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NAPLES - 1954

NEW CARGO CRANES IN THE PORT OF HAMBURG

by Baudirektor Dr.-Ing. Hans Neumann, Hamburg.

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New Cargo Cranes in the Port of Hamburg

by Baudirektor Dr.-Ing. Hans Neumann, Hamburg

In appraising the following paper on the development of dockside cranes in Germany during the past years it should be borne in mind that the considerations are based specifically on the development of crane design in the Port of Hamburg. On the one hand this is because Hamburg, being the largest German ocean port, has long taken a leading position in this field among the German ports, and secondly, because the author from his professional work, is familiar with the development at Hamburg. Furthermore, the problems with which the German seaports are concerned can be most appropriately explained by the Hamburg example.

In the reconstruction of the installations of the Port of Hamburg after World War II it was frequently objected that the capital needed for the mechanical equipment proper of the loading installations represented an increasing percentage of the total cost (incl. quaywalls, sheds, roads, trackage). The question whether the German seaports, and more particularly Hamburg, should be equipped with dockside cranes to handle the cargo, or whether one should follow the example set by the USA, i.e., handling the cargo by ships' gear only, need not be discussed here because this question has already been broadly investigated with the result that the use of dockside cranes is generally held to offer more advantages. Therefore, if the capital outlay for the mechanical loading equipment was to be curtailed, such a reduction had to be effected by other measures.

General considerations.

The first step was to ascertain the number of wharf cranes required. This question is closely interrelated with that whether in the case of wharves equipped with sheds preference should be given to the full portal or the semi-portal. At this point the opinions of the German seaports diverge. Whereas at Bremen the semi-portal crane used there for many years past is being adhered to, Hamburg, in reconstructing its

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port after the war, made its decision in favour of the full-portal crane.

For a better understanding of the development in this field I may briefly refer to the modification of the quay section during the past 15 years. Prior to World War II, the major part of the cargo was transported to and from the port of Hamburg via the Elbe river. This is why the port of Hamburg plan shows large water areas in the port basins, and (on account of the small extent of rail traffic at that time), usually not more than one, rarely two, tracks on the waterside of the quay sheds. This scene was completely changed after World War II. The iron curtain separated Hamburg from its natural hinterland and its waterway connections. The goods had to be transported by rail or motor truck instead of barges, and the volume of materials to be loaded directly from railway to ocean ship and vice versa increased rapidly. Consequently, the port organization was compelled to extend the wharf track system and to effect the separation of railway from road traffic. As a consequence, the typical Hamburg quay section after 1945 provides for 3 tracks on the waterside, whereas the landside of the quay shed is reserved for motor truck traffic.

This modification of the quay section entailed an alteration of the crane system. Under the loading conditions prevailing in Hamburg, it is desirable that the sheds should be provided with wide loading ramps on the waterside. If semi-portal cranes as generally used earlier at Hamburg were installed, they had to be of a span of over 25 m. They would be too heavy and too difficult to manoeuvre. It was therefore, decided that full-portal cranes should be installed throughout. This decision brought some further essential advantages.

First, the sub-soil of the Port of Hamburg is of rather poor bearing quality so that any structure must be based on pile foundations which of course are subject to varying degrees of subsidence. The waterside portal leg of a semi-portal crane is supported on the quay wall, while the landside rail runs upon a crane runway placed on a separate foundation along the shed. As a consequence, in the course of many years

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the centre distance between the crane rails of the semi-portal cranes formerly generally used in Hamburg showed a substantial change. In contrast to this, the two runway rails of the full-portal crane are placed on a single structure, namely the quay-wall. Moreover, the overlapping of loading tracks and loading ramp of the shed by the semi-portal is a disadvantage especially if a number of cranes are required to operate closely side by side for quick service on a seagoing ship. Finally, the uniform track gauge of the full-portal cranes (6 m. at Hamburg) enables the cranes to be relocated at will in any part of the port by means of a floating crane, to meet a special loading demand.

The experience gained with full-portal cranes justifies these measures. At some points of the quay the railway service track crosses the crane rails. To permit the cranes to run safely over the crossings, the landside track wheels of the portals have no flanges while the waterside wheels are of the double-flange type for proper guidance of the cranes. This arrangement has proved to be very satisfactory in actual practice. There have been hardly any cases where the loading operations were interfered with by the approach of railway cars because it is the general practice here to serve the railway cars before or after the working shifts or during working intervals.

