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THE WHARF CRANES OF THE PENNSYLVANIA RAILROAD COMPANY AT GREENVILLE, N.J.

By John Lyle Harrington, M. Can. Soc. C. E.

The great industrial development of the last century was accompanied and largely made possible by co-ordinate growth in the facilities for both foreign and domestic transportation. Within that period the railway became the most important single factor in the material life of all progressive nations, and the steamship relegated to a secondary place the sailing craft which had been for all the preceding centuries substantially the only means of carrying on foreign or domestic commerce.

The traffic carried by the railways and the merchant-marine of the world has assumed almost incomprehensible proportions, but the development of the means for transferring goods from one great carrier to the other has not kept pace with the demand. The mast and gaff, operated by the ship's winches, and the hand truck still remain the chief means for handling package freight, though the greater steamship lines have very recently equipped their wharves with electric hoists to operate the mast and gaff.

The handling of iron ores, however, has received the attention of many of our ablest engineers during the last third of a century, and the traffic in iron ore now existent upon the great lakes is only made possible by the improved facilities for removing the ore from the vessels and delivering it to railway cars, cheaply and with dispatch.

The handling of coal, especially in the seaboard cities, has also received the attention of specialists, and the machinery for this work has reached a high state of development.

This rapid and economical handling of ores, fuel, and flux has greatly reduced the cost of iron and steel, and thus exerted incalculable influence upon the world's industrial growth.

Cranes for handling package freight have been sporadically developed, here and there, for handling very heavy loads. The most notable of these are the cranes used by the great navies for the trans-shipment of heavy guns. But the greater portion of the package freight is still handled by comparatively primitive means. The cost of trans-shipment is great, and the earning power of vessels and cars is considerably reduced because they are idle during the time required for loading and unloading cargo.

Both the railway and the steamship companies are rapidly reaching the conclusion that they must make the necessary expenditure for freight-handling machinery, if the work is to be done economically and quickly. About two years since, when the Pennsylvania Railroad Company began the construction of its new freight terminus in the New York harbour at Greenville, N.J., they invited various engineers and builders of prominence to submit designs for cranes, to be operated by electricity and to handle freight, both bulk and package, between the railway cars and the vessels.

In response numerous carefully thought out designs were submitted, and the engineers of the various companies tendering, exposed very fully the methods of operation and construction proposed and their advantages. The Railroad Company's engineers made a minute and careful examination of these plans, visited and examined in operation various installations of hoisting machinery employing the principles embodied in the designs offered, and made a report which resulted in the selection and purchase of the three cranes described below.

By the initial arrangement there were to have been two cranes of one type designed primarily to handle loose freight such as coal, broken stone, sulphur, and iron ore, in bulk; the third crane being of larger capacity and especially designed to handle heavy package freight; upon further study of the situation, however, the plan was modified so as to combine in one type of crane the more desirable features of both.

The cranes, as constructed, embody the best thought of the manufacturers' engineers, ably aided by the advice and suggestions of the engineers of the Pennsylvania Railroad Company, and, it is thought, represent the most advanced type of construction yet developed for the purpose.

