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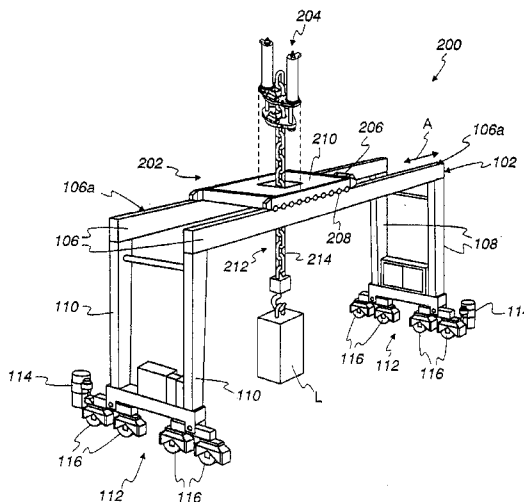
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(54) Title: FAILURE PROOF GANTRY CRANE AND CHAIN JACK HOIST ASSEMBLY



(57) Abstract: This patent discloses embodiments of a crane system that provide for high-capacity failure proof operation. For example, an overhead crane system may include a trolley configured to translate between a first position and a second position. The crane system may further include a lift mechanism carried by the trolley or a support span portion of the trolley and be configured to releasably translate a chain between a support position and a lift position. The lift mechanism, in turn, could include a fixed latch configured to engage a first link of the chain, the fixed latch having an open position and a closed position, and a traveling latch movably aligned relative to the fixed latch and configured to engage a second link of the chain, the traveling latch having an open position and a closed position.

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FAILURE PROOF GANTRY CRANE AND CHAIN JACK HOIST ASSEMBLY

TECHNICAL FIELD

[0001] This patent generally relates to crane systems, and more particularly to a gantry or bridge crane that incorporates a fail-proof hold lift mechanism.

BACKGROUND

[0002] Overhead crane and lifting systems are well known and utilized in industrial environments to move and transport goods, equipment and/or materials. FIG. 1 illustrates one exemplary embodiment of a known lifting or crane system 100. The crane system 100 includes a bridge or gantry 102 configured to support a wire hoist 104. The bridge or gantry 102 includes a pair of transverse beams 106, each of which is coupled to a leg or support 108, 110. The legs 108, 110 are attached and disposed at respective ends of each of the transverse beams 106, thereby creating an open arch-like structure. In many application, the legs 108, 110 are not required because the structure or building in which the crane system 100 operates includes an elevated runway system (not shown). The elevated runway (not shown) allows the bridge or gantry 102 to translate along a pre-defined path within the structure. Drive systems 112 are coupled to each pair of legs 108 and 110, thereby providing additional support and rigidity to the overall gantry 102. Alternatively, the drive system 112 may be coupled directly to the bridge or gantry 102. Each of the drive systems 112 includes a motor 114 such as, for example, a traction motor, mechanically coupled to a plurality of wheels or rollers 116. The motor 114 on each of the drive systems 112 motivates the wheels 116 which, in turn, moves or drives the gantry 102 in a desired direction or to a desired location.

[0003] The wire hoist 104 is supported by a platform or trolley 118 carried along a top rail on the surface of the transverse beams 106. The trolley 118 is configured to traverse or travel along the plane defined by the transverse beams 106. The wire hoist 104 includes drives and controllers (not shown) designed and arranged to control and monitor a plurality of wires or ropes 120. The wires 120 extend from the wire hoist 104 and engage a container C. The container C hangs from the plurality of wires 120 and can be moved in the direction of travel followed by the trolley 118 or the drive system 112, or both.

[0004] The lifting or loading capacity of the exemplary systems such as the crane system 100 may be increased and/or augmented by utilizing multiple wire hoists 104. In order to provide a high-capacity, high safety factor system, a crane system must typically be designed to support five to ten times the normal operating load. This excess load capacity is intended to ensure, that in the event of an accident or catastrophe such as, for example, a seismic or dynamic event, the load will remain secure and supported. In order to provide the necessary level of protection and redundancy in these known systems, a great deal of mechanical and electrical complexity must be incorporated into the system design. These additional systems and components, in turn, provide multiple points of potential failure that must be monitored, reinforced and/or otherwise protected. Points of failure may, among other things, include the electrical and control circuitry and wiring, the mechanical drive and lift components, and the wires utilized for supporting and lifting the container C or other loads.

