1-inch pipe connections. No important deductions should be made from an indicator connected up in this manner, as the diagrams are inaccurate, especially if the stroke of the engine is long. On engines running with a steady load, such as a dynamo engine driving a ship's lighting plant, a very good correction can be computed by taking a diagram from each end of the cylinder with a short direct connection, and then

FIG. 47.

taking a set with the three-way cock and side pipe, and the difference noted. If this operation is attempted, care should be taken to have the steam, voltage and current the same when the cards are taken. In the case of small engines, the pipes should not be over ½ inch inside diameter, because the pipe adds to the volumetric clearance, and this in turn distorts the diagram. On large engines the pipes may be increased to 1 or 1¼ inches inside diameter with advantage, as such pipes tend to do away with friction and do not sensibly affect the clearance volume.

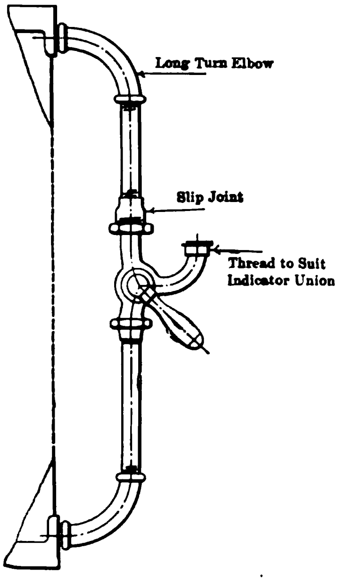


FIG. 48.

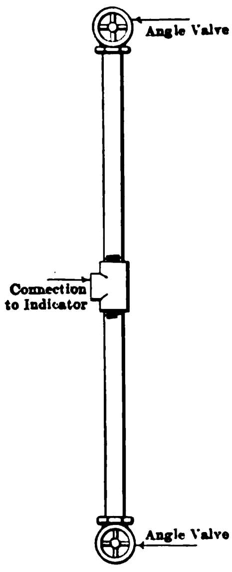


FIG. 49.

The arrangement should be about as shown in Fig. 48, the bends being as long and easy as practicable, and the cock located in the middle of the length of pipe. The arrangement illustrated in Fig. 49 is particularly bad, and should never be used. Either one of the angle valves may leak or be left partly open, and in any case the entire pipe has to be filled at each revolution. A diagram taken with this form of connection will indicate large clearance, deficient lead and obstructed steam ports when these defects do not exist. Brass pipe should be used in fitting up. The burrs caused by the pipe cutter should be removed with a reamer, and red lead paint and other kinds of pipe "dope" omitted. A small particle of hardened red lead or other foreign substance on the indicator piston will sometimes cut queer figures on the diagram. Oil should be used in making up the joints, and if the leaks persist they can be easily stopped by winding a strand of cotton waste in the pipe thread. The pipes and cocks should be blown through with live steam, both before and after connecting up, and the openings kept carefully plugged or capped after the job is completed.

(To be continued.)

THE U. S. COLLIERS MARS, VULCAN AND HECTOR.

