



CRANE

This invention relates to a crane, particularly though not exclusively a crane that is suitable for use in loading or unloading a vehicle, a conveyor belt or a vessel such as a ship. The invention also encompasses a method of operating such a crane.

The invention will be explained hereinafter in relation to loading and unloading of cargo ships, it being understood, however, that the invention can be applied to the movement of goods or commodities in any circumstances or within any facility, for example in loading or unloading other cargo-carrying means such as land vehicles or conveyor belts.

Cargo ships form the backbone of worldwide trade, carrying cargo ranging from loose bulk materials to freight containers all over the globe. This cargo can be carried internally within holds that are typically covered by movable hatches, or externally on deck as is common on container ships.

Economics dictate that a cargo ship must be unloaded and then reloaded as quickly as possible when it is in port. At present, these operations are commonly performed by an array of gantry cranes at dockside, each crane of the array being aligned with a respective hatch of the ship to gain access to the holds or being aligned with, for example, particular containers on deck. The cranes can be moved along the dockside with respect to the ship for this purpose.

Each crane typically includes a lifting tackle suspended by wires from a trolley. The trolley is movable on an elevated horizontal track defined by a pair of rails supported by a jib or gantry, the trolley spanning the gap between the rails. The trolley reciprocates between two positions during an unloading operation, one position being for lifting items from the ship and the other position being for depositing those items at dockside. The items may, for example, be deposited onto a vehicle such as a truck or a train, or possibly onto a conveyor belt that carries the items away as they are deposited thereon. Of course, a loading operation is merely the same operation in reverse.

An array of several cranes all operating simultaneously or in parallel allows faster handling of cargo than if a single crane is used successively to access different positions along the ship. However, there is a speed limit determined by the time that each trolley takes to move between the two abovementioned positions. Accordingly, for a substantial part of the operation, the jib of the crane lies uselessly over the ship



waiting for the trolley to return before further items can be lifted out or lowered on board.

- Attempts to speed the process by providing more than one crane for each hold or position along the ship's length are impractical. Each crane is necessarily bulky if it is to support substantial loads; this means that there is too little room for two such bulky cranes to fit side-by-side without mutual interference while still being correctly aligned with respect to the ship and its cargo.
- 10 Applicant has had the insight that the speed limit on the loading or unloading process could be raised enormously if a single crane could have two or more lifting tackles operating simultaneously and preferably independently of one another. This would have the same effect as if two or more cranes were working in the same location, and could be expected to multiply the speed of the process in accordance with the number of tackles used.
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In order to operate two or more tackles along the same gantry in order to emulate two or more cranes working in the same location, it is essential that the tackles and their loads or lifts should be able to pass clear of each other at all times. Of course, the structure of the crane itself must also be capable of working safely with the combined weights, momentum and vibrations involved in simultaneous multiple lifts.

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Applicant has found old prior art disclosures of cranes in different technical fields that employ more than one tackle but these multiple tackles act on one load and do not teach accelerating a loading or unloading process involving multiple discrete loads. Accordingly, they do not lead to the present invention which involves simultaneous movement of discrete loads to speed the process of transfer.

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For example, UK Patent No. 1,223,379 to Krupp was published in 1971. It discloses an overhead travelling crane for use in the shipbuilding industry, particularly for moving single large pre-constructed sections of a ship which may weigh several hundred tons. The crane is on a massive scale: it is in the form of a bridge supported by columns, one at each end, which travel on rails on opposite sides of a dry dock in which a ship is to be built.

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Krupp's crane provides for turning a single heavy load about either a horizontal or vertical axis, as may for example be necessary to turn a prefabricated ship section through 90° from its orientation on delivery at the shipyard to the orientation required

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for installation on a ship being built. This is achieved by running two crabs on each side of the bridge, thus making four crabs in total, with the crabs being divided into an upper pair, one upper crab being situated on each side of the bridge, and a lower pair, one lower crab being situated on each side of the bridge. Cables hang from each crab
5 to support the load.

Various means are provided whereby the upper pair and the lower pair of crabs can pass each other without the crabs, their cables, their tackles or suspended loads fouling each other. This relative movement between the pairs of crabs causes the load to turn
10 as desired, in conjunction with varying the lengths of the cables and optionally removing and reattaching the cables at different points on the load during the turning process.

Whilst the individual crabs and the pairs of crabs are independently movable, their
15 movements are, in a sense, always linked to each other. This is because the crabs always support one and the same load and must therefore move in a continuously coordinated manner within a range of movement limited by the overall size of the load.

