions show the boat in course of construction in the yard, also when completed, and as she appeared afloat while being towed to the trial course. The view of the boat building shows the method of construction of the "hull," which consists of two concentric cylinders, the outer of which is 110 ft. long and 22 ft. dia. The inner cylinder is 15 ft. dia., and slightly longer than the outer, each end being in shape the frustum of a cone. At each end of this inner cylinder there are several steel rails, or tracks, extending around the inner circumference, and securely fastened to the inner shell. Upon each set of tracks there is a platform with flanged wheels carrying a boiler and engine, the latter connected to the supporting flanged wheels by gears. The smoke pipes of the boilers are carried out and up at the ends of the cylinder. On the outside of the outer cylinder there are sixteen paddles, or fins, 15 ft. long and 8 in. deep, which are riveted to the shell. These form an angle with the radius of the cylinders, so that when the boat moves forward they enter the water at an angle, after the manner of a feathering float. When the "ship" is afloat and the engines are put in motion the immediate tendency is for the platforms to climb up the inside of the inner shell on the tracks already referred to. The outer cylinder, however, being afloat, and free to move in the water, commences to revolve and continues to do so as long as no serious obstruction is offered, and thus the boat "rolls" over the surface of the water. This is assuming that the vessel is moving in still water. How it would behave in a cross sea, or how long it would take for a wave to break over the smoke pipes and drown out the fires, has not been demonstrated so far as we can learn. In the Knapp boat there is an observation gallery at each end which is hung from the inner platform.

Steering is effected by the use of large tail boards situated one on each side below the platforms. On the trial trip a speed of six miles an hour is said to have been made when the cylinder was turning six revolutions a minute. According to statements put in circulation during the time the boat was building, a speed of as high as 88 ft. per second was counted upon. Passenger accommodation in this form of boat is intended to be provided for in interior cabins built upon the central platform. The space between the inner and outer shells is made water-tight to give the necessary buoyancy.

KNAPP ROLLER BOAT DURING CONSTRUCTION AND AFLOAT.

Recent mishaps to steamships in which the electric lights have been extinguished by water flooding the dynamo rooms have moved the British Board of Trade to recommend that the lighting plants be installed at such a height in the vessel as to prevent such a contingency. Here plants are usually placed in the engine room.

ON THE PROGRESS OF THE STEAM TURBINE FOR MARINE PROPULSION.*

BY HON. CHARLES PARSONS.

The want of a fast running engine for driving dynamos presented an immediate field for the application and development of a suitable steam turbine engine. The advantages of a steady running engine having no reciprocating parts, of small size and extreme lightness, were sufficiently obvious, provided that fairly economical results as to steam consumption could be realized. The highly economical results obtained from water turbines gave hopes that, provided suitable conditions could be arranged, similar efficiencies would be obtained with steam as with water, and, assuming this to be possible, it would naturally follow, after taking all other losses into account, that the steam turbine would be more economical in steam than the piston engine. These possibilities, and the interest of applying a practically new method for motive power purposes, led us to build an experimental engine of 10 horse power, coupled directly to a dynamo. For practical reasons it was, however, necessary to keep the speed of rotation of the turbine as low as possible, and also to construct the dynamo to run as fast as possible, so as to couple the turbine directly to it; and in order to obtain the necessary conditions for steam economy, the turbine was

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* From a paper read before the Institute of Marine Engineers, London, 1897.

made what is called compound, or, in other words, a series of successive turbine wheels were set one after the other on the same spindle, so that the steam passing through them one after the other, the fall in pressure being spread over the series of turbines, should be gradual, and the velocity of the steam nowhere more than was desirable for obtaining a high efficiency for each turbine of the series.

The Turbine Motor.

The turbine motor consists of a cylindrical case with rings of inwardly projecting guide blades, within which revolves a concentric shaft with rings of outwardly projecting blades. The rings of blades on the cylinder nearly touch the shaft, and the rings of blades on the shaft lie between those on the case, and nearly touch the case. There is left between the shaft and the case an annular space, which is fitted with alternate rings of fixed and moving blades. Steam passes first through a ring of fixed guide blades, by which it is projected in a rotational direction upon the succeeding ring of moving blades, imparting to them a rotational force; it is then thrown back upon the succeeding ring of guide blades, and the reaction increases the rotational force. The same process takes place at each of the successive rings of guide and moving blades. The energy to give the steam its high rotational velocity at each successive ring is supplied by the drop in pressure, and the steam expands gradually by small increments. In a moderate size turbo-motor there may be from 30 to 80 successive rings, and when the steam arrives at the last ring the expansion has been completed. On the left side of the steam inlet are the dummy or rotating pistons, which are fixed to and rotate with the shaft. On their outsides are grooves and rings which project into corresponding grooves in the case. By means of the thrust bearing of the motor, the longitudinal position of the shaft is adjusted, and grooves and projecting rings kept nearly touching, so as to make a practically tight joint. The object of these pistons is to steam balance the shaft and relieve end pressure on the thrust bearing. With compound condensing turbines a steam efficiency comparable with the best compound or triple expansion condensing engines was at length reached, and it was then resolved to test the application of the compound turbine to the propulsion of ships, for which purpose it seemed well suited, provided that as good an efficiency could be obtained from fast running screw propellers as with ordinary ones.

Torpedo Boat Turbinia.[1]

In January, 1894, a syndicate was formed, and a boat was designed for this purpose. The Turbinia—as the boat is named—is 100 ft. in length, 9 ft. beam, and 44 1-2 tons displacement. The original turbine engine fitted in her was designed to develop upwards of 1,500 actual horse power, at a speed of 2,500 revolutions per minute. The boiler is of the water-tube type, for 225 lb. per sq. in. working pressure, with large steam space and large return water legs, and with a total heating surface of 1,100 sq. ft. and a grate surface of 42 sq. ft. Two firing doors are provided, one at each end. The stokeholds are closed, and the draught furnished by a fan coupled directly to the engine shaft. The condenser is of large size, having 4,200 sq. ft. of cooling surface. The circulating water is fed by scoops, which are hinged and reversible, so that a complete reversal of the flow of water can be obtained should the tubes become choked. The auxiliary machinery consists of main air pump and spare air pump, auxiliary circulating pump, main and spare feed pumps, main and spare oil pumps, also the usual bilge ejectors; the fresh water tank and hot well contain about 250 gallons. The hull is built of steel plate, of thickness varying from 3-16 in. in the bottom to 1-16 in. in the sides near the stern, and is divided into five spaces by watertight bulkheads. The deck is of steel plate, 1-16 in. to 1-8 in. in thickness. The approximate weights are: Main engines, 3 tons 13 cwts.; total weight of machinery and boilers, screws and shafting, tanks, etc., 22 tons; weight of hull complete, 15 tons; coal and water, 7 1-2 tons; and total displacement, 44 1-2 tons. Trials were made with screws of various patterns, but the results were unsatisfactory, and it was apparent that a great loss of power was taking place in the screw. Owing to the cavitation[2] of the water, the matter was then thoroughly investigated, theoretically and experimentally, and it was finally determined (as the best course to overcome the difficulty) to subdivide the turbine motor into separate compound turbines. Consequently, the single compound turbine engine was removed from the boat and replaced by three separate compound turbines, directly coupled to three shafts, working in series on the steam, the turbines being the high pressure, intermediate, and low pressure, and designed for a complete expansion of the steam of hundredfold, each turbine exerting approximately one-third of the whole power developed, the three new screw shafts being of reduced scantling. By this change the power delivered to each screw shaft was reduced to one-third, while the division of the engine into three was favorable to the compactness and efficient working of the turbines. The total weight of engines and the speed of revolution remained the same as before. The effect on the screws was to reduce their scantling, and to bring their conditions of working closer to those of ordinary practice. The thrust of the propellers is balanced by steam pressure in the motors. At all speeds the boat travels with an almost complete absence of vibration, and the steady flow of steam to the motors appears to reduce the liability to priming: at any rate, no sign of this has yet occurred with ordinary Newcastle town water. No distilling

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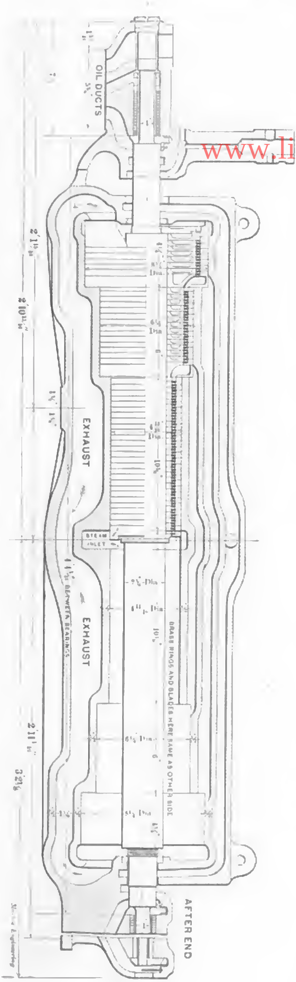
[1] See also June issue, page 6, and July issue, page 11.

[2] See October issue, page 16.

apparatus has yet been fitted. The boat has been run at nearly full speed in rough water, and no evidence of gyroscopic action has been observable, though such a result would be anticipated from the known small amount of these forces under actual conditions; indeed the Turbinia has so far proved herself an excellent sea boat.

For the purpose of going astern a small reverse turbine is used. This turbine has hitherto been of an inefficient form, and has constituted a part of the low pressure motor; the power consequently that has been developed has been very small, and has given an astern speed of three knots. A powerful reversing motor is, however, now being fitted of similar construction to the ahead motors; its weight is three-quarters of a ton, and it is estimated that the astern speed will then exceed 10 knots. The turbine will be permanently connected to the central propeller shaft, and its casing will be connected to the condenser, and the amount of power spent in turning it when going ahead will be insignificant. In June last the Turbinia steamed from the Tyne to Harwich at the average speed of twelve knots, and from Harwich to Cowes at the average speed of sixteen knots. During and after the week of the Spithead Review she was run at speeds up to 34 1-2 knots, estimated from the curve of steam pressure and speed, and ample steam is provided by the boiler at the highest speeds hitherto reached.



SECTIONAL SKETCH OF 60 H. P. "SINGLE COMPOUND" TYPE PARSON'S PATENT TRIPLE-EXPANSION STEAM TURBINE.

Results of Trials.

In April a series of trials were made by Professor J. A. Ewing, and the following paragraphs are extracts from his report, which comprises, I believe, the most complete set of investigations made on the working of a small fast vessel: "The mechanical friction of the turbines is particularly small, and the work spent on friction is not materially increased by increasing the range of expansion. This allows the steam to be profitably expanded much farther than would be useful or even practical in an engine of an ordinary kind. Apart from questions of friction, the addition of weight and bulk to allow for this extended expansion would be enormous in the ordinary engine; in the turbine it is very moderate. Steam is expanded nearly two hundredfold in the Turbinia, and this is accomplished with engines which are much lighter than reciprocating engines of the same power, although in these the expansion would be much less complete. Rough weather was met with in some of the trials, and I had the opportunity of seeing that the Turbinia is for her size a good sea boat. The machinery worked with perfect smoothness, the screws did not race, and the bearings remained perfectly cool throughout. From first to last during the whole of the trials there was no hitch whatever or difficulty of any kind in the action of the turbines. Some twenty trial runs in all were made under various conditions as to speed, the range of speeds tested extending from 6 3-4 knots to 32 3-4 knots. Fullspeed trials were made on April 10, the boat having then been in the water for fully a fortnight. Two successive runs on the measured mile, in opposite directions, in smooth water and at the slack of the tide, gave the following data:

Time on the mile	109 4-5 secs.	110 secs.
Corresponding speed in knots	32.79	32.73
Mean speed in knots	32.76	
Revolutions per minute of high pressure and intermediate shafts	2,230	
Revolutions per minute of low pressure shaft	2,000	
Steam pressure in boiler by gauge	210 lb. per sq. in.	
Steam pressure on admission to high pressure turbine	157 lb. per sq. in.	
Greatest pressure in stokehold by water guage	7 1-4 in.	

The speed reached during this trial, 32.76 knots in the mean, is, I believe, the highest recorded for any vessel. It is greatly in excess of the speed hitherto reached in boats so small as the Turbinia. It is clear, then, that the exceptional speed developed in the Turbinia has been achieved without sacrifice of any economy, and that the substitution of turbines driving high speed screws in place of reciprocating engines driving screws of much more moderate speed is not attended with increased consumption of steam so far as fast running is concerned."

Turbines for Large Vessels.

In conclusion, the application of the steam turbine principle to fast ships in general, including passenger vessels, Atlantic liners, and ships of war, would appear to present no special difficulties. It may be said, generally speaking, that the larger the scale on which the engines are made the simpler the construction and the higher the steam efficiency, and the lower the speed of rotation. In sizes hitherto constructed, the largest being the engines of the Turbinia, this has been found to be the case. In applying turbine engines to a large passenger vessel or warship of, say, 30,000 I. H. P., probably four screw shafts with two screws on each shaft would be adopted. Each of the four shafts would be driven by one compound turbine at a rate of between 400 and 700 revolutions per minute, and the turbines would consist of the high pressure, the intermediate, and two low pressure, each turbine developing approximately one-quarter of the total power. The screw propellers would be about one-half the diameter of ordinary twin screw propellers, and the aggregate blade area would approximate closely to ordinary practice. With such engines the consumption of steam per propulsive horse power would probably be less than that found in the mercantile marine, and considerably less than that found in engines of war vessels, where space and other conditions must necessarily be considered. There is also no limitation in steam pressure in the case of turbines, other than those imposed by the boilers; and it is probable that in conjunction with water tube boilers higher pressures than those at present usual would be generally adopted. With turbine engines in passenger vessels there would arise no questions of vibration from machinery or propellers.

LOADING OF VESSELS ENGAGED IN "KLONDIKE" TRADE ON THE PACIFIC COAST.

BY JAMES S. TYLER.

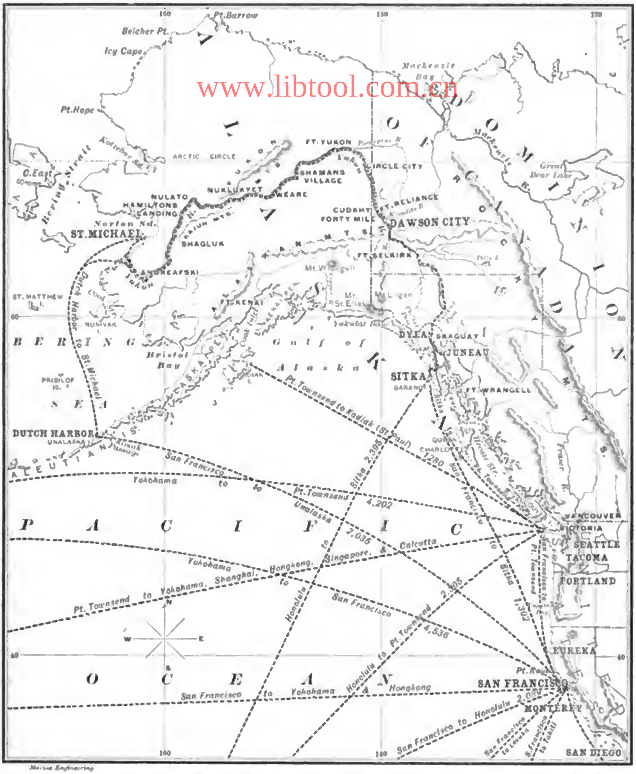
The growth of the Alaskan passenger and freight traffic on the Pacific side was spontaneous. Prior to the discovery of gold on the Klondike and its tributaries the bulk of the carrying trade between St. Michaels, Juneau, and Alaska ports was controlled by the Pacific Coast Steamsip Co. and the Alaska Commercial Co. The former corporation confined its field of operations to Southeastern Alaska, with Juneau as the northern terminus of the line. The Alaska Commercial Co. operated steamers to St. Michael Island during the spring and summer months, calling at Unalaska and occasionally at other ports.