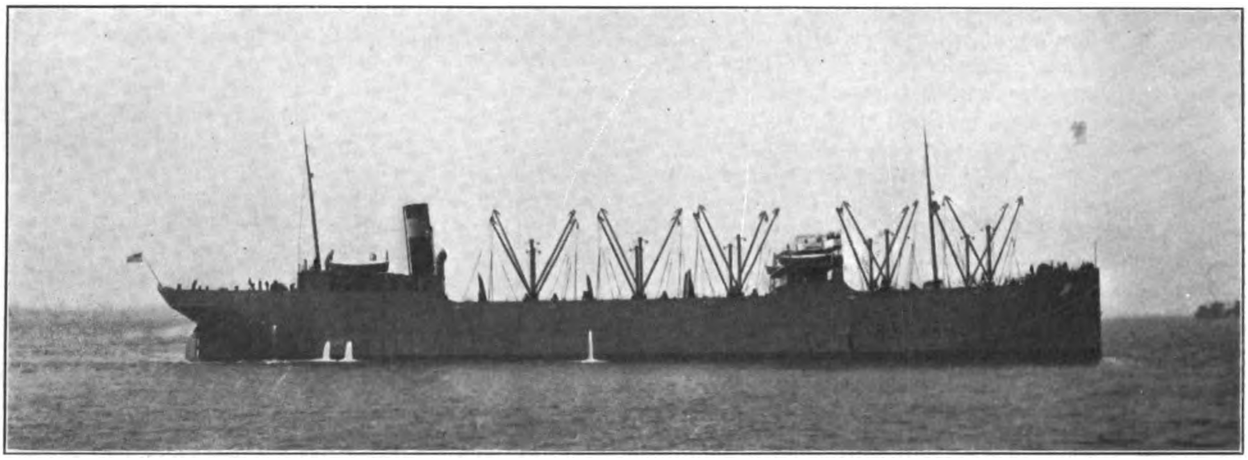
On May 13, 1908, the United States Congress appropriated $1,575,000 to buy three colliers, with a cargo-carrying capacity of approximately 7,200 tons dead weight each. The Secretary of the Navy being authorized to make the purchase, issued a circular stating the particular features required and the maximum time of delivery, asking for bids to be opened on June 1, 1908. The Massachusetts Steamship Company and several ship-building firms offered to furnish these boats, the Massachusetts Steamship Company being the only bidder who had the ships built and could deliver them immediately; the others were to construct them. These bids were all thrown out on the ground that they did not meet with the requirements of the circular and new bids asked. These were opened on Sept. 1, 1908. The Maryland Steel Company was the lowest bidder offering to build the three ships for $1,138,800 and to deliver then in ten, eleven and twelve months. These ships, the *Mars*, *Vulcan* and *Hector*, have just been delivered to the government by the above company after having satisfied the requirements of the contract.

They are single-decked self-trimming vessels, with poop bridge and forecastle, with a pilot house above the bridge, two masts and ten derrick posts; each having two booms, arranged to lift hatch covers and to handle cargo. There are ten large hatches with steel covers, especially fitted to be water tight. A double bottom runs from the after boiler room bulkhead to the forward peak bulkhead, and upper wing ballast tanks are formed in the triangular space between the deck and the side, outboard of the cargo hatches. The machinery space, containing four Scotch boilers, two triple-expansion engines and auxiliaries, is placed aft. The bunker coal is carried in longitudinal bunkers abreast the boilers and on the main deck around the boiler casing. A donkey boiler is located on a flat forward in the boiler room. Fresh-water tanks are in the engine room, while a refrigerating plant is located on the main deck aft. The officers' quarters are in the bridge house, the engineer's in the after-deck house on the poop deck, and the crew on the main deck aft. The forecastle contains the windlass engine and storerooms. The hull and machinery are constructed in accordance with the requirements of the American Bureau of Shipping for their highest class.

THE HULL.

The principal dimensions are: length between perpendiculars, 385 feet; length over all, 403 feet; beam molded, 53 feet; depth, 32 feet 6 inches; draft, 24 feet 6 inches; speed, loaded, 12 knots. The upper stem is bar steel and the lower cast steel, efficiently connected to the forward keel plate; the stern post is cast steel of channel section, with an opening for the propellers, and extends into the hull to efficiently connect with the keel plate. Hangers for the shafts are bolted to the main piece. The rudder is of the built-up type of wrought steel, connected to a 10-inch diameter extension stock by a flanged coupling bolted, the weight being taken by a bearing on the main deck.

The keel is a flat plate 36 inches by 35 pounds, the center keelson 22 pounds 48 inches high, connected to the keel plate by double angles 6 inches by 4 inches and to the tank top by



THE COLLIER MARS.