Moreover, the Krupp crane is designed for painstaking and careful orientation of
20 single, very large loads, in which it is acceptable to remove and reattach cables as the crabs pass each other. The present invention requires no such steps. In general, there is no teaching in Krupp of crab movement suitable for the large, rapid, repetitive and preferably independent movements that are used when loading or unloading a ship. It
25 is also noted that the Krupp crane would not be suitable for dockside use, even if scaled down, because it requires support at both ends of the bridge.

UK Patent Nos. 907,399 and 972,477, both to Creusot, are a decade older than Krupp. They describe cranes for suspending and tilting a movable ladle in a steelworks. The
30 cranes employ an arrangement of three tackles, two mounted on an upper trolley that support the weight of the ladle and one mounted on a lower trolley that controls the tilt of the ladle. The trolleys run along respective tracks, the lower trolley running on a track that is narrower than and lies beneath the other track. In this way, during a tilting operation, the inner trolley and its tackle can run inside the tackles suspended from the
35 outer trolley without interfering with the outer trolley or its tackles.

As with Krupp, the Creusot documents are concerned with positioning and orienting a single load, which must be moved slowly and precisely. The movements of the various



tackles and the range of that movement are therefore constrained. It is also noted that the Creusot cranes would not be suitable for dockside use, even in the unlikely event that a person seeking to load or unload a ship would look to the art of steelmaking for a solution.

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In summary, therefore, neither Krupp not Creusot move separate loads quickly and efficiently using a single crane having more than one tackle.

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From one aspect the invention may be described as a method of operating a crane, the method comprising moving goods or commodities in a plurality of loads, wherein: each load is carried by a respective carriage that moves reciprocally with respect to the crane along a respective path to transfer the load and return for a further load; the carriages pass each other as they reciprocate along their respective paths; and at least one carriage changes configuration to avoid collision with another carriage or its load as the carriages pass each other.

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Preferably, the method is applied to loading and/or unloading a cargo-carrying means such as a ship and so comprises moving cargo in a plurality of loads.

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From another aspect, the invention resides in a crane adapted to move a plurality of loads as when loading or unloading cargo from a cargo-carrying means, the crane comprising a plurality of carriages each movable reciprocally with respect to the crane along a respective path to transfer a load and return for a further load, the carriages passing each other as they reciprocate along their respective paths; and means for changing the configuration of at least one carriage to avoid collision with another carriage or its load as the carriages pass each other.

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The invention also resides in optional features defined in the following specific description and the sub-claims.

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In order that the invention can be more readily understood, reference will now be made, by way of example only, to the accompanying drawings in which:

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Figure 1 is a cross-sectional end view of a gantry crane having parallel tracks disposed side-by-side, each track supporting a trolley and a tackle;



Figure 2 is a simplified perspective view of a gantry crane having two tackles passing clear of each other in a nested arrangement;

Figure 3 is a cross-sectional end view of the gantry crane of Figure 2, the crane having tracks disposed in a tiered arrangement, where trolleys span the width of the tracks;

Figure 4 is a side elevation of the gantry crane of Figure 2, showing a collision prevention zone;

Figure 5 is a plan view from underneath of the crane of Figure 2, 3 and 4;

Figure 6 is a cross-sectional end view of a gantry crane having an inner track, a trolley spanning the width of the inner track, and an outer track comprising two parallel rails, each rail carrying a separate half-trolley or crab; and

Figure 7 is a cross-sectional end view of a gantry crane as in Figures 2 to 5, but showing a wire arrangement adapted to suit unitised lifts such as containers.

Referring firstly to Figure 1, trolleys 10 run on parallel tracks 11 disposed side by side under a gantry, defining a central vertical plane (not shown) between the tracks. Sheaves 12, 13 move with each trolley 10 and support wires which suspend tackles A and B. The wires pass over the sheaves 12, 13 and are wound onto drums (not shown) that are independently operable to move the tackles laterally by varying the relative lengths of the two wires that suspend each tackle.

In Figure 1 for example, the wire working from the sheave 12 closer to the central plane takes most of the load on tackle A when tackle A is at the lowered level shown, suitable for picking up and dropping off a load. In contrast, the wire working from the sheave 13 further from the central plane is used to stabilise the load against sway but is also shortened to swing the tackle and lift it outwards and away from the central plane, as shown for tackle B, so as to pass clear of the other tackle when the tackles move past each other.

This technique for allowing two tackles to share a single crane is advantageous for its simple mechanical design and also because it allows the gantry itself to be of conventional structure. Against this, the two tackles cannot both reach exactly the same point on the central plane and therefore this method is more suitable for less



precise work such as the operation of grab lifts for moving bulk commodities from a stockpile or ship's hatch.