[0005] It would be desirable to provide a lifting or crane system that could provide for high lifting capacity and/or failure proof hold capabilities while simultaneously utilizing a simplified mechanical and control system. These simplified systems could be utilized in critical environments in which high-capacity and failure proof hold systems are required to comply with safety and/or governmental regulations. Moreover, these simplified systems should include fewer points of failure thereby increasing the overall operational time and usability of the equipment.

SUMMARY

[0006] Discloses herein are embodiments of a crane system that provide for high-capacity and failure proof hold operation. For example, the disclosed crane system may be configured to support a load during a seismic event that could cause the load to momentarily and dynamically increase by a factor of five to ten. One disclosed embodiment is an overhead crane system that includes a trolley which incorporates a support span and carries a drive system on the support span. The drive system may be, in turn, configured to translate the trolley between a first position and a second position. The crane system may further include a lift mechanism carried by the support span and configured to releasably translate a chain between a support position and a lift position. One exemplary lift mechanism may include a fixed latch

configured to engage a first link of the chain, the fixed latch having an open position and a positive closed position, and a traveling latch movably aligned relative to the fixed latch and configured to engage a second link of the chain, the traveling latch having an open position and a positive closed position. In operation, while the fixed latch is in the open position and the traveling latch is in the positive closed position, the lift mechanism can translate between the support position and the lift position. Similarly, while the fixed latch is in the positive closed position and the traveling latch is in the open position, the lift mechanism can translate between the lift position and the support position. Thus, regardless of the direction of travel of the load or the chain, one of the latches (fixed or traveling) is always in the positive closed position thereby supporting and holding the load.

[0007] Additional features and advantages are described in, and will be apparent from, the following Detailed Description and the figures.

BRIEF DESCRIPTION OF THE FIGURES

[0008] FIG. 1 illustrates one embodiment of a known crane system;

[0009] FIG. 2 illustrates an exploded view of a crane system constructed in accordance with the teaching disclosed herein;

[0010] FIG. 3 illustrates a perspective view of an embodiment of a trolley that may be utilized in conjunction with the crane system disclosed herein;

[0011] FIG. 3A illustrates a top view of the trolley shown in FIG. 3;

[0012] FIG. 4 illustrates a perspective view of a lift mechanism that may be utilized in conjunction with the crane system shown in FIG. 2 and the trolley shown in FIGS. 3 and 3A; and

[0013] FIG. 4A illustrates a plan view of the lift mechanism that may be cooperatively engaged to a chain.

DETAILED DESCRIPTION

[0014] FIG. 2 illustrates an exemplary embodiment of a bridge or gantry crane system 200 that may be utilized to transport materials and/or equipment in a conventional manner with a high safety factor utilizing mechanical friction brakes or stops in cooperation with a wire rope hoist system (discussed below). For example, in a nuclear power plant the transportation of a reactor head, a reactor vessel, fuel cask or other potentially radioactive or otherwise hazardous load must be conducted in compliance with regulations and laws provided and/or enforced by entities such as the

Nuclear Regulatory Commission (NRC). Thus, it is desirable for the crane system 200 to be designed to lift and transport a load while maintaining, for example, a ten to one (10 to 1) lift capacity or ratio to support that load throughout a catastrophic event. For example, if the crane system 200 is designed to lift a thirty-five ton (35 ton) reactor vessel, then the system 200 may be built with the capacity to lift and hold three-hundred and fifty tons (350 tons) or ten times the anticipated normal duty-cycle load. While the likelihood of a dynamic or seismic event occurring during a lift or transport operation is extremely low, e.g., around 0.0000001 or 1×10^{-7} , the ability to prevent a catastrophic failure is desirable. In this configuration, should the system 200 experience a seismic event producing forces or accelerations of 3Gs (or three times the force of gravity) during the transport of a reactor head, the reactor head would still be supported and held secure. Thus, the excess holding capacity of the system 200 provides for a failure proof hold operation.

