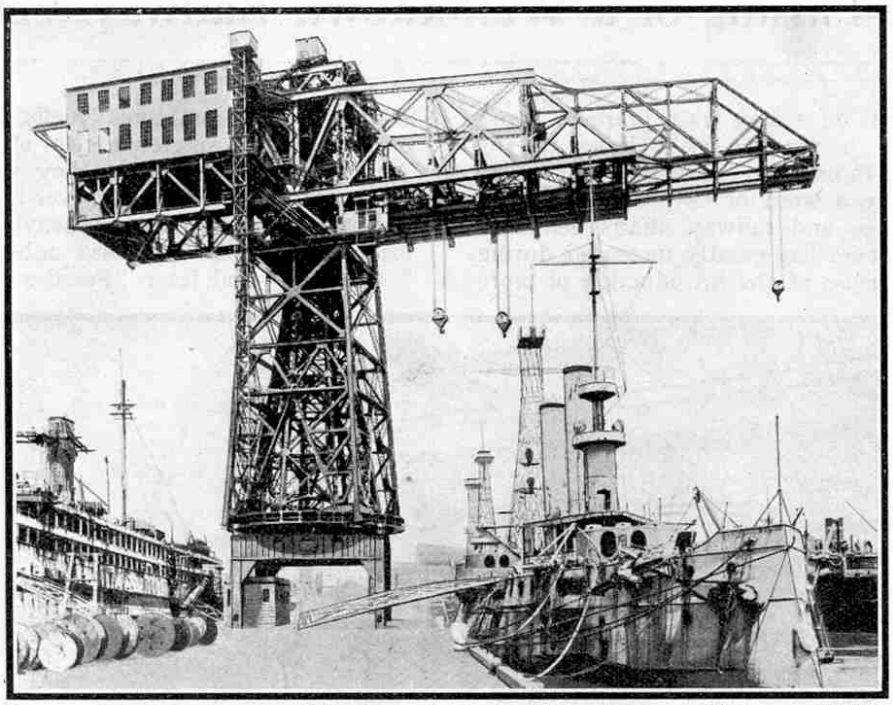
of machinery. The runway on which this crane operates extends through the rear wall of the machinery-house for a distance of 17 ft. By lowering the rear wall of the house, which is specially designed for the purpose, the crane is permitted to travel out beyond the end of the building in order to transfer parts to and from the fitting-out pier approximately 215 ft. below.

The counterweight is of concrete and weighs 628,000 lb.

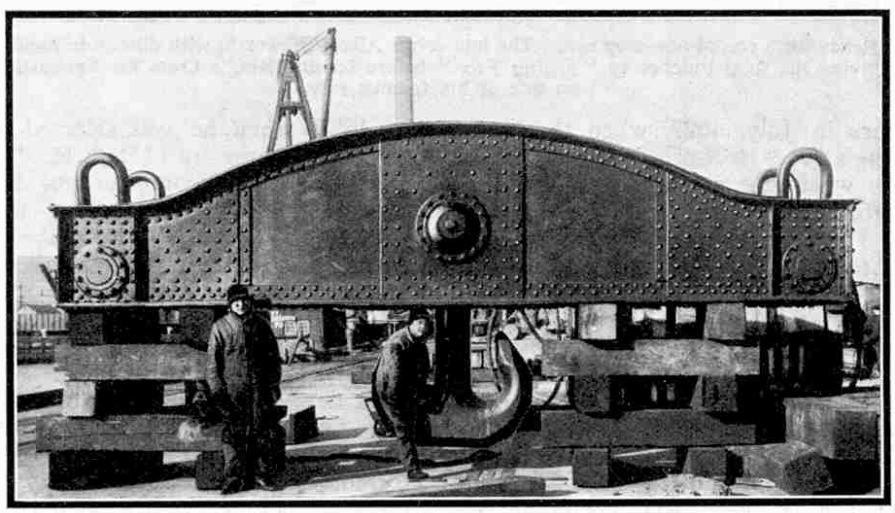
The pintle supporting the rotating part of the structure (jib and "skirt") is of cast steel, 60½ in. in diameter; and when the crane is loaded to its rated capacity, carries a vertical load of 5,834,000 lb; and takes a lateral thrust due to maximum conditions of wind, loading and eccentricity, of 607,000 lb. The vertical load is taken by means of 220 roller bearings, 3 in. in diameter; and the horizontal thrust by 62 rollers 2 in. in diameter. The metal of the bearing rollers is a high-carbon, high-chromium tool steel with the exceptional ultimate bearing strength of 290,000 lb. per sq. in. after hardening treatment, raised from 96,000 lb. per sq. in. before treatment.