Turning now to Figures 2 to 5, a gantry crane 14 comprises an elevated elongate jib or gantry 15 that extends horizontally in cantilevered fashion from a support offset
5 towards one end. The support comprises two pairs of legs 16, the legs of each pair splaying apart towards the ground for stability. The gantry 15 is a framework box section of tubular steel elements for strength and lightness.

10 As best shown in Figure 3, the gantry supports an upper pair of rails 17 and a lower pair of rails 18 that respectively define upper and lower tracks in tiered relation. Each track supports and is spanned by a respective trolley, the upper track having a relatively wide upper trolley 19 thereon and the lower track having a relatively narrower lower trolley 20 thereon. Each trolley 19, 20 supports a respective pair of
15 wires 21 which converge downwardly from sheaves 22 to tackles 23 and 24 respectively.

The tracks and trolleys 19, 20 are so arranged that the lower track and trolley 20 can pass within the wires 21 that depend from the upper trolley 19, in a nested relationship.
20 As shown in Figures 2 and 4, it is also necessary for the tackle 23 to be lifted above tackle 24 to an extent that permits any load hanging from tackle 23 to clear tackle 24 and its associated wires. However, there is no need to remove a load from either tackle 23, 24 as the trolleys 19, 20 pass each other.

25 Safety is, of course, paramount in any crane system. The primary safety issue to be considered in practice of the present invention is the risk of a collision between loads, tackles and wires as the tackles move in relation to one another. This can be avoided by electromechanical sensors and cut-outs, microprocessor controlled brakes or other logical switching to the same effect.

30 With reference to Figure 4, these safety measures can be used to create a 'collision prevention zone' shown in dashed lines to ensure that the tackle 23 and any load supported thereby are progressively lifted by the lower trolley 20 as they reach a minimum separation on approaching tackle 24, so that the tackle 23 is at all times high
35 enough to avoid collision; and if this is not so, the abovementioned safety measures should correct the situation or stop movement of whichever trolley 19, 20 is moving.



Similarly for the parallel tracks of Figure 1, the tackle and any load in motion along the gantry should be fully swung away from the central plane on approaching the other trolley; and if this is not so, the abovementioned safety measures should correct the problem or stop movement of the or each moving trolley.

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Figure 5 shows the trolleys 19, 20 passing each other and also shows how the box structure of the gantry 15 itself can define the rails 17, 18. In this arrangement, the rails 17, 18 are four parallel longitudinal members connected at their ends by transverse members 25. The legs 16 are attached to the upper rails 17 which are also the outer rails as seen in Figure 5.

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In this arrangement, the vertical spacing between the upper rails 17 and lower rails 18 increases the beam stiffness of the structure as a whole. This particularly lends the invention to the construction of cantilevered cranes suitable for use in docks for loading and unloading ships. However, this increased stiffness will obviously be of benefit to all cranes, including bridge cranes.

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Whilst the embodiment of Figures 2 to 5 permits the use of trolleys of conventional design, it will be apparent that the lower pair of rails 18 defining the lower track can only be supported beyond the desired extremes of movement of the upper trolley 19. This is because any supports placed along the length of the lower track will either interfere with the movement of the upper trolley 19 if they extend generally vertically, or with the movement of the tackle 24 and wires 21 of the upper trolley 19 if they extend generally horizontally. Accordingly, although this embodiment is attractive due to its simplicity, in practice its use could be limited to lighter cargo due to the bending loads on the lower track.

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Referring now to Figure 6, an alternative embodiment of the invention employs an inner trolley 26 running on an inner pair of rails 27 that define an inner track akin to the lower track of Figures 3 and 4. A pair of crabs 28 - effectively two halves of an outer trolley - run outside the rails 27 on an outer pair of rails 29. Otherwise, the arrangement is nested substantially as in Figures 2 to 5, and like numerals refer to like parts.

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It will be noted that eliminating the upper trolley of Figures 3 and 4 enables the inner pair of rails 27 to be supported from above by a gantry at any or all points along their length - for example by suspending the rails by vertical struts depending from a gantry frame above (not shown) - without interfering with the movement of the crabs 28.

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It is preferred that the pairs of crabs move in rigid conformity with each other. This could be achieved, for example, by the use of synchronous electric drive motors controlled by microprocessors. It would also be possible for one crab 28 to convey
5 positional information to the other crab 28, for example by transmitting infra-red signals to the other crab 28 which can be interpreted and used to synchronise the movement of the other crab 28. Other electromechanical devices could be used to achieve the same effect.