The steamers Bertha, Excelsior, and Dora composed the little fleet that handled the freight trade of the Yukon between San Francisco and the mouth of the river. These vessels connected with the river boats operating between St. Michaels, Dawson City, and intermediate points. The combined fleets of coast and river craft were barely able to accommodate the business tendered them, and each season found them struggling to transport sufficient provisions and general merchandise to the mining districts. There were frequent rumors of an improved service, which never materialized. Increased facilities were not provided until the Klondike boom suddenly awoke the Pacific coast.

When the steamer Excelsior brought the pioneers of Dawson and their sacks of gold to San Francisco there was but one transportation line—the Pacific Coast Steamship Co.—prepared to advertise first-class accommodations for passengers and space for freight. The Alaska Commercial Co. announced almost immediately on learning that a rush was about to be started toward the mines, that it was not in the Alaska trade for the purpose of carrying passengers or "outside" freight to Dawson. Its steamers, the management averred, would accept only a limited amount of merchandise for Dawson, and sign only a few passengers. The Pacific Coast Steamship Co. was prepared to handle a large volume of business, but those who arranged with that corporation had to face the arduous trip from Juneau over the Chilcoot Pass.

As the gold fever became more virulent the ship owners attempted to accommodate the increasing host of prospectors. Every available steam vessel was put into commission, and craft which had lain idle for months found many prospective purchasers who were willing to pay the original cost of the ships. The fleet offered for charter consisted mostly of steam schooners, colliers and a few passenger craft. The local coast trade was dull, and the Humboldt Steamship Co. forsook its competitive route to Eureka, withdrew the new and well-appointed wooded propeller steamer Humboldt, leaving rivals in full possession of the North California local trade.

The Humboldt and the Farallon—the latter was taken off the Yaquina Bay route—were, with the exception of the steamers Queen and George W. Elder, the best adapted of available vessels for the Alaskan service. The Queen was the regular Alaskan tourist vessel which connects at Puget Sound for Juneau, Wrangell, and other points north of the British Columbia boundary.



ROUTES OF WATER TRANSPORTATION FROM PACIFIC COAST PORTS TO THE YUKON GOLD FIELDS.

(Compiled by Marine Engineering from the latest official and other authentic sources.)

The Elder was placed on the berth at Portland, Ore., to handle the Northwestern traffic of railway lines, with terminals at Portland. The vessels out of San Francisco connecting with the Queen were the Umatilla and Walla Walla, both ships of 2,168.37 tons register, modern in every repect, and the steamer City of Puebla, of 1,713.90 tons net, the swiftest of the Pacific coast passenger fleet.

The Humboldt and Farallon were placed on the berth for St. Michaels and Skaguay, respectively. The Farallon, though a small vessel, 252.37 tons, 175 horse power, did not go out of port overloaded, as was reported in the Eastern press. The Humboldt sacrificed passenger accommodations for freight, and, besides, carried on her 'tween decks forward machinery for a 125 horse power river steamer and the wood-hull sections. Her decks were hampered with lumber and cases of general merchandise. The attention of the local Inspectors of Hulls and Boilers was directed to the ship. Although to the eye the ship seemed unreasonably burdened, it was found that the stevedore had complied with the regulations governing steam vessels carrying passengers, and had left wide gangways open fore and aft on the main deck. The Farallon sailed with a two-third cargo and fifty passengers. She was provided with light-draft boats for transferring cargo at Skaguay, but no other freight was stowed above decks.

Public attention was then directed to the steam schooners, the collier Willammette and the sailing vessels. The craft of the steam schooner class which were engaged are herewith tabulated according to their tonnage:

South Coast	171.35
Navarro	209.31
National City	230.99
Noyo	229.84
North Fork	244.04

The Willammette is a steel collier of 1,200 tons. She had to be overhauled to accommodate passengers. Rows of bunks, regulation three tiers high, were built lengthwise in her hold. At San Francisco and Seattle—she stopped at the latter port before starting for the Arctic—about 500 passengers were signed. A large quantity of freight was carried, but the vessel was not dangerously overloaded. It was the alleged crowded and overloaded condition of this ship and the National City which formed the basis of much of the adverse comment that was wired East concerning the "unseaworthiness" of many of the San Francisco vessels placed on the Alaska route. Inspector of Hulls Bolles and Inspector of Boilers Phillips made a thorough examination of the Willammette before she left San Francisco and decided she was seaworthy; that her hull was sound and her machinery in good repair. The vessel, though staunch of hull, developed weaknesses in her engineer's department. When she was several miles outside of San Francisco Bay her boilers choked and portions of her machinery showed signs of failure. No technical description of the troubles could be obtained, as the owners were extremely reticent. It was stated on good authority after the steamer reached Seattle that the choking of the boiler tubes was due entirely to poor fuel, and that the defects in machinery were caused by too hasty work during repairs at San Francisco. When the vessel was hove to off Point Reyes substantial repairs were made and the trip north continued. On arrival in the Sound better coal was placed in the bunkers and the rest of the voyage was completed without further accident.

The steam schooner National City was also most severely criticised by the press. The inspectors examined the vessel, but apparently did not settle the case on its merits. Inspectors Bolles and Bulger argued that the vessel's cargo had been well stowed, and added: "The question of the loading of ships is clearly without the jurisdiction of this board. The Revised Statutes of the United States governing steam vessels provide that inspectors should see that a sufficient number of life-rafts, life-boats, and life-preservers are provided for the use of passengers, and that gangways are kept open fore and aft of the ship." The writer made a careful examination of the ship in company with several ship owners who were anxious to satisfy themselves personally concerning the manner of loading. The steamer has 33.8 ft. beam, but the steam launch Hettie B., for Yukon work, and a scow barge 20 ft. wide by 40 ft. long, projected outbound at the port and starboard sides, bearing the steamer well down by the head. The Hettie B. rested on a cushion of sacks of grain piled three sacks high. Forward there was erected a temporary deckhouse of rough boards and 3 in. by 4 in. scantlings, intended to house five or six of the crew. The barge completely blocked the way to the forecastle-head and the 'tween decks forecastle. The starboard and port poop ladders were removed and in their places there were secured two 4,000-gallon water tanks. The poop deck was reached by a companion ladder placed alongside the starboard tank. Lumber for several houses was piled rail-high amidships. The vessel was loaded well over her water line, and the main deck was nearly awash forward of the after house.

The steamer South Coast was loaded in a manner almost similar to the National City; but with these two exceptions the coast fleet was not in an "unseaworthy" condition. It should also be borne in mind that the season of the year during which the San Francisco fleet started north only calm seas and light airs are found. The North Pacific during the summer is as smooth as a lake from Cape St. Lucas to the Bering.

San Francisco ship owners are making active preparations to handle the spring passenger and freight trade between this port, St. Michael and Juneau. The Alaska Commercial Company, Alaskan Development Co., Pacific Coast Steamship Co., and Pacific Steam Whaling Co. have already commenced to lay their plans for the future. Seattle and Portland are not behind. The Dawson City Transportation Co, organized by a number of Eastern and Washington State capitalists, has arranged for new steamers to be built at coast shipyards. On this side of the continent there is no doubt that thousands of dollars will be expended in new tonnage. There is very little, if any, available tonnage for charter on the Pacific side. Nearly every steam vessel of any capacity is engaged. The demands of the Hawaiian and North Pacific coast trade have been great, and those who are interested in fostering the Alaskan business have had difficulty in securing options on ships.

The Alaska Commercial Co. has secured the Alliance, 213.52 tons, which was about the only vessel fitted for the passenger and freight trade offered here. The Alliance can accommodate about fifty passengers by making some additions to her deck houses. She will, however, be used principally as a freight boat, as the company has just called for specifications from the Union Iron Works for a 2,500-ton passenger steamer, modern in every particular, and especially adapted to the business of carrying gold-seekers. Plans are now being worked out.

The Pacific Coast Steamship Co. has just purchased the Atlantic Coast steamer Curacoa, 825.21 tons, 1,200 horse power, which is a comparatively new vessel, built at Philadelphia in 1895. At the Union Iron Works they will also cause to be built a steamer to be called the Senator, which, the company states, will replace the Orizaba on the Mexican route; but it is believed in shipping circles that the vessel will be used as an Alaskan trader, as the Mexican trade does not justify the employment of so fine a vessel. The Senator is intended to be a 16-knot boat. She will be 288 ft. long over all, 38 ft. 2 in. beam, 21 ft. depth of hold, and will carry 1,500 tons dead weight on a draft of 15 ft. The engines will be triple expansion, of 1,850 horse power, with the cylinders 23 in., 26 in., and 60 in. dia. by 36 in. stroke. Accommodations for fifty first-class and fifty second-class passengers will be provided. There will be electric lights throughout the ship.

The Pacific Steam Whaling Co. has purchased one steamer in New York and will soon bring her around the Horn. The company is looking for another vessel, and may possibly place an order soon with an eastern shipyard. The name and description of the ship purchased is kept a secret. The company has a small steamer named the "Walcott" on the Copper River, San Francisco route.

The Seattle Dawson City Transportation Co. will have two first class river steamers on the Yukon. One of the boats is now building at Nowell's Mill, Puget Sound. The boats will be 230 ft. long., 30 ft. beam, 4 1-2 ft. depth, and will have 10 in. draft when light and 2 ft. draft when loaded. Each will carry 200 tons of freight.

The Alaska-Yukon Co. has left a contract to Moran Brothers, of Seattle, for twelve river steamers, two stern wheel towboats, and twenty-four barges. Six of the steamers will be 260 ft. long, 35 ft. beam, and 2 ft. draft when loaded. Each barge will be supplied with a steam winch and two cargo derricks for handling freight.

Pacific coast investors are convinced that a fleet of twenty river boats will be able to handle all the Yukon business. No vessels for Alaskan rivers are building at San Francisco. The Hudson Bay Company may place an order at a near date for a river steamer for the Stickeen River route.

PITTSBURG AND CINCINNATI PACKET LINE STERN WHEEL STEAMER QUEEN CITY.*

BY BERT L. BALDWIN, M. E.

Other interesting apparatus peculiar to these vessels is the 7 in. by 14 in. nigger engine, geared to winding drums, which are placed over the main forward hatches, and are intended for handling heavy freight, and the steam capstan, which is used in handling the landing stage, and for straining the lines when necessary to spar over a shoal or warping in a bow or stern line. The landing stage is strictly a Western river device, there being but few wharf boats at the small towns, and it is impossible to use piers on account of the great variation in the water level. At the city of Cincinnati, for instance, it is usual, in the early spring time, to have 50 ft. of water over the low-water mark, and it has gone beyond the 71 ft. mark on occasions. The landing stage is 45 ft. in length by 6 ft. in width, having deep white pine gunwales and oak beams and floor. It is properly ironed to resist wear and increase its stiffness, as well as having projecting trussed brackets, for handling. This is accomplished by tackle, supported by the stage boom, which terminates in a stage span and spreader, so as to give a clear passageway over the stage. On many steamers there are two of these landing stages, handled by side derricks, which are also used in handling the spars and for loading freight upon the upper decks, but on the steamer Queen City one central mast, with its boom and galvanized steel standing rigging, is light and occupies less room.

The steamer is also equipped with derricks on either side of the mast, and seated in hemispherical deck sockets. Each derrick is supplied with a heavy iron-pointed spar, and suitable running rigging, to be used where necessary, for the purpose of holding the steamer away from the bank, or for sparring off bars or over shoal places. In using the spars, they are set on either side of the steamer's bow, their falls are connected to heavy deck fastenings, which are reinforced by lashings that extend over the guards to the pendent straps, situated on the bows above the water line, and through bolted to the frames and strakes. The fall lines lead through snatch blocks, and are strained by the capstan until the bow is raised clear of the obstruction, when, by the aid of the main engines, the steamer is backed off or forced ahead, according to circumstances. In the illustration of the Queen City [1] the derricks will be noticed, but the spars were stowed away under the boiler deck at the time the photograph was taken.

One detail which should not be overlooked, which belongs to the mechanical equipment of the steamer, is the chimney-handling gear. As will be noticed, the upper portion of the chimneys is

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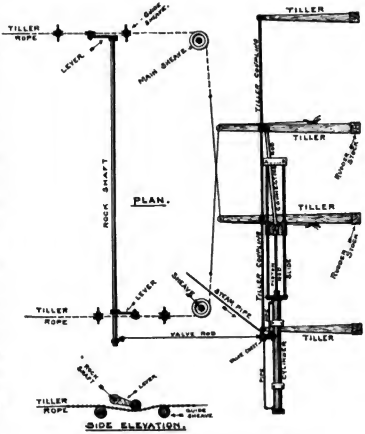
* Commenced in October issue.

[1] See October issue, page 7.

hinged so as to be lowered when it is necessary to pass under the low bridges. This is accomplished by gear on the hurricane deck just aft of each chimney, and consists of 2 1-2 in. dia. square thread screws working in suitable nuts, which are seated in heavy pipe braces (into which the screws telescope) that are hinged to the upper section of each chimney. The screws are operated by hand cranks through miter gears, as shown, and by slacking away the forward chimney guy lines the gear is ready for operation. All of the various systems of water and feed piping are arranged with long radius bends, similar to the main steam piping, so as to allow for expansion, contraction and twisting; and all pipes that carry steam or hot water are covered by high grade sectional pipe covering.

The steam steering gear is in the engine room. It is made by Crawley & Johnston, of Cincinnati, and is so simple in its construction and effective in operation that it deserves attention. The engraving on this page illustrates the principle of this steering apparatus, which consists of an 8 in. dia. steam cylinder, secured to the underside of the boiler deck, provided with a cross head, working upon cylindrical slide bars, and coupled to one of the main tillers by means of a substantial connecting rod. The valve which regulates the admission and release of steam is operated by a small lever upon a cross rock-shaft. This rock-shaft has levers near each end, which carry small sheaves that are arranged so that they both depress a short portion of the main tiller rope. When the pilot turns his wheel and throws a strain upon one tiller rope, and at the same time throws a certain amount of slack in the other rope, it acts upon the levers, causing one to rise and the other to fall, which turns the rock-shaft, and, through the small lever and valve rod, operates the valve, admitting steam to one end, and opening the exhaust at the other end of the cylinder. As long as the pilot continues to turn his wheel, the valve will remain in this position and the piston will continue to move in the one direction; but as soon as the pilot wheel stops revolving the continued motion of the piston takes up the slack on the one side and throws it ahead on the other, causing a reverse movement of the valve, which, if continued, allows steam to enter at the opposite end of the cylinder, forming an effective cushion. By this arrangement the pilot has very little more than the friction of his wheel to overcome, while the steam gear performs the laborious portion of the work, and automatically resists all strains which come upon the rudders, as these strains act upon the tiller ropes and steam valve, in a manner similar to what has just been cited, in case of the piston overrunning its intended stroke. The extreme simplicity of the apparatus recommends it, and makes it interesting to boat owners who would not consider the question of equipping their vessel with the usual type of steam quartermaster, on account of its complications and high first cost.

