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Abstract

A handling apparatus is provided comprises at least one pair of jaws for gripping an elongate item to be handled. The pair of jaws is operable between a more open configuration and a more closed configuration by a driven member which can be moved between a first position and a second position, and the jaws are arranged to be locked in the more closed configuration. In another aspect a handling apparatus comprises: a retaining mechanism for gripping drill rods; a first four-bar linkage formed by a base unit, two support members and a first link and a second four-bar linkage, located between the first four-bar linkage and the retaining mechanism.

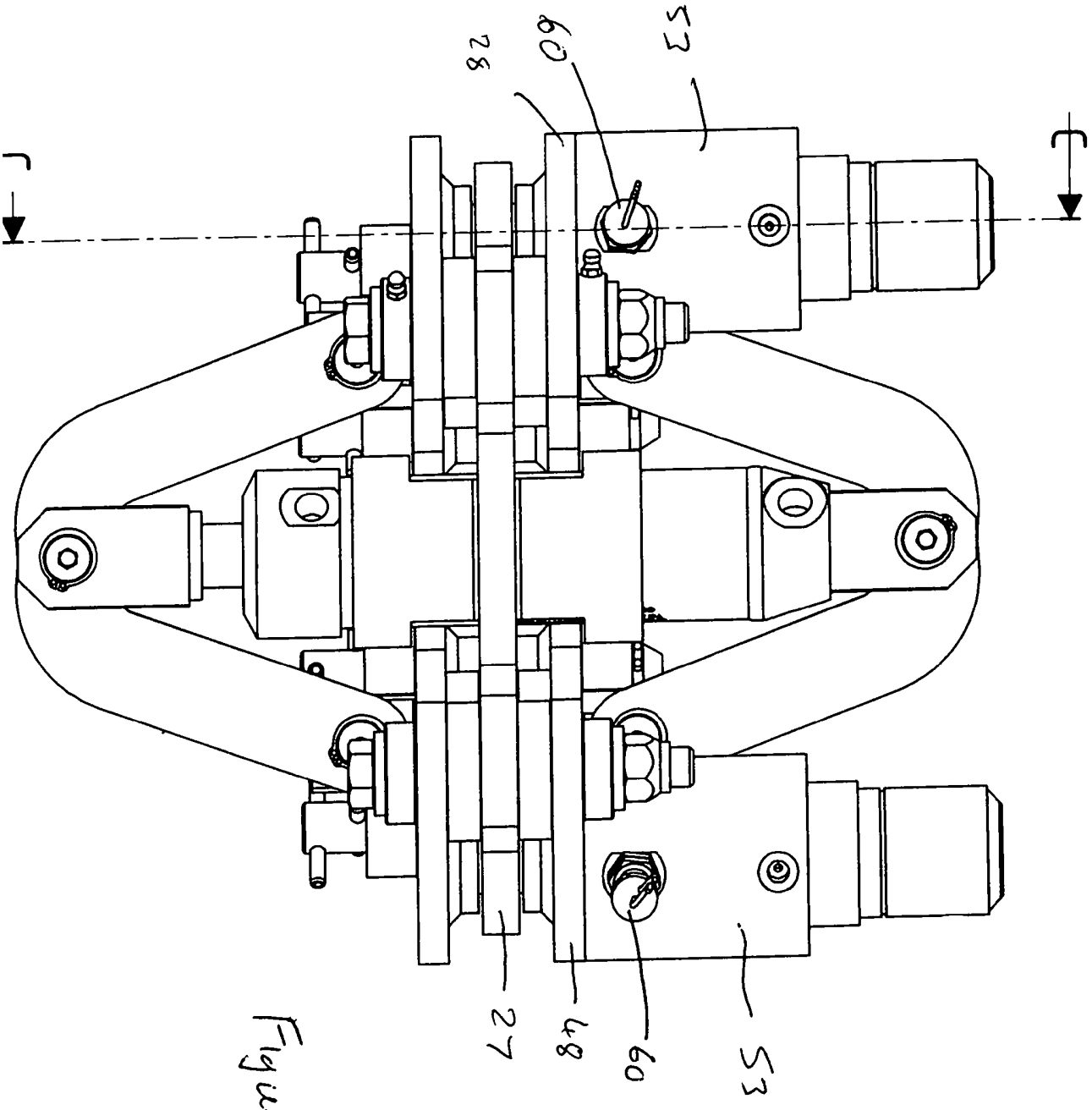

Figure 5

GRIFFITH HACK
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SPECIFICATION

OF

PATENT APPLICATION

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COMPLETE SPECIFICATION

Standard Patent

Applicant(s):

Sandvik Mining & Construction Australia Pty Ltd

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HANDLING APPARATUS

The following statement is a full description of this invention, including the best method for performing it known to me/us:

HANDLING APPARATUS

FIELD OF THE INVENTION

The present invention relates to a drill rod handling apparatus. In particular the invention relates to features which can be incorporated in the drill rod handling apparatus described and illustrated in Australian Patent Application No. 2005202267 ("the Parent Apparatus"), and its equivalents, United States Patent Application Ser. No. 11/137052 and Canadian Patent Application No. 2508157. The disclosure of Australian Patent Application No. 20052002267 ("the Parent Application"), United States Application Ser. No. 11/137052 and Canadian Application No. 2508157 is incorporated herein by reference.

BACKGROUND

The Parent Application discloses a drill rod handling apparatus which includes at least one pair of jaws for gripping an elongate member to be handled, wherein the jaws are operable between a more open configuration and a more closed configuration by a driven member which can be moved between a first position and a second position, wherein the jaws operate substantially in a plane, and wherein the direction of movement of the driven member between the first position and the second position is substantially perpendicular to said plane.

The Parent Application further discloses a drill rod handling apparatus in which support structure in the form of a parallelogram four-bar linkage is provided by a base unit, two support members and a first link. The first link supports a second link which supports a retaining mechanism for gripping drill rods. The four-bar linkage arrangement of the Parent invention enables the orientation of the second link to be constant even when

the second link and retaining mechanism, are being moved laterally relative to the base unit.

The inventor has discerned improvements to the Parent Apparatus.

SUMMARY OF THE INVENTION

According to a first aspect, the present invention provides a handling apparatus which comprises at least one pair of jaws for gripping an elongate item to be handled;

wherein said at least one pair of jaws is operable between a more open configuration and a more closed configuration by a driven member which can be moved between a first position and a second position;

and wherein the jaws are arranged to be locked in the more closed configuration.

Preferably, the apparatus comprises a locking mechanism for locking the jaws in the more closed configuration.

Preferably, the locking mechanism is distinct from the driven member.

Preferably the apparatus is a drill rod handling apparatus.

Preferably, the jaws are arranged to be locked by pins which are arranged to be received in apertures in the jaws when the jaws are in the more closed configuration.

Preferably, the apparatus comprises a pair of pins.

Preferably each pin is arranged to be hydraulically driven into a respective aperture in the pair of jaws when the jaws are in the more closed configuration.

Preferably the or each pair of jaws is provided as part of a jaw arrangement, and the locking mechanism comprises at least one locking member arranged to be

received in an aperture in the jaw arrangement when the jaws are in the more closed configuration.

Preferably the locking member is a locking pin.

Preferably at least one jaw arrangement has at least two locking apertures defined in respective mutually relatively moveable parts thereof, arranged so that they are aligned when the jaws are in the more closed configuration, and at least one locking pin of said locking mechanism is arranged to be receivable in said aligned locking apertures when the jaws are in the more closed configuration.

Preferably at least one of said two mutually relatively moveable parts is a jaw of the jaw mechanism and at least one of the said two mutually relatively moveable parts is a mounting member of the jaw mechanism on which said jaw is mounted moveably mounted.