10 Turning finally to Figure 7, a further embodiment of the invention corresponds broadly to the tiered and nested embodiment of Figures 2 to 5 and again like numerals are used for like parts. This embodiment is adapted for use with unitised items of standard dimensions such as containers of 12.19 metres (40 feet) in length. In that application, the tackle commonly has to be lowered into spaces between neighbouring stacked
15 containers on into cellguides in the hold, only as wide as a container itself. In this case it is necessary to provide a reducing means for the wires to the tackles so as to fit the space restrictions, for example by using wire spreaders and collectors as part of the tackle of the outer/upper trolley.

20 One such example is the container ship loading and discharge shown in Figure 7. In this case the loads or lifts are standard containers. Accordingly, the narrower inner/lower trolley 30 and its tackle 31 are limited to 12.19 metres (40 feet) as their maximum transverse dimension.

25 Of course, the upper/outer trolley 32 needs to be wider than 12.19 metres (40 feet) if its wires are to clear the lower/inner trolley 30; but the tackle 33 of the upper/outer trolley 32 has to be brought down to a maximum width of 12.19 metres (40 feet) if it is to reach between the neighbouring containers 34 and lock onto another container 35. To achieve this, a wire collector frame 36 is suspended by wires 37 below the point
30 where the narrower lower/inner trolley 30 will clear its lift through the wider tackle 33.

Many variations are possible without departing from the inventive concept.

For example, the half-trolley or crab arrangement of Figure 6 could be applied to the
35 embodiment of Figure 7 that is adapted to handle unitised loads.

The aforementioned safety measures can be made more active by providing for automatic control of the path taken by the tackles and hence by any loads that they



support. This motion could be pre-programmed according to a memorised and possibly standardised pattern of movements appropriate to the loads in question, and/or could be controlled by sensors that monitor the clearance between passing tackles, wires and loads and so enable a microprocessor to determine a safe path.

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The cranes of the invention can also be driven manually, in which case a driver's cab could be attached to or otherwise associated with each respective trolley or crab so as to follow the movement of the respective tackle. If clearances are critical, as may be the case with unitised lifts for example, the cabs could be separate from the trolleys or crabs and could run on further tracks that are independent of the tracks on which the trolleys move. In this case, it would be advantageous to synchronise the movement of a cab to the trolley that the cab commands. The means for synchronising cab movement could, for example, be as set out above in relation to the embodiment of Figure 6 for synchronising the movement of the crabs 28.

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Whilst the abovementioned embodiments all involve two tackles, one nested within the other, it would be possible and desirable to have three or more tackles operating in a nested arrangement if space permits.

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It would of course be possible to have all trolleys, including the innermost one, defined by two crabs or half trolleys. Also, whilst the embodiment of Figure 6 is shown with the inner and outer pairs of rails substantially level, the pairs of rails could be disposed at different levels with one above the other in a tiered structure.

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CLAIMS

1. A method of operating a crane, the method comprising moving goods or
5 commodities in a plurality of loads, wherein: each load is carried by a respective
carriage that moves reciprocally with respect to the crane along a respective path to
transfer the load and return for a further load; the carriages pass each other as they
reciprocate along their respective paths; and at least one carriage changes
10 configuration to avoid collision with another carriage or its load as the carriages pass
each other.
2. The method of claim 1, wherein each carriage comprises a travelling hoist,
suspension means for suspending a load from the hoist and load engagement means for
engaging a load.
- 15 3. The method of claim 2, wherein the load engagement means is a tackle, a grab or
means for engaging a container.
4. The method of claim 2, wherein the suspension means varies in length to change the
20 configuration of a carriage.
5. The method of claim 4, wherein a carriage changes configuration during collision
avoidance by the suspension means raising or lowering the load engagement means.
- 25 6. The method of claim 5, wherein the suspension means comprises first and second
strands one on each side of the load engagement means and both strands are
lengthened or shortened together to raise or lower the load.
7. The method of claim 4, wherein the carriage changes configuration during collision
30 avoidance when the suspension means moves the load engagement means transversely
with respect to the general direction of travel of the carriage.
8. The method of claim 7, wherein the suspension means comprises first and second
strands one on each side of the load engagement means and the relative length of the
35 strands is varied to achieve said transverse movement.
9. The method of any preceding claim, wherein one carriage passes within another
carriage.