The non-condensing main engines drive the paddle wheel at a speed of 24 rev. per minute, when the boilers are worked to the limit allowed by the Government, with steam at 166 pounds above the atmospheric pressure. The engines under these conditions would cut off steam at 3-8 of the stroke, which would show a mean effective pressure of about 100 lbs. per sq. in. upon each piston, and develop collectively 1,024 horse power, and when the engines are worked to the later point of cut-off they will develop over 1,400 horse power. By forcing the fires so as to maintain a high boiler pressure, the Queen City attains a maximum speed of 14 miles per hour against the current, which runs from 2 1-2 to 3 miles per hour, according to the stage of the river. This, of course, is when the steamer is working light with very little freight. She is registered at 624 23-100 tons. Under ordinary working conditions she draws 32 in. of water throughout her entire length, while, when loaded to her maximum carrying capacity, with 1,400 tons of freight, she draws 5 ft. of water at the stern and 9 ft. at the bow. This may seem a peculiar manner in which to load a boat, but experience has proved it to be a correct plan where heavy currents are to be encountered, and to obtain the most satisfactory results from the stern wheel.



CRAWLEV AND JOHNSTON STEERING GEAR.

The boilers in a Western river steamer are so limited in size by the many restrictions that it is a surprise to almost every engineer, who has occasion to make an investigation, to discover how well the boilers meet the excessive demands for steam that are made upon them. It has just been stated that the engines of the Queen City indicate over 1,000 horse power when working under full pressure and at their usual point of cut-off. In addition to this, there is a 30 horse-power electric light engine, as well as steam pumps, steam steering gear, and the injectors, which all use steam at the same time. The main engines are as economical as the Corliss, or any other well-proportioned automatic cut-off engine working under the same range of cut-off, but this efficiency is, of course, not possessed by the small slide valve engine, the steam pump, or the large injectors, so that it is a conservative estimate to rate these boilers as supplying 1,100 horse power in steam. The actual effective heating surface of each boiler is about 580 sq. ft., which gives 2,320 sq. ft. heating surface for the entire battery of four boilers, or less than 2.11 sq. ft. heating surface per indicated horse power. The boilers are usually worked with forced draft, produced by the exhaust discharging through contracted nozzles in the chimneys. This is very necessary at certain stages of the river when the chimneys are hinged back to clear bridges, though this blast, while increasing the amount of water evaporated per unit of heating surface does so usually at the expense of the coal pile.

It is to be regretted that the steamer is not arranged so that a systematic evaporative test could be made to determine the exact efficiency of these boilers, and it is to be hoped that this may be done in the near future. At present we must be satisfied with the practical results obtained, which show that the boilers are under steam continuously for six days and fifteen hours each week, which include a round trip of about 2,000 miles steaming and handling freight, during as well as at each end of the voyage. In this period of time an average of 3,800 bushels of Pittsburg coal is consumed, which includes the amount of coal burned in supplying steam to all of the various auxiliary engines, as well as the main engines, and also supplies a vast amount of steam to the chime of whistles, which is used often and long in river service.

The most remarkable feature in connection with the amount of fuel consumed by this steamer upon her average trip is the fact that she uses no more coal, with her high pressure non-condensing engines, than is used by the steamer Virginia, which is a twin sister as far as the general dimensions and model are concerned, with coupled tandem compound condensing engines, having steam cylinders 15 in. and 33 in. by 84 in., with independent air pumps and condensers for each engine, which easily maintain a vacuum of from 24 to 26 in. To be very accurate in this statement, the actual cost of fuel per "average round trip" of the steamer Queen City amounted to 75 cents more than that for the Virginia, while the former boat made the faster time.

With the exception of a few weeks during the fall of the year, when the upper portion of the Ohio River is very low, the Queen City makes regular trips between Pittsburg and Cincinnati, leaving the latter city every Saturday evening, and arriving on the return voyage early in the morning of the following Saturday, her actual running time being six days, over a route which, with the various curves necessary in rounding to in making landings, is equal to a journey of 1,000 miles. This is an average speed of about 7 miles per hour, and includes the time consumed in making fully 100 landings in each direction, as well as the time necessary to take on and put off freight.

Another point, which sounds strange, but one upon which all river men agree, is that a limber boat is much faster than a rigid one, and for this reason a boat becomes faster as it grows old. It has been suggested that this is due to the fact that the limber boat can conform more readily to ground swells produced by inequalities in the river's bottom, but it is claimed upon the other side that the same conditions prove true where there is forty feet of water in the channel, and at stretches where there are no known inequalities that could cause ground swells.

Although one of the strongest points in favor of a stern-wheeled boat is its ability to work well in shallow water, yet if the water is too shallow it increases the resistance on the wheel and causes the engines to labor. For example, with the steamer which has just been described, working over a stretch of river in which the water is 30 ft. deep, the engines will drive the wheel at full speed, and when the steamer strikes into shallow water, which is 10 ft. deep, the engines will commence to labor, and the speed will drop off fully three revolutions per minute, with uniform boiler pressure in each case.

Of late years, most of the river steamers have been built with stern wheels, fully eight of this type to one side wheeler, and to be able to navigate the river properly, the side wheel steamers have been built with disconnected wheels, so that the wheels may be operated independently of each other.

In extreme cases, one may be working ahead while the other is working astern, yet, withal, a good stern wheel boat can turn completely around three times while the side-wheeler is making one turn, the wonderful steering and handling qualities of the stern wheel boats, as well as their great carrying capacity, making them general favorites for river traffic.

A short description of the Cincinnati Marine Railway, where the Queen City and many other well-known boats for the river service were designed and constructed, may prove interesting, as it also bears upon Western river practice. The Marine Railway consists of a series of inclined ways, composed of heavy timbers, securely anchored in position, and extending from the top of the river bank down to a level that is considerably below the low-water mark. There are eight pairs of these ways, each of which is equipped with a sliding cradle, the bottom slides of which rest upon the inclined ways, while the framing is so arranged that the upper surface is horizontal. At the upper end of the inclined plane there is a continuous line-shaft, driven by a powerful engine, with clutches arranged so as to operate, through 9 trains of double-worm gearing, heavy winding drums upon which the hauling chains are wound that are connected to the various cradles. By this arrangement of machinery any or all of the cradles can be drawn up or lowered down the inclines simultaneously. A boat in need of repair can be floated over a number of these cradles, and drawn up the inclines until she is high above the water level, and after being properly repaired, lowered until she again rests upon the river. Very often a boat is raised toward the top of the ways, and supported in this position by a separate system of blocking, while the cradles are lowered for the purpose of handling some other craft in need of attention.

At the top of these inclined ways, convenient to the mill room and pattern loft, where timbers for her framing could be machine-shaped and dressed, the steamer Queen City was built upon stocks and suitable blocking, lying parallel to the river with her bow up stream. In this position the hull was built, the various decks and deck house erected, the machinery put in position and connected up, so that when the day arrived for launching she was complete, with the exception of a few finishing touches necessary to complete the cabin. The cradles had been brought into position supporting the entire weight, the blocking removed and the steamer lowered down the ways, until she stood only a few feet above the water level, with a full head of steam upon the donkey boiler, for the purpose of handling the capstan, the pumps, if necessary, and the whistle. With the usual launching ceremony the catches were tripped, and the cradles with their burden shot into the river; the cradles, sinking deep below the surface, allowed the Queen City to float upon the surface of the Ohio, drifting slowly down stream clear of the cradles, and to a landing below the ways; the handling of the boat being regulated by the bow lines.

The designers and builders of these Western steamers deserve both praise and credit for the manner in which they have perfected the methods of construction, which, it is claimed, combines a greater amount of strength with a corresponding degree of lightness than can be found in any other type of marine architecture of corresponding size and carrying capacity.

The Ohio River, from Pittsburg to its junction with the Mississippi at Cairo, Ill., is about 1,000 miles long. The amount of capital invested in the steamboat business is approximately $8,500,000, and the average annual shipments include, freight, 7,000,000 tons, and passengers carried 1,500,000. The value of the freight shipped during 1896 was $250,000,000, in round numbers.

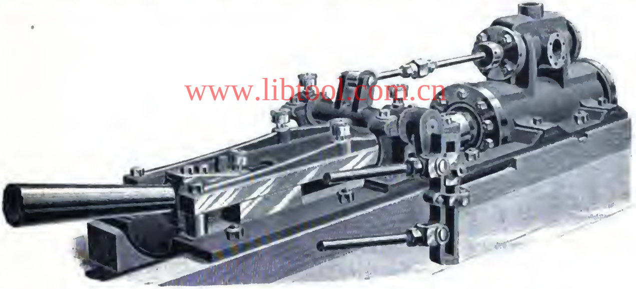
IMPROVED APPARATUS.

Balanced Piston Valve Paddle Engines.

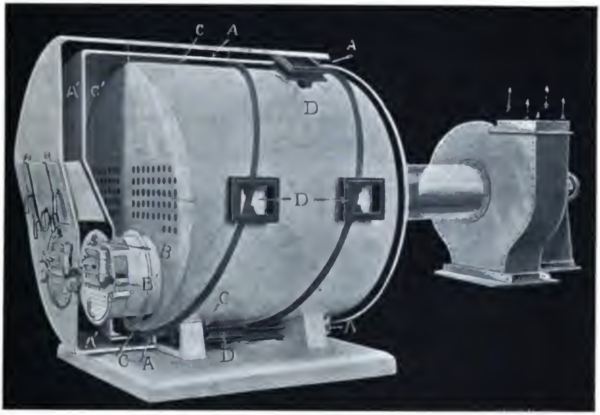
The engraving herewith shows a modern balanced piston valve engine for stern wheel steamers, designed by Charles P. Willard & Co. There has been a great increase of late in the number of light draught vessels built for domestic river trade, and also for shipment to the Klondike. As will be seen by the engraving, the bed plate on which the cylinder rests is continuous and forms the lower cross head slides. The steam chest is placed on top of the cylinder, thus saving a little in the space taken up by the engines in the boat. The piston valve, which is suitably constructed to remain steam tight, runs in bronze valve chambers having gridiron openings the entire circumference of the valve, thus insuring very quick admission and ample steam opening with the minimum of valve travel. Admission ports are at the end of the valve and the exhaust in the center, insuring the desirable feature of short and free release. By the use of the rocker arm, the eccentric rods can be made somewhat shorter than in the ordinary engines of this class. Both connecting rods and eccentric rods are of hollow steel, with solid forged ends. The eccentric rods have strap and key joints, with brass boxes at each end, and connect with steel cranks on the ends of the paddle wheel shaft. These cranks are usually set quartering, so there is no dead center, and the engines move either ahead or astern, according to the position of the link, instantly when the throttle valve is opened. Several river boats so fitted are now under construction at the shops of Charles P. Willard & Co., 15 North Canal street, Chicago.

Eaves Helical Induced Draft.

An improved form of induced draft applicable to Scotch boilers on sea or land, in conjunction with Serve ribbed tubes, is shown in the accompanying illustration. The cold air for the combustion of the fuel enters from the back end of the boiler, passing along the outer space A and A′ to the valves B and B′ in furnace fronts as shown in the cut. On its way the cold air is guided around the outside of the "inner" space C in a "helical" or spiral direction by the partitions shown. After combustion, the waste hot gases discharged from the tubes pass through the smoke-box into the inner space C, and by partitions are also made to pass around and in close contact with the boiler, in a "helical" direction, on their way to the suction fan. It will thus be seen that the boiler is completely enveloped in the waste heat, which would otherwise pass into the smokestack or chimney unused, and that both "radiation" and "condensation" are effectually prevented. It also prevents any straining of the boiler under forced conditions, such as the rapid generation of steam from cold water, or sudden and greatly increased evaporation. The cold air, too, on its way to the valves B and B' absorbs much heat from the waste gases and enters the furnaces at a high temperature. After making careful tests, John Brown & Co. (Ltd.), Sheffield, Eng., state that a very high efficiency is obtained by the use of this draft. Tests made with boilers fitted with Serve ribbed tubes, showed an efficiency equal to 80 per cent of the actual calorific value of the coal used. With Welsh coal, which has a calorific value of 16.18 lbs., the evaporation was 13 lbs. of water per lb. of coal, from and at 212° F., with a rate of combustion of over 30 lbs. of coal per sq. ft. of grate, and with a ratio of heating surface to grate surface of only 28 to 1. It is claimed that two boilers with natural draft would be required to do the work of one of the same size fitted with the Helical Draft and Serve tubes, and as space is worth something on board ship—to say nothing of the economy in fuel—an investigation of the claims for this new system of draft would seem to be a profitable field for investigation by engineers and steamship owners. The agent is Charles W. Whitney, 11 Broadway, New York.



WILLARD BALANCED PISTON VALVE ENGINE FOR STERN WHEEL STEAMERS.



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The fifth general meeting of the Society of Naval Architects and Marine Engineers, held during November, was a successful and representative convention of the constructive marine interests of the country. A good programme had been arranged, and the papers as a whole were of special interest and were fresh evidences of the ability of the profession in America, which only needs the aid of speculative capital to make this the foremost shipbuilding and ship-owning country in the world. Indeed, the high standard and special character of many of the papers read made some discussions seem,by comparison, rather weak. This was due entirely to a feature of the arrangements and not to any lack of capability of those present to add accurate criticism or helpful suggestion. Few of those who were in attendance had had much, if any, opportunity previous to the meeting to read the papers presented, and consequently many were not prepared to take a forceful part in debate, or even speak at all upon matters in which they were recognized authorities. It is an experience common to all scientific bodies that, frequently, those who are best informed on a subject will not express views until they have had proper opportunity to digest the facts presented for criticism. The more able the paper read the greater the need for quiet consideration of its expression in the light of one's own experience. This applies especially to a body, such as the Society of Naval Architects and Marine Engineers, whose membership does not include a large proportion of sea lawyers or parliamentarians, skilled in ready debate. The habit of mind of the Naval Architect and Engineer is essentially reflective, trained to careful consideration of cause and effect. Action rather than elocution is the physical result. But even supposing that the papers read were of an every-day character, about which intelligent judgment would be in the ready possession of the hearers, the fact that they were read at the meeting would not have altered the results. Many of the members in attendance had occasion to transact business elsewhere at times during the sessions and would perhaps arrive in the hall in time to hear only a portion of a paper, treating of a subject with which they were familiar, and by hearing part, and not the whole, would get a wrong impression of the author's views. The result could only be confusion. We have spoken of this matter at some length because we believe that an outsider, reading the transactions, would possibly get a wrong impression of the information and authority of the society, in the light of its discussions. Another source of distraction from the purposes of the daily technical sessions was the necessity for members who, perhaps, came together only at the annual meeting, renewing their acquaintanceships in the convention hall. It is difficult to intelligently follow an author and keep up a pleasant conversation with a neighbor, on other topics, at the same time. Members do not come to a meeting solely to hear papers read and discussed, but also for the very desirable purpose of getting in personal touch with their brethren of the profession. This experience has caused similiar societies at home and abroad to set apart a time during the convention in which the members may meet and fraternize. It is regrettable that more representatives of the operating departments of the mechanisms discussed were not in attendance. On other pages in this issue a report of the proceedings at the meeting will be found; also a commencement of the reproduction of papers read, which we shall continue in future issues.

The paper reproduced in this issue is by Professor W. F. Durand and gives an introductory account of an investigation into the influence of surface on the performance of the screw propeller. Of the many features which may enter into this problem all are kept constant except *pitch ratio*, *slip*, and *surface ratio*. The investigation is intended to proceed with an accompanying variation of these features, each in turn, the others meanwhile remaining constant at various values within a wide working range. Such an investigation, even partially completed, is worth far more than an equal amount of desultory work. The use which can be made of such data as are presented in the paper will depend much on the individual. It seems to be the intention of the author to provide certain definite scientific data showing under certain circumstances what may be expected. The engineer is left free in the exercise of his judgment, as to how nearly these circumstances represent those with which he has to deal. The portion of the proposed investigation which is here reproduced relates only to pitch-ratio, or probably one-fifth of the whole. We believe we voice the wish of the entire profession of marine engineers and constructors in expressing the hope that the author may be able to complete the experiments.