[0015] The crane system 200 includes a bridge or gantry 102 similar to the one discussed in connection with the crane system 100. The gantry 102 or movable gantry, in turn, supports a trolley 202 configured to carry one or more hydraulic lift mechanisms 204 (shown in an exploded perspective view in FIG. 2). It will be understood that the lift mechanism 204 may be oriented in a variety of manners with respect to the gantry 102 or the trolley 202, but will often be oriented or aligned in a symmetrical manner with respect to each other (or multiple lift mechanisms) in order to balance forces and load communicated to the gantry 102 and/or the trolley 202. In one embodiment, the trolley 202 may include wheels or rollers 208 mounted along a bottom trolley surface in contact with the top edge of the transverse beam 106. The top edge or top rail 106a of the transverse beam 106 may, in turn, be designed to cooperate with the rollers 208 or may include a rail (not shown) along which the trolley 202 may travel. The trolley 202 may include a drive system 206 that is configured to directly drive the rollers 208 along the transverse beams 106. Alternatively, the drive system 206 may include a dedicated drive wheel (not shown) that can couple directly to the transverse beams 106 to drive the trolley 202 and the rollers 204 may simply act as free-wheeling bearing or support surfaces.

[0016] The trolley 202 may further include a support deck 210 that spans the distance between the transverse beams 106. The support deck or support span 210 can be configured to carry the hydraulic lift mechanisms 204 and/or any control or hydraulic equipment required to operate the same. The support deck or span 210 may

be fixedly attached to the trolley 202, or may be shiftable relative to the trolley structure to allow for precise positioning of the hydraulic lift mechanisms 204. The hydraulic lifts or lift mechanisms 204 may be a linear chain jack manufactured by the BARDEX CORPORATION of Goleta, California. The hydraulic lifts 204, in one exemplary embodiment, releasably engage a chain 212 that extends through the support deck 210. The chain 212 includes a plurality of links individually identified by the reference numeral 214. The chain 212, in turn, may be secured to a load L.

[0017] FIG. 3 illustrates an enlarged partial perspective view of another embodiment of a trolley 300 that may be utilized to transport the load L. The trolley 300 may be an extended length trolley designed to span the width of a rectilinear structure or the circumference of a round structure, and may be configured to translate along a rail 302 via the roller or wheels 304 disposed or positioned at its ends. In this environment, the trolley 300 and the rail 302 are permanently mounted within a structure as opposed to upon the gantry 102. For example, the rail 302 can be mounted around the circumference or perimeter of a structure thereby allowing the trolley 300 to transport materials therein.

[0018] The trolley 300, as previously discussed in connection with the trolley 202, includes a support deck or support span 306. The support span 306 may be fixedly attached to the trolley 300, or alternatively may be configured to translate along the structure of the trolley 300 independently of the trolley's motion along the rail 302. The support span 306 carries a hydraulic generation and control equipment 308 and electrical control and monitoring equipment 310. For example, the hydraulic generation and control equipment 308 may include a one hundred twenty-five horsepower (125 HP) motor driving a hydraulic power unit (not explicitly shown) configured to generate fifty-two hundred pounds-per-square-inch (5,200 PSI) of oil pressure to drive the hydraulic lift 204. Regardless of the specific horsepower and pressure generation capacity of the hydraulic generation and control equipment 308, the power generated by the equipment 308 may be utilized to drive and control the lift mechanism 204. It will be understood that the hydraulic generation and control equipment 308 and/or the hydraulic power unit may be designed and selected from commercially available components and will be sized based on the design and load requirements of the crane system 200 and/or trolley 300. The hydraulic generation and control equipment 308 may further include hard-piping 312 (see FIG. 3A) and at least one one-way control valve or simply a control valve 314 (see FIG. 3A) that

allows the fluid to be freely pumped into the lift mechanism or hydraulic lift 204, but released only upon receipt of a specific command from the hydraulic and/or electrical control and monitoring equipment 310. In this way, once the hydraulic lift 204 is carrying the load L, it is physically incapable of releasing the load until the electrical control and monitoring equipment 310 commands and/or instructs at least one of the one-way valves or control valves 314 to open and release the hydraulic pressure therein. Thus, the load L is continuously held and supported by one of the two sets of latches (discussed more below) and the hydraulic lift 204.

[0019] The electrical control and monitoring equipment 310 may be communicatively coupled to the hydraulic lift 204 and the hydraulic generation and control equipment 308. The electrical control and monitoring equipment 310 may include, for example, an industrial computer (not explicitly shown), sensors, proximity switches, relays, transmitters and receivers, and other command, control, and communication equipment. The electrical control and monitoring equipment 310 may further be communicatively coupled to the drive systems 112, 206. In this way, the electrical control and monitoring equipment 310 may be programmed to direct and control the movement and/or rotation of the trolley 300 and/or crane system 200. Alternatively, the electrical control and monitoring equipment 310 may be in communication with a central control room (not shown) and be configured to communicate control and movement instructions received from the same. In yet another alternative embodiment, the electrical control and monitoring equipment 310 may incorporate a Web server (not shown) that allows for equipment monitoring and control over a network such as, for example, the Internet, an intranet, a wide area network (WAN), etc.