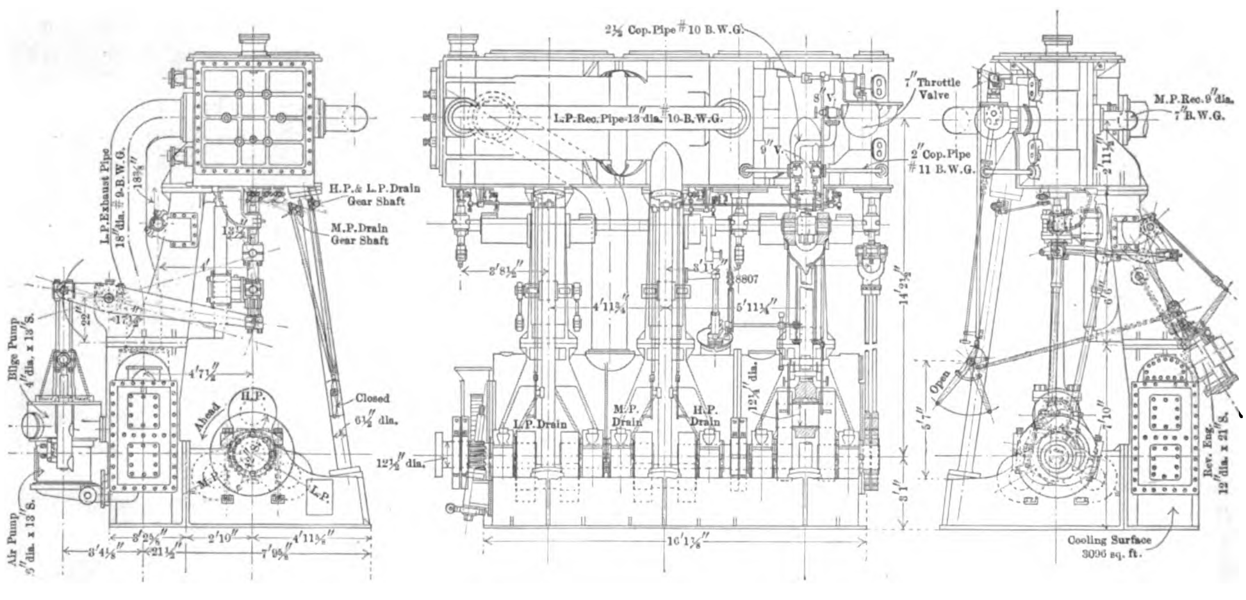
4-inch by 4-inch angles. The frames in the water bottom are 3½-inch by 3½-inch angles, between the margin and top side tanks 10-inch by 3½-inch channels split at the bilges, and bracketed to the top side tanks, at the ends they are 8-inch by 3½-inch bulb angles, in one piece from center line to deck, in the top side tanks 7-inch by 3½-inch angles, in way of erections 6-inch by 3½-inch angles, and the bulkhead frames are double 3½-inch by 3½-inch angles; all spaced 26 inches. The reverse frames are 3½ inches by 3½ inches by 10 pounds by 9 pounds in one piece from center line to margin, double in the machinery space.

There are solid floors on every frame 18 pounds to 15 pounds at ends, increased in the machinery space. Two intercostals are on each side of the center line, 17-pound plates amidship to 15-pound plates at the ends, they have large lightening holes and the necessary limber and air holes.