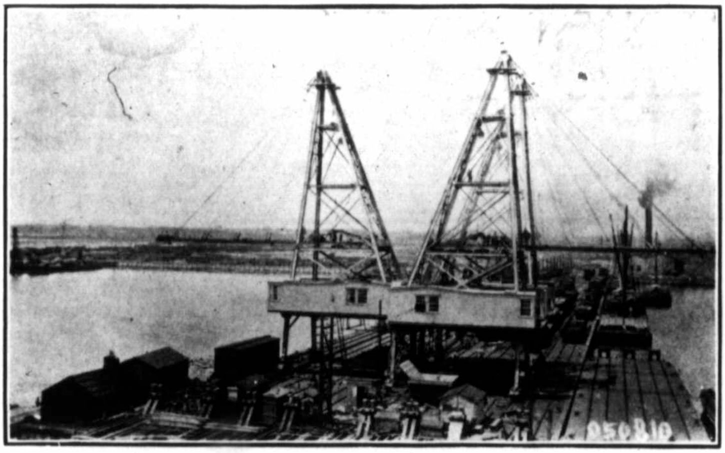

FIG. 1

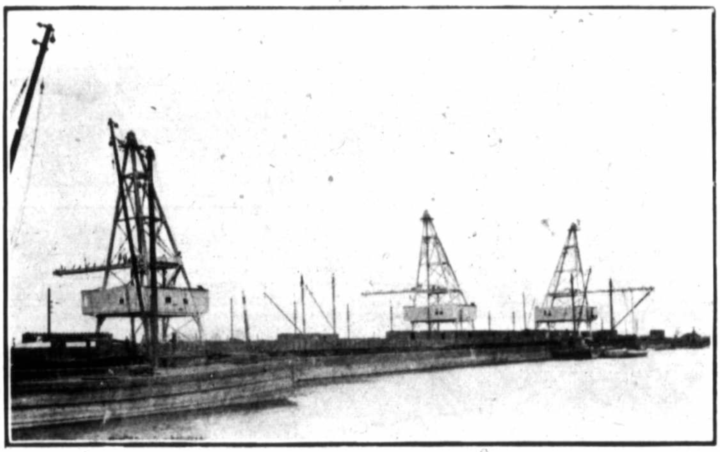

FIG. 2

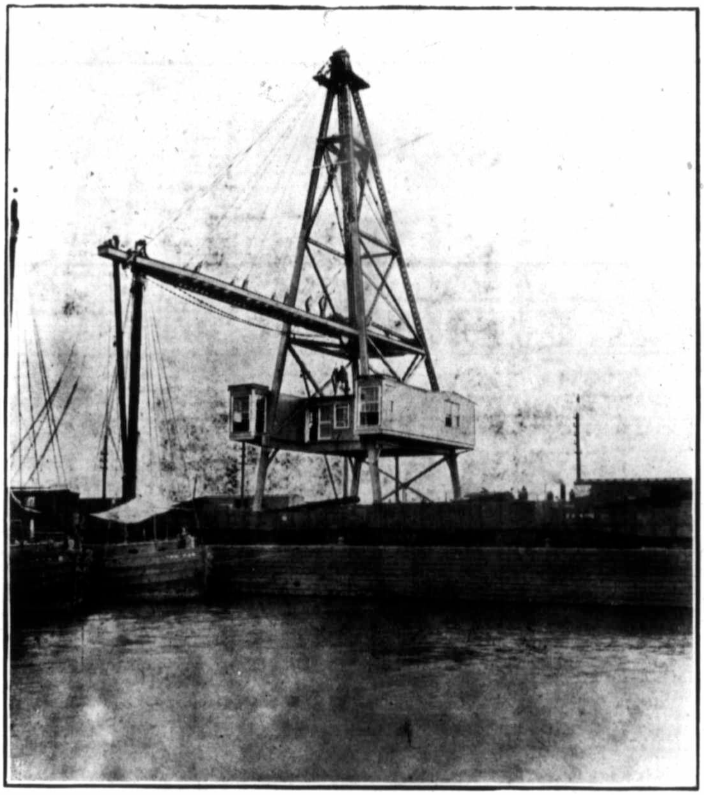

Fig. 3

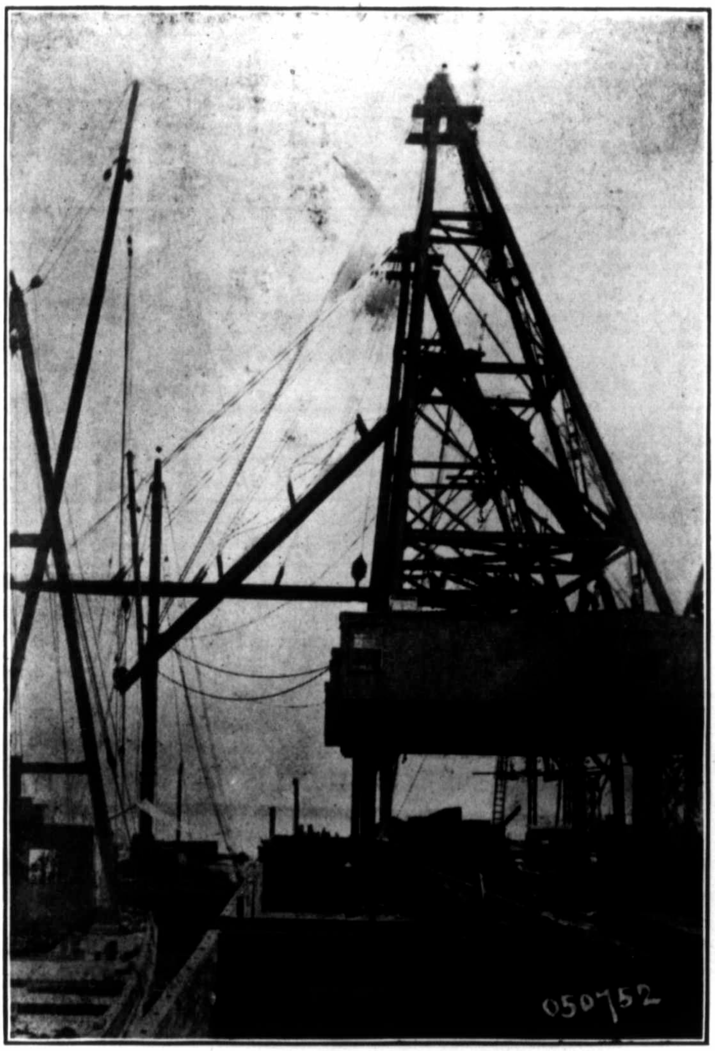

Fig. 4

GENERAL DESCRIPTION.

The illustrations presented herewith expose the principal features of the cranes, but there are many details of large importance in the operation of the machinery, which for lack of space must be left untouched.

Fig. No. 1 affords a general view of the three cranes in position upon the pier, and the railway tracks on which freight is delivered and received.

Fig. No. 2 shows the cranes disposed over the pier in operation and the arrangement along the centre of the pier of the poles which carry the feed wires for the crane, the telephone and the electric light wires, and the stationary electric lamps.

The pier is 120′ wide by about 1,000′ long, substantially constructed of timber, and especially designed to carry the cranes. Eight railway tracks are symmetrically disposed about the centre line throughout its length. Freight is delivered and received on the four tracks nearest the edge of the pier, while the four at the centre are reserved for switching purposes.

Each crane in working order weighs about 125 tons, the height is about 100′, the span centre to centre of crane trucks 41′, the distance between trucks longitudinally to the piers 30′, and the clear headroom beneath the cranes is 20′. The boom projects approximately 60′ beyond the pier, and the extreme working position of the truck is 52′ from the edge.

The cranes are designed to handle a normal load of ten tons of package freight at any point on the boom, and to operate a clam shell bucket of about sixty cubic feet capacity for handling the bulk freight. All of the cranes are designed for the use of an auxiliary hoist for placing slings about the loads in preparation for handling them with the main hoist, but the auxiliary hoisting engine is provided on only one crane.

Each crane is carried on four four-wheeled trucks running on two tracks of 14″ gauge. The two trucks at one end are driven, and the two at the opposite end are fitted with air brakes.

For the receipt of bulk materials which are handled by the clam shell bucket, a removable hopper is provided and so designed that it will occupy the space between the operators' houses, as shown in Fig. No. 3, and may be hoisted to position by the crane itself.

The boom is made to fold so as to clear the rigging of vessels, as shown in Fig. No. 4.