The number of cranes to be placed on the wharf thus is influenced by the type of portal, since a smaller number of permanent cranes are needed on the shed if it is possible to increase their number quickly if required by relocating cranes working on less busy portions of the wharf. The high mobility of modern cranes facilitates such an interchange of cranes on a long wharf stretch from one shed to another. These considerations led to a change of the density of cranes. Whereas in earlier times it was the practice at Hamburg to provide abt. one crane per 20 m length of shed, this is now about 25 - 28 m. for modern wharf sheds, and efforts are being made to increase this figure to 30 m, although the port management is keenly opposed

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to this development.

Further considerations aiming at a reduction of the cost of mechanical equipment had to deal with the wharf cranes themselves. It was attempted to rid the crane of any dispensable parts, retaining only what is absolutely necessary for satisfactory crane operation. Proceeding from this basis, harbour boards, service engineers and crane manufacturers discussed the possible extent to which such simplification of crane design could be carried consistent with the specific duties of the wharf crane The result was a certain typification of cranes permitting the cranes to be manufactured in greater series than before. Thus it has been possible for the first time in the history of German crane engineering to effect kind of a series production of dockside cranes, the components of the cranes being largely manufactured with the aid of jigs and fixtures so that the unit price per crane could be lowered. The Hamburg Port Authority purposely refrained from developing a standard crane that could have been built by any of the crane manufacturers. It was considered appropriate to establish only the basic guiding principles and let the crane industry itself evolve the best type of crane on this basis. In this way free engineering development was not handicapped and the crane industry had the chance of making use of its know-how and experience gained elsewhere for the benefit of the best solution to this problem.

The basic requirements posed by the Hamburg Port Authority included the provision that in the new crane designs the curb ring principle hitherto prevailing on the cranes installed in the port should be departed from because it had been found that the race rollers arranged tangentially in relation to the race circle were worn in strenuous operation, causing increased maintenance costs. Moreover, the king pin necessary in this type of crane for the centering of the revolving superstructure prevents any access to the revolving part through the centre of the crane. As discussed later in the description of the types developed by the several crane manu-

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manufacturers, the solution has been to support the slewing portion of the crane either on a slewing column in the portal or on a double ball race designed to resist the tip-over moments.

As to the design of the jib, the single-link type of jib has been generally preferred to the double-link jib for the carrying capacities and radii required for the handling of piece-goods. The jib drive should be always positive in order to enable the crane operator to safely handle the load at any time.

The crane portal width should be of a minimum in order to enlarge the wharf area that can be served by the crane.

Constructional Details.

Many of the details of the cranes have been improved as compared with earlier crane designs. The hoist, for example, was formerly driven by a special low-speed motor manufactured to special order, while it is now the practice to use a standard motor. The increased motor speed necessitates the provision of a multi-reduction gear drive. All gearing is of the unit type with gears operating in an enclosed oil case. The motors are invariably flange mounted. Special care has been taken to permit all components to be easily dismounted for repair.

The worm gear drives of the slewing mechanism have been replaced with spur gear units. The unit construction enables the drives to be readily interchanged and repairs to be carried out in the shop.

Band brakes have been replaced with double post or multiple plate brakes.

Gear rims for the slewing gear made of grey iron are no longer satisfactory under the increasing stresses to which modern cranes are subjected and therefore have been replaced with pin wheel drives or machine cut gear rims.

The control of the cranes was uniformly arranged in such a way that the crane driver operates the hoist controller (hoisting and lowering movements) with the right hand

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and the universal control lever for level-luffing and slewing with the left hand, the directions of movement of the universal control lever corresponding to the respective crane movements. The crane travel controller, which is not so frequently operated, is controlled by a handwheel.

As regards the hoist, an electric contactor-operated brake lowering control is now generally used. The working speeds of the several movements are medium speeds (hoisting: 40 m/min.). The number of duty cycles in the case of the dockside cargo crane has been about 20 per hour since decades so that the secondary times (attaching and detaching of load, waiting) rather than the relative operating period of the motors are preponderating. Any substantial increase of the working speeds would greatly enhance the hoist of the mechanisms without an increase in the tonnages handled.

Most of the new types have small machine cabs in order to simplify the design of the superstructure and minimize the tail radius of the crane. The enclosed unit drives for hoisting, slewing and luffing can be located out of doors at the points most suitable for their respective duties. With such an arrangement the crane cab usually needs only accept the access opening through the centre of the crane, and the electrical gear.