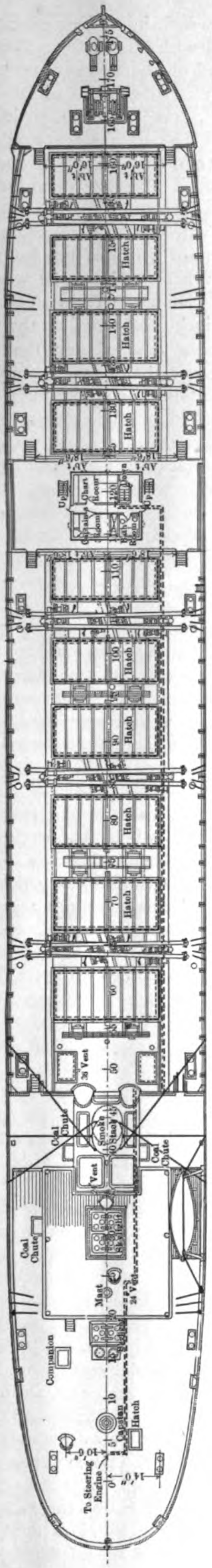
The tank tops, 19 pounds amidships to 16 pounds at the ends, with the butts lapped and double-riveted seams, single-riveted in the cargo spaces, the hold ceiling of 2½-inch yellow pine is laid on 2½-inch yellow pine battens.

The margin plate is 19 pounds amidships to 17 pounds at the ends, fitted in a straight line between butts. The top side-tank stiffeners are 7-inch by 3½-inch angles, the ties 6 inches by 3½ inches and the plating 17½ pounds. Two side stringers are fitted built of 10-inch by 3½-inch channels, with 20-pound intercostal plate. The shell is built on the clinker system on the bottom and in and out on the sides; the bottom is 24 pounds, the bilge 26 pounds, the sides 24 pounds and the sheer 26 pounds, all reduced at the ends, the sheer strake retaining the same thickness through the machinery space.

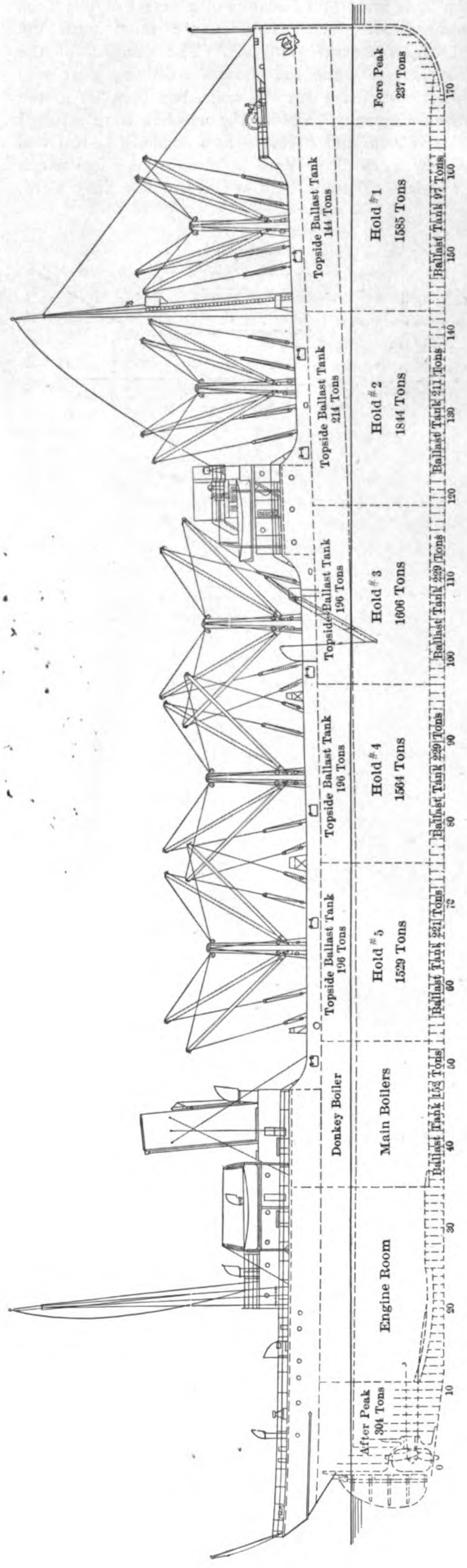
A bilge keel of 10-inch bulb angle and 3½-inch by 3½-inch angle extends throughout the parallel portion of the hull. The main deck stringer is 66 inches by 25 pounds, the plating is 17 pounds, both reduced at the ends, and the beams are 12-inch channel, spaced on alternate frames. In way of hatch openings they are 8-inch by 3½-inch channels on alternate frames, with 7-inch by 3½-inch intermediates. There are seven bulkheads, which divide the ship into eight water-tight compartments, built of 17 to 14-pound plates stiffened with vertical flanged plate and 10-inch bulb angles bracketed top and bottom. Also there is one non-water-tight bulkhead between the engine and boiler rooms. The forecastle bridge and poop in general are constructed of 15, 16 and 14-pound stringers, 12 and 14-pound plating, and beams of 7-inch by 3½-inch and 10-inch by 3½-inch channels. The hatch coaming is 21-inch by 20-pound plate attached to an 18-inch plate that forms the inner end of the top side tank, making a total height above deck of 39 inches.