[0020] FIGS. 4 and 4A illustrate an enlarged view of the hydraulic lift 204 that may be utilized in conjunction with the crane systems and trolleys disclosed herein. The hydraulic lift 204, in this exemplary embodiment includes a pair of hydraulic cylinders 400 each having an extendable rod 402 and hydraulic cylinder head (disposed within the cylinder and therefore not shown). The extendable rods 402 being hydraulically shiftable between a support or retracted position adjacent to the hydraulic cylinders 400 and a lift or extended position. The extendable rods 402 each include a rod end 404 configured to support and carry a traveling cross arm 406. In this exemplary embodiment, the lift or hydraulic cylinders 400 are substantially vertically lined and arranged in a parallel manner with the respect to each other.

Moreover, it will be understood that one or more flow valves (not shown) in fluid communication between the hydraulic cylinders 400 and the hydraulic generation and control equipment 308 may regulate and balance the flow/pressure provided to each of the cylinders 400. In this way, the hydraulic pressure provided by the hydraulic generation and control equipment 308 will be equally delivered to the hydraulic cylinders 400 thereby causing the extendable rods 402 and the associated rod ends 404 to shift and/or move at a substantially common rate or velocity. Furthermore, by tying or coupling the rod ends 404 together via the traveling cross arm 406, the movement of the extendable rods 404 may be further regulated.

[0021] A fixed cross arm 408 ties together a top or base portion 410 of the hydraulic cylinders 400. Similar to the traveling cross arm 406, the fixed cross arm 408 spaces apart and secures the hydraulic cylinders 400 while providing additional rigidity and stability to the overall hydraulic lift 204. Both the traveling cross arm 406 and the fixed cross arm 408 each support and carry a pair of latches, wherein each pair of latches is individually identified as traveling latches 412 and fixed latches 414, respectively. The latches 412, 414 are one-way latches which allow movement in a single direction and prevent movement in the opposite direction. In this exemplary embodiment, the latches 412, 414 allow vertical movement in the direction indicated by the arrow A1 and prevent movement in the direction indicated by the arrow A2. The latches 412, 414 are mounted adjacent to a slot 416 (see FIG. 4A) manufactured through and provided within both the traveling cross arm 406 and the fixed cross arm 408, respectively. The slot 416 is sized to accept the chain 212 and the individual links 214.

[0022] In operation, the chain 212 is oriented and aligned substantially in the direction indicated by the arrow A1 and positioned through the slots 416 provided within the traveling cross arm 406 and a fixed cross arm 408, respectively. The links 214 of the chain 212 are alternately and individually engaged by the traveling latches 412 and the fixed latches 414. In particular, the fixed last 416 engages and carries an inner portion of the link 214 when the extendable rods 404 and the associated traveling cross arm 406 are translating towards an extended position, i.e., a position away from the hydraulic cylinders 400. During this movement, the fixed latches 414 do not engage the chain 212 and may be aligned substantially parallel to the direction indicated by the arrow A1. Upon reaching the extended position, the fixed latches 414 rotate or close to a position substantially perpendicular to the direction of the

chain 212 and any one of the links 214. In other words, the fixed latch 414, while substantially aligned with the traveling cross arm 406, engages one of the links 214. As the hydraulic cylinders 400 reverse directions and begin to retract the extendable rods 404, the chain 212 is carried and moved in a substantially vertical direction indicated by the arrow A1. The movement of the chain 212 in a substantially vertical direction, causes the previously closed fixed latch 414, i.e., the fixed latch 414 was releasably engaged with one of the links 214 and arranged substantially perpendicular to the direction of the chain 212 and any one of the links 214, to swivel and open to a position substantially aligned in the direction indicated by the arrow A1. Thus, while the hydraulic cylinders 400 force the extendable rods 404 and associated hardware towards an extended position, the chain 212 is securely held by the latches 412 supported on the fixed cross arm 408. Similarly, while the hydraulic cylinders 400 retract the extendable rods 404 and the associated hardware, now engaged and supporting the links 214 of the chain 212, the latches 412 release the chain 212 thereby allowing free movement of the same. Thus, the chain 212 is always securely fastened and mechanically supported by one of the two sets of latches 412 and/or 414 thereby providing for a secure hold of the chain 212 and the associated load L.