The driver's cab which projects as far as possible in the direction of the jib has been designed with particular care. Large glass windows afford the operator an unobstructed view of the entire working area, the jib head pulley and the wharf area directly underneath.

The painting of the cranes in Northern climate demands particular care. In this regard, too, new approaches were taken. Large portions of the crane consist of light-gauge plates. Some years ago this material was in short supply in this country so that the plates were used as soon as they left the rolls, without the so-called rolling skin having been removed. If the red lead painting was applied immediately,

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large portions of the rolling skin were liable to peel off later on along with the paint so that corrosion of the light plates would constitute a severe danger to the structure. It was not possible to remove the rolling skin by sand blasting because in view of the short delivery times the mechanical parts had to be mounted simultaneously with the structural steelwork. Thus, the only way out was to allow the rolling skin to rust until it scaled off. This idea proved to be a dull success, for it takes a little less than one year for the scale to loosen sufficiently that it can be easily removed. The surfaces need merely be brushed off and the structure can then be prepared for painting.

The new crane types selected for manufacture.

In designing the crane, wide lattitude was granted to the German crane manufacturers. Working conjointly with the Port Authority and the Port Management of Hamburg the crane industry developed new designs of which those described later were selected for manufacture. The number of cranes ordered of each type was based on the consideration that on the one hand it was planned that large series of cranes of the same type should be ordered and that each wharf section should be equipped with only one type of crane, not merely because of the uniformity of outward appearance, but also with a view to changes of crane operators and ready inspection and maintenance.

The DEMAG Crane.

The new dockside crane created by Messrs. DEMAG of Duisburg, has a carrying capacity of 3 tons at a radius of 22,4 m. The lines of the crane make it clear even to the layman how the load is distributed from the slender jib through the slewing part down to the portal so that an aestetically satisfactory style of construction results. First of all, this type of crane is characterized by its three-legged portal. The three-point support of wharf cranes has been discussed in Hamburg as long as 25 years ago without this idea being materialized. The three-legged portal offers certain advantages where the ground or foundation is liable to subside so that the crane rails vary in level. Despite such movements of the ground the portal remains at all times statically determinate. Also, it offers more freedom for the crossings of the crane rails with the waterside tracks. The distance of the tip-over line from the centre of gravity of the three-legged crane is of course shorter than in the case of a four-legged crane because of the smaller base of the triangle formed by the three legs. The resulting lower stability of the three-legged portal is compensated for by ballast weights in the portal legs which are of welded bent plate construction. For this purpose the legs are filled with concrete all the way up, and only one of the legs is driven. The portal is sufficiently rigid, so that a single drive is entirely adequate. The centre distance between the runway rails at Hamburg has been uniformly arranged at 6 m. at which the ballast necessary for sufficient stability can still be easily placed in the legs. If the centre distance between runway rails is 5 m. or less, a detailed recalculation must reveal whether sufficient ballast can be placed in the legs or whether it will be necessary to use a four-legged portal.

The upper part of the crane revolves upon a double ball race capable of resisting both compressive forces and tensile forces (tip-over moments). Hence the diameter of the ball race can be held to a smaller dimension and the tail radius of the revolving part can be reduced. Thus it is possible to move the cranes closely together when it is necessary, for example, to engage two or three cranes simultaneously on one hatch of the seagoing ship. Moreover, the axis of rotation of the crane can be placed close to the wharf edge. The ball race which requires little attention, gives undangerous access to the crane through the centre of the ballrace even while the crane is working, the access stairway being suspended from the slewing part of the crane within the ball race, rotating along with the crane.

In the construction of the jib which was to be made very light, advantage was taken of the experience gained in the construction of aeroplanes. Accordingly, the jib was made of 4 mm. gauge bent plates welded according to the shell-type of construction in which the load-carrying members consist of the outer plating itself rather than of a steel framework merely covered by a skin of sheet metal. In this way it has been possible to construct a jib of a length of 28 m. weighing 3.9 tons. The smooth surfaces of the jib and the portal permit convenient painting and do away with any inaccessible points easily attacked by corrosion.

The jib is driven by a segment rack and pinion arrangement, the dead weight of the jib being equalized by a sliding counterweight suspended from two parts of rope. It slides vertically along the rear member of the superstructure of the crane as the jib is raised and lowered. A specially designed luffing system of the rope equalizing type ensures a horizontal movement of the load during luffing, the ropes being guided three times between the jib head pulley and the pulley block in the head of the superstructure.

