

METHOD OF CHANGING THE RAIL GAUGE OF QUAYSIDE RAIL MOUNTED GANTRY CRANES

FIELD OF THE INVENTION

The present invention relates to a method of changing the rail gauge (span) of a rail mounted crane.

BACKGROUND OF THE INVENTION

Rail mounted gantry cranes, such as those used by the side of a quay, come in many different forms of construction and purpose. Their function is to lift cargo on or off of a vessel berthed alongside a quay. Generally, quayside cranes have a lower structure, consisting of a portal frame of steel construction to which rail bogie trucks, usually one set in each of four corners, are connected such that the multiple rail wheels distribute the crane weight and other forces to the crane rails on the quay. The upper or superstructure of the crane may be fixed or rotating depending upon the functional requirements of the crane and the particular type of cargo and method used for handling.

Quays are usually, but not always, of piled deck construction. The crane rails are set on top of strong reinforced concrete beams able to take the substantial operating weight of the crane, which may vary with different cranes from several hundred tons to well in excess of one thousand tons, depending on the purpose for which the crane and quay were constructed. The crane rails, termed 'seaside rail' and 'landside' rail' or similar, are supported on many reinforced concrete piles throughout their length. The quay deck between the seaside rail and landside rail, and beyond the landside of the landside rails is of a much lighter construction, with fewer pile supports and much lower load bearing strength, normally no more than 10 tons per square metre. Therefore, the quay surface, apart from the area immediately above the crane rail beams, is not capable of supporting the weight of the crane without substantial additional structure to spread the load, should there be the requirement to lift the crane for any purpose.

Continuing developments in the shipping industry, particularly related to vessels and cranes, causes major ports to upgrade their cranes from time to time to keep abreast of changes. The dimensional standards and capacity of older cranes

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make them obsolete in major, or hub, ports. Thus older cranes with many years useful life remaining have to be relocated or scrapped to make way for newer larger equipment. Smaller ports, without the need or capability of handling the largest vessels, frequently acquire these used quayside cranes. For smaller ports, the advantages of such acquisitions on short time scales and relatively low capital cost can be considerable.

For economic reasons, relocation of these large cranes is often performed by specialist contractors without dismantling the crane. Cranes are prepared for transportation and transported by sea in the fully erect condition on special project vessels or barges. Examples of the transporting vessel are:-

A 'forklift' semi-submersible type capable of loading or discharging the quayside crane from the quay and skidding the crane into and out of its hold or dock without external assistance from other lifting equipment.

A heavy lift vessel with its own heavy lift crane or cranes capable of loading and discharging the quayside crane.

A barge or vessel used in combination with a floating crane for loading and discharging, or for short journeys, a floating crane alone.

A barge or vessel used in combination with a system of skidding beams or rails to load and discharge the quayside crane, such that the quayside crane is rolled on wheels or skidded on sliding pads from quay to vessel and vice versa.

Frequently in such relocation of quayside cranes, the loading quay and discharge quay have different rail gauges. Therefore there is a frequently occurring requirement for the rail gauge of the crane to be changed before it can operate on the new rails at the destination quay.

Changing the rail gauge of such a crane is a major structural alteration requiring the crane to be supported while one set of rail bogie trucks and leg structure is relocated to the new gauge. Prior Art methods of changing the rail gauge of quayside cranes involve making a support structure to spread the load on the quay surface such that one side of the crane, usually the landside, can be lifted clear of the rail while the leg structure is cut or otherwise disconnected from the portal frame and moved to the new location for reconnecting to a newly prepared structural attachment. Such works are time consuming, involve the manufacture of relatively large temporary support structures and immobilise the crane during the process. In major ports, it would not be permitted that operational quay space be occupied by

an immobilised crane for the period of time necessary for the works to be carried out. In any port it will be inconvenient and expensive for quay space to be occupied by an immobilised crane for the period of the works.

OBJECT OF THE INVENTION

It is one object of the present invention to provide a system for changing the rail gauge of the quayside crane without the need to immobilise the quayside crane for little more time than would be normally required for the transportation loading operation.