Preferably at least one jaw arrangement has at least two sets of locking apertures, each set of locking apertures arranged so that the locking apertures of the set align when the jaws are in the more closed configuration. Preferably said at least one jaw arrangement has at least two locking pins associated therewith, each arranged to be receivable in a corresponding set of locking apertures when the jaws are in the more closed configuration.

Preferably at least one jaw arrangement is provided with two sets of locking apertures, one corresponding with each jaw of the pair of jaws, and has two locking pins associated therewith.

The or each jaw may comprise a jaw member for engaging an object to be gripped and a jaw-member holder for attaching the jaw member to the rest of the jaw arrangement.

Preferably the or each locking member is hydraulically driveable.

Preferably the or each locking pin is arranged to be hydraulically driven into at least one respective

aperture in the jaw arrangement when the jaws are in the more closed configuration.

Preferably, the handling apparatus further comprises at least one detector to detect when the jaws are locked in the more closed position.

Preferably, apparatus is arranged so that, when operated in a mode in which it is intended that the jaws be in the more closed position, its operation is inhibited unless the one or more detectors indicate that the jaws are locked in the more closed position.

Preferably, apparatus is arranged so that, when operated in a mode in which it is intended that the jaws be in the more closed position, elevation of the jaws in a manner which would correspond to lifting of an item being gripped is disallowed unless the one or more detectors indicate that the jaws are locked in the more closed position.

Preferably the detector comprises a proximity switch arranged to detect when said locking member is received in the apertures in the jaw arrangement.

Preferably the detector comprises a proximity switch arranged to detect when said locking pin is received in the apertures in the jaw arrangement.

Preferably, the locking member comprises a trigger part for facilitating detection of its position by the detector. The trigger part may be a projection, which projects outwardly from a locking pin. The projection may be a flange.

Preferably, the jaws operate substantially in a plane, and the direction of movement of the driven member between the first position and the second position is substantially perpendicular to said plane.

In an embodiment the locking mechanism comprises a hydraulic cylinder and piston arrangement. The hydraulic cylinder and piston arrangement may be adapted to drive a locking pin into locking, and to withdraw the locking pin out of, locking apertures provided in the

jaws. The locking pin may be coupled to the piston in a manner which allows some lateral play, so that lateral forces applied to the locking pin (eg by the jaws) are not transmitted to the piston. This can assists in maintaining the integrity of the cylinder and piston arrangement, and avoiding leakage of hydraulic fluid.

In an embodiment the handling apparatus is arranged for enhanced safety of operation by limiting otherwise undesirable movements when the jaws are intended to be gripping an item, unless the proximity switches indicate that the pins have been received in the apertures in the jaws. That is, attempted elevation of an item, eg a drill rod, to be handled is inhibited unless the detector detects that the jaws are locked in the more closed configuration (corresponding to the item being securely gripped).

Preferably, the handling apparatus comprises at least two pairs of jaws which operate in substantially parallel planes.

Preferably, the driven member is part of a piston assembly.

Preferably, the driven member is part of a piston assembly and each end of the piston assembly is attached to respective first ends of each of a pair of links, wherein the respective second ends of each link are connected to the jaws, and wherein extension of the piston causes the second ends of each of the four the links to be drawn towards a centreline of the jaw assembly, thereby forcing the jaws together.

According to a second aspect, the present invention provides a handling apparatus for loading drill rods comprising:

a base unit;

a retaining mechanism for gripping drill rods;;

first and second elongate supports each pivotally coupled at a first end to the base unit, and at a second end to a first link to provide a first four-bar linkage

support structure;

a second four-bar linkage support structure comprising third and fourth elongate supports each pivotally coupled at a first end to the first link and each pivotally coupled at a second end to a second link;

whereby the second link is supported, in use, by the first and second four-bar linkage support structures, such that varying the angle of elevation of the first and second elongate supports and varying the angle of elevation of the third and fourth supports can vary a height of the second link and a horizontal distance of the second link from the base unit without changing the vertical orientation of the second link; and

wherein the retaining mechanism is pivotally coupled to the second link.

The third and fourth elongate supports may be pivotally connected directly to the first link.

The third and fourth elongate supports may be connected to an intermediate member which is coupled to the first link such that its orientation is fixed relative to the first link.

Preferably the handling apparatus comprises a first-linkage driving mechanism for selectively changing the angle of elevation of the first and second elongate supports by forcing the first and second supports to pivot relative to the base unit.

Preferably the handling apparatus comprises a second-linkage driving mechanism for selectively changing the angle of elevation of the third and fourth elongate supports by forcing the third and fourth supports to pivot relative to the first link.

Preferably the handling apparatus comprises a retaining-mechanism driving mechanism for selectively orienting the retaining mechanism relative to the second link.

Preferably the retaining-mechanism driving mechanism comprises a first hydraulic cylinder coupled at

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a first end thereof to the retaining mechanism and at a second end thereof to the second link.

Preferably the retaining-mechanism driving mechanism further comprises a cylinder orientation mechanism for moving the second end of the first hydraulic cylinder relative to the second link, and thereby changing the angle of the first hydraulic cylinder relative to the retaining mechanism. This can assist in providing greater manoeuvrability of the retaining mechanism.

Preferably the cylinder orientation mechanism comprises a cylinder mounting member which pivotally connects the first hydraulic cylinder to the second link and a second hydraulic cylinder which can change the orientation of the cylinder mounting member relative to the second link.

Preferably, the retaining mechanism comprises at least one clamping mechanism for clamping onto said drill rod.

Preferably, the at least one clamping mechanism comprises a pair of jaws operable between a more open configuration and a more closed configuration.

Preferably, the relative motion of the jaws between the more open configuration and the more closed configuration is substantially in a plane, and the direction of movement of the driven member between the first and second positions is substantially perpendicular to said plane.

Preferably, the apparatus comprises a locking mechanism for locking the jaws in the more closed configuration.

Preferably, the handling apparatus further comprises at least one detector to detect when the jaws are locked in the more closed position.

Preferably, apparatus is arranged so that its operation is inhibited unless the one or more detectors indicate that the jaws are locked in the more closed position.

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Preferably, apparatus is arranged so that elevation of the jaws in a manner which would correspond to lifting of an item being gripped is disallowed unless the one or more detectors indicate that the jaws are locked in the more closed position.

According to a third aspect, the present invention provides a handling apparatus comprising:

a retaining mechanism for gripping drill rods;

a first four-bar linkage formed by a base unit, two support members and a first link, wherein the first link supports the retaining mechanism via a second link, and wherein the support members of the first four-bar linkage can be selectively orientated to move the second link and retaining mechanism; and

a second four-bar linkage, located between the first four-bar linkage and the second link, wherein support members of the second four bar linkage can be selectively orientated to move the second link and retaining mechanism;

wherein a constant orientation of the second link is maintained as it is moved by orientation of the first and second four-bar linkages.

It will be appreciated that handling apparatus in accordance with one of the above aspects may include one or more features set out above in relation to other aspects.