The machine cab is mounted on the lower platform and accommodates the slewing mechanism, the electrical control elements and the driver's compartment. The upper platform, which forms the roof of the cab, supports the hoist and luffing gear. Since the cranes must be frequently relocated, the Port Authority made the provision that means be provided by the crane manufacturers permitting the crane to be conveniently handled as a whole by means of a floating crane. It was impracticable to weld lifting eyes for the total crane weight to the portal because with the DEMAG design the eyes would be difficult to reach. The very practical solution adopted by DEMAG consists of two tubes fitted to a horizontal cross member of the crane superstructure in which are inserted the pins of a lifting device attached to the hook of a floating crane. This device permits the dockside crane to be suspended within a few minutes' time and to be transported by the portal crane. This is possible because the double ball race is designed to take also tensile forces,

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ensuring a safe connection between the revolving part of the crane and the portal. Messrs. DEMAG have been successful in an attempt to erect their new type of crane without the need for erection derricks by using the jib of the crane as an erection mast. This is a simplification of the field erection procedure which may be of considerable advantage in overseas ports on account of the saving in freight for erection gear.

Many of the components of the new DEMAG crane are manufactured in series with the aid of jigs and fixtures. This ensures complete inter-changeability of assemblies and components of the crane as well as absolute uniformity and accuracy of size.

The many new approaches taken by the designers of this type of crane, involving the departure from hitherto usual standard specifications made it necessary to provide first of all, in addition to accurate design calculations, the scientific basis for the designs. Thus, in order to determine the behaviour of the crane under wind pressure (and thereby to obtain the accurate factors for the static calculation), a model of the jib was tested in the wind tunnel of a School of Technology. The stiffness of the box section construction of the portals was determined by loading a 1:5 scale model until failure occured which was only after 6 times the maximum rated load was applied.

The fact that the new crane design is a success is reflected by the reduction of the weight of the steelwork which for a crane of 3 tons carrying capacity at a radius of 20 m. formerly amounted to some 40 - 50 tons, whereas the weight of the structural steelwork of the new DEMAG crane is only 28 tons. The ballast weight in the portal legs is 28.6 tons, the fixed balance weight of the slewing part 12 tons, and the sliding weight counterbalancing the jib, 4.6 tons, that is, a total of 45.2 tons of cheap concrete weight as compared with 28 tons of steel weight.

The DEMAG port crane known as H-B crane was placed on exhibit at the Hannover Technical Fair of 1953.

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The KAMPNAGEL A.G. crane.

Messrs. KAMPNAGEL A.G., Hamburg, have developed two types of cranes for the handling of general cargo in sea ports, which have been built in a capacity of 3 tons at 25 m. radius for the Hamburg port.

One of the two types is the further development of the approved curve-guided crane, the other has been developed from the ellipseguide crane and is called a column-guided crane. Both cranes use a slewing column.

Many of the curve-guided cranes of the earlier type have been supplied by this firm to the Hamburg port. It met the basic working requirements, namely a sure control of the movement of the load during luffing, by simple means. Since the rope equalizing effect is influenced by the design of the curve guide, it can be made to a high degree of accuracy for the horizontal movement of the load. Moreover, the equalization is of advantage with respect to the deadweight of the jib and the masses to be moved during luffing are small.

The new crane has a four-legged portal of welded plate construction. Between the waterside portal legs is arranged a beam carrying the track mechanism for both corners of the portal. The landside legs are not interconnected so that cross traffic is not impeded. The necessary stiffness of the portal is given by horizontal tie members at a level above the top of the railway loading gauge.

The slewing part of the crane is supported on a slewing column of rectangular section, which is of welded steel construction. The base of the column rests in a spherical roller thrust bearing in a spider located on a level with the cross tie members of the portal. The horizontal forces are transmitted by the horizontal thrust rollers to a rail ring of the portal. The rollers can be accurately adjusted by eccentric pins and ensure a nonvibrating and smooth rotation of the column. The slewing column dispenses with the conventional centre post so that the crane cab is conveniently accessible through the centre of the column in any position of the

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crane.

The curve-guided crane requires more space than other types of cranes because of the curve guide and the rear pedestal frame, so that it would be unnecessary to restrict the space requirement for the driving mechanisms. Therefore, all driving mechanisms for this crane can be accommodated in the enclosed machine cab which in its rear portion houses the fixed balance weight. A projecting full-view driver's compartment ensures an unobstructed view of the entire working area.