The crane as seen from the fitting-out pier in the Navy Yard. A 10-storey building could be placed under the massive jib.

The eccentricity just mentioned is due to the fact that the jib is designed so that the overturning moment, or the tendency of the jib to overturn, is equal and opposite in direction under each of the two conditions of no loading and maximum rated load. In the case of no load on the crane, the centre of gravity of the rotating mass is 12.45 ft. behind that of the tower; and in the case of maximum load 10.65 ft. in front. This tendency toward overturning is resisted by the horizontal bearing of the bottom rim of the "skirt" on the circular girder encircling the tower legs, as well as by the horizontal bearing at the pintle. The horizontal thrust at the bottom rim of the "skirt" is taken up by means of sixty-four 26-in. wheels mounted on two chains and bearing on a circular girder 55 in. in depth and 64 ft. in diameter.

The slewing or revolving mechanism located at the top of the portal consists of an 87-h.p. motor with gearing driving four pinions working into a rack 64 ft. in diameter having 768 teeth of 3.1416-in. pitch and 12-in face.



The steel equalising beam, by which the 350-ton forged steel lifting hook is carried from two 175-ton blocks on the crane jib. The beam has a maximum depth of 4 ft. 10½ in.

The operating speeds of the crane are as follows:—Hoisting—Main hoist, 2½ ft. per minute; auxiliary hoist, 15 ft. per minute. Racking—Main trolley, 15 ft. per minute; auxiliary trolley, 80 ft. per minute. Revolving—One complete revolution in 12 minutes.

All the operations of the crane are controlled from the operator's cab, located under the jib, adjacent to the tower and in full view of all the handling operations of the crane. The machinery is controlled from the cab by means of master controllers operating solenoid switches situated in the machinery-house. Clutches for throwing the hoists into high or low gear, and for coupling together the main hoists when using the equaliser beam, are located in the machinery-house and are mechanically operated by levers in the operator's cab. The structure is designed so that when it becomes necessary to renew pintle bearings or make repairs the entire loading structure can be jacked up from the portal by means of four 30-in. jacks, each of 560-tons capacity.

The portal has four legs spaced 56 ft. from centre to centre, each of a sectional area of 385 sq. in. of structural steel, supporting the massive girders 9 ft. in depth that carry the octagonal tower. The maximum load on one of these legs was calculated at 3,000,000 lb. under maximum conditions of wind pressure, and the legs and the foundations were designed for this load. The portal has a clear height of 25 ft. 7 in., which provides ample clearance for locomotive cranes or other equipment on the two tracks passing through it. A power sub-station that furnishes the current for the operation of the crane is also situated beneath the portal, as shown in the upper illustration on this page.

The entire deadweight of the crane structure is calculated at 4,000 tons. Four bolts, 3 in. in diameter, are used to anchor each leg to the foundations.

The four tower legs are supported on grillages, 10 ft. 4 in. square, each made up of two layers of rolled steel girders embedded in massive reinforced concrete caps, 35 ft. 4 in. square and 9 ft. 6 in. in depth, tied together longitudinally and transversely by the deep reinforced concrete girders of the pier deck. Each of these caps rests on 156 timber piles driven to the hard cemented gravel river bottom and cut off at water level. The piles are supported laterally by an earth fill enclosed and retained by reinforced concrete sheet piles driven into the river bottom. Most of these sheet piles are 18 in. by 24 in. in section, 52 ft. in length and weigh about 12 tons. They are tongued and grooved to interlock one with another to form a reinforced concrete wall around the entire foundation, 24 in. in thickness, and spanning from caps and lateral connecting girders to the river bottom.