It is another object of the present invention to provide a system which avoids the need for large temporary support structures, or the need to apply heavy loads to the quay surface other than those normally applied by the crane wheels to the crane rail, or to significantly apply loads anywhere other than would be normally applied during the loading operation for the quayside crane if it were loaded in the modified or unmodified condition.

It is another object of the present invention to enable the crane to be mobile on the rails (with external assistance by towing vehicle, if necessary) immediately prior to the loading operation and immediately after the discharge operation. This feature enables more flexibility in the choice of precise location along the quay length for loading and discharge operations and final placement of the quayside crane. Such choices may normally be limited by water depth, water current, bollard positions for mooring the transport vessel, clearance for positioning the transport vessel and its anchoring system.

Other objects, features and advantages of the present invention will become apparent from the detailed description which follows, or may be learned by practice of the invention.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided A method of changing the gauge of a railway mounted crane having a set of first legs and a set of second legs, from a first gauge to a second gauge, including the steps of:

attaching a first connecting means corresponding to each of the first legs such that the distance from the first connecting means to the corresponding first leg is approximately equal to the second gauge;
attaching a second connecting means to each of the second crane legs;
supporting the crane by a seaborne lifting device;
detaching the second legs from the crane and lifting the crane free from the second pair of legs;
moving the crane with the lifting device such that the second connecting means of each of the second legs align with the first connecting means;
lowering the crane such that the first connecting means engage with the second connecting means; and
attaching the first and second connecting means together.

In this way the crane has its span adjusted while being moved, thus removing the need for additional support of the entire mass of the crane. The time required for the span change is also greatly reduced, thus freeing up the quay for use.

Preferably, the first connecting means and the second connecting means are hingedly attached to allow each of the second legs to pivot. The hinged attachment also allows for adjustment of the span to be made during lifting of the crane.

Preferably, the first connecting means is a pin, and the second connecting means is a plate, wherein the plate has upward facing open jaws adapted to connect hingedly with the pin.

The use of such plates and pins allows the legs to be self adjusting for span, and also allows the pins to be guided into the jaws of the hinge plates, thus making alignment of the pins and plates easier.

Preferably, the first and second connecting means are fixedly attached such that the second leg is able to support the crane.

In one form of the present invention, the first connecting means is attached to the crane by a support structure. The support structure allows the first connecting means to be attached to the crane at a point further from the first leg than the first span, thus allowing the span of the crane to be increased. (The support structure may also be attached to the crane at point nearer to the first leg than the first span, allowing the span of the crane to be decreased).

This gives the advantage that the adjustment of the span of the crane can be done while the crane is at the original quay, and minor adjustments can be made at later stages.

A preferred embodiment of the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a side elevation of a crane on a quay in accordance with the present invention;

Figure 2a is a side elevation of the crane of figure 1 having additional reinforcement beams and a support means;

Figures 2b and 2c are detailed views of the modifications to the leg of the crane as shown in figure 1.

Figure 3a is a side elevation of the crane of figure 2 having additional lift equipment;

Figure 3b is a detailed view of the modifications to the crane leg shown in figure 2;

Figure 4a is a side elevation of the crane of figure 3 with a lifting vessel in position to lift the crane;

Figure 4b is a detailed view of the leg of the crane shown in figure 4a;

Figure 5 is a side elevation of the crane of figure 3 being lifted clear of the quay by the lifting vessel, having landside legs detached;

Figure 6a is a side elevation of the crane of figure 5 with the detached leg in a new position;

Figure 6b is a detailed view of the crane leg shown in figure 5

Figure 7 is a side elevation of the crane of figure 6 loaded onto the lifting vessel;

Figure 8 is a side elevation of the crane of figure 6 on the vessel in final transportation position;

Figure 9 is a side elevation of the crane of figure 6 in a discharge position at the destination quay;

Figures 10a, 10b and 10c are side elevations of the crane of figure 6 having new lower leg portions positioned at the destination quay;

Figures 11-14 are side elevations of the known method of changing railspan for a quayside crane.

As can be seen in figure 1, the quayside crane 10 is supported by a set of legs, being quayside legs 12 and landside legs 14. The legs 12, 14 sit atop rail bogie trucks 13 which run along rail tracks, thus giving the crane 10 mobility along the quay 11. The gauge of the track is fixed, and often varies from quay to quay.