All of the engines and the air compressor are electrically operated and are situated in the rear of the engine house. The operators, however, are stationed, one on either side of the crane, in the extreme fronts of the engine house. The windows are so situated that each operator always has a full view of the load and of the railway tracks. The levers for operating the friction clutches and brakes are led to the operators' stands, where the controllers are also placed. The operator who controls the movement of the boom truck also controls the movement of the cranes along their tracks.

The cranes are amply provided with electric lights both for the engine room and for illuminating the pier and vessels for night operation.

Each crane is provided with a telephone for communication with the other cranes or with shore connections.

DETAILED DESCRIPTION.

The steel framework is designed and constructed in accordance with the Pennsylvania Railroad Company's specifications for railway bridges, in so far as they are applicable to a structure of this type. A very substantial and rigid floor system supports the engine house and takes up the vibrations of the machinery. The house itself is constructed of wood with a double floor in the ordinary manner. Access to the engine house and to the sheaves at the top of the tower is obtained by means of a ladder, shown in Fig. No. 3.

Each truck is composed of four standard chilled car wheels of the heaviest type, standard 5 x 9 journals, journal boxes and bearings, and a steel frame composed of heavy 15″ channels, substantially braced. Two of the trucks are provided with air brakes, as shown in Fig. No. 10, the brakes being operated from the engine house. Each of the other two trucks is fitted with a 25 h.p. railway type motor and cut spur reduction gearing for operating the crane on its tracks, as shown in Fig. No. 8. The driving trucks are also provided with double rail stops which are suspended from the body of the truck when the crane is in operation, but which are let down on the rails between the wheels when the crane is not in service. The large surface exposed to the wind would enable a very light breeze to move the crane along the tracks, but after a very slight movement two pairs of wheels mount these stops and prevent further travel in either direction. All the trucks are articulated in two directions, hence a proper bearing on the tracks is always assured, no matter what the condition of the pier may be.

The main hoisting engine which is illustrated in Figs. Nos. 5 and 6, is designed to handle either the package freight on a one, two, or