[0023] In one exemplary embodiment, each hydraulic cylinder 400 may be a six inch (6") diameter hydraulic cylinder configured to receive fifty-two hundred pounds per square inch (5,200 PSI) of hydraulic pressure from the hydraulic generation and control equipment 308. The force (F) in tons generated by this exemplary cylinder is equal to the hydraulic pressure (P) provided multiplied by the area ($A = \pi * r^2$) of the cylinder head (in this instance area is equal to $\pi * (3 * 3)$) minus the area of the two inch diameter rod (in this instance area is equal to $\pi * (1 * 1)$) divided by two thousand pounds (2000 lbs) or $P = (F * A)/2000$. In this example, each hydraulic cylinder 400 is capable of pulling with a force equal to approximately sixty-five (65) tons. Thus, the two hydraulic cylinders 400 of the hydraulic lift 204 can combine to carry or move approximately one hundred and thirty (130) tons. By utilizing two or more hydraulic lifts 204, two-hundred and sixty (260) tons can be carried or moved. Alternatively, cylinders of greater or lesser area may be utilized to increase or change the capacity of the crane system 200 and trolley 300. In yet another alternate embodiment, the pressure provided by the hydraulic generation and control equipment 308 may be increased or decreased to further alter the lifting capacity of the system(s).

[0024] It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present invention and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

CLAIMS

What is claimed is:

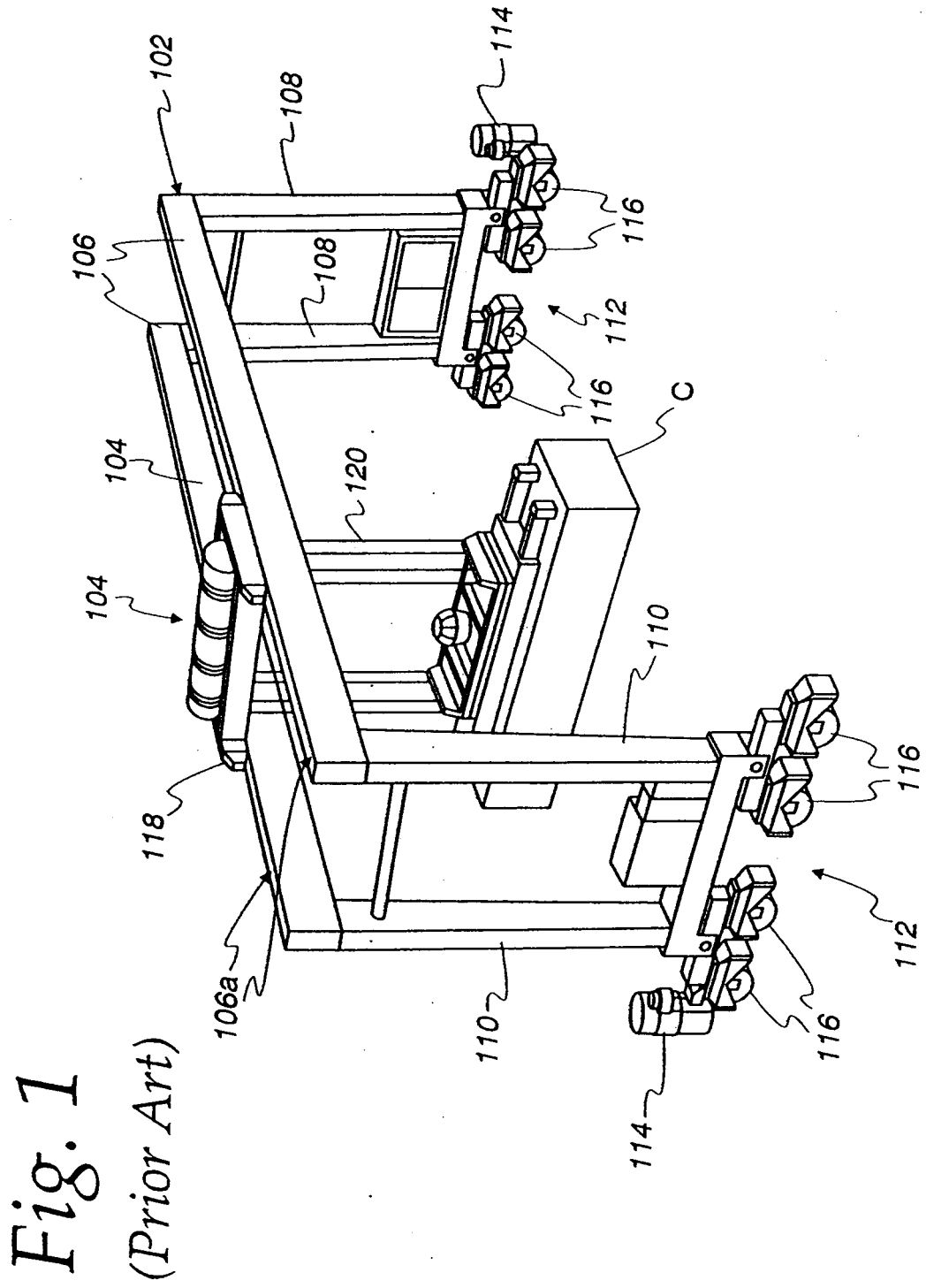
1. An overhead crane system comprising:
a trolley, the trolley comprising:
a support span;
a drive system configured to translate at least the support span between
a first position and a second position; and
a lift mechanism carried by the support span and configured to releasably
translate a chain between a support position and a lift position, the lift
mechanism comprising:
a fixed latch configured to engage a first link of the chain, the fixed
latch having an open position and a closed position; and
a traveling latch movably aligned relative to the fixed latch and
configured to engage a second link of the chain, the traveling
latch having an open position and a closed position;
wherein the fixed latch is in the open position and the traveling latch is in the
closed position as the lift mechanism translates between the support
position and the lift position, and wherein the fixed latch is in the
closed position and the traveling latch is in the open position as the lift
mechanism translates between the lift position and the support
position.
2. The system of claim 1 further comprising a gantry configured to support the
trolley.
3. The system of claim 2, wherein the gantry includes:
a transverse beam;
a first leg coupled to a first end of the transverse beam; and
a second leg space apart from the first leg and coupled to a second end of the
transverse beam distal to the first leg;
wherein the transverse beam is configured to support the trolley.