10. The method of any of claims 1 to 8, wherein one carriage passes beside another carriage.
- 5 11. The method of any preceding claim, wherein the carriages move independently of one another.
12. The method of any preceding claim, wherein the carriages reciprocate over a range of movement that is substantially larger than the loads being carried.
- 10 13. The method of any preceding claim, wherein configuration of the carriages for collision avoidance is under automatic control and configuration follows a stored predetermined pattern as the carriages reciprocate.
- 15 14. The method of any preceding claim, wherein controlling the configuration of the carriages for collision avoidance includes automatically monitoring the clearance between passing carriages including any loads that they carry.
- 20 15. The method of any preceding claim, wherein the loads are carried by their respective carriages throughout the range of movement of the carriages.
16. A crane adapted to move goods or commodities in a plurality of loads, the crane comprising a plurality of carriages each movable reciprocally with respect to the crane along a respective path to transfer a load and return for a further load, the carriages
25 passing each other as they reciprocate along their respective paths; and means for changing the configuration of at least one carriage to avoid collision with another carriage or its load as the carriages pass each other.
17. The crane of claim 16, wherein each carriage comprises a travelling hoist,
30 suspension means for suspending a load from the hoist and load engagement means for engaging a load.
18. The crane of claim 17, including means for varying the length of the suspension means to change the configuration of a carriage.
- 35 19. The crane of claim 18, wherein the suspension means comprises first and second strands one on each side of the load engagement means.





20. The crane of claim 19, comprising means for varying the length of the first and second strands in unison with one another.
21. The crane of claim 19, comprising means for varying the relative lengths of the first and second strands.
22. The crane of any of claims 16 to 21, wherein the load engagement means is a tackle, a grab or means for engaging a container.
23. The crane of any of claims 16 to 22, and being arranged such that one carriage passes within another carriage.
24. The crane of claim 23, wherein the carriages are movable along respective tracks that are in nested relation.
25. The crane of claim 24, wherein the carriages are movable along respective tracks that are in tiered relation.
26. The crane of any of claims 16 to 25, comprising collision avoidance means under automatic control associated with storage means for storing a predetermined pattern of carriage configuration.
27. The crane of any of claims 16 to 26, comprising automatic monitoring means for monitoring the clearance between passing carriages including any loads that they carry.
28. The crane of any of claims 16 to 27, comprising collision prevention means adapted to ensure that the configuration of a carriage is changed to avoid collision as that carriage reaches a minimum separation from another approaching carriage.
29. The crane of any of claims 16 to 28, comprising an elevated elongate jib or gantry that extends horizontally in cantilevered fashion from an upright support offset towards one end.
30. The crane of claim 29, wherein the jib or gantry is a framework of structural elements including upper and lower rails, the rails defining upper and lower tracks disposed in tiered relation and a carriage being movable along each respective track.





31. The crane of claim 29 or claim 30, wherein the rails are parallel longitudinal members connected at their ends by transverse members.
32. The crane of any of claims 29 to 31, wherein the support is attached to rails that are disposed outermost.
33. The crane of any of claims 16 to 32, wherein tracks support and are each spanned by a respective travelling hoist, an upper track having a relatively wide upper trolley thereon and a lower track having a relatively narrow lower trolley thereon.
34. The crane of claim 33, wherein the lower track and lower hoist pass within suspension means that depend from the upper hoist.
35. The crane of any of claims 16 to 34, comprising a pair of crabs running on a pair of outer rails disposed outside and one each side of an inner track, each crab running on a respective outer rail.
36. The crane of claim 35, comprising means for moving the crabs in conformity with each other.
37. The crane of claim 35 or claim 36, wherein the inner track includes at least one rail supported from above at any or all points along its functional length.
38. The crane of any of claims 16 to 37, adapted for use with unitised items of standard dimensions.
39. The crane of claim 38, wherein the unitised items are standard containers.
40. The crane of claim 39, wherein load engaging means is capable of being lowered into a space between neighbouring stacked containers or cellguides that is substantially as wide as a container itself.
41. The crane of claim 40, wherein a reducing means operates on suspension means that suspends the load engaging means.
42. The crane of any of claims 16 to 41, comprising a driver's cab attached to or otherwise associated with each respective carriage so as to follow the movement of that carriage.



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43. The crane of claim 42, wherein the cabs are separate from the carriages and run on dedicated tracks.
- 5 44. The crane of claim 43, comprising means to synchronise the movement of a cab to the movement of a carriage that the cab commands.
45. The crane of any of claims 16 to 44, comprising three or more tackles operating in a nested arrangement.
- 10 46. The crane of any of claims 16 to 45 and being arranged such that one carriage passes beside another carriage.
47. The crane of claim 46, wherein the carriages are movable along respective tracks
- 15 disposed side by side.
48. A method of operating a crane, substantially as hereinbefore described with reference to or as illustrated in any of the accompanying drawings.
- 20 49. A crane, substantially as hereinbefore described with reference to or as illustrated in any of the accompanying drawings.