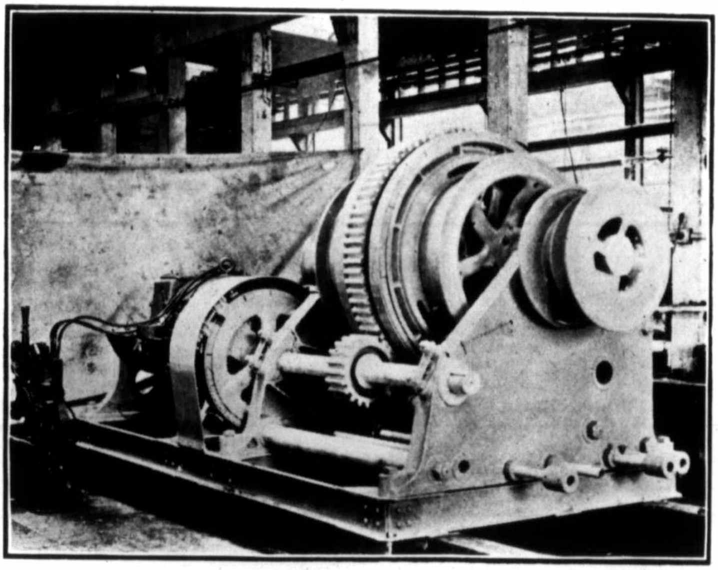

FIG. 5

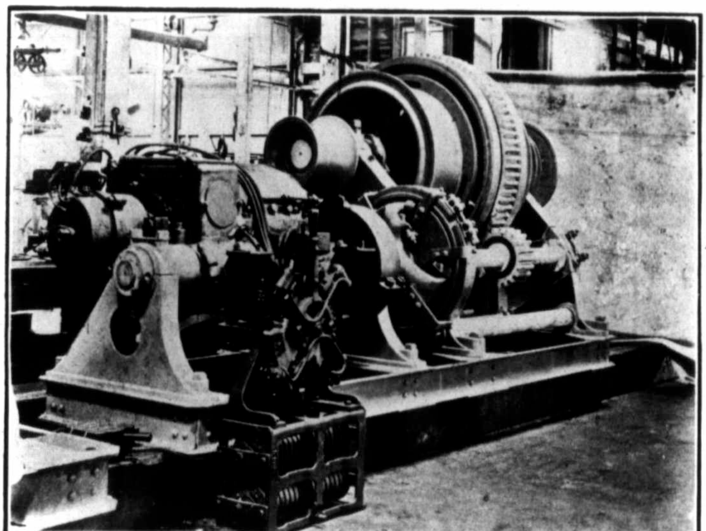

FIG. 6

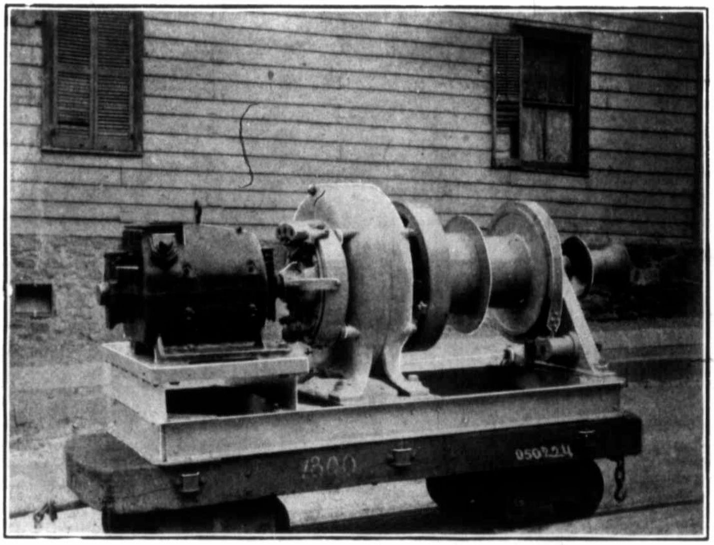

FIG. 7

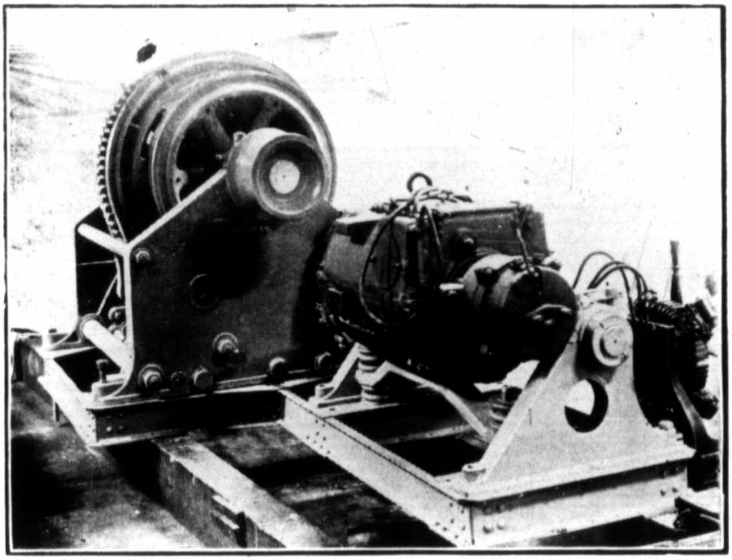

FIG. 8

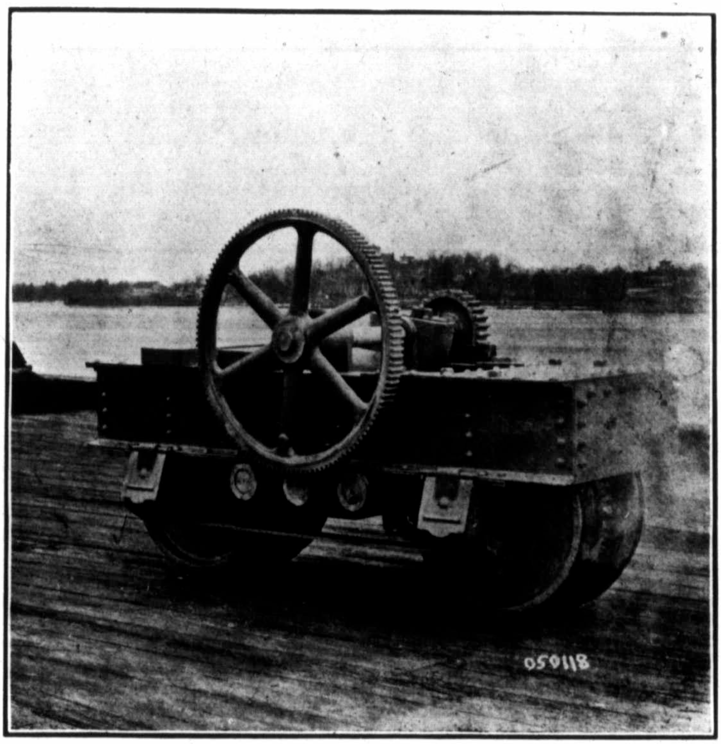

Fig. 9

three part rope, or to operate the clam shell bucket, for which two ropes are, of course, required. It is fitted with a solenoid brake and with an exceptionally large and efficient load brake, which absolutely prevents the load from running down in case the current should be cut off or accident should happen to the motor. A small drum attached rigidly to the shaft, as shown on the near end in Fig. No. 5, is used to fold the boom. Each of the main hoisting drums is fitted with a conical friction clutch and a band brake, and consequently is under full control of the operator. A 100 h.p. motor wound for 500 volts direct current and mounted on springs, much as it would be on a railway car, operates the engine.

For hoisting package freight but one rope is used. This is led from one of the drums directly over a large sheave in the head of the tower, thence over the outer of the two boom truck sheaves, around the sheave in the running block, over the inner sheave on the boom truck, and then attached by a shackle to the running block, as shown in Fig. No. 11. Obviously a single or double part rope may be used for rapid work with light loads.

When the clam shell bucket is employed the main hoisting rope is operated by one drum, and the closing rope, which also assists in the hoisting, by the second drum. These ropes also lead over the sheaves in the head of the tower, thence over the sheaves in the boom truck, and connect to the bucket.