Differences which have existed between the Line and Staff Corps of the Navy for many years are now the subject of inquiry by a special board of naval officers, with Assistant Secretary of the Navy Theodore Roosevelt as president. The membership of this board includes:

Captains W. T. Sampson, A. S. Crowninshield, Robley B. Evans, and A. H. McCormick; Commander J. N. Hemphill, Lieutenant Commander Richard Wainright, and Lieutenant A. L. Key, on the part of the Line, and Engineer-in-Chief G. W. Melville, Chief Engineers C. W. Rae and G. W. Kearney, and Passed Assistant Engineer W. M. McFarland, of the Engineer Corps.

At this time the result of the deliberations of the committee is a scheme to amalgamate the two corps—carried by a vote of 9 to 1. So far as known the scheme contemplates assigning only engineering duty to the senior thirty-six engineers now on the navy list who hold the relative rank of captain, commander, and lieutenant commander. Engineers of the relative rank of lieutenant may qualify for line duties if they so elect, or, in case they do not, they are to be eligible only for duty in connection with the machinery. All other grades of the Engineer Corps are to be absorbed by the Line, and these officers must qualify for line duties. To put it plainly the identity of the Engineer Corps is to be destroyed. The only possible explanation for this proposed Gilbertian combination is that it is a compromise. Parenthetically it might be asked, why not carry the plan to its logical conclusion? Amalgamate the scriptural and surgical departments, so that the surgeon-chaplain may minister to the needs of body and soul simultaneously or alternately. Also join the Naval Constructors and the Pay Department in the bonds of unity and peace, and do likewise with the Marine Corps and Civil Engineers. In this age of specialization the scheme proposed is extraordinary. We wonder what the directors of the American line would reply to such a proposition for the reorganization of their forces. It would likely be brief and expressive. Certainly the proposal is not in accord with the suggestions of Engineer-in-Chief George W. Melville, who, in his annual report, states "two things are necessary to the highest efficiency of the Engineer Corps." These are, an increase of numbers from 195 officers to 300, and the conferring of actual rank and titles. The first is a reasonable, even modest request, clearly in the best interests of the Navy, and so of the nation. As to rank, that is one thing, title another. That an engineer of the Navy should stand squarely on his rights, and that these should be absolute in his own department and co-equal with those of his brother officers in other departments, where, owing to the exigencies of the service his authority might be needed, is a proposition that only prejudice, ignorance, or vested interests could dispute. That his title should be other than "Engineer," with such additions as would signify his actual rank or length of service—as now in force—we cannot perceive. The name Engineer is more misused than any other signifying a man of brains, but nevertheless it is a grand title, the noblest of the century. Other naval titles, from Admiral down, have been hallowed by age and made glorious by memories, but future battles will not be fought by heroes of the past. The modern ship is truly an engine of war, and what better name could designate the officer who should keep this in efficient condition than Engineer? But a ship has to be navigated and the guns operated to be effective in war. Do the line officers admit that these duties are so relatively unimportant that they will have ample time to properly administer the duties of the engineer officer as well? Considering the ever increasing importance of the mechanical equipment of the war vessel, possibly this position is well taken. For our part we do not so believe. The real engineer is born not made, though it is only in the merchant marine that the survival of the fittest is really worked out. The sailor and engineer, as such, have little in common in their makeup, and though the former needs be a fighter, the latter may be peacefully efficient, though none the less courageous.

PROCEEDINGS AT THE FIFTH GENERAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

HELD IN NEW YORK, NOVEMBER 11 AND 12, 1897.

Concise Report of Routine Business, Which Included Passing of Resolutions, Election of Officers and of New Members.—Brief Abstracts of Papers Read and Gist of the Discussions Which Followed.

At the engineering headquarters, 12 West Thirty-first street, New York, the fifth general meeting of the Society of Naval Architects and Marine Engineers was held on November 11 and 12. There was a good attendance of members, though many familiar faces were not in the hall when, in the unavoidable absence of President Clement A. Griscom, Charles H. Cramp called the opening session to order. He explained the circumstances, and called John C. Kafer, member of the Council, to the chair. This was a happy choice, for throughout the proceedings he performed his duties with dignity and great courtesy.

Charles H. Cramp was given the floor to present a set of resolutions. He said: "Last summer our society was honored with an invitation from the Institution of Naval Architects to join in the International Congress of Naval Architects and Marine Engineers to celebrate the Queen's Jubilee. The Congress lasted from July 5 to 15 of this year, the meetings for the discussions of papers being held in London, and the excursion, including visits to Portsmouth Dockyard, Southampton, Glasgow, and Newcastle. In addition to this the many social features of the Congress included a visit to Windsor and a reception by the Queen. Our transatlantic cousins were most cordial hosts, and it seemed to us that our common speech and ancestry made our welcome the warmest. All of the arrangements were perfect, and the whole elaborate programme was carried through with great success. Our society was represented by a fair number of members, including two former Engineers-in-Chief of the Navy, several of our leading shipbuilders, and two delegates sent by the Navy Department. Besides the entertainments on the programme, the individual members of our delegation were the recipients of many personal courtesies. To show our personal appreciation of the kindness we had experienced, we sent an engrossed testimonial to the Institution of Naval Architects before we separated in London. It seems to me, however, that it would be a graceful act for our society to do something in the way of placing on record its appreciation of the courtesies shown to its representatives, and I have the pleasure, therefore, to offer the following resolutions:"

Whereas: The British Institution of Naval Architects on the occasion of the Diamond Jubilee of the Queen's Reign invited this Society to join with it and like organizations of other countries in an International Congress of Naval Architects and Marine Engineers, and

Whereas: The possibilities of hospitality and courtesy were exhausted by the British Institution toward the representatives of this and other like organizations elsewhere who were its guests.

Therefore Resolved, That the American Society of Naval Architects and Marine Engineers do offer the British Institution this expression of its profound sense of the courtesy extended and of the hospitality lavished, and,

Resolved, That a suitably engrossed copy hereof be sent by this Society to the British Institution through its President, the Earl of Hopetoun.

E. Platt Stratton seconded the motion.

Chairman Kafer spoke briefly. He believed it was right that the society should take cognizance of the treatment received by members, and others who were not members, at the recent meetings of the Institution of Naval Architects. "I think it eminently proper that we should pass a resolution of this character because we cannot do too much to honor the Institution which is the parent of ours."

Charles Ward, who had attended the British meetings, said the entertainments provided for visitors were simply superlative. He did not believe the society could express itself in any way too strongly in appreciation of the kindness shown to the American visitors. The motion was unanimously carried and ordered engrossed.

Secretary Francis T. Bowles read the report of the council, and election of members was taken up. These were unanimously elected:

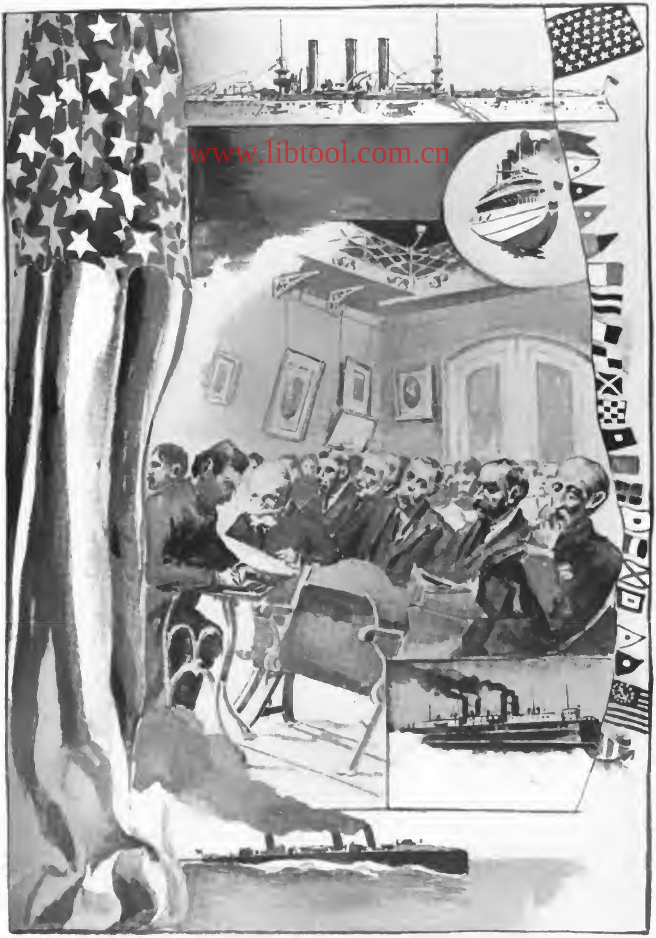
Members—Carl Herbert Clark, Robert Brooke, Henry Hess, Everett M. Mathews, William Poultney Smith, Harry A. Spiller, Alexander Thomson, Nathan Pratt Towne, Fairfax Williams, and Siegfried Popper, Hungarian Navy, and C. Ferrand, French Navy.

Associate members—John W. Burnham, Mason Smith Chase, Winthrop Cole, William Henry Deming, John F. Kane, Parker Henry Kemble, Thomas S. Mathewson, Axel Samuel Vogt, Spencer Miller, and Frank Richard Wheeler.

Juniors—Joseph Ward Clary, Ralph Worthington Crosby, Max Dercum, Henry Newton Whittelsey, Morris Mortimer Whitaker, Herold Lee, and Henry A. Swanton.

James Swan was promoted from Junior to Member.

Chairman Kafer referred feelingly to the death of



SCENE IN AUDITORIUM DURING THE FIFTH GENERAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

Vice-President Rear Admiral Richard W. Mead, which had occurred during the year.

Captain Miller presented resolutions in which the society expressed its appreciation of the "chivalrous character and knightly loyalty" of the deceased naval officer, and these were adopted by a standing silent vote.

Nominations of officers resulted in the re-election of the entire list of officers, with the additions to Vice-presidents of Commodore F. M. Bunce, U. S. N., to fill the vacancy caused by the death of Admiral Mead, and General T. W. Hyde, to fill the vacancy occurring during the year, and Colonel E. A. Stevens, additional. Members of the Council elected were: Passed Assistant Engineer W. M. McFarland, U. S. N., and Professor C. H. Peabody. This for the time concluded the routine business before the meeting, and attention was next given to the technical papers.

WATER TIGHT BULKHEAD DOOR.

The reading of papers was begun with that of William B. Cowles on "Water-Tight Bulkhead Doors and the 'Long Arm' System on the U. S. S. Chicago." This describes a system of closing doors by hydraulic power, the term "long arm" being applied as descriptive of the method of controlling the position of all doors from a central station by an operator, who is thus enabled to "reach out" in any direction throughout the ship. Instead of requiring nearly 100 men to close doors, as in the case of the battleship Massachusetts, one operator in the central station can make all compartments tight. A modification of this system is also described in which the closing of doors would ordinarily be effected at their respective locations, but in cases of emergency the officer in charge of the ship can close all doors simultaneously. In both systems an attachment at each door permits the opening of the door by any person shut in a compartment by reason of an unexpected closing of the door. This automatically causes the door to close again after the person is released. The doors on the Chicago are of the vertical sliding pattern connected by a piston with the hydraulic power cylinder.

Naval Constructor Francis T. Bowles, U. S. N., in opening the discussion, said in considering the fittings of warships he was opposed to further complexity and rather advocated simplicity. After careful consideration, however, he had recommended the introduction of the Cowles system on the Chicago in its simpler form. The great advantage of the door seemed to be that the application of the water tightness did not occur until the door was in position and seated. The reverse process was followed in opening. He was not in favor of a central system for operating doors by calling up an operator, who might not be on hand when most needed.

Lieutenant William P. White, U. S. N., also advocated simplicity, but at the same time some positive-acting apparatus was needed for closing doors. The confusion following the signal to close doors on a warship caused unavoidable delay. Under present methods there was the possibility that openings in coal bunkers in protective decks might be left open, and there was no means of examination except by opening the doors communicating with the fire rooms. It was a common occurrence to have five or six men operating a screw on the berth deck to close a door and, even with the aid of some convenient lever, being unable to get the door water tight. He considered the inventor deserved the thanks of all men who go to sea.

Lewis Nixon spoke in favor of the system, which he said was absolutely certain in its application, for even in action if some of the supply arrangements were shot away it would still be possible to go to each door and close it by the pump attachment.

Colonel Edwin A. Stevens wanted to know what the effects of shell fire would be upon the system; if local damage to one of the pipes would affect the system, and in such a case if it were possible to arrange the gear so that all the doors would close, much as the air brake valve applies the brakes on a train in case of damage to pipes. He had had experience with collisions in smooth water and had observed that anything near the point of impact was much distorted, water and steam pipes almost invariably leaking badly. These collisions occurred between light vessels at low speeds and the energy of the blow was not comparable to that delivered in the case of H. M. S. Victoria, or the S.S. Elbe. He supposed every one knew the valuelessness of any present device for closing doors, and recalled cases where water pressure had got on one side of a bulkhead where there were openings, and leaks invariably followed.

Mr. Newman said the system was really simpler than present methods. He cited instances in his experience abroad, in one of which it required several men to close the bunker doors in a light-armored cruiser. In another case of a 5,000 ton armored cruiser similar results were experienced. Very stiff door frames were a necessity. When running only from one dockyard to another, in a ship in which the doors had been accurately fitted, on arrival at the second dockyard it was found impossible to close the doors. He believed the Cowles system would find its most important application on transatlantic liners.

Charles H. Cramp spoke briefly. Complexity on a ship was to be avoided. Each individual system placed on board a ship, such as electricity, drainage, ventilation, the handling of ammunition, the movement of turrets, and others, was now much divided, so that the ship had grown to be such a monster that it could not be managed by one man. He believed the modern ship too complex. The greatest ship building establishment in the world employed an expert, at a large salary, to make daily walks through every ship building and find out, not what could be added to the ship, but what could be dispensed with.

A. F. Yarrow, the English torpedo boat builder, who was present, was called on by the chair, and replied that he knew nothing about water-tight doors. "In all the boats we build," he said, "we do not adopt water-tight doors at all."

E. Platt Stratton called attention to the subdivision of transatlantic liners into anywhere from ten to sixteen compartments with water-tight bulkheads. It was desirable to employ men in certain compartments and have their duties confined to such compartments, so as to obviate as much as possible the necessity for men moving from one part of the ship to another in case of emergency. This also did away with the necessity for a number of compartment doors. The method might possibly be applied to naval vessels.

Mr. Coles in closing the discussion argued that the present multiplicity of shafting and gear, connecting doors with the closing mechanism on the berth deck, was not only unscientific and bad engineering, but more complicated than his system. By the adoption of the central station plan in battleships, for instance, instead of requiring 110 men to close the swinging doors, three or four at the most could make the entire ship secure. The others would be available for other emergency duties, such as getting out the collision mat. Regarding the effect of shell explosions on piping and the system, in the Chicago all the system was placed below the protective deck with the exception of the 1-8 in. pipes operating the valves and telltale in the pilot

house. She had no protective tube under the conning tower, and consequently these pipes were exposed to gun fire. In such a case an automatic cut-off valve would keep the system below deck intact, and this was applicable to any exposed branch. The jar and strain of gun fire or shell explosions affected large pipes, which are stiff and have great inertia, more than small pipes which take up motion quickly and and are more flexible. In the Chicago the largest diameter of pipe was but 2 in. and this ran for only a short distance. In case of damage to the system the doors could be worked by hand, the discharge from the power cylinder running to a reservoir which always remained full, giving sufficient capacity for the operation of the hand pump, which could be worked more quickly than the present locking devices. A door on the Chicago was pumped up by one man in ten seconds. It was simply a question of piping and areas, and capacity of pumps.