The four-bar linkage arrangement of the Parent apparatus enables the orientation of the second link to be constant even when the second link and retaining mechanism are being moved laterally (non-rotationally) relative to the base unit. The two four-bar linkage configuration, can similarly enable the orientation of the second link to be constant even when the second link and retaining mechanism are being moved laterally (non-rotationally) relative to the base unit, while facilitating improved manoeuvrability of the loader head compared to the Parent apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the Parent and Present inventions will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a reproduction of Figures 20a and 20b of the Parent Application;

Figure 2 is a reproduction of Figures 21a and 21b of the Parent Application;

Figure 3 is a plan view from above of an embodiment of a jaw mechanism of apparatus in accordance with the present invention;

Figure 4 is a section on A-A of Figure 3;

Figure 5 is a rear elevation of the jaw mechanism of Figure 3;

Figure 6 is a section on C-C of Figure 5;

Figure 7 is a side elevation of the jaw mechanism of Figure 3;

Figure 8 is a perspective view of the jaw mechanism of Figure 3;

Figure 9 is a reproduction of Figure 1 of the Parent Application;

Figure 10a is a side elevation of an embodiment of a handling apparatus of the present invention, illustrating the presence of two four-bar linkages;

Figure 10b is an enlarged view of second four-bar linkage of Figure 10a, and some adjacent parts of the apparatus; and

Figures 11a to 11x are reduced size views equivalent to Figure 10a illustrating the manoeuvrability of the handling apparatus of an embodiment of the present invention facilitated by the two four-bar linkage configuration.

DESCRIPTION OF EMBODIMENTS

Figures 1 and 2, which reproduce Figures 20a, 20b, 21a and 21b of the Parent Application, illustrate a pair or set of jaws 162 (jaw arrangement) of the Parent apparatus. It is considered useful to present these drawings, and accompanying description, in order to facilitate description of preferred embodiments of the present invention because a preferred embodiment in accordance with the present invention has many similarities to the jaws described in the Parent application.

The jaw arrangement 162 is designed to be compact in order to allow access to rods when, for example, there is a rod close to either side of the rod it is desired to pick up using the jaws 162.

Each of the first and second jaw elements 220, 240 of the pair of jaws is mounted to a respective first or second jaw holder 228, 248, by jaw pins 222. This allows easy replacement of the jaw elements 220, 240 for renewal or replacement with jaw elements of a different size for use with drill rods of a different diameter. Each jaw holder 228, 248 is pivotably mounted to a mounting plate 227, via an insert 230, such that pivoting of the jaw holders, 228, 248 allows the jaws to open or close. The jaws are operable by a hydraulic cylinder 201 which passes between the jaw holders 228, 248, in order to provide a compact configuration. The hydraulic cylinder 201 is attached at each of its ends 202 to a pair of plate links 209, and respective first and second plate links 209 of each pair are attached to the first and second jaw holders 228, 248. Since, in use, each jaw and corresponding jaw holder move as a unit, the jaw holders may be regarded as parts of the jaws. When the cylinder 201 is extended, or stroked out, as shown in Figure 2 (Figures 21a and 21b of the Parent application), the distal ends of the first and second plate links 209 of each pair are forced away from each other, and the ends of the plate links 209 which are attached to first and second

jaw holders 228, 248 are consequently pulled in towards the axis of the cylinder 201, thus clamping the jaws. It is desirable to have the cylinder aligned substantially perpendicular to the plane of the jaws in order to keep the jaw arrangement compact and help avoid the cylinder obstructing access by the jaws to objects to be grasped. In order to balance forces within the mechanism, the cylinder 201 is able to float through bushes 232 provided in the mounting plate 227. The cylinder 201 contains a spring to bias it to its extended position, so the jaws are closed, or kept closed, in the event of a hydraulics failure. It will be appreciated that hydraulic retraction of the cylinder, as shown in Figure 1(Figures 20a and 20b of the Parent application), will cause the jaws to open allowing release of an object held.

Turning to Figures 3 to 8, an embodiment of a jaw arrangement 62 of a handling apparatus in accordance with the first aspect of the Present invention is illustrated in a closed configuration.

The jaw arrangement 62 is similar in overall structure to the jaw arrangement of the Parent application, as is evident from the drawings, and only the differences are described in detail with reference to Figures 3 to 9.

The jaw arrangement 62 is provided with hydraulic cylinders 53 which can move locking members, which in this embodiment are in the form of locking pins 49, in order to lock the jaws 20, 40 in the more closed configuration. Jaw holders 28, 48 and mounting plate 27 are provided with locking apertures, designated 30, 31 respectively in Figures 4 and 6, which only align when the jaws are in the more closed configuration. As illustrated in Figures 4 and 6, when the jaws are in the more closed configuration the jaws can be locked by insertion of both pins 49 (only one shown in Figures 4 and 6) in the locking apertures 30, 31. The pins prevent substantial movement of the jaw holders 28, 48 relative to the mounting plate, effectively

locking the jaws until the pins 49 are withdrawn from the locking apertures. The pins 49 are moveable between the illustrated position engaged in the locking apertures 30,31, and a withdrawn, unlocked, position by operation of hydraulic cylinder 53.

As illustrated in Figures 4 and 6, pin 49 is connected to the hydraulic cylinder 53 by a cylinder rod 51 connected to a piston 50 moveable in the hydraulic cylinder 53. The hydraulic cylinder 53 has an upper passage 54 above the piston 50, and a lower passage 55 below the piston. Net fluid pressure at the upper passage 54 can be used to force the piston downwardly, forcing the locking pin 49 towards the locked position (as illustrated). Net fluid pressure at the lower passage 55 can be used to force the piston upwardly, forcing the locking pin 49 towards the retracted, unlocked, position.

The locking pin is connected to the cylinder rod 51 by a roll pin 56, and the connection is arranged to allow some lateral play. This helps avoid transmission of lateral forces (which may be applied to the locking pin 49 by the jaw holders 28, 48) to the cylinder rod 51, thereby reducing or avoiding sealing problems where the rod enters the hydraulic cylinder 53.

Each hydraulic cylinder 53 is provided with a detector, in this embodiment in the form of a proximity switch 60, which can detect when the locking pin is engaged in the locking apertures (ie, when the jaw is locked). In this embodiment the locking pin is provided with a pin shoulder 57, which in this embodiment is in the form of a flange, which facilitates detection of the pin position by the proximity switch 60. The proximity switch is arranged to disable at least one function of the handling apparatus when the handling apparatus is operated so that the jaws should be closed but the pin 49 is not in the locked position. The disabled function is preferably elevation of the jaws in a manner corresponding to lifting a drill rod. That is, the potential problem of the jaws

improperly gripping a drill rod, lifting it, and then dropping it due to the improper grip is avoided, because elevation is disabled unless the jaws are locked in their closed position, and the closed position cannot be obtained if a rod is improperly gripped (for example if a rod is gripped between the tips of the jaws).

In the illustrated embodiment the proximity switch sends a signal to a computerised control system of the handling apparatus, and the computerised control system effects disablement or enablement of the function accordingly. For clarity it should be stated that in this embodiment an operator controls the handling apparatus, including operating a control to operate the jaws between an open position and a closed position. In order to allow movement of the retaining mechanism when the jaws are open, the control system does not prevent elevation (in response to the detector signal) when the controls are set so that the jaws should be in their open configuration.

Referring now to Figure 9 (Figure 1 of the Parent Application), the drill rod handler 100 comprises a base 102 and first and second support members in the form of respective first and second arms 104, 204. The arms 104, 204 are pivotally attached to the base 102 at their respective first ends 106, 206 and are pivotally attached to a first link in the form of an elevator frame 110, at their respective second ends 108, 208. The pivotal attachments of the arms 104, 204 are spaced apart appropriately, and the arms 104, 204 are dimensioned so that the arms remain parallel in use, and consequently the orientation of the elevator frame 110 remains constant in use, irrespective of changes in the angle of elevation of the arms 104, 204.

Providing two parallel arms provides greater load bearing capacity than would a single arm, and allows long rods to be handled.