The boom truck is fleeted outward along the boom by means of the engine shown in Fig. No. 7. The drum is divided into two parts, one of which is somewhat larger in diameter than the other. When the clam shell bucket is in use a single rope leads from each part over sheaves supported in the rear of the boom, thence over the sheaves at the outer end of the boom, shown in Fig. No. 4, thence to their connections on the boom truck. The rope attached to the larger part of the drum is connected to the outer end of the truck, and the other rope to the inner end. Thus the outer pair of wheels and sheave are drawn out more rapidly than the inner pair and sheave, and the truck spreads as it approaches the end of the boom. Longitudinal bars connect the two parts of the truck but permit this extension. This movement of the sheaves in the boom truck separates the hoisting ropes and prevents the clam shell bucket from turning and twisting the ropes as it enters or leaves the hold of the vessel, yet permits the hoisting ropes to come together as the bucket approaches the boom in its parabolic path.

When package freight is being handled, but one trolley rope is employed and the parts of the truck do not alter their relative position as they traverse the boom.

The engine is operated to draw the truck toward the end of the boom, while the horizontal component of the hoisting ropes brings the truck in toward the tower when the clutch and brake are released. The engine may, however, be operated to draw the truck to its inmost position if desired. This engine is also fitted with solenoid and load brakes. The reduction gears are enclosed in an oil-tight case, have cut teeth, and run in a bath of oil.