REGULATIONS FOR LOADING VESSELS.

"Regulations for Loading Vessels" was the title of the next paper, read by Lewis Nixon. This consisted of a statement of the rules and regulations of the British Board of Trade, and the American National Board of Marine Underwriters, governing the loading of vessels. The author also stated that the loading of steamers in American ports is practically in the hands of the underwriters, though their business is not so much in the direction of proper stowage as in adjusting the rates to the character of risks run. The government should strengthen their hands in every way possible without interfering with trade, and this could only be done through a body similar to the British Board of Trade. The effort of this government has been more in the direction of providing safeguards against loss of life and against boiler explosions.

Chairman John F. Kafer said the rate of insurance usual in any commercial enterprise would govern such matters. If dealt with by legislative action it should be carefully handled so that it might not be overdone.

E. Platt Stratton said any interference of the government with the private affairs of merchant shipping would have to be done discreetly. The steamboat inspection service was now carried out in a pretty efficient manner, but how far this might be extended in the line of a general shipping act he was not prepared to say. He advocated caution.

Mr. Newman, speaking on behalf of the shipping of the Great Lakes, said during his stay there he had noticed with great astonishment the careless methods adopted in the manner of sending ships out of port. He had seen ships carrying from 4,000 to 5,000 tons coming down from Lake Superior to Lake Erie, and he thought he might safely say they had no more than 4 inches of freeboard. This was entirely improper and should be made criminal. The argument he had found used was that they never had very serious accidents, but at the same time accidents did occur. It seemed that it would be proper to draw up a code of laws governing these methods of loading, and he styled Mr. Nixon "the American Plimsoll."

E. Platt Stratton said that about five years ago a bill was presented to Congress to regulate the matter of freeboard, especially on the lakes; but it was discovered that there was not water enough in most of the channels to load vessels down to the proper line of freeboard, so the whole matter was dropped.

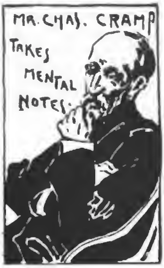
Mr. Nixon, in closing, said the bill fathered some years ago by Senator Fry was too complicated and would have been an interference with trade, so it died a natural death. There was a dangerous liberty allowed in loading ships along the coasts and some restriction should be placed on it.

TORPEDO BOAT DESIGN.

The paper on "Torpedo Boat Design" was read by the author, Assistant Naval Constructor H. G. Gillmor, U. S. N. He gave a concise history of the torpedo-boat in general and the U. S. torpedo-boats in particular, from the torpedo-launch Lightning of 1876 to the latest destroyers. This was followed by a dissertation on the functions of the torpedo-boat and a practical consideration of the question of design under the two heads, viz: The seagoing boat and the harbor or coast defense boat. The paper was accompanied by carefully drawn sketch-plans for both types of boat and tables of dimensions and other data. The special features of design included the use of single screws with, of course, one set of engines. The estimated cost of the seagoing boat was given as $100,000, and of the harbor boat, $30,000.

Assistant Naval Constructor Frank B. Zahm, U. S. N., said of the list of twenty-one boats given by the author probably eighteen would be in active service in another year. The most interesting in the list were the six thirty-knot boats, for which, in the matter of proposals and bids, the bidders had been given every possible latitude in design. With regard to the three boats for which bids were received last June, it was observed in examining the designs that three types were represented, the Thornycroft, the Yarrow, and the Normand. There was little originality shown in any of the designs. It was the desire of the chief constructor that the boats should be distributed between the three types, but because of incompleteness and price the bid on the Yarrow type was thrown out on the final settlement. The chair called on Mr. Yarrow to speak, and the renowned English builder was received with applause when he arose.

Mr. Yarrow proposed a vote of thanks to the author of the paper, which, he said, on its face evidenced a great deal of work and research. As Yarrow boats were referred to in the paper he would give some account of the performances of boats mentioned. The Entre Rios, a torpedo-boat destroyer built for the Argentine government, ran from St. Vincent to Buenos Ayres, a distance of 3,700 knots, on 130 tons of coal. This was 28 knots to the ton. In running this and three similar boats a gain of about 5 per cent in economy was secured by working one engine and one screw and disconnecting the other. The speed on the run out averaged 9 knots and the mean load carried was 80 tons. These boats had thicker plates and were consequently heavier in displacement than the ordinary torpedo-boat destroyer. The Injeniero Hyatt, built for Chili, ran to Los Palmas in five days at 12 1-2 knots an hour on a consumption of one ton for 60 knots. The entire run out of 11,000 miles was made with 185 tons of coal and 135 gallons of oil. Two days after the arrival in port, and without cleaning the boilers or making any preparations, the Chilian boat ran her official trial trip successfully. "I think one point that is worthy of the consideration of naval authorities," he continued, "is whether any steps should be taken to offer some protection to the machinery of the torpedo-boat or torpedo-boat destroyer from rifle fire or small shot, or shots that hit at a very fine angle. I imagine that it would be a very difficult thing to find any part of the boiler or engine room that could be pierced with a rifle shot without its hitting something that might possibly disable the boat, and therefore I think that it is not unreasonable to suppose that some reduction of speed might be worth being exchanged for some protection. As to the Kotaka, referred to in the pa-



per, that is a Japanese torpedo-boat which we built about ten years ago. The deck and the sides where the engine room and boiler room were, were protected by 1 in. plates, and this boat led the torpedo attacks, the two principal attacks that were made by the Japanese, one at Port Arthur, and the other at Wei-he-Wei, and there was a great gain by this protection. Of course an inch plate will do a good deal against anything like small arms. In the boats that we built for the British government for the Nile (there are eight of them), we used hard steel plates 3-16 in. thick, and they were proof against the Lee-Metford rifle at point blank at 20 yards. Suppose these plates were suitable for torpedo-boat construction and were increased to 1-2 in., with the reduction of speed for that increased thickness below what it otherwise might be, we will say half a knot, or further increasing the thickness at a sacrifice of a knot, it appears to me that it might be worth paying that price for. It is a matter for very serious consideration of naval authorities, I think, whether something of that kind should not be done. Of course in any construction like a torpedo-boat we have got to take a great deal of care that we do not have a rigid portion of the vessel and join it to a very elastic portion, suddenly. Whatever change in the elasticity takes place must take place very gradually. As regards the coal consumption, it may, perhaps, be interesting to know that between the locomotive boiler and the water-tube boiler there is a decided gain in favor of the water-tube boiler under the same conditions of trial. We have tried this very carefully, and that gain varies from 7 to 10 per cent in favor of the water-tube boiler. The author refers to the Russian torpedo-boats. He says that 100 boats were built by the Russian government very early in the torpedo-boat constructing age, and that they were built by different firms. They were all built by the Baltic Works, at St. Petersburg, of which Captain Casey was the head, and a very distinguished man he was. I suppose you are aware that the French on their trials use briquettes, and there is no doubt a very great gain by using the briquettes over any Welsh coal. These briquettes are made out of Welsh coal. The coal is washed very carefully and then amalgamated together. We have found when we have had a difficulty in getting a trial through with some Welsh coal, if we sent over for some French briquettes we very often got through without difficulty. The great advantage briquettes give for a trial is that there is no cleaning. This fuel is very uniform in its character and is made by the French government particularly for torpedo-boat work. There is one thing that you will find a difficulty in, and that is arriving at any comparison between torpedo-boat trials of different nations and different constructors. If one could only get everybody to agree to a certain standard of trial it would simplify matters very much in tabulating results. Of course the French trials have a great advantage in consequence of the use of these briquettes, and the English government will not allow us to use briquettes. In reference to any increase of speed, you will all agree with me that when increase of speed is only obtained by increase of size there is no very special credit in consequence, and I should like in touching on this part of the subject to refer to my friend, M. Normand, who is a very distinguished man, and a scientific man of a very high order. He has been particularly successful in obtaining speeds on small dimensions, and that is where the real credit in construction lies. A gentleman was referring to the speed of some of these destroyers, and of course I take it that the government has a certain amount of money to spend on vessels of this class, and it is a matter for consideration how they should get the greatest amount of defence or offence for a given sum. You will find that the difference between 27 knots and 30 knots means an increase of price of 50 per cent. Now, it does appear to me that, in many countries, it is extremely questionable whether the additional three knots is worth paying so much for, considering that you could get three 27 knot boats for what two 30 knot boats would cost."

Lieutenant William P. White, U. S. N., said a torpedo-boat when approaching a vessel or fleet would be compelled to reduce speed so the wave caused by the screw and bow would not be perceptible, and discover the position of the boat. Thirty knots was entirely in excess of requirements, except in the case of destroyers.

Mr. Wheeler asked Mr. Yarrow what advantages briquettes had over coal.

Mr. Yarrow: "I do not know if for a given quantity of coal or briquette we get any more speed. The briquette is much easier to handle and does not clinker over the bars. That is principally where the gain is."

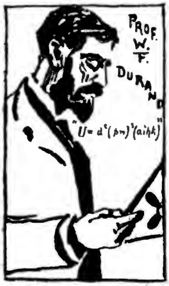
Mr. Swan inquired whether the "good economy gained in some of the French boats was due to the use of briquettes?"

Mr. Yarrow replied: "I am not aware that there is any more economy in the French boats than the English ones."

Mr. Swan: "As I remember the results, they certainly show a very unusual economy per horse power per pound of coal, and I thought perhaps it was due to that. It would be rather hard to weigh the briquettes and balance that weight against the weight of coal."

Mr. Yarrow remarked that he supposed they were "published" accounts, with an accent on the "published," and Mr. Swan responded that "they were."

C. D. Mosher said the matter of speed was often misjudged. The speed of a torpedo-boat on its official trial very much exceeded that which would be realized in practice with an ordinary crew. Thirty knots was not too high speed for a boat which had to keep out of the way of our fastest cruisers, in case the water was rough. If a reduction in speed due to the ineffiiciency of the crew and rough water were made it was a question whether or not a 30 knot boat, that did not exceed 200 ft. in length, could retain a speed of more than 23 knots in reasonably rough water. A 26 knot boat would not meet the requirements at all in practice. Recent experience everywhere had been to increase speed due to size largely, but much could be done on a smaller boat in the matter of speed. "We have only made a beginning as to the speed at which we can run the engines satisfactorily, and the number of cylinders used," he said. "I think economy can be carried very much further, beyond what has been done. Economy at the engines is of the greatest importance, for it reacts back on the size of the boilers and the coal consumed, not only for a short period of time, but throughout the entire mileage of the boat. If worked out, it will be found, perhaps, that an economy of 5 per cent in the engines may amount to 15 or 20 per cent increase of mileage of the boat." As to obtaining high speeds with small boats there was likely to be more progress in these than in larger boats. Few would experiment with large boats; but in the case of small yachts and launches things could be carried to an extreme that would not be attempted from a purely commercial standpoint. As to "fatigue" there was evidence, from the experience of eminent build-



ers in the reduction of vibration and other features of fatigue, which completely changed ideas that prevailed before these questions were gone into. By giving attention to vibration, taking care in the counterbalancing of the engines and distribution of weights, certain portions of the boat could be put under tension, or expressed differently, it would be possible to change the tune of the boat and reduce vibration very much. Not much had been done in this direction, though if investigation were carried far enough the evils of fatigue could be so reduced as to be an unimportant factor on very long runs at high speed. On high-powered boats which the speaker had recently constructed, vibration was so reduced that, except at the critical points, it was not noticeable by any tests, such as filling a glass to the brim with water.

Thursday Afternoon, November 11.

Chairman John C. Kafer called the meeting to order at 3:10 o'clock in the afternoon and announced further discussion on Mr. Gillmor's paper in order.

Professor W. F. Durand referred to the absence of data regarding "Power" in the paper. This was not the fault of the author, for such data was not obtainable. In order to obtain the best results it was necessary in designing to have comprehensive data covering the particular classes of vessels dealt with and drawn from vessels working under generally similar conditions. The step from data relating to Atlantic liners to the design of torpedo-boats could not be made, and data covering the torpedo-boat itself was absolutely necessary. There were great practical difficulties in the way of securing diagrams from these fast running engines, and contractors did not as a rule desire the encumbrance of persons taking cards on official trials. He desired, however, to call special attention to the lack of such data, and believed it would be well worth while for the government to obtain data regarding power subsequent to the official trials. The revolutions and general characteristics of the propellers were usually obtainable, but no judgment could be formed regarding the propulsive and general economic performances, without the important item of indicated horse power.

Chairman John C. Kafer had no doubt, should an emergency arise, harbor tugs would be equipped with torpedoes—a dozen of them—to attack any possible enemy. It would not make any difference if eleven of them went down, men enough could be found to do the work if the honor and emolument were made large enough. This was the experience during the civil war.

Mr. Gillmor in closing the discussion said, with regard to the warning of the coming of torpedo-boats on a ship, there was little experience from which to draw conclusions. In the case of the Ting Yuen timely warning was given by the pickets, but the boat which sunk the war vessel was within less than half a mile when she was discovered. He agreed with Mr. Yarrow as to the advisability of protection, but it was a matter for those who used the boats to decide whether it was worth the necessary sacrifice. The value of trained crews was shown in the performances of U. S. boat No. 6. Great difficulty was experienced in running with a crew composed of men from the builders' works, but after some of the crew of the Cushing assisted, a satisfactory official trial was possible. A torpedo-boat which on trial made 25 knots should be fully capable of repeating the performance with such a crew as she would have after being for a time in commission. He agreed with Professor Durand as to the necessity for power data, and in the absence of this, he had incorporated such data regarding machinery in his paper as make possible an approximation to results.

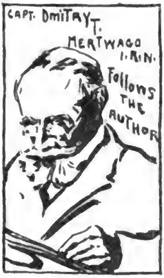
PAPERS READ BY TITLE.

In the absence of the authors two papers were next read by title. These were: "The Commerce of the Great Lakes," by Charles E. Wheeler, and "Progressive Speed Trials of the Boston Police Boat Guardian," by Professor Cecil H. Peabody.

INFLUENCE OF SURFACE ON SCREW PROPELLERS.

Professor W. F. Durand then read his paper on "An Experimental Study of the Influences of Surface on the Performance of Screw Propellers." This will be found in full, with the accompanying drawings, elsewhere in this issue. The discussion following the reading of this paper was along practical lines rather than an expression of critical opinion of the scientific investigations pursued by the author.

Chairman John C. Kafer said as to the propeller there was no one thing about a ship so little understood, but about which people thought they knew more. In making a propeller one particular to be borne in mind was not to have the propeller travel slower than the ship itself. "I always considered that the bow of a ship was resistance enough," he said, "but I have found a great many propellers where part of the propeller blade traveled at a very much less speed than the ship itself. This is due to the thickness of blade. While the driving surface of the blade would have ten, fifteen, or twenty per cent more pitch than due to the speed of the ship, the back of the blade had often much less pitch, so I have made many alterations in propellers. By altering the pitch near the hub, I made the back of the blade the same pitch as the speed that the ship was designed for so that it would travel along with the speed of the ship and have a beneficial influence." He then referred to the influence of surface, citing the case of the U. S. SS. Marblehead, Detroit, and Montgomery, which were identical in build. The engines of the Marblehead were built with great care and were expected to give more power than the others. There was a premium on speed, and the propeller for the Marblehead was given a little more surface than that for the Detroit. The result was remarkable, as with the same power they could not get the same speed, and a substantial loss of bonus money was the result. This was entirely due to increase of surface, for the Marblehead was a better boat under ordinary circumstances. On trial the other vessels got more speed with less power. Calling attention to Professor Durand's method of measuring thrust, he said, Mr. Mattice when in the Navy designed a loose thrust block with a hydraulic balance so that an indicated thrust could be got at all times when the ship was under way. It would be a desirable addition to all vessels of the navy. He then referred to recent experiences connected with the construction of three merchant steamers by his firm. These were the Yorktown, Jamestown, and Princess Anne, of the Old Dominion line. The latter had 250 tons more displacement and 2 ft. more beam and yet required less power and less coal per trip by about 7 to 8 per cent. The real cause of this had not been discovered, but he believed it was attributable to wave formation. The propellers were identical, so that comparisons of ships of almost the same size, with similar or different propellers, were not entirely reliable in determining which was the better propeller. He said Mr. Yarrow's plan was to make five or six propellers for each boat and try the one thought to be best suited. If the speed was got with the first propeller the others were discarded.