The slewing brake is a hydraulic pedal-operated brake. In the case of the port cranes with a greater working radius the jib movement should be smooth without any impacts in order to avoid excessive inertia forces. For this reason this type of crane is equipped with a hydraulic luffing gear. The luffing movement of the jib is effected by a hydraulic power cylinder. The hydraulic power plant consists of a totally enclosed unit located in the crane cab and containing the hydraulic pump and control valves. The pump is driven by a flange-mounted motor which is operated in the usual manner from the luffing controller. With this arrangement a perfectly uniform and accurately controlled jib movement is ensured. The braking action is steady and flexible. The satisfactory operation of this hydraulic drive gives reason to expect its being applied to other crane movements in future.

The weight of the jib is balanced by a counterweight fitted to a rocking lever and rigidly connected to the jib above the crane cab.

Special care has been taken to ensure a simple guidance of the hoist rope which runs always in the same direction over the pulleys without any reverse bends.

For transporting the whole crane by a floating crane, Messrs. KAMPNAGEL A.G. have developed a suspension gear which engages straps arranged at the base of the jib and at the rear guide above the crane cab. Connection between the bottom part of the slewing column and the bearing spider in the portal is established by a special suspension arrangement.

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The total weight of the crane is 57 tons, 33.5 tons for structural steelwork and 23.5 tons for counterweights.

The other type of crane developed by KAMPNAGEL, the column-guided crane (Type SL = Saulenlenkerkran) embodies the advantages of the simple ellipse guided crane in which the horizontal movement of the load is held to a high degree of accuracy. By an automatic correction of the rotation of the hoist rope drum, the free length of the hoist rope is altered so that the load remains on the same level. This is accomplished by transmitting the movement of the jib balance weight by an auxiliary rope and sun and planet wheel gear to the hoist drum.

The typical arrangement of the column guided crane shows the simple, straight lattice jib which has the shape of a two-arm lever. The centre of rotation is located precisely in the neutral axis. The hoist rope drum is placed on the axis of rotation of the jib. The hoist rope passes from the drum direct to the jib head pulley without any deflection. The jib counterweight (8 tons) moves on a path in the centre of the crane. It is connected to the jib by links. Owing to the arrangement of the counterweight in the centre of rotation of the crane, the unbalanced inertia forces due to acceleration and retardation during slewing are practically eliminated.

The portal of the crane, is of welded box-section construction. Its design is similar to that of the curve-guided crane described before. The slewing column is mounted in a spherical roller bearing.

In the case of the column-guided crane, too, Messrs. KAMPNAGEL prefer the arrangement of the hoist, the electrical control and auxiliary gear and the hydraulic power unit of the luffing gear in the crane cab which later on is to receive also the slewing gear. This weather-protected arrangement offers operational advantages in respect of inspection and periodic maintenance.

Unlike the arrangement adopted in the case of the curve-guided crane, the hydraulic

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pump of the luffing gear is driven by a continuously running motor. The movements of the hydraulic power cylinder are in this case controlled directly by the crane driver.

The total weight of the column-guide crane amounts to 72 tons, 43 tons for the steelwork and 29 tons for the balance weight.

The crane was placed on exhibit at the Hannover Technical Fair of 1954.

The MAN crane.

The four-legged portal crane of Messrs. MAN (Nurnberg) has a carrying capacity of 3 tons at 25 m. radius. As is the case of the DEMAG and KAMPNAGEL cranes, expediency of design and gracefulness of appearance have been the guiding principles. The new type is called "Blocksaulenkran" in order to describe it as a gear units type and as a column guided crane. It is characterized by a compact, space saving form, most favourable for cargo handling.

The portal is of substantial plate construction 8 mm gauge plate, and carries in the centre a spider of welded construction to accept the adjustable rolling contact bearing for the base of the slewing column. The crane does not require a fixed balance weight in the slewing part for balancing the load. Counter-balancing is effected exclusively by the concrete filling of the four portal legs. The waterside portal legs are interconnected by a track beam carrying the track drive and the base landing of the access ladder. The landside legs do not have such a tie in order to permit an unobstructed cross traffic.