Fig. No. 8 illustrates the third engine employed to operate the auxiliary hoist for placing slings under the loads of package freight. The hoisting rope is led directly from the engine to a sheave in the rear of the boom, thence forward to a block suspended by a slide from the underside of one part of the boom. The rope is then led around the running block in the usual manner. This slide is moved along the boom and held in any position by a continuous rope running over sheaves at both ends of the boom and operated by the winch head on the engine. The engine is also operated by a 25 h.p. railway type motor mounted on springs. The hoisting drum is controlled by a conical friction clutch and band brake in the usual manner.

The construction and operation of the crane boom merits especial attention. It consists of two symmetrically disposed parts, each composed of an I beam and a channel well braced together. The parts are rigidly connected together at the ends, but throughout the traverse of the boom truck are separated to admit the passage of the hoisting ropes. The truck runs on rails placed directly upon the I beams. As shown in Fig. No. 3 the boom extends to the extreme rear of the tower where the horizontal thrust due to the weight of the boom and the tension in the trolley ropes is carried by a heavy girder. The guy ropes always occur in pairs in order that the hoisting ropes may traverse the length of the boom between them, and they are so attached that the respective halves of the boom are balanced under load and do not twist. They are provided with turnbuckles near the head of the tower for adjustment.

The boom is hinged for vertical movement at the rear and at a point just forward of the front legs. This construction permits the boom to be folded to clear the vessel's rigging, as shown in Fig. No. 4, by means of blocks attached to the outer boom hinge and to the tower near its head and falls operated by the small drum on the main engine. The position of the outer hinge is so chosen that but slight additional weight is required to cause the boom to resume its normal position when the hoisting ropes are released. This additional weight is supplied by the boom truck which, when the boom is folded, lies in a pocket formed by bent ends of the rails on the rear of the boom, and by the forked brace at the rear, as shown in