The arms 104, 204 can be moved by a driving mechanism in the form of first and second hydraulic

cylinders 120, 130. The first hydraulic cylinder is pivotally attached to the base 102 at a first end 122 thereof and is pivotally attached to a first end 142 of a floating support 140 at the second end 124 of the first hydraulic cylinder 120. The first end 132 of the second hydraulic cylinder 130 is attached to the first end 142 of the floating support 140, and the second end 134 of the second hydraulic cylinder 130 is attached to the first arm 104. The second end 144 of the floating support 140 is pivotally attached to the base 102. Retracting of one or both of the hydraulic cylinders 120, 130 pulls the arms 104, 204 and elevator frame 110 into a more elevated position, so that the elevator frame is laterally relatively close to the base 102.

The elevator frame 110 is pivotally attached to a second link member in the form of a loader tilt arm 150, by a pivot arrangement 152. However, the elevator frame 110 and the loader tilt arm 150 can be prevented from relative pivotal movement by insertion of a locking insert pin 154 which passes through coaxially aligned apertures in the elevator frame 110 and the loader tilt arm 150.

The loader tilt arm 150 is pivotally attached to an elongate frame in the form of a loader head frame 160. The loader head frame is provided with first and second sets of jaws 162, 164 which are spaced apart by a spacer 166. a head cylinder 168 is operable to move the spacer 166 and jaws 162, 164 along the loader head frame 160.

A third hydraulic cylinder 170 is provided for driving relative pivotal movement of the elevator frame 110 and the loader tilt arm 150 (although it cannot be effectively operated while the locking insert pin 154 is in position).

A fourth hydraulic cylinder 180 is provided to drive relative pivotal movement of the loader tilt arm 150 and the loader head frame 160.

As the orientation of the elevator frame 110 (in the plane of the arms 104, 204) is constant during use,

when the locking insert pin 154 is in position, the orientation of the loader tilt arm 150 is also constant, so the orientation of the loader head frame 160 can be determined by the fourth cylinder 180 which can control the orientation of the loader head frame relative to the loader tilt arm 150. Adjustable stops or rotation limiters 182, 184 are provided on the loader tilt arm 150 to allow desired extremes of orientation of the loader head frame 160 to be present prior to use of the rod handler 100.

With reference to Figures 10a and 10b an embodiment of a handling apparatus in accordance with the present invention is generally designated 300. Similarities between the drill rod handler 100 and the apparatus 300 will be evident, and mainly the differences are described hereafter.

The drill rod handler 300 comprises a base 302 and first and second support members in the form of respective first and second arms 304, 306 pivotally attached to the base 302 at their respective first ends and pivotally attached to a first link in the form of a first link member 310, at their respective second ends to form a first four-bar linkage. Thus the orientation of the first link member 310 remains constant in use, irrespective of changes in the angle of elevation of the arms 304, 306.

The arms 304, 306 can be moved by a driving mechanism in the form of first and second hydraulic cylinders 320, 330 pivotally attached to the base 302 at a first ends thereof and pivotally attached to a first end 342 of a floating support 340 at the second ends. The second end 344 of the floating support 340 is pivotally attached to the base 302. Retracting of one or both of the hydraulic cylinders 320, 330 pulls the arms 304, 306 and first link member 310 into a more elevated position, so that the first link member 310 is elevated and laterally relatively close to the base 302.

Third and fourth support members in the form of respective third and fourth arms 314, 316 are pivotally attached to the first link member 310 at their respective first ends. As can be seen in Figures 10a and 10b the pivot points for attachment of the third and fourth arms 314, 316 to the first link member 310 are actually provided on an intermediate member 312. However, the intermediate member 312 is attached to the first link member so that is remains at a constant orientation relative to the first link member 310, and the third and fourth arms 314, 316 are therefore effectively pivotally attached to the first link member 310. (In the illustrated embodiment the first link member 310 and intermediate member 312 are actually parts of a single welded-together frame which thus acts as a 'bar' for each of the first and second four-bar linkages).

The third and fourth arms 314, 316 are pivotally attached to a second link in the form of a second link member 318, at their respective second ends to form a second four-bar linkage. Thus the orientation of the second link member 318 remains constant in use, irrespective of changes in the angle of elevation of the arms 304, 306, 314, 316.

A third hydraulic cylinder 370 is provided for driving relative pivotal movement of the fourth arm 316, relative to the first arm 304, and thus controlling elevation of the second four-bar linkage.

The second link member 318 is attached to a loader support arm 350, such that the loader support arm remains at a constant orientation relative to the second link member 318. Thus the orientation of the loader support arm 350 remains constant in use, irrespective of changes in the angle of elevation of the arms 304, 306, 314, 316.

The loader support arm 350 is pivotally attached to an elongate frame in the form of a loader head frame 360. The loader head frame is provided with a retaining

mechanism (not shown, but optionally equivalent to the equivalent features of drill rod handler 100), and the loader head frame may be regarded as part of the retaining mechanism.

A fourth hydraulic cylinder 380 is provided to drive relative pivotal movement of the loader tilt arm 350 and the loader head frame 360. As best shown in Figure 10b the fourth hydraulic cylinder 380 is coupled at a first end thereof to the loader head frame 360 and at a second end thereof to the loader support arm 350. However, the fourth hydraulic cylinder 380 is not connected directly to the loader support arm 350, but is connected via a pivot arm 381, which is pivotally connected at a first end portion thereof to the fourth hydraulic cylinder 380, pivotally connected at an intermediate portion thereof (at 382) to the loader support arm 350 and pivotally connected at a second end portion thereof to a first end of a fifth hydraulic cylinder 383. The second end of the fifth hydraulic cylinder is mounted immovably to the loader support arm 350. Operation of the fifth hydraulic cylinder can pivot the pivot arm 381 and thereby change the orientation of the fourth hydraulic cylinder 380. This arrangement comprises a cylinder orientation mechanism for moving the second end of the fourth hydraulic cylinder relative to the second link, and thereby changing the angle of the fourth hydraulic cylinder relative to the loader head frame 360. This can assist in providing greater manoeuvrability of the loader head frame 360 (retaining mechanism).

As the orientation of the loader support arm 350 remains constant in use (in the plane of the arms 304, 306, 314, 316) the orientation of the loader head frame 360 can be controlled by use of only the fourth cylinder 380 which facilitates control. However, compared to the Parent apparatus the use of a second four-bar linkage provides enhanced manoeuvrability of the loader head frame 360, and thus of drill rods (or other items being

handled). Figures 11a to 11x are reduced size views which together illustrate the manoeuvrability of the handling apparatus of an embodiment of the present invention facilitated by the two four-bar linkage configuration.

It will be appreciated that although the present invention is presented herein as relating to improvements to the Parent apparatus, the present invention need not be limited to incorporation into the Parent apparatus, and the present invention may have other applications.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

Claims

1. A handling apparatus for loading drill rods comprising:

a base unit;

a retaining mechanism for gripping drill rods;;

first and second elongate supports each pivotally coupled at a first end to the base unit, and at a second end to a first link to provide a first four-bar linkage support structure;

a second four-bar linkage support structure comprising third and fourth elongate supports each pivotally coupled at a first end to the first link and each pivotally coupled at a second end to a second link;

whereby the second link is supported, in use, by the first and second four-bar linkage support structures, such that varying the angle of elevation of the first and second elongate supports and varying the angle of elevation of the third and fourth supports can vary a height of the second link and a horizontal distance of the second link from the base unit without changing the vertical orientation of the second link; and

wherein the retaining mechanism is pivotally coupled to the second link.

2. A handling apparatus as claimed in claim 1 wherein the third and fourth elongate supports are pivotally connected directly to the first link.

3. A handling apparatus as claimed in claim 1 wherein the third and fourth elongate supports are connected to an intermediate member which is coupled to the first link such that its orientation is fixed relative to the first link.

4. A handling apparatus as claimed in any preceding claim wherein the handling apparatus comprises a first-linkage driving mechanism for selectively changing the angle of elevation of the first and second elongate supports by forcing the first and second supports to pivot

relative to the base unit.