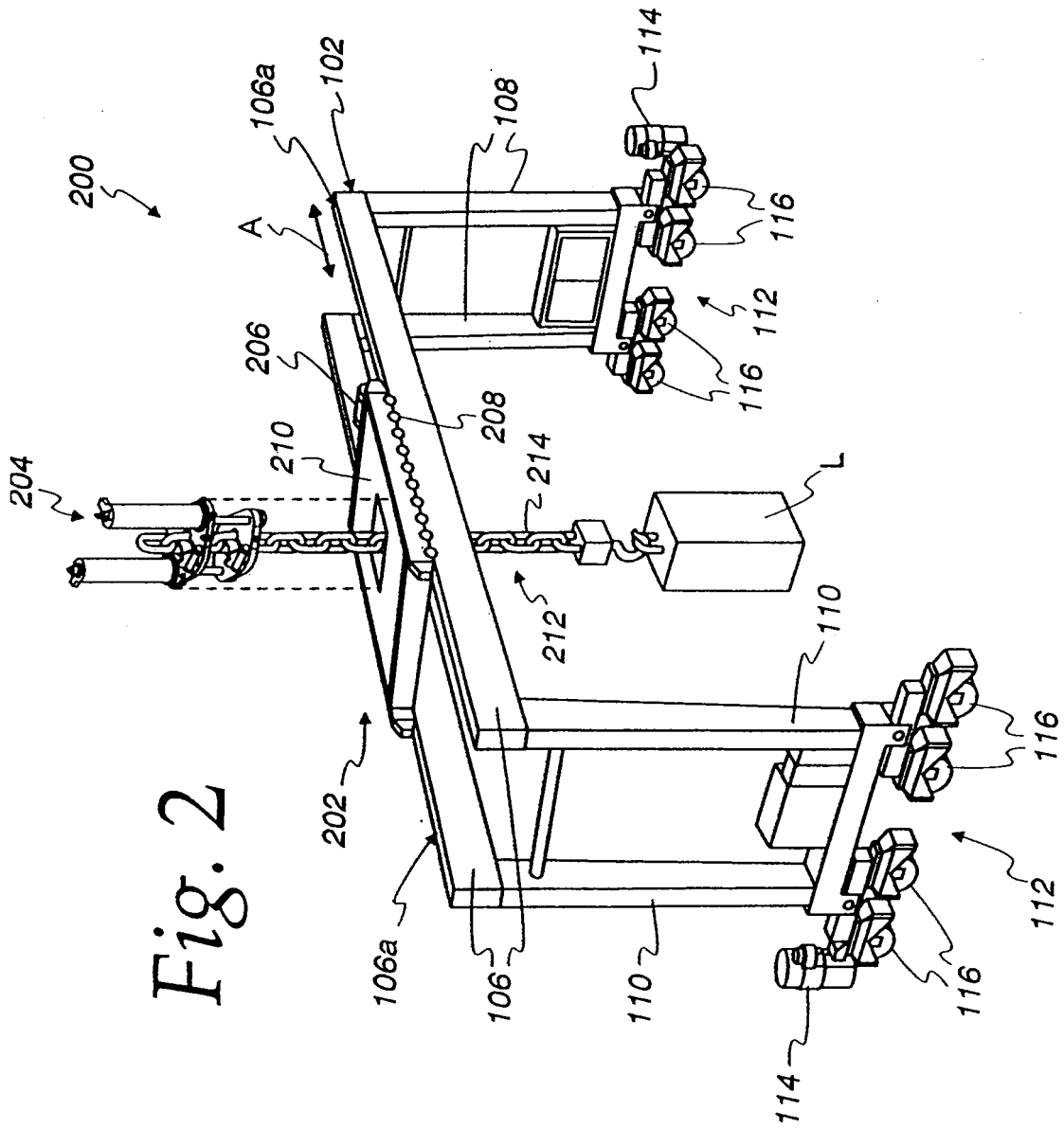
4. The system of claim 1 further comprising a hydraulic system carried by the trolley, wherein the hydraulic system is fluidly coupled to the lift mechanism.
5. The system of claim 4, wherein the lift mechanism includes at least one hydraulic cylinder, the at least one hydraulic cylinder fluidly coupled to hydraulic system and configured to translate between the support position and the lift position.
6. The system of claim 1, wherein the lift mechanism is configured to releasably translate the chain in a lift direction, and wherein the translation of the traveling latch in the closed position and the second link of the chain causes the fixed latch to release the first link of the chain and shift to the open position.
7. A crane system comprising:
 - a trolley translatable between a first position and a second position; and
 - a hydraulic lift mechanism carried by the trolley and configured to releasably translate a chain between a support position and a lift position, the lift mechanism comprising:
 - a fixed latch configured to engage a first link of the chain, the fixed latch having an open position and a closed position; and
 - a traveling latch movably aligned relative to the fixed latch and configured to engage a second link of the chain, the traveling latch having an open position and a closed position;wherein the fixed and traveling latches alternately and cooperatively secure the chains during the translation between the lift position and the support position.
8. The system of claim 7 further comprising a gantry configured to support the trolley.