In order to change the gauge of the crane 10, a first connecting means, such as pin 8 is attached to each of the landside legs 14 of the portal structure 16 of the crane 10 at points which will be directly above the crane rail centre line of a landside rail or seaside rail of the intended destination quay. The axis of the pivot of each pin 8 is parallel to the both of the rails and both pins 8 are in line with a common axis. The choice of landside or seaside rail depends upon the extent of the span change and structural considerations for each particular crane. In most, but not all cases, it will be considered appropriate to perform this operation on the landside legs 14.

The pivot pin 8 and a support structure 30 may be attached to the crane by welding as shown in figures 2b and 2c.

A second connecting means in the form of mating hinge plates 24 for the pivot pins 8, having a common axis parallel to the crane rails, are built into the existing landside legs 14 of the crane 10 at points directly above the rail centre line of the existing quay. The size of the pins 8 is selected according to load and stress calculations. However in most cases with cranes ranging in weight from 500 tons to 1000 tons, it is expected that the diameter of these pins will be in the range 150 to 250 mm. Each plate 24 is adapted to be self aligning to a degree suitable to this type of lifting operation by having upward facing open jaws 27. The horizontal distance between the axis of the pins 8 and the axis of the hinge plates 24 is equal to the required span change dimension difference.

Rail height differences between origin and destination quays are incorporated by different vertical dimensions between the axis of pins 8 and the axis of hinge plate 24, such that the vertical distance between the axis of the pins 8 and the axis of the hinge plates 24 is equal to this rail height difference.

Additional support structure which may include another hinge pin 7 is built into the existing leg frame as shown in figure 2c. This creates a load path for the vertical load from the upper structure through the landside legs 14 via the hinge plate 24 and pin 7. The joint so created can be quickly separated at the time the crane is lifted.

Local reinforcing of the landside leg 14 is accomplished by additional welded plates as necessary in each case. Stabilising supports 26 as shown in figure 4a may be fixed to the lower part of the landside leg 14 to hold it in a vertical position when it is free standing. These supports 26 are clear of the quay surface to allow crane mobility during the preparation period, but will be chocked with wooden blocks when the crane is in the final position ready to be lifted.

Prior art lifting attachments are fixed to the crane, and other preparations as necessary to lift the crane are made prior to the arrival of the transportation vessel or floating crane.

The crane 10, having the plates 24, pins 8 and 7 and supports 26 attached, will still be mobile on the crane rails and can be moved for convenience of the port operator and final positioning for lifting at the time of transportation.

When the transportation vessel or floating crane is in position and is taking the weight of the crane, the landside leg 14 is cut free or separated at the hinge plate area such that the crane 10 can be lifted free of lower leg frame 14a and the lower leg frame 14a remains on the quay supported by the stabilising supports 26 to hold it in a vertical position.

The crane 10 is lifted clear of the lower leg frame 14a and repositioned by moving seaward or landward such that the pin 8 is vertically above the hinge plates 24. The crane 10 is then lowered so that each pin 8 drops into the corresponding hinge plates 24 and a downforce is applied from the weight of the crane 10 to the legs 14.

By using a pin hinged joint, this process is self aligning to a degree suitable to this type of lifting operation, bearing in mind that there will be some vessel and sea motion during this process. The upper part of each hinge plate 24 has tapered jaws 27 leading to the hinge seat 28 of the plate to assist in the alignment of the pins 8 and the hinge plates.

Each pin 8 and hinge plate 24 is secured to one another by securing rings 35 which are welded or bolted to the hinge plates 24. The size of these rings, four in number, is sufficient to bear the weight of the lower leg frame 14a when the process is complete. Once complete, the crane 10 is lifted again with the hinged leg 14 re-attached to the crane. The hinged landside leg 14 is now in a position approximately the same distance from the quayside leg 12 as the span of the rails at the destination port.

The hinged landside leg 14 may be finally aligned to the precise rail gauge of the destination port at this time and temporary stays (not shown) attached to secure it in position and stop any further articulation during the remaining transportation.