MAIN ENGINES OF THE MARS.

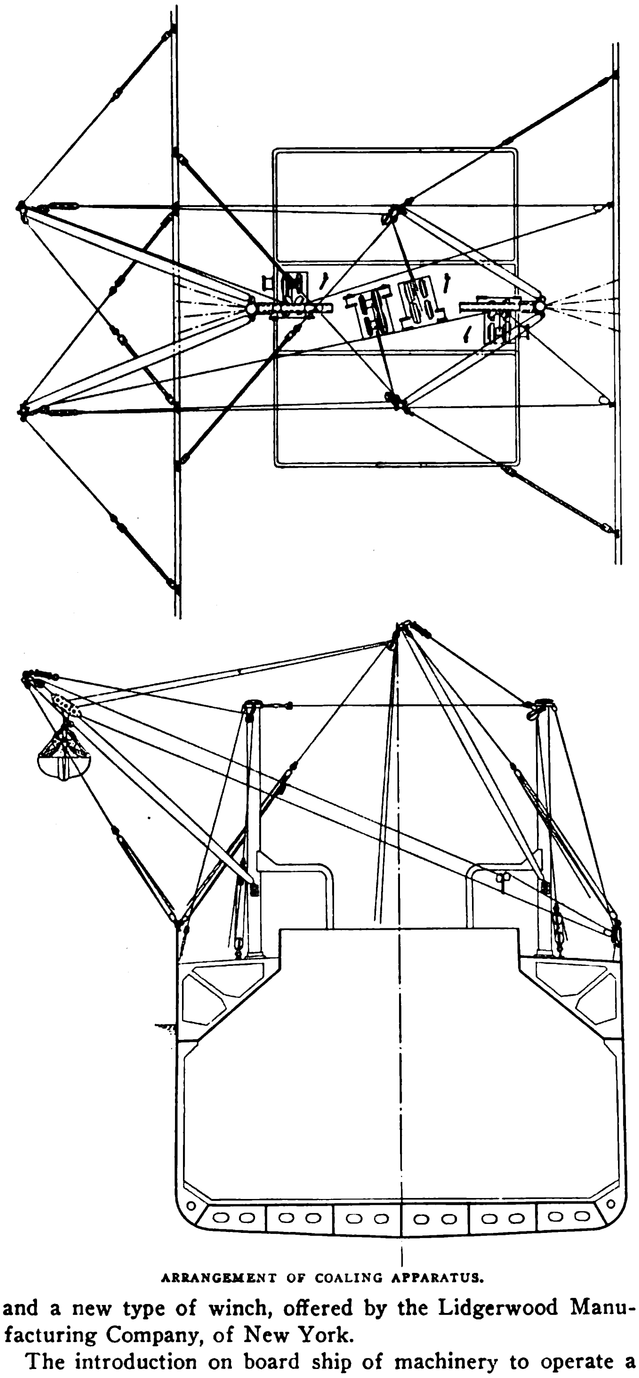


DECK PLAN OF THE MARS, SHOWING ARRANGEMENT OF HATCHES, CARGO BOOMS AND WINCHES.