Dr. Charles E. Emery: "A boat built, say, in Philadelphia, will come to New York, and a man after watching her will agree to do much better by putting on a new propeller for so much money, and will probably do it. The power which is developed by the machinery has a great deal to do with it, and the changes in speed may be due simply to the fact that the boiler steams more freely and the engines can make a few more turns. It has nothing more to do with the propeller and yet it has much to do with the particular boat. Or if the boiler does not steam freely a little more pitch relieves the boiler; they do not have to fire as hard and the boat does better—less coal is wasted and the boat is more efficient."

Mr. Newman was of opinion that the distribution of surface was a very important factor in propeller problems and cited the trials of the British war ship "Iris."

F. L. Du Bosque said the amount of work done by the author was enormous and he deserved the encouragement of the society in conducting his research.

H. B. Roelker had also seen boats come here from Philadelphia which had shown good speed with narrow blade propellers. Here, however, they were too slow for practical service because they could not be handled quickly. They were boats built for making many river landings and it was found necessary to nearly double the width of blade. An uncouth looking propeller was the result, but the time between points was reduced by about an hour and a half, as stopping and starting at landings was more quickly done. Old river men were apt to insist on very wide blade propellers for just these reasons. Narrow blade propellers gave very high efficiency, and where it was possible to choose diameter a two bladed very narrow propeller gave greatest efficiency.

Professor Durand in closing said his purpose had been simply to ascertain certain facts, and he hoped that the data here presented, with more of a similar character which he hoped to be able to derive in the future, would be of aid in the exercise of engineering judgment. In the experiments before the society he had kept the shape of the blade constant, choosing the elliptical contour, though there was no special virtue in the ellipse. No attempt had been made to put the formula in ready shape for design, as it seemed inadvisable at this time. If able to complete the investigation he hoped to present the data by means of formulæ. As to how accurately that would represent the conditions in large propellers depended upon how accurately model experiments might represent the actual performances of large boats. There was a large amount of model data in Froude's paper which related to the determination of the values of the coefficients h and k in the paper under discussion. It was possible by reasoning and the use of existing data to obtain approximate values of the regarding both amount and distribution. It would be unfair to the original experiments of Mr. Froude, however, or to any similar experiments, to force the data very far away from the conditions under which they were taken. It was possible, however, to depart slightly from the elliptical form of blade, and from the area, and reproduce satisfactorily the conditions of Froude's experiments. He referred to two such formulæ; one a formula by Robert Caird in the proceedings of the Institute of Engineers and Shipbuilders of Scotland for 1895, and the other presented to the society last year by Professor McDermott. The first did not take care of the variations of a and l. That of Professor McDermott took account of the variations of area—the factor a—but variations of shape were not considered.

Dr. Emery asked if the author intended to make experiments to obtain the thrust with propellers of different sizes.

Professor Durand replied that every additional variable introduced meant several years' work. Personally he believed that this information was less needed than some other. It was possible to step with more confidence from the results of a propeller 1 ft. dia. to one 2 ft. dia., or from one 2 ft. dia. to one 5 ft. dia., than to step from a shape of one kind to a shape of another kind, or from an area of one kind to an area of another kind.

F. L. Du Bosque related an experience with shape in a ferryboat. Wheels of the Delamater type failed to give the required speed by a mile and a half. These were changed for wheels of the Thornycroft type, with blades bent far aft and with the greatest area near the center of blade. With these of seven inches less diameter, and about 38 per cent surface, a mile and a half more speed was obtained with a slightly increased horse power.

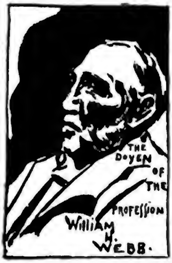
Professor Durand: "All my study of the matter both practical and theoretical leads me to place the highest importance on shape of blade, and from such data as I can obtain and such theoretical indications as we are able to arrive at, it is evident that the performance of a propeller will depend in high degree on the shape of the blade. The shape has here been kept constant simply in order to vary the area alone." He further expressed appreciation of the dependence of performance upon diameter, but insisted that where all other characteristics remained unchanged the step from one diameter to another could be made with more readiness than other changes, by the proportionality of the square of the diameter as expressed in the formula of the paper: $U = d^2 (pn)^3 (a\ l\ h\ k)$.

Friday Morning, November 12.

Many members who had not been present on the first day were in the hall when Vice President William H. Webb took the chair at 10:40 o'clock in the morning. There were several absentees, however, so that the attendance was about the same as at the opening session. Mr. Webb called Colonel Edwin A. Stevens to the chair in the absence of John C. Kafer and the reading of papers was resumed.

NOTES ON THE NEW BATTLESHIPS.

"Some Notes on the Speed Trials and Experience in Commission of Our New Battleships," was the title of the paper by Chief Constructor Philip Hichborn, U. S. N., which in his absence was read by Assistant Constructor Frank B. Zahm, U. S. N. This is a brief statement of the behavior of the battleships Indiana, Massachusetts, Oregon, and Iowa, which, the author explains, should be regarded as "notes" in the absence of full data with which to prepare an exhaustive paper. The trials, however, have been sufficient to demonstrate the compliance of the vessels with contract requirements and their value as vessels of war. To the paper is appended an interesting table of estimated and actual weights of the battleship Iowa, which show that the net finished weight of the ship, with her designed coal, at normal displacement, was within 20 tons of the original estimate—the total finished weight being 11,127 1-2 tons, and the original estimate 11,108 tons. Owing to changes made during construction an exact comparison of some of the details of estimated and finished weights is not possible. The record of finished weights shows a total of 67 tons greater than that corresponding to the actual displacement of the ship. This, the author explains, is accounted for by small scrap, by trimming of wood



work, loss of paint, and drying out of water contained in cement.

William H. Webb said he had experience in building large vessels and none was fitted with bilge keels. Half a dozen bilge keels would not prevent a vessel rolling unless they were large enough to seriously interfere with the speed of the vessel. He believed they were of little, if any, value, for if the model was not right no number of bilge keels would make it right.

Naval Constructor Joseph H. Linnard, U. S. N., said one point specially noted in the paper was the inadequacy of the trials. Ships were so badly needed when ready for commission that sufficient time could not be allowed for exhaustive experiments. The society should endeavor to impress upon the authorities the advisability of making exhaustive trials to determine the nautical and military qualities of each type. The wave profiles of the Indiana and Massachusetts, at speeds of about 13.75 knots, which accompanied the paper, showed a considerably greater wave disturbance for the Massachusetts than for the Indiana. The probable reason for this difference was the impracticability of obtaining accurate measurements of speed during the runs up the coast when the profiles were taken. Probably the speed of the Massachusetts was appreciably greater than the Indiana when the respective observations were made. As the ships were very bluff ships with full model, and not designed for high speed, the wave disturbance increased very rapidly with a small change of speed. The tendency in modern warship design was toward increased speed, and the speaker quoted M. Normand, who believed that, with the exception of fleet scouts and seagoing torpedo-boats, too much had been sacrificed for speed. The United States battleships had been criticised because they had not the speed of battleships of other nations, but the responsible designers seemed to be satisfied, as no material increase of speed was contemplated in the latest designs. In future, battleships would not likely be fitted with unbalanced turrets. The experience with the Indiana and Massachusetts showed that the position of the center of gravity outside of the center of rotation caused many inconveniences, not only in a seaway, but in the design of turning gear and other features. The balanced turret of the Iowa had proven eminently satisfactory. While it was true that it was necessary to overhang the rear end beyond the barbette, which had been objected to on account of the danger from shell explosion under the overhanging part, it should be remembered that this part was turned away from the enemy in action. The turret guns could be loaded in any position. As to bilge keels referred to by Mr. Webb, when fitted on the Massachusetts they had an obvious effect, and the British had had similar experiences. Bilge keels were, of course, a great annoyance, but on the five battleships now under construction a new design was being fitted. This consisted of a combination of docking keel and of bilge keel. In the center parts of the ship a wooded keel was fitted extending down to the level of the outer plate of the main keel, and placed at a sufficient distance from the center line as to support part of the weight of the ship when in dock. As the docking keels would be entirely too deep at the ends, there were placed at the ends, on each side, fins of the usual style of construction of bilge keels. These fins did not extend beyond the line of the midship section, so they would not be in the way in entering dock. While not as extensive as ordinary bilge keels, it was believed they would be effective, as experiments carried out recently in England showed unexpected value was obtained with shallow bilge keels. As superintending constructor of the Iowa it was a source of great satisfaction to the speaker that the designed weights so closely approximated to the actual. During the building there had been unanticipated increase of weights. After the battle of the Yalu river metal was largely substituted for wood, and all wood was ordered fire proofed, which perceptibly increased its weight.

Naval Constructor Francis T. Bowles, U. S. N., said the paper was practically an invitation to criticism of the battleships, and the absence of criticism from the officers who had had experience in them at sea he judged to be a matter of congratulation.

Lieutenant William P. White, U. S. N., agreed that the paper was a bid for criticism from the standpoint of the officer who goes to sea. They fully realized the limitations which the designers had been under in regard to draught and other dimensions, and that a compromise was necessary. Although they did not criticize the lack of speed in the battleships he was not ready to acknowledge that the speed arrived at—16 knots—was sufficient if more could be got. Unfortunately there were too many sacrifices in other directions, and if more speed was to be sought it would be at the expense of protection and weight of armament. Too many sacrifices had already been made and too small a limit in coal carrying capacity. Given opposing fleets, equal in every other respect, the faster had a decided advantage.

Naval Constructor John G. Tawresey, U. S. N., believed the comparison between designed weights and the displacement of the vessels a matter for congratulation. It was a common case to find the required weights, upon completion of the vessel, very much under the displacement. At first sight the reader would be at a loss to account for the excess of 67 tons. This was actually "small scrap," as all items of scrap of appreciable weight were weighed and deducted. In determining the displacement of the ships the actual density of the water in which they floated at the time the draught was taken was allowed for.

Alexander J. Maclean inquired if the "estimated weight calculated" was obtained from a known war vessel or from the drawings, and whether the center of gravity was in accordance with the designs.

Naval Constructor Joseph H. Linnard, U. S. N., in reply, said the "estimated weight calculated" was obtained by the usual process: as far as possible from the drawings, and otherwise it was estimated by comparison with other ships. The metacentric height of th Iowa came out within four one-hundreths of a foot. The designed height under conditions of normal draught and with certain coal on board was 4.27 ft., and the actual metacentric height, as determined under the same conditions, was 4.23 ft. As to the speed question he cited the results of a series of games at the Naval War College. In these a fleet of 12 vessels of 12 knots speed opposed a fleet of 11 vessels of 14 knots speed and defeated it badly. It was thus demonstrated that in a fleet action the value of two knots extra speed in a fleet, obtained under actual designing conditions, with a consequent decrease in the other effective qualities of a vessel, was not worth one ship in twelve.

Lieutenant White, U. S. N., in reply, said in the War College games one side had one move by which to know exactly what the ships of the opponent would do, and under such circumstances the advantages of speed were not nearly as great as in battle, when neither side knew how the other would maneuver.

Assistant Constructor Frank B. Zahm, U. S. N., said it would be a matter of much regret to the Chief Constructor that seagoing officers were not present

to discuss the paper, especially as so many ships were now at the New York Navy Yard.

Colonel E. A. Stevens, from the chair, announced that the paper on the "Performance of Scotch Boilers and their Durability under Forced Draught," by Edwin S. Cramp, had not been handed in. The next paper on the list was on the "Use of Water Ballast for Colliers in the Pacific Coast Trade," by William P. Frear.

USE OF WATER BALLAST.

As the author was not present the paper was read by Mr. King. It deals with several types of vessels used in coal carrying between the Puget Sound district and southern ports, the return trips of these vessels usually being made without cargo and with water ballast. During eight months of the year the return trips are made against strong northwest winds and head seas. The paper deals with particular vessels, including the spar deck, partial awning deck, whaleback and Doxford turret types. Various structural damages sustained by the ships while sailing light, from racing, pounding, and rolling, are narrated by the author, who is of opinion that there should not be less water ballast than one-quarter the dead weight capacity of the ship, and if she is unusually full or club footed forward one-third would be the more desirable proportion. Diagrams accompany the paper showing ballast tanks located on the main deck as well as in the bottom.

The discussion on this paper was brief. Lieutenant W. P. White, U. S. N., favored the French naval practice of putting a long protruding snout to seagoing vessels. He told of an experience while on the Olympia, steaming against a very strong southwest monsoon. A French cruiser of the Jean Bart type, with high freeboard forward, was able to maintain a 12 knot speed, while the British cruiser Crescent had to slow down, and the Olympia also. The latter had been running at 21 knot speed, but took a sea over the bow, which very nearly crushed in the forecastle, bending stanchions, and distorting beams.

Attention was now given to a supplementary list of names of persons which the Council recommended for membership. This list, as read by Secretary Bowles, included:

Members—William B. Beckley, Charles B. Edwards, Louis W. Walker, and Andrew Wood.

Associates—Harrison B. Moore, Henry G. Barbey, Joseph Barre, William Boyd, Hazen J. Burton, Oswald Sanderson, Joseph F. Tams, Charles E. Wheeler, T. C. Zerega, Ridgely Hunt, U. S. N. (Ret.) and Henry M. McLaud, Halifax, Nova Scotia.

The recommendation of the Council was carried unanimously.

Friday Afternoon, November 12.

At 2 o'clock Member of the Council John C. Kafer again called the members to order from the chair, and announced that in the absence of Professor George R. McDermott, the paper entitled "Estimated Weights of Machinery" would be read by Professor Durand.

ESTIMATED WEIGHTS OF MACHINERY.

The formulæ presented by the author represents the work of many years of business life, during which he had gathered recorded detail weights of machinery of more than 300 vessels, embracing all types to be found in both warship and mercantile fields of service. The formulæ is classified under these leading divisions: (1) Engine room weights. (2) Boiler room weights. (3) Shafting weights. (4) Propeller weights. Further subdivisions include naval and mercantile vessels and both paddle and screw machinery. Tables accompany the paper giving the leading particulars of machinery of a selected number of typical vessels, both war and mercantile.