Each of the two auxiliary travelling cranes has a maximum lift of 130 ft.—of which 90 ft. is above and 40 ft. is below the level of the pier—and a maximum radius of 140 ft. at which it can be rotated at a speed of 300 ft. per minute.

The construction and erection of this giant crane occupied 11 months and cost almost two million pounds.

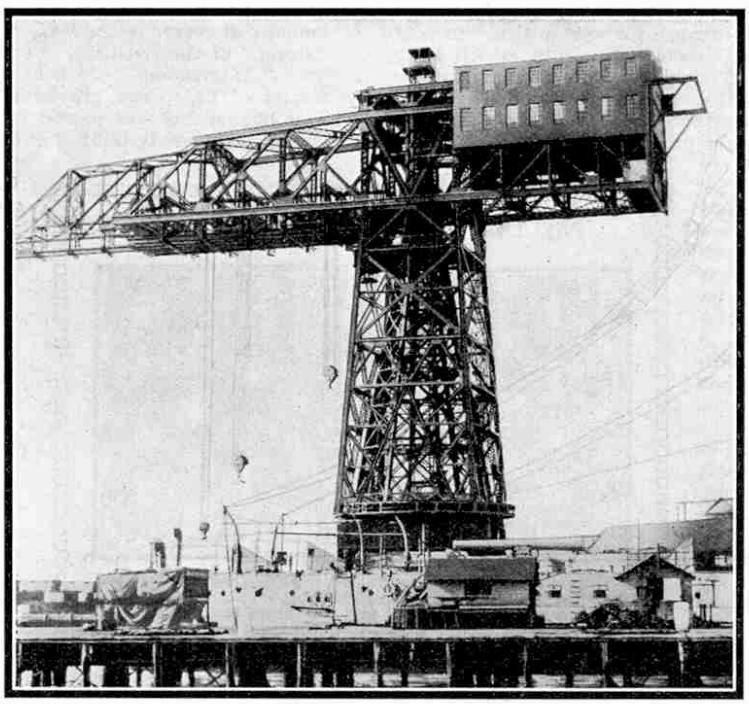
Giant Hammerhead Crane in American Navy Yard

Loads of 350 Tons Handled With Ease

THE ever-growing size and weight of the component parts of modern ships has resulted in a corresponding growth in the size and power of the dockside cranes that handle these components. One of the most interesting of these modern giant cranes is the 350-ton electrically-operated hammerhead crane at the League Island Navy Yard, Philadelphia, U.S.A. In an earlier issue of the "*M.M.*" we gave a brief description of this crane, but it is of such engineering importance that further details will be of value.

The crane is situated on the 1,000-ft. fitting-out pier in the yard. Some idea of its size may be obtained from the fact that a 10-storey building could be placed under the jib of the crane, and that its overall height is more than 245 ft., or about that of a 17 or 18 storey building. It has been constructed for the purpose of placing the heavier parts such as turrets, ordnance armour plates, boilers, machinery, etc., on the big ships to be constructed at the yard, as well as handling heavy parts in connection with repairs to ships.

Tests of the crane, in the course of which it was loaded to 25 per cent. in excess of its rated capacity, were successfully carried out, the largest single load in these tests being 980,000 lb. In the most spectacular of these tests the crane lifted a total load of 1,010,000 lb., made up of a locomotive weighing 100,000 lb. on the auxiliary (50-ton) hoist; a load of steel billets weighing 416,000 lb. on each of the main (175-ton) hoists; and a locomotive weighing 78,000 lb. on the machinery-house crane.



An impressive view of the 350-ton electrically-operated hammerhead crane at the League Island Navy Yard, Philadelphia, U.S.A. For the details of this crane, and also for the photographs, we are indebted to the McMylor Interstate Co., Cleveland, Ohio.