Delivery to the destination port is accomplished by prior art methods. During unloading onto the destination quay, the crane is already set to the correct rail gauge and rail height. However, the temporary stays mentioned above may be removed during unloading to allow minor alignment if desired.

Figures 1 to 10 show the process of changing the railspace of a crane using the principles of the invention. By way of comparison, the prior art method of changing the railspace of the same crane is shown in Figures 11 to 14.

With specific reference to the figures, one embodiment of the method of the present invention will now be described.

Figure 1 shows a typical quay crane 10 (in this case a container quay crane) before commencement of any work for relocation or change of railspace.

Figures 2a, 2b and 2c show crane 10 with some reinforcement of the portal beams and installation of the temporary hinge equipment in preparation for relocation and rail span change.

Figures 3a and 3b shows the further installation of prior art lifting equipment.

Figures 4a and 4b show a forklift vessel in position 'stern-to' ready to lift.

Figure 5 shows the vessel lifting the crane 10 clear of the lower landside leg 14a. Note, it is normal that the crane is lifted clear from the bogie trucks 31 at this stage so that the overall width of the crane is reduced so that it may fit within the confines of the dock of the vessel.

Figures 6a and 6b show the ship and crane moved to position the crane at the new leg location and the crane lowered onto the leg. The mating parts of the hinge system are together and the leg is attached by securing rings 35 attached over each end of the pin and fixed to the leg by welding or bolting.

Figure 7 shows the crane lifted once again by the vessel, leaving the landside bogie trucks 31 behind and the crane 10 is skidded into the dock of the vessel.

Figure 8 shows the crane in its final transportation position in the vessel. After this the vessel will return to berth 'alongside' for loading of the bogie trucks 31 and seafastening of the crane 10.

Figure 9 shows the crane 10 in the discharge position at the destination quay. Note that the crane will be lowered directly onto the bogie trucks which are positioned on the crane rails.

Figures 10a, 10b and 10c show the crane 10 discharged onto the rails at the destination quay.

Figures 11 to 14 show the conventional prior art method for changing railspan as a 4 step process.

Figure 11 Step 1: Reinforcing and extension structures are welded to the crane.

Figure 12 Step 2: Two jacking towers or pillars are erected on the quay, one for each portal beam. Due regard must be taken for the load carrying capability of the quay surface and support piles.

Figure 13 Step 3: A skidding system is installed to move the leg frame. It may be necessary to remove the crane bogie trucks from the leg frame at this stage to permit installation of the skidding equipment.

Figure 14 Step 4: The rear leg frame is cut free, the crane lifted and the leg frame skidded to the new position for re-attachment.

As can be seen from the figures and above description of the present invention, to change the railspan of the crane some structural elements will be modified or added. This process will require a structural analysis of the crane to enable correctly sized and designed elements to be manufactured and incorporated into the crane structure. Figures 2a, 2b and 2c show these elements built into the structure of the crane 10.

Incorporated during the installation of these elements are the features of the invention. The pin 8 may be built in to the support structure such as portal beam extension 30, and located above the centreline of the new crane rail location for the destination port. A slot 32 is cut in the leg, both sides of both legs, to enable the hinge plates 24, and pin 7, to be installed. Note that the horizontal distance between the centres of pin 8 and pin 7 is equal to the railspan difference between origin and destination quays. The drawing also shows a vertical height difference between the centres of pin 8 and pin 7, these distances being equal to the change in seaside/landside rail height difference between origin and destination quays. The areas around hinged plate 24 and pin 7 are reinforced with additional plating (not

shown) to provide a load path of sufficient strength to carry the vertical load through the pins and plates when the landside legs 14 are cut away later in the process.

Further prior art lifting brackets are installed in figure 3 to complete the preparations for lifting. Preparations are also made at crane bogie level to allow the crane to be lifted from the bogie trucks. Removal of the bogie trucks 31 is normally necessary to reduce the low level overall width of the crane to enable it to be skidded with the width of the dock of the transport vessel.