4. A handling apparatus as claimed in claim 3 wherein the handling apparatus comprises a second-linkage driving mechanism for selectively changing the angle of elevation of the third and fourth elongate supports by forcing the third and fourth supports to pivot relative to the first link.

5. A handling apparatus as claimed in any preceding claim wherein the handling apparatus comprises a retaining-mechanism driving mechanism for selectively orienting the retaining mechanism relative to the second link.

6. A handling apparatus as claimed in claim 5 wherein the retaining-mechanism driving mechanism comprises a first hydraulic cylinder coupled at a first end thereof to the retaining mechanism and at a second end thereof to the second link.

7. A handling apparatus as claimed in claim 6 wherein the retaining-mechanism driving mechanism further comprises a cylinder orientation mechanism for moving the second end of the first hydraulic cylinder relative to the second link, and thereby changing the angle of the first hydraulic cylinder relative to the retaining mechanism.

8. A handling apparatus as claimed in claim 7 wherein the cylinder orientation mechanism comprises a cylinder mounting member which pivotally connects the first hydraulic cylinder to the second link and a second hydraulic cylinder which can change the orientation of the cylinder mounting member relative to the second link.

9. A handling apparatus as claimed in any preceding claim wherein the retaining mechanism comprises at least one clamping mechanism for clamping onto said drill rod.

10. A handling apparatus as claimed in claim 9 wherein the at least one clamping mechanism comprises a pair of jaws operable between a more open configuration and a more closed configuration by a driven member which

can be moved between a first position and a second position.

11. A handling apparatus as claimed in claim 10 wherein the relative motion of the jaws between the more open configuration and the more closed configuration is substantially in a plane, and the direction of movement of the driven member between the first and second positions is substantially perpendicular to said plane.

12. A handling apparatus as claimed in either of claims 10 or 11 wherein the apparatus comprises a locking mechanism for locking the jaws in the more closed configuration.

13. A handling apparatus as claimed in claim 12 wherein the pair of jaws is provided as part of a jaw arrangement, and the locking mechanism comprises at least one locking member arranged to be received in an aperture in the jaw arrangement when the jaws are in the more closed configuration.

14. A handling apparatus as claimed in either of claims 12 or 13, wherein the handling apparatus further comprises at least one detector to detect when the jaws are locked in the more closed position.

15. A handling apparatus as claimed in claim 14 wherein the apparatus is arranged so that, when operated in a mode in which it is intended that the jaws be in the more closed position, its operation is inhibited unless the one or more detectors indicate that the jaws are locked in the more closed position.

16. A handling apparatus as claimed in claim 15 wherein the apparatus is arranged so that elevation of the jaws in a manner which would correspond to lifting of an item being gripped is disallowed unless the one or more detectors indicate that the jaws are locked in the more closed position.

17. A handling apparatus comprising:

a retaining mechanism for gripping drill rods;

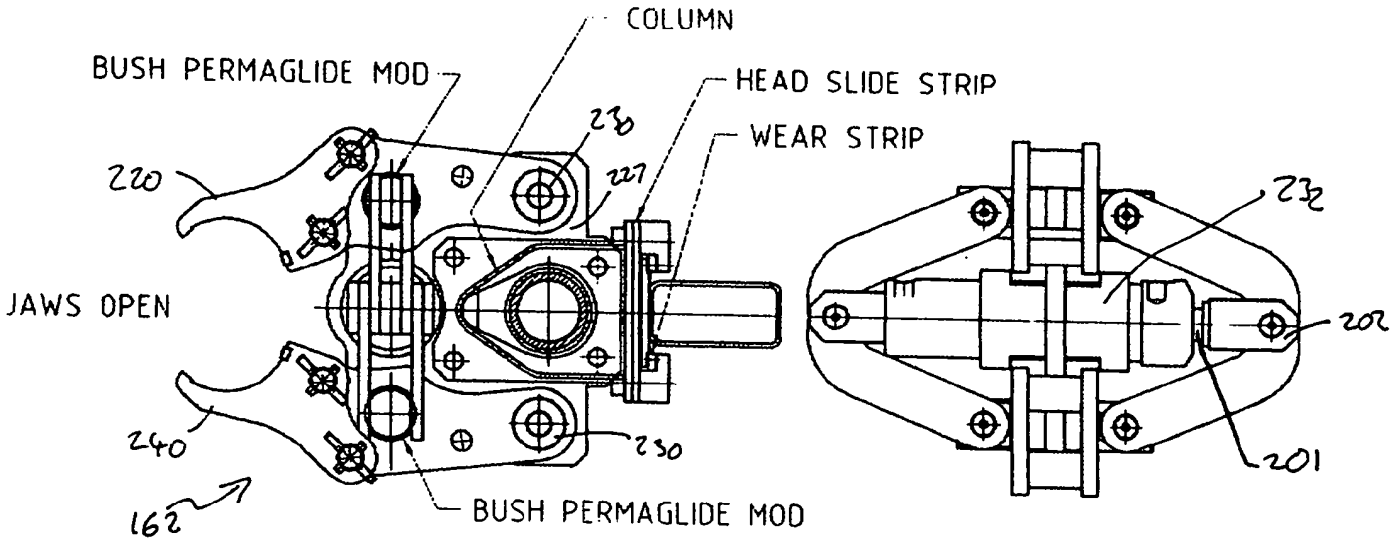
a first four-bar linkage formed by a base unit,

two support members and a first link, wherein the first link supports the retaining mechanism via a second link, and wherein the support members of the first four-bar linkage can be selectively orientated to move the second link and retaining mechanism; and

a second four-bar linkage, located between the first four-bar linkage and the second link, wherein support members of the second four bar linkage can be selectively orientated to move the second link and retaining mechanism;

wherein a constant orientation of the second link is maintained as it is moved by orientation of the first and second four-bar linkages.

18. A handling apparatus for loading drill rods substantially as hereinbefore described with reference to, and as shown in, Fig.s 10a to 11x.



[Fig 20a OF PARENT APPLICATION]

[Fig 20b OF PARENT APPLICATION]

Figure 1

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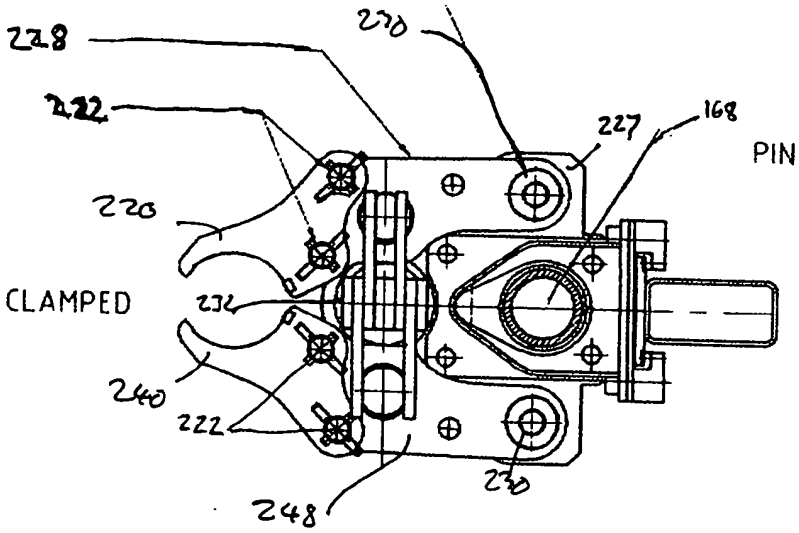