INBOARD PROFILE OF THE MARS, SHOWING ARRANGEMENT AND CAPACITIES OF HOLDS AND TANKS.

One of the most important features of a vessel of this class is the coaling gear. These colliers are fitted with the Lidgerwood Miller marine transfers. The decision of the Navy Department to equip the colliers with this gear was reached after the contract for the ships had been let to the Maryland Steel Company. Before the winches were selected for the colliers *Vestal* and *Prometheus* a competitive test was held in the New York Navy Yard between a very fine winch with wood and iron frictions, built at the Norfolk Navy Yard,



ARRANGEMENT OF COALING APPARATUS.

and a new type of winch, offered by the Lidgerwood Manufacturing Company, of New York.

The introduction on board ship of machinery to operate a clam-shell bucket (thereby dispensing entirely with the shoveling of coal in the hold) was new, and no ship's winch has ever been designed or constructed for this purpose. Deck space is valuable and limited, and the winches designed by the Lidgerwood Manufacturing Company occupy a space of only 7 feet 8 inches long by 5 feet 10½ inches wide. These winches have only 8¼-inch by 10-inch cylinders and yet they have proved capable of handling a 1⅝-cubic yard load (one gross ton of coal) with perfect ease and with an ample factor of safety. In shore coaling towers 10-inch by 12-inch cylinders are the smallest that are ever used with this bucket. Wood and iron friction drums are employed on shore towers very extensively and with success, but there is room there for them and they are of very large diameter, even 40 inches, 50 inches and 60 inches in some instances. The deck space available on the colliers limited the diameter of the frictions to something like 24 inches and the Lidgerwood Company regarded the use of wood and iron frictions as impossible for this service. Even their metallic frictions provided with air-cooling passages got extremely hot in the course of a run of one hour's duration. In the test at the New York Navy Yard the wood and iron frictions, in three hours' running, were rendered unfit for further service, having ¼ inch of charcoal on the wood.

The winches having been adopted for the *Vestal* and *Prometheus,* and the Lidgerwood Company standing ready to guarantee an output of 100 tons of coal per hour per hatch if the same system was installed on the colliers *Mars, Vulcan* and *Hector,* the Navy Department, therefore, decided to adopt them, and a subsequent contract was made with the Maryland Steel Company. The Lidgerwood Company was under a penalty of three hundred dollars per ton for each ship for every ton less than 100 handled from each hatch. Coal to the amount of 117 tons was discharged from one hatch on the *Mars* in one hour; 170 tons from the *Vulcan* and 190 tons from the *Hector.*

There were three important points not ignored by the Lidgerwood Company in the design and construction of these winches. First, the employment of the metallic slip frictions with air-cooling passages; second, the employment of the lever control, which made the operation comparatively easy for the operator; third, the position of the operator was such that he could see the bucket in all parts of the hold as well as in every position it might take above the hatch. One operator attends wholly to the closing, hoisting and lowering of the bucket, while the other attends wholly and exclusively to the swinging of the same. The booms are fixed. The bucket operates in a curved line in a plane athwartships.