9. The system of claim 8, wherein the gantry includes:
 - a transverse beam;
 - a first leg coupled to a first end of the transverse beam; and
 - a second leg space apart from the first leg and coupled to a second end of the transverse beam distal to the first leg;wherein the transverse beam is configured to support the trolley.
10. The system of claim 7 further comprising:
 - a first leg; and
 - a second leg space apart from the first leg;wherein the first and second legs are configured to support the trolley.
11. The system of claim 7 further comprising a hydraulic system carried by the trolley, wherein the hydraulic system is fluidly coupled to the hydraulic lift mechanism.
12. The system of claim 11, wherein the hydraulic lift mechanism includes at least one cylinder, the at least one cylinder fluidly coupled to hydraulic system and configured to translate between the support position and the lift position.
13. The system of claim 7, wherein the lift mechanism is configured to releasably translate the chain in a lift direction, and wherein the translation of the traveling latch in the closed position and the second link of the chain causes the fixed latch to release the first link of the chain and shift to the open position.

14. A crane system comprising:
a trolley, the trolley aligned in a substantially horizontal manner and translatable between a first position and a second position; and
a lift mechanism carried by the trolley, wherein the lift mechanism is aligned substantially perpendicular to the trolley in a first direction, and configured to releasably translate a chain in the first direction, the lift mechanism including:
a fixed latch configured to engage the chain; and
a traveling latch movably aligned relative to the fixed latch and configured, with respect to the fixed latch, to alternately engage the chain;
wherein the fixed and traveling latches alternately and cooperatively secure the chains during the translation in the first direction.
15. The system of claim 14 further comprising a gantry configured to support the trolley.
16. The system of claim 15, wherein the gantry includes:
a transverse beam;
a first leg coupled to a first end of the transverse beam; and
a second leg spaced apart from the first leg and coupled to a second end of the transverse beam distal to the first leg;
wherein the transverse beam is configured to support the trolley.
17. The system of claim 14 further comprising a power generation system carried by the trolley, wherein the power generation system is coupled to the lift mechanism.
18. The system of claim 17 further comprising at least one cylinder, the at least one cylinder fluidly coupled to power generation system and configured to translate the traveling latch.

19. The system of claim 14, wherein the lift mechanism is configured to releasably translate the chain in a lift direction, and wherein the translation of the traveling latch and the second link of the chain causes the fixed latch to release the first link of the chain.





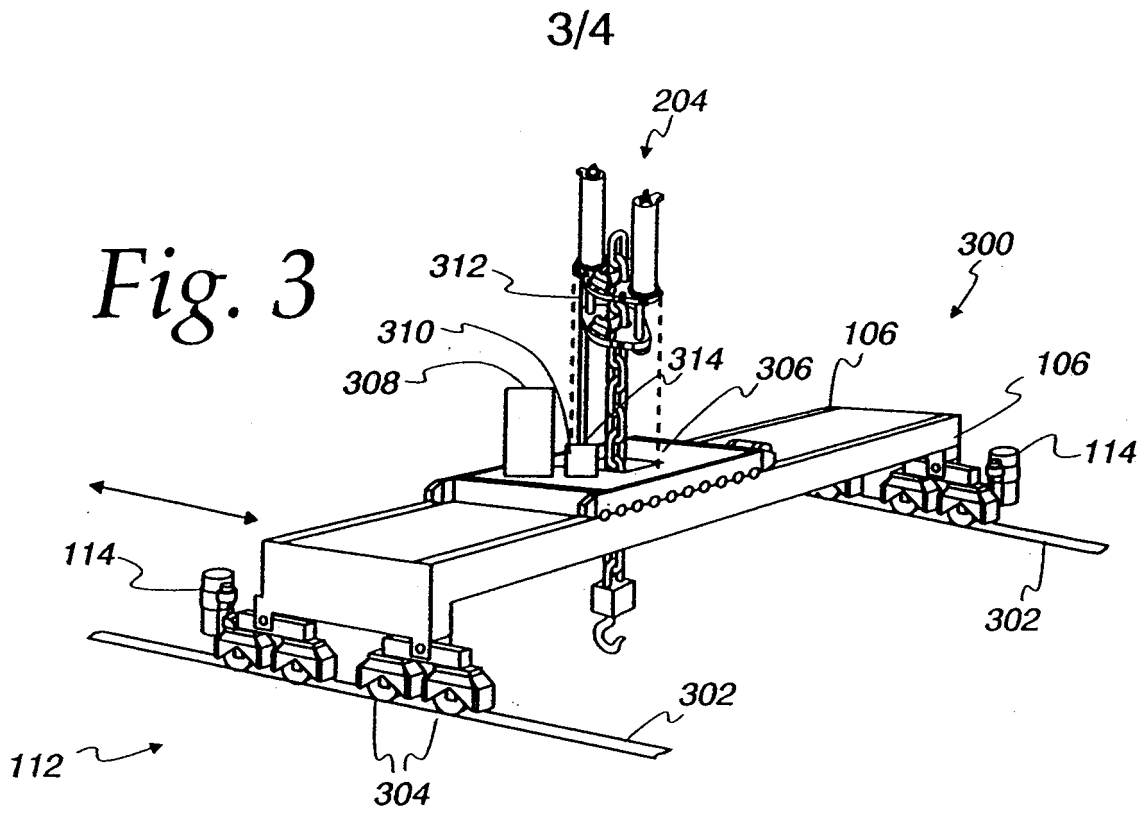


Fig. 3A