By way of comment, Chairman Kafer, after the paper was read, said he would take exception to some of the formulæ given, naming that which applied to the weights of engines. In this D was incorporated as a factor, D representing the sum of the squares of the diameter of each cylinder directly connected to cranks. Then the author extracted the square root of that, which brought it down practically as a factor to the diameter of the cylinder, so that a cylinder of double the diameter would mean double the weight, whereas the area of cylinder heads and the pistons would vary as the square of the diameter if they were the same thickness, and it was a well known fact that where the distance between the support was greater, the thickness and strength of the various parts would of necessity have to be greater. So, for engines of the same stroke, the area, and consequently the weight, must vary as the square of the diameter. From his own experience, and from a number of engines he had tabulated and arranged, and from many calculations he had made as to the weight of engines, he always used the square of the diameter of the cylinder, making the factor the mean of the diameters of the three cylinders of a triple expansion engine, or the mean of the diameters of the two cylinders of a compound engine. In his experience, the weight of engines varied very nearly as the square root of the length of stroke, because an engine is built to withstand pressure, the stress varying as the square of the diameter of the cylinder, and the area of piston rod, the connecting rod, the crank and crank shaft varying proportionally. The walls of the larger cylinder, with the same thickness, would vary directly as the diameter, but it was a general practice to make the walls of the large cylinder very much thicker than the smaller cylinders, not so much for strength as to preserve rigidity. Thumb rules, the result of experience, were used in building engines, and it was largely a question of judgment. No one could tell whether a little water might not come over with the steam and create havoc. In torpedo boat engine design the cylinder heads were made so light that they would spring, and yet the designer, while saving this small amount of weight, would invite a number of persons on board during a trial trip whose total weight would approximate to the weight of the entire engines. It seemed foolish to reduce the weight of any particular part of the engine where there was likely to be an accident due to improper condition of the steam. With reference to Scotch boilers it was unnecessary in the ordinary type of boiler to go into much detail with regard to approximate weight. All boilers varied as the squares of their diameters, in the main, because the thickness and surface varied directly as the diameter. The heads vary as the squares of the diameter, because they may be, approximately, of the same thickness in a small boiler as in a large boiler. The number of tubes and the interior of the boiler—the socket bolts and other details—also vary as the square of the diameter, and multiplying by the length and by the steam pressure, and using with this formula a factor of about .22 in some cases, the approximate weight could be found.

Colonel Edwin A. Stevens said, in designing machinery, after the power was determined the next deduction was the number of square feet of heating surface. It was easy enough to select out of published trials the units generally given. The number of square feet per indicated horse power was an easily accessible quantity. The easiest way to get

weight was on the basis of square feet of heating surface. He suggested that Professor McDermott add to his paper formulæ applicable to water tube boilers.

Mr. Newman believed that in working out weights the most satisfactory method was to arrange the engines in types. Experience showed that in the engines for battleships 12 to 13, or even as high as 16 indicated horse power, could be got on a ton of weight, of engines, boilers, and all. In H. M. S. Nile 16 had been secured. In later vessels heavier boilers had been used. In British crusiers of the Blenheim class 12.8 was the figure attained, and in the torpedo catchers Sharpshooter and Salamander 20 to 23 indicated horse power. In the machinery of an ordinary tramp steamer 6 to 7 indicated horse power per ton of weight was considered good. High speed passenger vessels more closely approximated to naval conditions. He advocated the use of cast steel in place of cast iron to keep down weight.

Mr. Roberts related his experience with heating surface. Years ago in several horizontal tubular boilers, set in masonry, the tube ends became thin. He cut off one course of shell plates, cut off the bad tube ends and set back the head, making the boilers 12 ft. long instead of 16 ft. The result was more steam, greater economy. Judging from this experience it would be difficult to estimate the weights of boilers, taking H. P. into consideration, by the heating surface.

Mr. Cowles suggested: "If you increase the efficiency of the boiler by cutting off 4 ft., you might cut off 8 ft. and increase it still further?"

Mr. Roberts, in response: "Supplement that by increasing the length of the boiler to double what it was originally, thus doubling its capacity according to the general method of valuing boilers by the heating surface irrespective of grates."

A. J. Maclean, in his experience in British shipyards, had found that engine builders differed very considerably in estimated weights, and as to the center of gravity, that was never given correctly. Each engineer had his own way of putting in different material, and one hard and fast formula was not satisfactory for all kinds of machinery.

Mr. King called attention to the lack of data about marine beam engines. The author had classified paddle engines into oscillating and inclined engines and had entirely ignored the beam engine. The speaker had felt the need of such data in practice. In his preliminary work in design he had always calculated engine weights on cylinder cubic contents, and boiler weights on cubic contents also. In a multiple cylinder engine it was not necessary to consider the capacity of all the cylinders, a more ready method being to take the capacity of the low pressure cylinder and have a separate co-efficient determined for a triple, compound, and a single engine, of standard types. The formulæ furnished by Professor McDermott would have to be used with discretion, as a source of error would be that the data given was largely determined from big engines. He did not suppose that, for example, the figures given would be applicable to a tug boat engine without a considerable allowance. In small engines castings were considerably thicker than they would be if proportioned from the larger engines. The foundrymen insisted on this. The formulæ also took into account the engine room weights outside of the main engines. Actually the weight of floor plates and other paraphernalia about the engines would be much greater in the case of the smaller engine. As to boiler formula he did not think the author took account of the great range of pressures in use. The figures were drawn simply for triple expansion engines, with a pressure of 160 to 165 pounds, but the author had taken into account the heating surface and size of furnace. These the speaker regarded as immaterial in making up weights. Steam pressure was more material, and it was convenient, and within practical limits, in the case of the Scotch boiler, to take the cylindrical contents and have a coefficient for the several pressures—160 to 165 pounds for triple expansion, 110 pounds for compound, and 60 pounds for single engines.

Stevenson Taylor, speaking to the references to the beam engine, said it needed no defense. From the standpoint of the engine repairer this engine was not as good as many others. His firm had just made a contract for a beam engine for parties who had purchased a beam engine of them about 16 years ago. This engine the owner considered "first class," as in all the time it had been running the cost of repairs did not amount to $500. His experience with weights had been peculiar, in that the firm never built two boats alike, unless two were built at the same time for one purchaser. He had, moreover, much available data and with the aid of a good memory could readily make weight approximations without the aid of any special table or formula.

Professor Durand replied briefly, in the absence of the author, that the paper was the result of many years investigation, and the forms used had only been adopted after long consultation, in which the speaker had participated. He suggested to those who preferred to make estimates on the basis of so much weight per indicated horse power, or so much heating surface, or other proportion, that they would find all necessary data in the tables attached to the paper.

PNEUMATIC STEERING GEAR.

"Pneumatic Steering Gear as Applied to the U. S. Monitor Terror," by H. A. Spiller, was read, in his absence, by Secretary Bowles. This describes an installation of a direct steering gear in which two athwartship cylinders are used with pistons attached to the same rod, which carries at mid-length a slotted head fitted with brasses permitting the sliding of the tiller as its angularity changes. The cylinders are situated to starboard and port. A pressure of 125 pounds per square in. is available in the steering cylinders, and this is supplied when under way by one of the main air-compressing engines of the ship, which is run at 4 revolutions per minute. Steering is effected from the chart house or the forward turret by the use of the ordinary power wheel, connected by wire ropes with a pneumatic valve in the tiller room, or by a handle for controlling an electric motor which operates the pneumatic valve. Telltales are also fitted to show the helm angle. The gear has been in regular use on the Monitor since April, 1896.

John G. Williamson criticized the operation of the rudder direct without any intermediate gear. The movement direct from piston to tiller made a very rank movement and consequently the quartermaster would have to have much experience with the apparatus to make it steer as finely as with the steam steering engine. The common proportion of movement of piston in the ordinary steering engine to that of the end of the tiller or quadrant was about 16 to 1, so it did not require the same care to steer finely as with the direct movement. The latter had been used before both for hydraulic and pneumatic steering, but the objection to the rank movement had caused such gears to be replaced by steam engines. He had noted that the least time from hard over to hard over in the Terror was 4 seconds. This was a very dangerous speed, and greatly in excess of what it should be for the safety of the rudder and connections. The common practice in river and coasting steamers was from 10 to 20 seconds, according to size and speed of boat. The specifications for naval vessels called for 20 seconds from hard over to hard over and even this speed was nearly double that of the transatlantic liners Campania, Lucania, St. Louis, and St. Paul. In these the time ranged from 35 to 40 seconds. On the SS. St. Louis the steering engine was originally proportioned for the speed of 20 seconds, but after months of service this was altered to the slower speed of 35 seconds. The theory that the rudder should be made to go hard over as soon as possible to steer quickly was not correct in practice, as it not only retarded speed, but was dangerous to rudder and connections. If the rudder could be brought hard over instantly, the vessel would require time to overcome the inertia before the stern would move, and then the movement would be gradual; so that by giving a gradually increasing pressure on the rudder it would give us good a resultant and much less danger.

Lieutenant William P. White, U. S. N., spoke of the advantage of compressed air in place of steam on account of the heat from steam pipes, which made hot houses of certain compartments and was very trying on the men, especially in the tropics. Compressed air could also be used for handling turrets and ammunition, an advantage steam did not possess.

Naval Constructor Joseph H. Linnard, U. S. N., said the main objection to steam steering gear seemed to be on account of heat produced and not because it was not thoroughly satisfactory in operation. This objection could be removed by putting the air compressing engine in the engine room and piping air instead of steam to the steering engine. He had no doubt of the success of the pneumatic gear on the Terror, but this arrangement could not be adopted on some of the modern fine steamers as it occupied too much room. The ordinary steam gear was very durable and worked effectively even when receiving almost no care, for months at a time.

Mr. Newman considered the apparatus excellent, but had found that its cost was nearly twice as much as the steam steerer. He quoted Mr. Linnard as advocating the placing of a compressing plant in the engine room.

Naval Constructor Linnard, U. S. N., interrupted to say he had expressed no opinion as to the "advisability" of doing so.

Lieutenant William P. White, U. S. N., got the floor again to speak about the rapidity of action which had been criticized by Mr. Williamson. "The Terror being a flat bottomed monitor, having very little hold in the water, is very dilitificult to steer." he said, "and it is necessary to have a very quick acting rudder in order to go from one helm to the other. The helm is not shifted in any such time as would be indicated by the experiments, that is only the speed which can be obtained. * * * * We know that it takes some appreciable time for a ship to start after the helm has been put over. Sometimes the helmsman puts over his wheel and the ship does not seem to start. He looks at the compass and it may be a bit sluggish and he takes another turn, and the first thing he knows, if he is not an experienced helmsman, the ship is going off at almost a tangent from its course. Then we want to right the helm as soon as possible. Speed of movement to get the helm back to midship position is very desirable. You cannot get it back too quickly, you can put it over too quickly."

Colonel Edwin A. Stevens, speaking of vessels in inland waters, especially ferryboats, said the objection to the direct application of the piston to the tiller was the uncertainty as to where the helm would stop. In harbor work it was absolutely necessary to know where the helm would stop, and in all experiments he had known, except in some small craft, the direct action in the quadrant or tiller had been abandoned in favor of some other method by which a short stroke engine could be used. The old fashioned way of heaving over the wheel by hand had to be reproduced as closely as possible. The prime necessities in inland waters were: certainty of action and reliability of gear. Speed while desirable and even essential was secondary to certainty, and he did not know of any gear in which certainty had not been attained which had met with any success at all.

F. L. Du Bosque desired to emphasize Colonel Stevens' remarks about the necessity for "certainty" in ferryboats. The present steering engine, however, was very expensive on steam consumption. The power of the engine was made to greatly exceed the power required for turning the rudder so as to make it sure, and the gear used for applying the reciprocating engine was very wasteful. It was generally recognized that a direct application to the tiller was desired—the ability to steer quickly. Owing to condensation this was not possible with steam as a medium, for the tiller could not be held in the position it was placed in. With air this was possible as there was no condensation. Another present source of waste was that the steam engine was sufficiently powerful to pull the tiller, say, in the range of 32 to 35 degrees. It possibly took only one-tenth of this power to pull the tiller from 1 to 10 degrees, and the power was not applied proportionally to the amount used.

William B. Cowles believed that the question of additional expense attending the installation of an air compressor need not apply to a warship. A battleship was full of auxiliaries, and land practice might be copied in the working of these, to the extent of placing a plant in the engine room which would supply power to all points. By constructing a suitable reciprocating engine to use air it would then be possible to continue the present type of steering gear.

Chairman John C. Kafer, in further discussion of the paper, said that if air was used instead of steam in the ordinary steering engine, as had been mentioned, it would simply add another machine to accomplish the same purpose. "If you wish to pay twice the price for the same object, you are perfectly at liberty to do so," he remarked. "As to heat, steam pipes can readily be covered so as not to radiate much heat, and the steam steering engines now in use are perfectly satisfactory. With a very small motion of the piston of an ordinary steering engine the vessel can be kept straight very easily. In sound steamers a man can move the wheel with his finger and the helm follows the finger and stops with it—does not go any further. With a pneumatic gear attached directly to the tiller, whenever you allow the air to exhaust you must reduce the pressure, and that air is gone for good. The excess of pressure on the other side will force the piston over until the valve opens again and admits air on the opposite side, and thus it requires a great deal more air to do the same work, than would be equivalent to the amount of steam used in an ordinary steering engine. The question of cost is really immaterial, because the absolute cost of running the steam steering engine is very small as compared with the amount of steam used in the main engines of the ship, and the great advantage desired is certainty of action. As to elasticity, the ordinary ropes that are used to pull the helm over answer the purpose and are positive in their action."

NAVY YARD EXPENSES.

"Navy Yard Expenses," by Naval Constructor William J. Baxter, U. S. N., was next read, at the request of the Chair, by Mr. Tawresey. The author opens by stating there is no fixed standard by which to judge the expenses of navy yards, because the conditions are so dissimilar to those existing elsewhere. The output of navy yards is generally believed to be very costly, but a consideration of facts will show that the total cost of navy yard work has been less than supposed, and even this difference has been due to conditions now disappearing and which may vanish in the future. Present differences are mainly owing to higher prices of labor and material, lack of labor saving appliances, and, at times, to the exigencies of the naval service. While advocating the "carrying on of new construction in the navy yards at all times," the author expressly disclaims any suggestion "that warships should only be built in the navy yards."

Naval Constructor Francis T. Bowles, U. S. N., opened the discussion by stating his belief that war vessels could be built in the navy yards cheaper than elsewhere, but not under present conditions. Reorganization would be necessary to eliminate the system which made no person responsible and permitted no person to come in contact with those whom he had to deal with. In his experience of navy yard work he found that in the purchase of material, for example, he was not permitted to deal direct with the person who supplied the material.

Assistant Constructor Frank B. Zahn, U. S. N., believed there was no reason why the obstructions due to inefficient plants and insufficient funds should not be corrected, but administrative difficulties in the purchase of materials and like matters could not be easily changed, owing to the military status of the navy yard.

Lieutenant William P. White, U. S. N., spoke of the necessity for speedy repairs to vessels sent to the Navy Yards. There should be no difficulty in the military administration of the yards to prevent this. The officer in charge of a Navy Yard had not usually a sufficiently large staff to supervise the work in hand. Workmen who knew that a repair job would only last a few days took pains to nurse it, and this would not be possible under closer supervision. In order to retain an efficient force at the navy yard it was necessary to carry on sufficient work to make the work economical, and first-class workmen could not be hired for a few days and then laid off indefinitely. When a ship went to the yard to be overhauled the captain of the ship should be the judge of what work was absolutely necessary, and the carrying out of this work should be left in the hands of the navy yard officers.

Mr. Newman disagreed with the previous speaker. The captain of a war vessel was not fitted by practical or theoretical training to decide what repairs should be made. "I do not see how you can expect the captain of a ship to decide as to whether a ship requires repairs no more than you can expect a shoemaker to prescribe to you for the body," he declared.

E. Platt Stratton compared the navy yard to the frontiersman's pistol: "You do not want it often, but when you do, you want it terrible." In times of peace navy yards were not of much use, but in war time they would be needed badly.