The extraordinary success of this coaling gear is undoubtedly the beginning of a revolution in coaling our ships. At the present time our battleships are equipped with winches, booms and tackle, so that the sailors on the battleships can hoist coal in bags from the colliers or barges alongside. It is an extraordinary fact, as stated by Admiral Dewey, that at the time the fleet started on its journey encircling the globe that the entire available supply of 4-inch manila rope in the market was exhausted. The chief bill for cordage for the Navy Department is for manila rope used for coaling ships. If now, the clamshell bucket is introduced on all of our colliers it is clear that coal may be delivered in bulk at various parts of a battleship. Therefore, the necessity for winches and booms, and also for rigging on battleships, will disappear, because it is clear that the problem will then be one of taking the coal from piles on deck and shoveling it either to the chutes that are nearest the piles or shoveling it into bags or baskets and dragging them across the deck to other parts of the battleship. In the old method, also, the sailors were sent into the hold to shovel coal into bags, and it is worthy of note that the old colliers seldom delivered more than 25 tons of coal per hour per hatch, and even that required from 20 to 25 men. The *Mars* can easily discharge 1,000 tons of coal per hour—the work of a thousand men—and only twenty men will be required to perform this. Those twenty men must be better than the ordinary grade of sailor and they must be well drilled, and that is one of the problems before the Navy Department. To place twenty well-drilled men on a collier will represent a considerable increase in the expense of the collier service. On the other hand, if the sailors from the battleships are sent aboard the colliers, logically they will have to learn the art of handling these winches before they can attain the guaranteed or a better capacity. One suggestion has been made and that is that each battleship in advance of its coaling send men aboard the collier to learn the operation of the gear, for it is claimed that it requires only about two days' practice of men who have an aptitude for that sort of thing.

The main engines are of the vertical, inverted-cylinder type, having cylinders 22 inches, 37½ inches and 60 inches diameter by 42-inch stroke. The high-pressure cylinders are fitted with working liners and 9½-inch piston valves. The intermediate-pressure cylinders have 19-inch piston valves and the low-pressure cylinders have the usual double-ported slide valves. The cylinder heads are cast iron, with checkered-steel false covers. All the pistons are iron castings. The high-pressure and intermediate-pressure are fitted with followers and snap rings, the low-pressures are fitted with followers, bull rings and spring rings, set out by steel "C" springs. The piston rods are 5½ inches diameter in body and packed with metallic packing. The main-valve stems and throttle-valve stems are also packed with metallic packing. The connecting rods are steel of the forked type, 8 feet center to center, having hard brass boxes for the crosshead pins, and cast steel, white metel-lined boxes for the crank pins. The crosshead pins are 6½ inches diameter by 7¼ inches long. The guides of the bar type are iron castings fitted with water circulation and cast steel slippers faced with white metal. The front columns are polished steel 6½ inches diameter, and the back columns are cast iron resting on the main condensers. The bed plate is of a deep box section, cast iron, in one piece and has six main bearings fitted, each 13¾ inches long. Each bearing consists of a cast iron semi-circular bottom box, which rolls around the shaft to remove, and a cast steel cap. Both cap and box are lined with white metal. The crank shafts are of the built-up type 12¼ inches diameter, in one piece. The crank pins are 12¼ inches diameter by 13¼ inches long between webs. The high-pressure webs are 8½ inches thick, the intermediate-pressure are 8⅞ inches thick and the low-pressure webs are 9¼ inches thick. The valve gears are of the "Stevenson Link" type, having cast iron eccentrics and straps, and steel eccentric rods with cast steel yokes.

The reverse engines are straight steam rams, 12 inches diameter by 21-inch stroke.

The built-in type of main condensers are fitted, having a total cooling surface of 6,192 square feet. Each condenser contains 1,212 ⅝-inch diameter brass tubes, No. 16 B. W. G. thick, tinned inside and outside, and fitted with screw ferrules in rolled-brass tube sheets. An air pump and two bilge pumps are worked from each low-pressure crosshead. Each air pump is 26 inches diameter of bucket by 13-inch stroke, and each bilge pump has a 4-inch diameter plunger with a 13-inch stroke.