The location of the crane at the waists of the ships berthed on either side of the pier permits the placing of most of the heavy weights without moving or turning the ships. The placing of minor parts, which forms the greater portion of the work of fitting out a ship, is rapidly and economically carried out by two auxiliary quick-acting travelling cranes with a capacity of from five to 10 tons, installed to operate along the pier on each side of the main crane.

The crane as designed and constructed consists of a fixed portal 56 ft. square, supporting on deep girders an octagonal tower about 56 ft. in width at the bottom and tapering to a bearing pintle 5 ft. in diameter at a height of approximately 201 ft. above the deck of the pier. Supported vertically on this bearing pintle and revolving upon it is a horizontal cantilever jib or boom 300 ft. in length overall, to which is rigidly attached a "skirt" that envelopes the fixed tower from the bottom of the jib down to a height just above the portal. The entire vertical load from the jib is transmitted to the tower at the pintle, but lateral thrusts are taken into the base of the octagonal tower by the circular girder that forms the rim of the "skirt," as well as at the pintle.

The forward cantilever of the jib contains the three runways for the trolleys that carry the loads. The rear cantilever of the jib carries the counterweight and the house containing the machinery and drums for hoisting and lowering loads and racking the trolleys in and out on the forward cantilever. The machinery for revolving the jib is located at the lever at the top of the portal. girder and the rotating impulse is transmitted through the rim of the "skirt." This enveloping "skirt" provides a greater factor of safety against failure by over-turning of the jib in the event of accidental excessive overloading of the crane, than would be given by the more usual design, at one time under consideration, in which the jib is simply supported by the tower on a circular bearing similar to that of a swing bridge or a turntable. The entire framework of the crane is of structural steel of bridge grade, and the entire operation is by means of electricity.

Access to the jib, machinery-house, etc., is provided by means of a steel stairway in the tower and an electric elevator mounted on the outside of the "skirt" and the jib.

The forged steel hooks by which the loads are raised have, in the case of the 175-ton hook, a shank 9 in. in diameter, and in the case of the 350-ton hook one of 13 in. diameter. The 50-ton block and load are carried by eight $1\frac{3}{8}$ in. wire ropes; the 175-ton block and load by sixteen $1\frac{5}{8}$-in. wire ropes running on 50-in. pulleys; and the 350-ton hook and load by thirty-two $1\frac{5}{8}$-in. wire ropes. The 350-ton hook is carried from the two 175-ton blocks by a steel equalizing beam, 4 ft. $10\frac{1}{2}$ in. in depth.

The clear lift of the main hook is 141 ft. above and 29 ft. below the deck of the pier, and that of the auxiliary hoist 151 ft. above and 29 ft. below. The three trolleys carrying loads in and out on the forward cantilever of the jib operate on separate runways—the one 50-ton trolley to a distance of 190 ft. from the centre of the tower and the two 175-ton trolleys to a distance of 115 ft. from the centre. The two latter are arranged so that they can be coupled together in order to lift, by means of the additional hook and equalizing beam already mentioned, the capacity load of the main hoist, namely, 350 tons.

The forward cantilever is 200 ft. in length, 40 ft. in width from the tower to the limit of travel of the main hoists, and 13 ft. 4 in. beyond them. Its trusses have a depth of 40 ft. at the tower. The rear trusses carrying the machinery-house and the counterweight, are 100 ft. in length and 20 ft. in depth and form a cantilever 40 ft. in width.

The machinery-house itself is a large building 80 ft. in length, 43 ft. in width and 32 ft. in height. It contains the machinery for hoisting and lowering the hooks and for racking the trolleys. The two main hoisting motors and the one auxiliary hoisting engine are of 87 h.p. each; while the two main racking motors and the one auxiliary racking motor are each of $27\frac{1}{2}$ h.p. The drums on which the ropes for the main hoists are wound are 10 ft. in diameter and 14 ft. in length, and revolve on a shaft $10\frac{1}{2}$ in. in diameter. The machinery-house carries also an overhead travelling crane of the bridge type of 35 tons capacity (determined by the weight of the main drum and drum shaft) for the handling