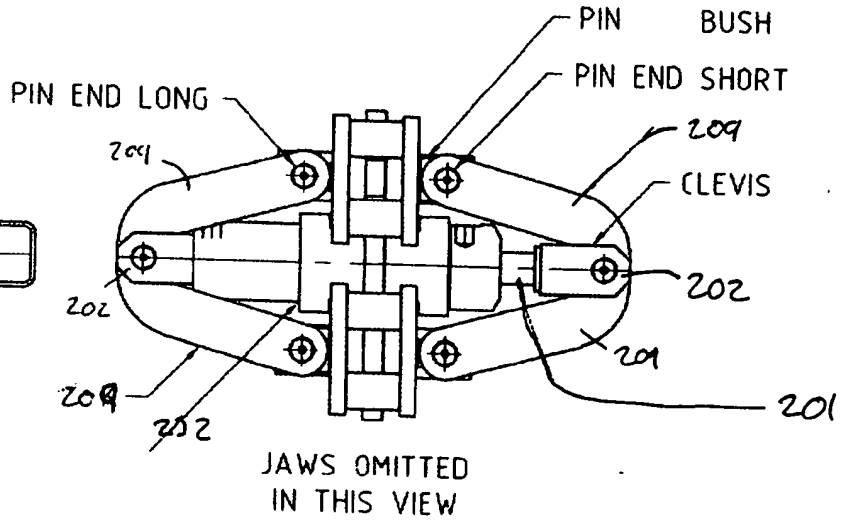

[Fig 21a of PARENT APPLICATION]

[Fig 21b of PARENT APPLICATION]

Figure 2

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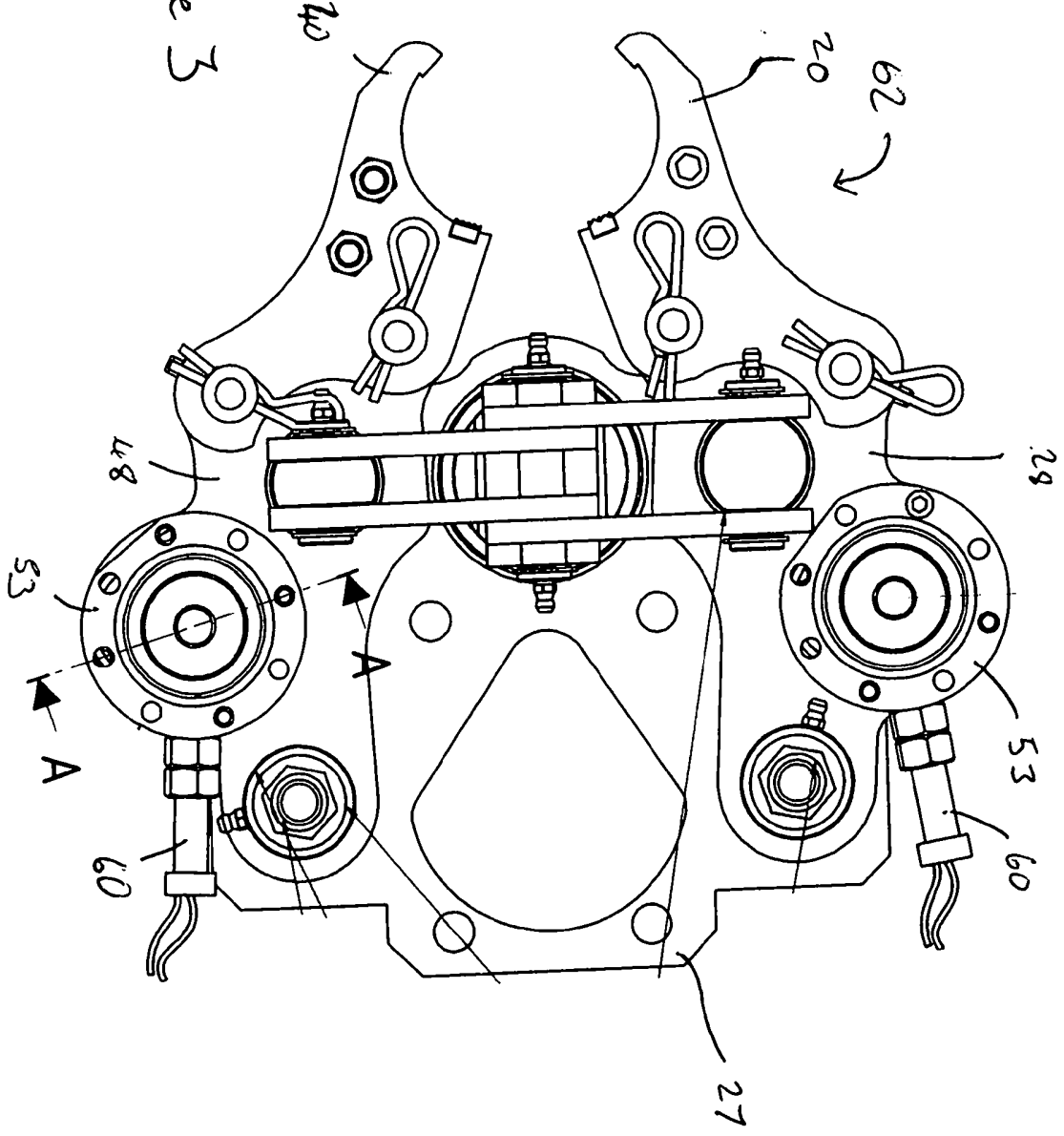
Figure 3