Naval Constructor John A. Tawresey, U. S. N., said there was an impression that navy yard work cost from four to five times as much as work in private yards, which was not true. Frequently in doing work in a navy yard the question of what account it would be charged to was raised. So long as new work was going on money was available, and often when there was little money in the regular appropriation for the particular work in hand, charges were made against new work. He believed supervision of work in navy yards was as effectively carried out as in private yards. Repairs were costly in navy yards, as when working on a ship in commission the cost was increased by the presence and interference of persons on the ship, as compared with what it would be if the ship were out of commission. The system of placing inspectors in charge to build new ships economically had been tried and found to have an opposite effect.

Chairman John C. Kafer remarked that the author had proved that work in a navy yard cost a great deal more than work in a private establishment, and the speaker's own experience enabled him to concur in this. Work in a private yard must pay a profit while in a navy yard this was not necessary. He agreed with Mr. Newman that the captain of a ship was not the proper person to decide upon the extent of repairs. In a merchant ship this was decided by the representative of the owners, the underwriters, or some one in charge. If there was direct damage to a warship the captain could report what the damage was and recommend that repairs be made at a certain yard. It should then be the duty of the Naval Constructor at that yard to determine how, and to what extent, the repairs would be made.

Naval Constructor Francis T. Bowles did not want it to go forth that the navy yards had to be kept up at enormous expense, for the simple reason that they would be needed in time of war. There would not be much difficulty in organizing the navy yard so that work could be done more cheaply there than elsewhere.

Chairman John C. Kafer believed such results would never be accomplished until it was possible for the Naval Constructor to give orders by telephone, throughout the country if necessary, for whatever material was needed and to do work without interference and with full authority in the yard.

E. Platt Stratton moved a vote of thanks to the American Society of Mechanical Engineers for the use of the society rooms, and this was carried heartily. Then Chairman Kafer declared the meeting stood adjourned without date.

Steamer Ulster Goes Ashore in Hudson River.

On Thursday, November 11, at midnight, the Hudson River steamer Ulster, of the Saugerties and New York Steamboat Line, while on her down trip, ran ashore at Storm King, about one mile below Cornwall.

Her bow ran within five feet of the West Shore Railroad tracks, which are twenty or twenty-five feet from the water's edge. The passengers immediately went ashore and most of the freight was also taken ashore before 7 o'clock in the morning, when the tide came in, and partly filled the hull with water. She then slid back a few feet and sank, leaving the bow sticking on the rocks, exposing ten feet of the keel, while the stern was entirely submerged. A wrecking concern was instructed to take charge of the steamer, and before they could arrive with their wreckers, the Ulster had loosened herself and floated to West Point, where she collided with a sand sloop and again sank. Subsequently she was raised, pumped out and towed to Marvel's shipyard at Newburg, where she will remain this winter for repairs. Before the Ulster leaves this yard she will be practically a new boat, as the hull is to be thoroughly overhauled, and she is to have new joiner work throughout.

The Ulster is a sidewheel steamer 205 ft. long, 30 ft. beam, and 8 ft. draft. She is fitted with the regular type of condensing beam engine with 42 in. cylinder and 8 ft. stroke. She had one return tube boiler 19 ft. 8 in. long and 126 in. dia., fitted with four flues and 108 4 in. tubes, which are 12 ft. long. A boiler pressure of 45 lbs. per sq. in. is carried.

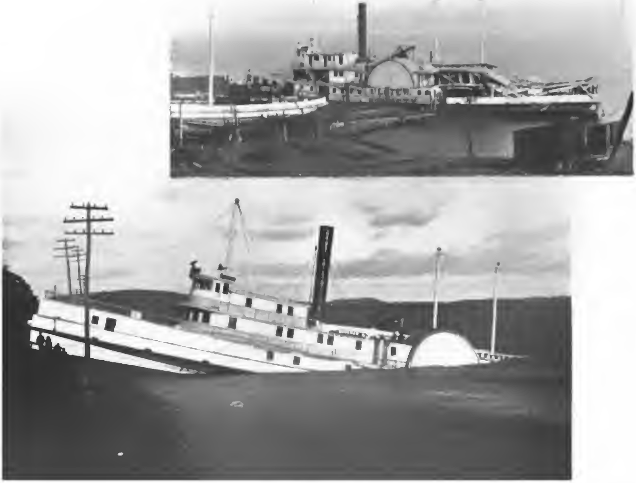
The hull is of wood and was built in 1892 at the Burtis shipyard, in South Brooklyn. The damage below the water line is as yet unknown, but it is known that the hull stood the strain remarkably well, as the boat, at present, only leaks slightly.

The engine and boiler were built in 1892 by McCurdy & Warden, in New York city, and do not appear to have been much damaged. The stern was very badly damaged, and the stateroom hall and ladies' cabin were completely destroyed. The damage is estimated at between $10,000 and $15,000.

Ezra Whittaker, the pilot, forwarded the following report to the local inspectors of steam vessels for the district of New York:

"I left Saugerties with the steamboat Ulster at 6 P. M. on Thursday, November 11, on our regular trip to New York, with freight and passengers. We made the usual landings and proceeded down the river. Charles Tiffany, wheelsman, was with me in the pilot house. A few minutes before midnight, when nearing Storm King, at the entrance to the Highlands, Tiffany brought me a sandwich, and I sat down in a chair and ate it, while he took the wheel. He then said to me: 'Cap, take the wheel a minute.' I arose and took my position at the wheel, and he stepped out, leaving me alone. In a very short time, probably not more than two minutes, I was seized with violent cramps, so severe that I was unable to stand up, and sank back into my chair. As near as I am able to judge it was about two minutes before I was able to rise and look-out, and at that moment the bow of the Ulster was about to strike the shore. It was too late to stop her or change her course, and she ran into the bank. Some time between the moment that I sank in my chair and the time the boat struck I was hit by the wheel in my back, breaking two of my ribs and cracking another."

We have pleasure in acknowledging the aid of Andrew Templeton, of Newburg, who took the very excellent photographs reproduced herewith.



VIEWS OF STEAMER ULSTER ASHORE IN HUDSON RIVER AND SUBSEQUENTLY AT YARD FOR REPAIRS.

A queer sucession of mishaps occurred to a 2,000 ton British tank steamer in the North Sea. While on a voyage from Philadelphia to Aarhuus with petroleum she went ashore in the Kattegat. The shock burst a tank and the oil poured into the stokehold and was ignited. The crew then abandoned the vessel and an explosion occurred shortly afterward, tearing a big hole in the side through which water came in and drowned out the fire.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—V.

BY WM. BAXTER, JR.

The general principles of the electro-magnetic action have been explained sufficiently in the preceding articles to enable us to proceed at this juncture to consider the manner in which these principles are applied in the actual construction of electric machinery.

The simplest form of electric motor or generator is that known as the two-pole type. Fig. 26, shows the appearance of one of the numerous machines of this class now upon the market. A diagramatic representation of this particular type of two-pole machine is shown in Fig. 27. The base, together with the uprights, on either side of the shaft, constitute the field magnet, commonly called the field. The extensions of the base in the direction of the shaft are not strictly a part of the field, as they play no part in the magnetic action, their only function being to support the shaft. The portion of the base between the uprights is generally made a solid, or nearly so, so as to afford a path of sufficient cross section for the magnetism, but the extensions that support the bearings are cored out leaving only as much metal as may be necessary to give the requisite mechanical strength. In Fig. 26, the wire through which the current that magnetises the field is passed is wound upon the uprights, as can be clearly seen from the cut: it is formed in two coils which are called magnetising coils. The portion of the base which connects the lower ends of the uprights is called the yoke, the portion of the uprights within the coil is called the core, and the portions above that, between which the shaft revolves, are called the poles. The cylinder upon the shaft, between the poles, is the armature; it is wound with wire, and this is caused to cut through the lines of force of the magnetic field, developed between the poles, by the rotation of the shaft. The small cylinder at the end of the armature, upon which stationary pieces are seen to rest, is the commutator, the office of which, as already explained, is to rectify the current generated in the armature. The parts that rest upon the commutator are the brushes through which the current is conducted to the external circuit.


FIG. 26.

Machines of the two-pole type are made in a great variety of forms, but they all operate upon the same general principles. In the early days of electrical development, nearly all machines were of this class, and as the theory of the subject was not very well understood, it was believed, by many, that modifications in the shape might lead to extraordinary results. Whether they did or not they gave inventors an opportunity to point out the difference between their machine and all others, and to claim a great superiority as a consequence of this difference. It would be a difficult, and in fact useless, task to present a full description of all the two-pole machines that have been brought to public notice, the great majority of which have no distinguishing features except their fantastic appearance; but as the vast number may be divided into a few distinctive types it will be well to illustrate the most prominent of these.

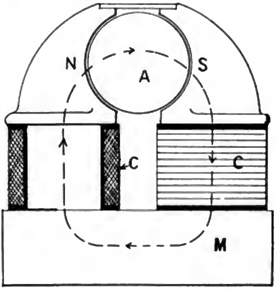


FIG. 27.

Fig. 27, as already stated, is the type to which Fig. 26 belongs; Figs. 28, 29 and 30, are three other types. Each of these can be modified in several ways. Thus Fig. 27, can be inverted so that the poles will be at the bottom and the yoke at the top; it can also be laid on its side, the outline of the various parts in these different positons can be changed to an almost unlimited extent, thus producing any number of machines having but a slight resemblance, but all substantially the same. The difference between the upright and the inverted modification would be greater than between any other, although the difference might not be noticed by those not familiar with the principles of electro-magnetic action. As in the inverted form the poles come directly on top of the base, the machine will not act unless a brass blocking piece is interposed between the two. As the base is made of iron, if the poles rested directly upon it the result would be that the magnetic lines of force would pass from the ends of the pole to the base, and

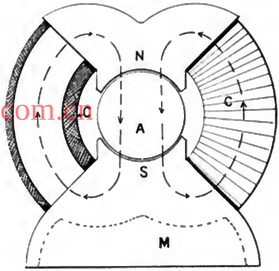


FIG. 28.

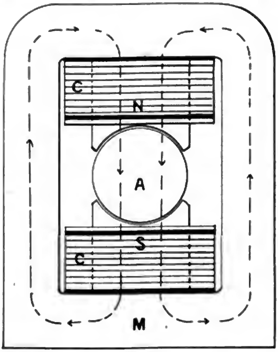


FIG. 29.

thus evade the armature. As the latter will not develope an electro-motive force, unless it rotates through lines of force no current would be generated. If, however, the poles are separated from the base, and the intervening space is filled in with a frame made of brass, the lines of force will nearly all pass through the armature, as brass, being a non-conductor will not allow the magnetism to pass through it with any more freedom, if as much, as would air. The Edison machine is the best known of the inverted modification of type Fig. 27 of two-pole machines.

The types shown in Figs. 28, 29 and 30, as can be seen, are very different from type Fig. 27. In the latter it will be noticed that the lines of force have only one path in which to circulate while in the other three figures, they have two. These paths are indicated by the broken line curves. So far as the magnetic circuits are concerned, the difference between these types is that Fig. 27 has a single magnetic circuit and the other three have a double magnetic circuit. Between Figs. 28, 29 and 30 there is still another difference. In Figs. 28 and 30 each magnetic circuit passes through a separate magnetising coil, but in Fig. 29, both circuits pass through the two coils, and, therefore, this type may also be regarded as belonging to the single circuit variety; for in that part of the machine in which the lines of force are developed, the two circuits emerge into one.

Whether the magnetism follows one or any number of paths after leaving the armature would make no difference if it were not for the fact that the magnetising force, that is, the amount of electric energy, and the length of wire required, is not the same with single and multiple circuits. The total magnetising effect of the electric current passing through a coil of wire is proportional to the area inclosed by the coil and the length of the magnetic circuit. If the length of the circuit remains the same, a given number of turns of wire in the coil traversed by a given current, will develop the same number of lines of force per square inch of cross section of the area within the coil, whether this area is large or small. To make this more clear, suppose the length of the magnetic circuit in Fig. 27, is the same as each one of those in Fig. 30, then to develop the same number of lines of force in each square inch of cross section of the core, in both machines would require the same number of turns of wire in the coils. That is each one of the coils in Fig. 30 would have as many turns as the two coils of Fig. 27 combined, for in this figure, both coils act upon the same circuit and, therefore, may be regarded as halves of one and the same coil. As the magnetising effect of the current is in proportion to the number of turns of wire wound around the magnetic circuit, it follows that the greater the number of circuits, the greater the current and wire required to develop the same magnetism. A coil ten inches in diameter will develop a total magnetism four times as great as a coil 5 in. dia., because a 10 in. circle is four times the area of a 5 in. one; but the circumference of the large circle is only twice as great as that of the small one, hence four times the magnetism is obtained with twice the electric energy, and double the length of wire.

Inasmuch as it makes no difference, so far as the amount of magnetising current is concerned, whether the magnetic circuits divide after leaving the coils or not, we may define single magnetic circuit machines as those in which all the lines of force that pass through the armature, also pass through each magnetising coil, and multiple circuit machines, as those in which only a part of the lines of force pass through each magnetising coil.

Although the single magnetic circuit machine can be magnetised with less current and less wire theoretically, practically the full advantage cannot in all cases be realized, owing to the fact that, as a rule, when two or more paths are provided for the lines of force these paths can be made shorter, and therefore there is a gain in this direction to compensate for the loss in the other. In the diagrams shown it can be seen that in Fig. 28, the length of the circuits can be made less than in Fig. 27, and this is also true of Fig. 30 although its circuits might also be longer than that in Fig. 27. The construction of Fig. 29, however, is such that the length of the magnetic circuits cannot be made as small as in Fig. 27, unless the coils are brought so close to each other as to overlap on the armature, and this is somewhat objectionable owing to the fact that the machine cannot be put together unless the field magnet is split in the center so as to be lifted off the top. Thus it will be seen that a very large portion of the advantage of single magnetic circuit machines can be lost if the design is such as to greatly increase the length of the magnetic circuits. The difference in the effectiveness of the magnetising coils is not directly proportional to the actual difference in the length of the path in which the lines of force circulate, owing to the fact that the resistance of all parts of the circuit is not the same. If the entire circuit were iron then its length would be an accurate measure of the number of turns of wire required to develope the required magnetism, but as part is iron and part air the case is altered. The resistance that air interposed in the path of the magnetic force is about 400 or 500 times as great, per inch of length, as that of iron. Therefore in making a comparison of the length of any two or more circuits, the air portion of each should be multiplied say 500 times, and when this is done it will be found that the iron part is possibly but a fraction of the whole. For an example suppose the length of the iron in Fig. 27 is 40 in. from pole S around to pole N, in the direction of the arrow head and through the armature 10 in., which would make 50 in. in all. Now suppose the distance from the face of the poles to the iron core of the armature is 1-2 in., then the total air space will be 1 in., and if this has a resistance 500 times as great as iron, it will be equivalent to ten times the length of the iron part of the circuit. Under these conditions an increase or decrease of say 10 in. in the length of the iron part of the circuit would only amount to an actual change in the length of the circuit of ten in 550, or about 2 per cent. If the air space is 1-5 in. instead of 1 in., the total length of the circuit would be equivalent to about 150 in., and then a difference of 10 in. would amount to about 7 per cent.

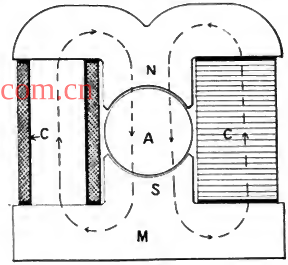


Fig. 30.

A sum of $100,000 is said to have been expended by Harland & Wolff, the Belfast shipbuilders, in preparations for the construction of the new White Star liner, Oceanic. Of this sum not one cent represented any work or material for the vessel. Among the improvements is included the erection of a powerful cantilever crane for handling the material over the ship.