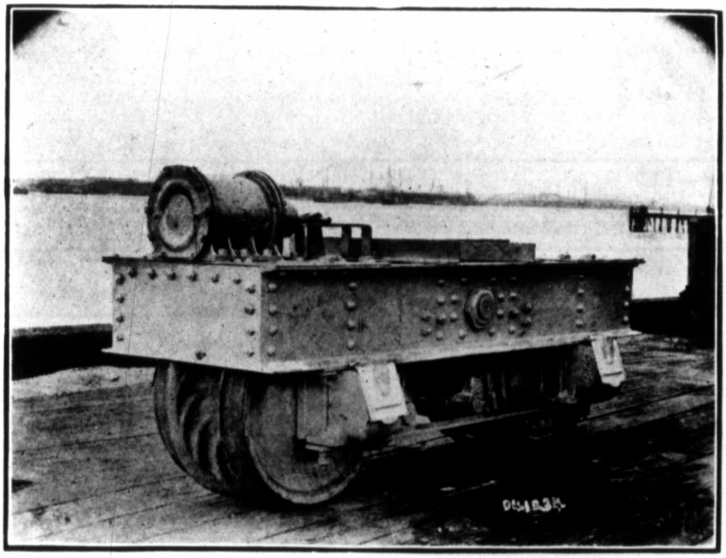

FIG. 10

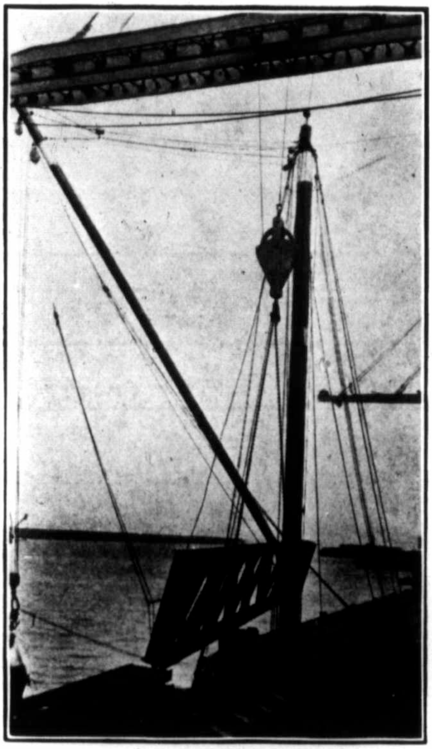

FIG. 11

Fig. No. 4. The brace is hinged at the rear, and the centre line of its hinges is made to coincide with that of the horizontal rear boom hinge, in order that the brace and hinge may rise together without friction. The brace is so supported on the bracing of the tower that it does not follow the boom to a horizontal position, but remains about four feet above. The vertical forks at the end, however, always project below the boom, and, since they flare downward, guide it to a central position as it rises, though they permit its free lateral movement when the crane is in operation. The action of this brace is evident from an examination of Figs. Nos. 1 and 4. The brace prevents the boom from turning over when being folded, as it has a tendency to do, since the centre of gravity is well above the points of support. At the extreme rear the boom is hinged in two directions, so that it is free to be folded and to swing sidewise in either direction within the range permitted by the front legs of the tower.

The boom is supported entirely by the wire rope guys and on a combined vertical and horizontal hinge at the rear. This arrangement permits the boom to swing freely when a load is being lifted from a point not directly beneath it, minimizes the effect of the shock from the accidental dropping of a load, and substantially eliminates the danger of damage from collision between the masts of a vessel and the boom. Lateral guy ropes limit the horizontal movement of the boom when it reaches the opposite front leg of the tower.

The removable hopper is so designed that it may be lifted by the crane and dropped into its working position. Bulk freight may be delivered from it into cars on the track in front of the crane or the first track beneath it. This material may be weighed as delivered if desired.

A water main is carried along the entire length of the pier just beneath the floor, and at intervals hose connections just above the floor are provided. Each crane is provided with two universal nozzles, one on top of each front corner of the engine house, from which duplicate pipes lead to the middle of the strut connecting the rear trucks, where coupling is made by means of flexible hose to the couplings on the pier. Thus each crane is made a veritable fire engine.

The cranes were designed to operate on their tracks at a speed of about 180′ per minute under the greatest estimated resistance. The motors are, however, under series parallel of control and operate together at full or half speed. The resistance is normally far below the maximum, consequently the speed of operation is commonly much greater than 180′ per minute. In fact the mobility of the cranes is astonishingly great. On this account it has, in operation, been found more advantageous to move the crane over the load and place the slings with the main hoist, than to employ the auxiliary hoist for that purpose. The leading of the hoisting ropes over the head of the tower and thence over the boom truck, which is never under full load, greatly facilitates the ease and rapidity of operation and greatly reduces any shock caused by the slipping of a load. The suspension of the boom proves to be extremely advantageous. One of the cranes has been so violently struck by a vessel that the boom was forced to its extreme position and the tower itself twisted until some of the trucks left the tracks, but, owing to this extreme flexibility of the boom, the resultant damage was negligible.

The operation of the cranes as a whole has been eminently satisfactory to both their designers and builders and to the Railway Company. They are large and expensive machines, but they have so thoroughly demonstrated their merits in the few months they have been in operation, that, in future, there is little doubt that similar machinery will be employed on all large wharves. The resultant economy in handling the freight and in the dispatch of vessels makes the installation of such machinery on all important wharves eminently advisable.

The cranes were designed and constructed by the C. W. Hunt Company, of New York. Although the plans were prepared under the author's direction, the design is the result of the combined work of Messrs. C. W. Hunt, C. C. King, Wm. Seaton, W. D. Stivers, and the author, ably assisted by Messrs. A. W. Gibbs, Genl. Supt. of Motive Power, his assistant, Mr. B. F. Wood, and A. S. Vogt, Mechanical Engineer, of the Pennsylvania Railroad Company.