The slewing column selected by MAN for the slewing part of the crane consists of 4 continuous tubes at the corners with sheet facing butt-welded to the tubes. Alternatively the column may be of welded bent plate construction. It is supported on the aforementioned spider fixed in the portal, which takes the vertical forces in radial and axial anti-friction bearings. The horizontal forces are transferred to the horizontal head ring of the portal by adjustable eccentric-mounted thrust rollers

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The pin wheel of the slewing gear is arranged here. The slewing column being hollow, undangerous access to the crane cab through centre of the column is possible in any position of the crane.

The restricted space conditions of the cab require all enclosed gear units to be located out of doors. For this purpose a balcony-like gallery was provided giving access to the side-mounted slewing gear and the rear-mounted hoist. Owing to its location in the rear part of the crane, the hoist acts as a balance weight. The gallery has been suitably faced to blend with the overall contour of the crane so as to give an architectonically refined appearance. The top of the portal, on which the suspension lugs for transportation of the whole crane are fixed can be reached from the gallery.

The crane cab proper accommodates only the electrical apparatus and the projecting driver's compartment.

The jib is pivoted on top of the cab and thus does not hinder the crane operator's vision. It is of light-weight construction, made of angle sections and weighs only 3 tons. The luffing gear drive consisting of rack and pinion is located in the upper third of the slewing column. Rope equalizing for horizontal load movement during luffing is effected by a pulley block interposed between hoist and jib counterweight. The weight of the jib is balanced by a counterweight sliding up and down on the rear side of the slewing column. The connection between counterweight and jib head is established by a combination of two ropes and a flat-link chain, with the chain steadily running over the deflecting pulleys of the top of the superstructure.

The slewing column tapers considerably in the upward direction and takes the guides for the sliding counterweight so that there is no space for a ladder giving access to the top of the superstructure. This problem has been solved by arranging an assembly platform on the rear side of the column in such a way that it can be raised

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and lowered from the inside of the slewing column by means of a crank handle. The luffing gear is accessible from inside the column over a hinged balcony. From this balcony the jib ladder can also be conveniently reached.

In developing this new type of crane, MAN also subjected various structural components to scientific tests in the test station of the Works before they were released for final manufacture. For example, 1:4 scale models of light-weight jibs of various types were load-tested under conditions approximating actual practice. On this basis a type of jib was selected which failed under an effective load corresponding to 5 times the maximum stresses possible in the worst case.

The total weight of the MAN crane is 62 tons, of which 35.5 tons are steelwork and 26.5 tons counterweights, the ballast weight placed in the portal legs weighing 22 tons.

Conclusions.

It is not yet possible to pass a conclusive verdict on the merits and success of the new crane types in actual port loading operations because the time for thorough trial has been too short. Generally speaking it may be said that all of the types mentioned have proved themselves successful. Particular attention will further be given to the following questions:

Three-legged or four-legged portal

Double ball race or slewing column

Travelling drive for portal on one or two legs

Stiffness of portal

Bent or straight legs

Luffing mechanism

Jib of shell-type or lattice construction

Outdoor or indoor location of driving mechanisms

Design of driver's compartment.

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Of the observations made on all of the new crane types, two deserve special mention: The substitution of the ball race or slewing column for the conventional turntable mechanism results in a far easier rotation of the cranes than formerly. The crane driver therefore has a more sensitive control of the crane than before. However, it is necessary to provide means preventing the crane to rotate due to oscillations of the load or wind pressure.

As to the stiffness of the portal a certain optimum value exists. The portal must not be too flexible because this would result in irregular travelling movements in that for instance the driven waterside of the crane portal leads before the land-side portion. On the other hand, if the four-leg portal is too stiff, it may happen, when travelling over uneven crane rails with the jib positioned over one of the landside legs, that the diagonally opposite waterside leg rises off the runway rail so that the crane is liable to derail.

All crane manufacturers have used their best efforts to arrive at the desired price reduction for the dockside crane. An essential step towards this goal has been made in standardizing the crane components and the application of series manufacturing techniques. Nobody would think of having a motorcar custom-built because the cost would be much too high. The purchaser should rather be afforded the possibility of selecting the right thing from a number of approved types manufactured in series. In a similar way the German crane building industry has endeavoured to contribute towards a reduction of the cost of cranes by developing a few suitable types which can be made in greater series. The user will gladly refrain from any special wishes if he recognizes the advantages offered him by such policy. The Port Authorities are then able to purchase more cranes at lower prices and thus provide the facilities necessary in the joint struggle of the ocean ports against the delay in the turn-round of ships.

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