The crane 10 may be lifted on two skid brackets on the seaside leg frame, one bracket on each side, and a skid beam spanning the skid rails of the vessel which supports the crane via two support columns near the landside leg. These are prior art arrangements and are described for purposes of clarification only. The skid brackets and skid beam are guided and slide or skid on rails built into the deck of the transport vessel. A material such as Teflon is used at the skid face of the beam and bracket, sliding on oiled stainless steel rails to provide low friction and hence low pulling force during the skidding of the crane.

The transport vessel approaches the crane 'stern-to' for the 'fork-lift' loading process in figure 4 and is aligned with the skid beam and skid bracket for the vertical lifting operation.

The crane is lifted clear of the seaside bogie trucks and landside leg 14 as shown in figure 5 by de-ballasting and trimming the vessel. The landside leg 14 is separated from the crane at pin 7/ hinge plate 24. At this point the seaside bogie trucks would normally be towed clear to allow unimpeded access for the remainder of the operation.

The crane is then moved seaward either by skidding on the vessels rails or by movement of the whole vessel to align pin 8 vertically above hinge plate 24 and the vessel ballasted to lower the crane 10 and guide pin 8 into engagement with hinge plate 24 as shown in figures 6a and 6b. The sizes of the components make this operation self aligning to a degree which is suitable to this type of marine lifting operation.

The downforce transmitted through pin 8 and hinge plate 24 can be controlled by the extent of ballasting of the vessel. It is best if some portion of the crane weight remains on the skid beam to prevent the skid beam lifting clear of the vessels skid rails. The reason is simply to eliminate the time required to re-align the skid beam with vessel skid rail should separation occur. When pin 8 and hinge plate

24 are in good contact, the securing rings 35 can be installed. These are substantial steel rings welded or bolted to hinge plate 24 to complete the hinge configuration.

Once the securing rings 35 are installed, the crane 10, complete with landside leg 14 can be lifted clear of the landside bogie trucks and skidded into the vessel as shown in figure 7, for seafastening in final position as shown in figure 8. If required for seafastening or other reasons, the newly pivoting landside leg 14 can be fixed in position by struts welded to the skid beam.

The crane 10 is discharged onto its bogie trucks at the destination quay as shown in figure 9. After discharge, the temporary hinged area of the landside legs 14 is plated over and the hinged parts removed as shown in figures 10a, 10b and 10c.

While one particular case of implementation of the invention has been described and illustrated, it is understood that the principles of the invention can be applied in many varied and different ways to the process of transporting and changing the railspan of quayside cranes without departing from the scope or spirit of the invention.

The accompanying drawings which are incorporated into and constitute part of the description of the invention, illustrate embodiments of the invention and serve to explain the principles of the invention. It is to be understood, however, that the drawings are designed for purposes of illustration only, and not as a definition of the limits of the invention for which reference should be made to the claims appearing at the end of the description.

CLAIMS

1) A method of changing the gauge of a railway mounted crane having a set of first legs and a set of second legs, from a first gauge to a second gauge, including the steps of:

attaching a first connecting means corresponding to each of the first legs such that the distance from the first connecting means to the corresponding first leg is approximately equal to the second gauge;

attaching a second connecting means to each of the second crane legs;

supporting the crane by a seaborne lifting device;

detaching the second legs from the crane and lifting the crane free from the second pair of legs;

moving the crane with the lifting device such that the second connecting means of each of the second legs align with the first connecting means;

lowering the crane such that the first connecting means engage with the second connecting means; and

attaching the first and second connecting means together.

2. The method of claim 1 wherein the first connecting means and the second connecting means are hingedly attached to allow each of the second legs to pivot.

3. The method of claim 1 wherein the first connecting means is a pin, and the second connecting means is a plate, wherein the plate is adapted to connect hingedly with the pin.

4. The method of any one of the preceding claims wherein the first and second connecting means are fixedly attached such that the second leg is able to support the crane.

5. The method of any one of the preceding claims wherein the first connecting means is attached to the crane by a support structure.

6. The method of claim 5 wherein the support structure allows the first connecting means to be attached to the crane at a point further from or nearer to the



first leg than the first span, thus allowing the span of the crane to be increased or decreased, respectively.

7. A method of changing the rail gauge or span of a quayside rail mounted crane including the step of relocating part of the supporting structure by detaching the supports to be moved, and reattaching the supports at the new span using a hinged joint.