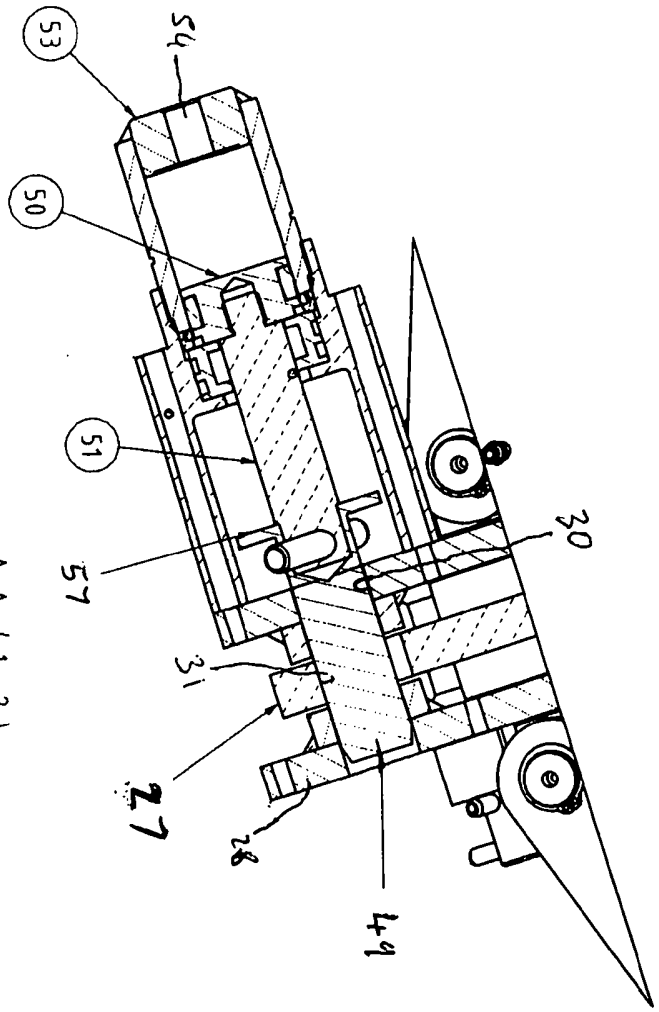


Figure 4

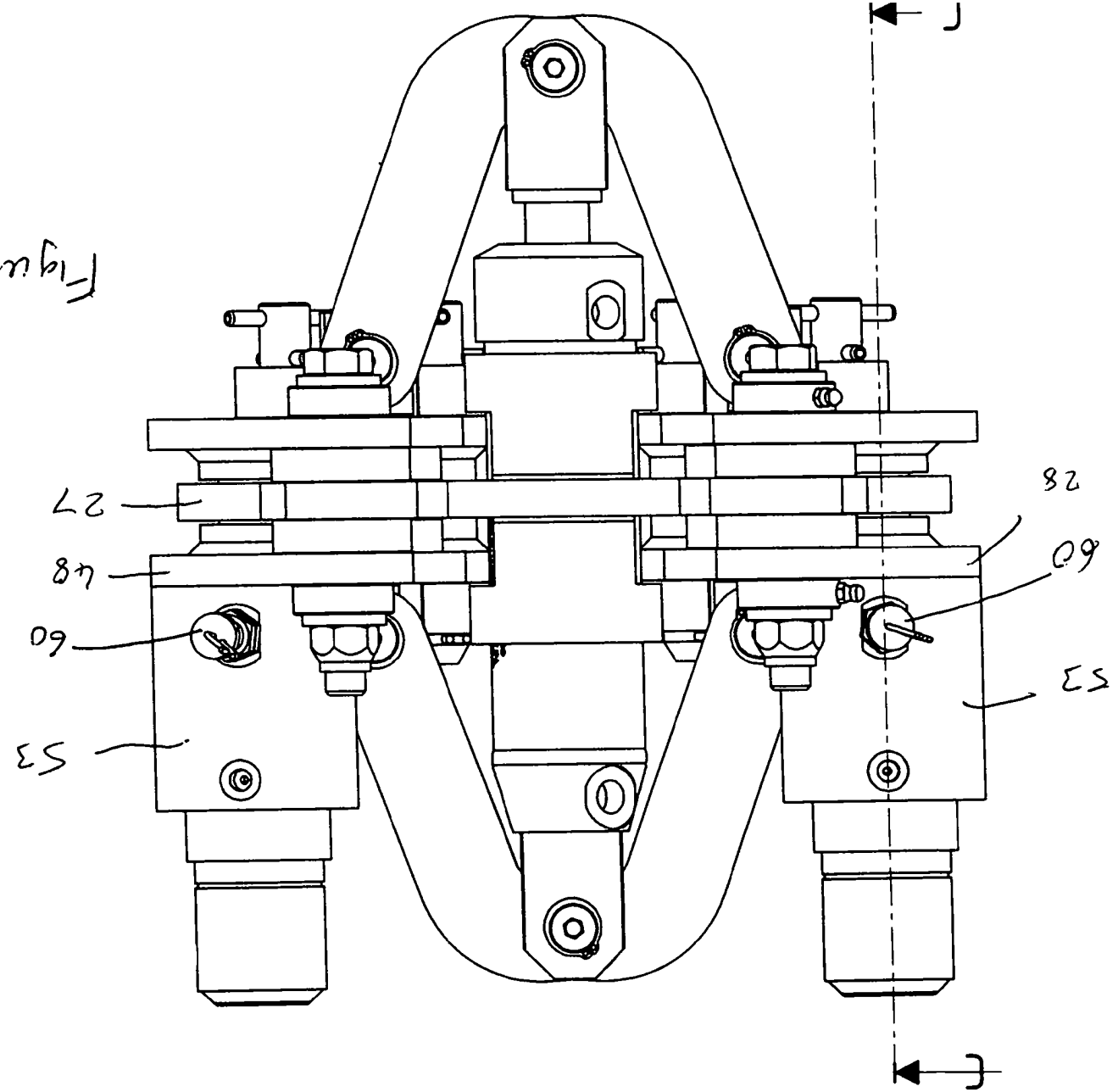


Figure 5

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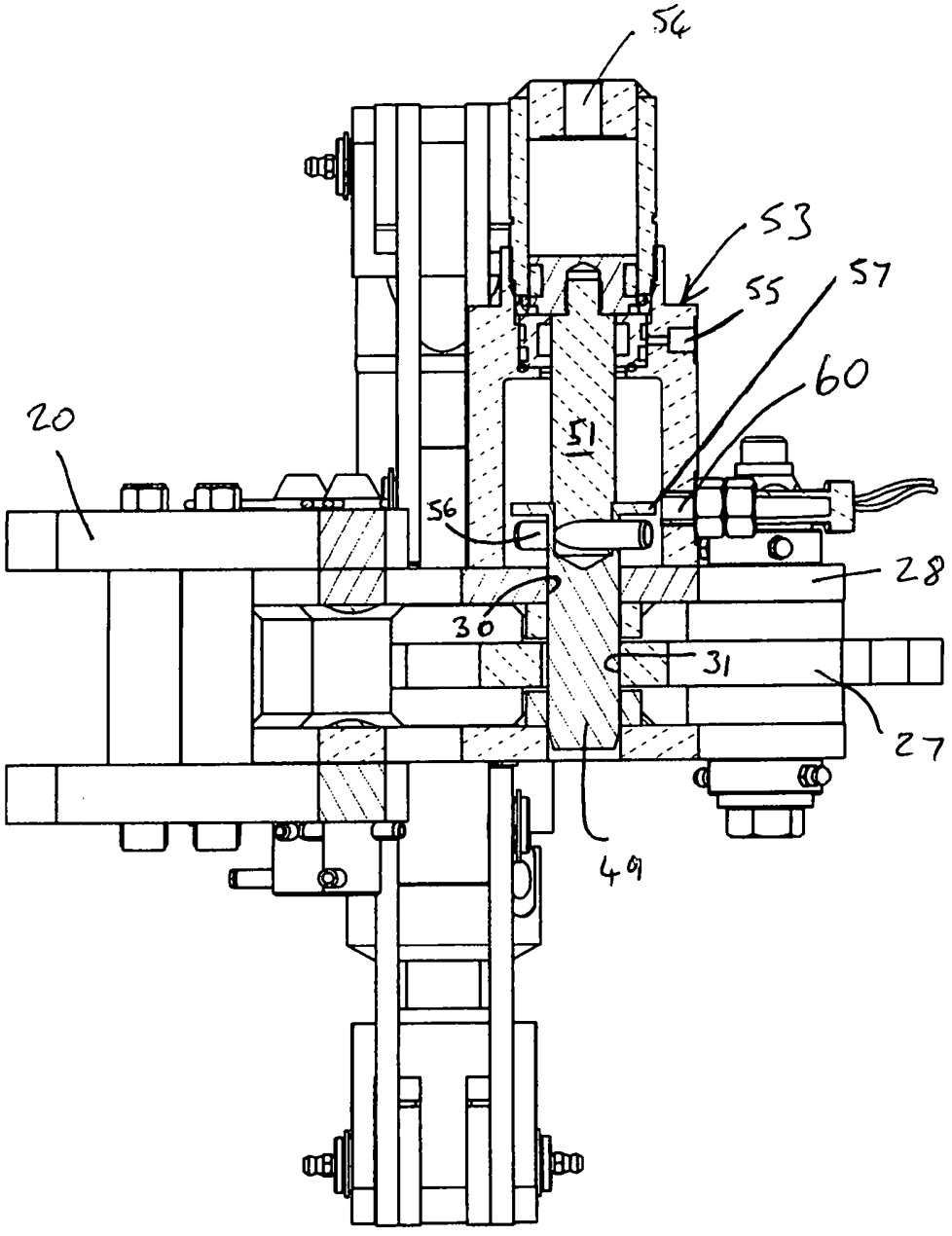