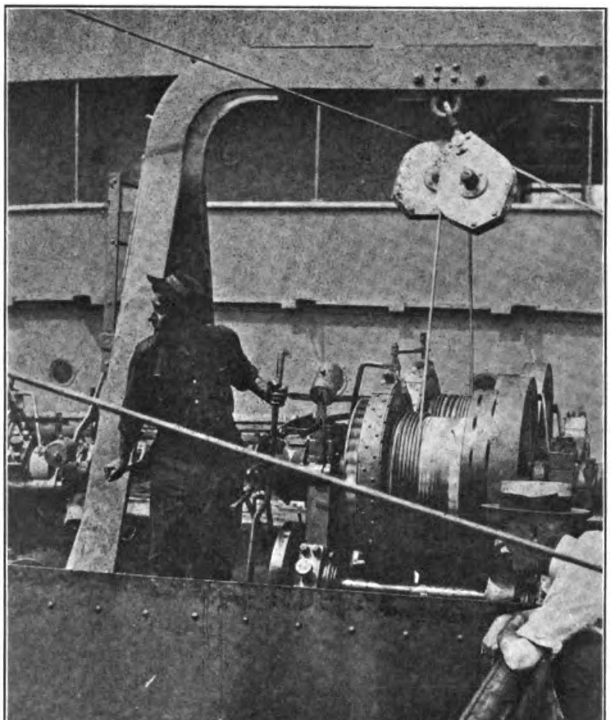
A double-cylinder 6-inch by 6-inch turning engine is located between the main engines just aft of the main bed plates, and connected to main shafts by double-worm gearing.

The thrust shafts are 12¼ inches diameter, each having eight 18-inch diameter collars. The shoes are cast iron, faced with white metal, and held in place on steel rods by brass nuts, permitting independent or collective adjustment. The whole block is fitted with water circulation.

As the main engines are well aft, there is only one piece of line shaft to each main shaft. These shafts are 11¾ inches diameter. The propeller shafts are 13 inches diameter, with brass sleeves throughout the entire length of the stern tube. The propellers are 14 feet 9 inches diameter and 14 feet 3 inches pitch, adjustable 3 inches either way. The hubs are of semi-steel, with cast iron caps. The blades are bronze.

There are four main boilers and one donkey boiler, built for a working pressure of 200 pounds per square inch. The main boilers are 15 feet diameter and 10 feet 9 inches long, designed and fitted for Howden's system of forced draft. The tubes are 2½ inches diameter, fitted with retarders. Each boiler contains three 44-inch inside diameter Morison flanged furnaces, with a combustion chamber to each furnace. The total heating surface is 10,200 square feet. The furnaces are fitted with cast-iron fronts, doors and grates 5 feet 4 inches long. The donkey boiler is a single-end Scotch, 8 feet diameter and 10 feet 6 inches long, having one 44-inch inside diameter Morison furnace.

The independent pumps consist of the following: Two vertical, simplex, main feed pumps, cylinders 14 inches, 10 inches by 24 inches; one vertical, duplex, auxiliary feed and fire pump, cylinders 10 inches, 7½ inches by 12 inches; one vertical, duplex, ballast pump, cylinders 12 inches, 14 inches by 12 inches; two vertical, duplex, fresh-water and sanitary pumps, cylinders 5¼ inches, 4¾ inches by 5 inches; one horizontal, duplex, evaporator feed pump, cylinder 4½ inches, 3¾ inches by 4 inches; one vertical, duplex, donkey boiler feed pump, cylinder 4½ inches, 2¾ inches by 4 inches, and two M. S. Company's make centrifugal circulating pumps, having 12-inch suctions and driven by vertical single 8-inch by 8-inch engines.



ONE OF THE LIDGERWOOD WINCHES INSTALLED ON THE MARS.

One 12-ton and one 5-ton Reilly evaporator, and one 15-inch Reilly distiller are also installed. A 36-inch Reilly feed-water heater and a 4-inch Blackburn-Smith grease extractor are fitted in the main feed lines. A Wheeler auxiliary condenser, having 1,000 square feet of cooling surface, is located in upper engine room. The two blowers for the forced-draft system are driven by vertical single 5-inch by 4-inch engines, and are also in the upper engine room. A 15-kilowatt Sturtevant direct-connected electric set complete, with switchboard, etc., has also been provided in upper engine room. A refrigerating plant of 800 cubic feet capacity is installed aft on main deck.