Figure.6

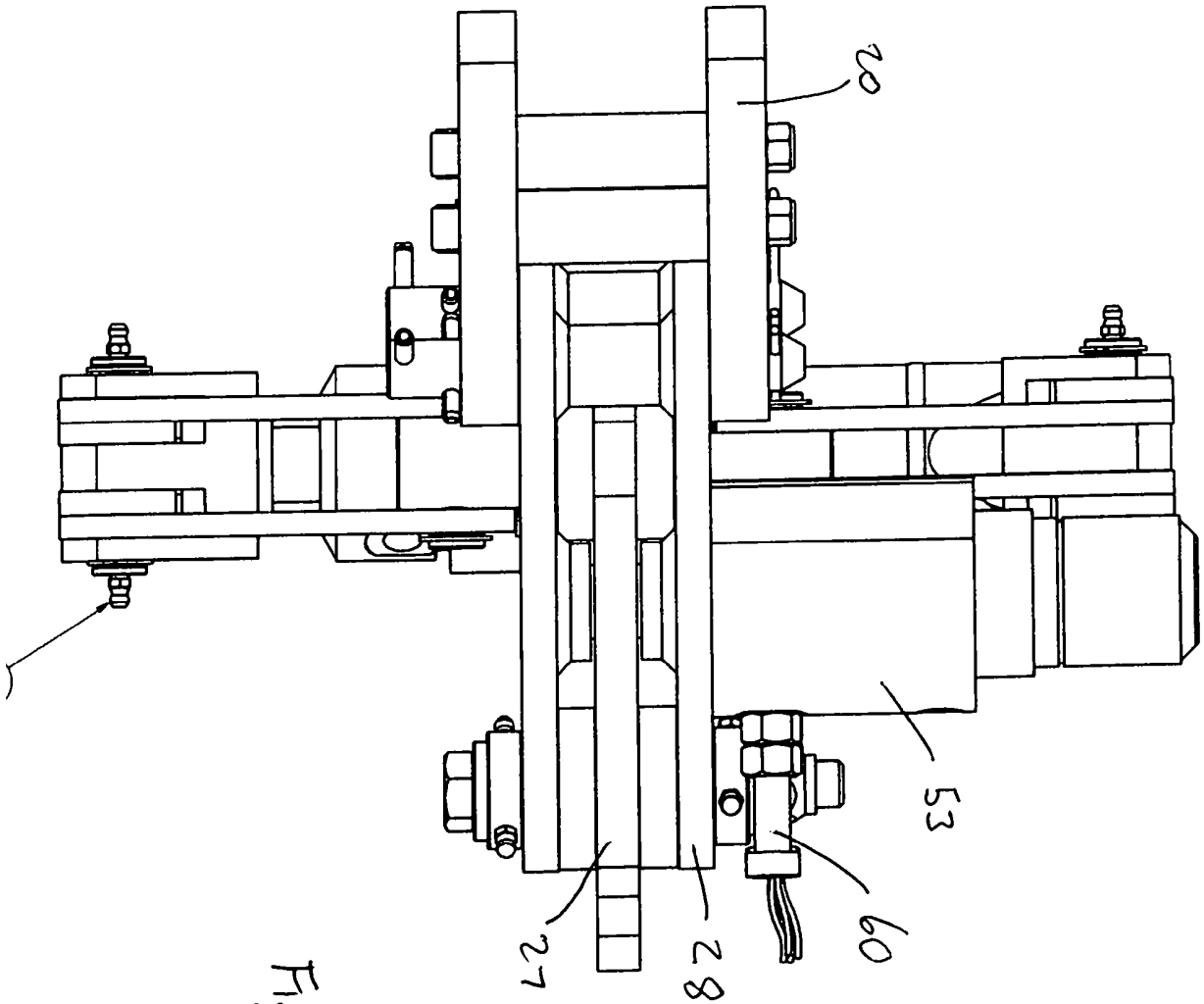
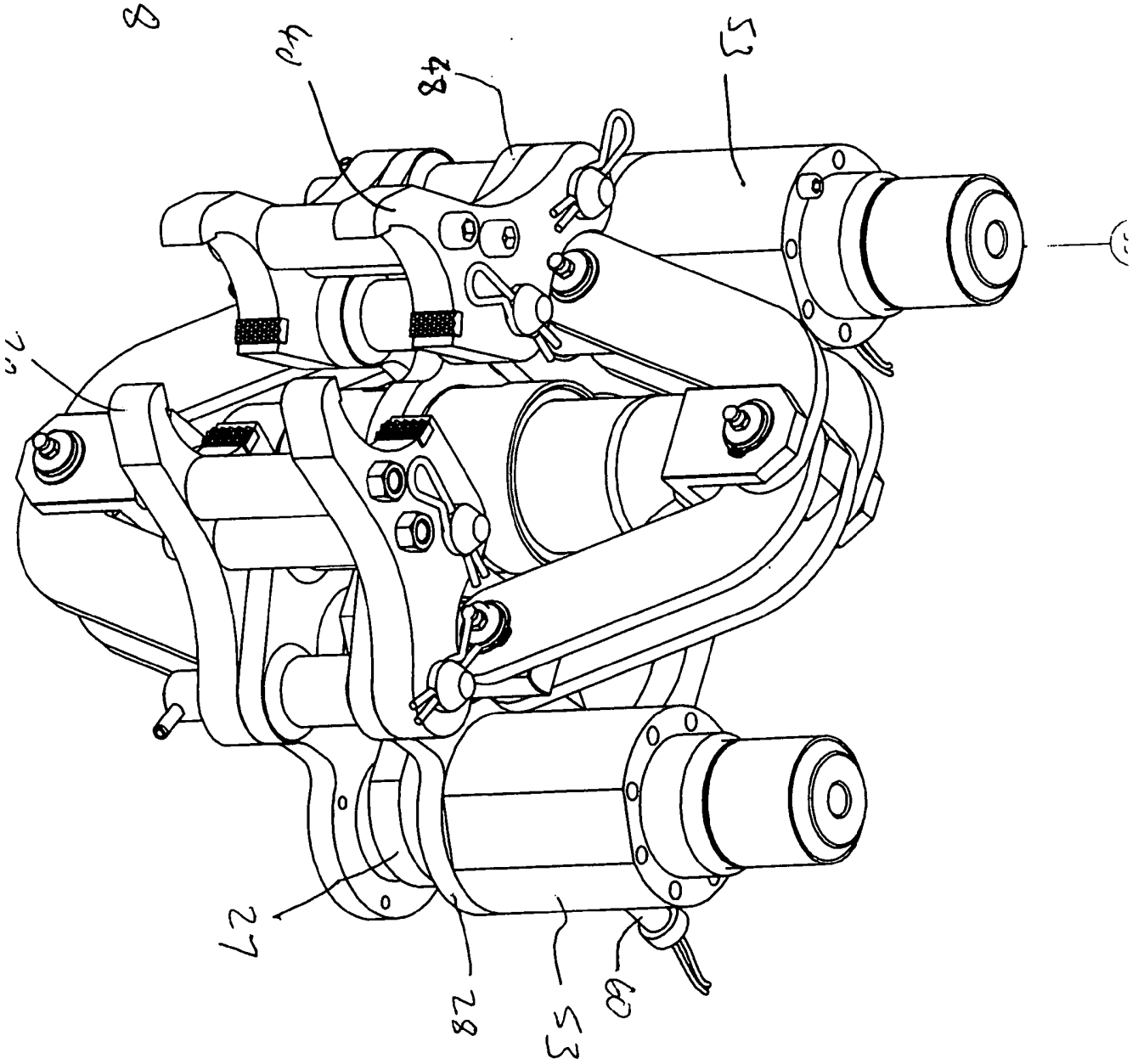


Figure 7

Figure 8



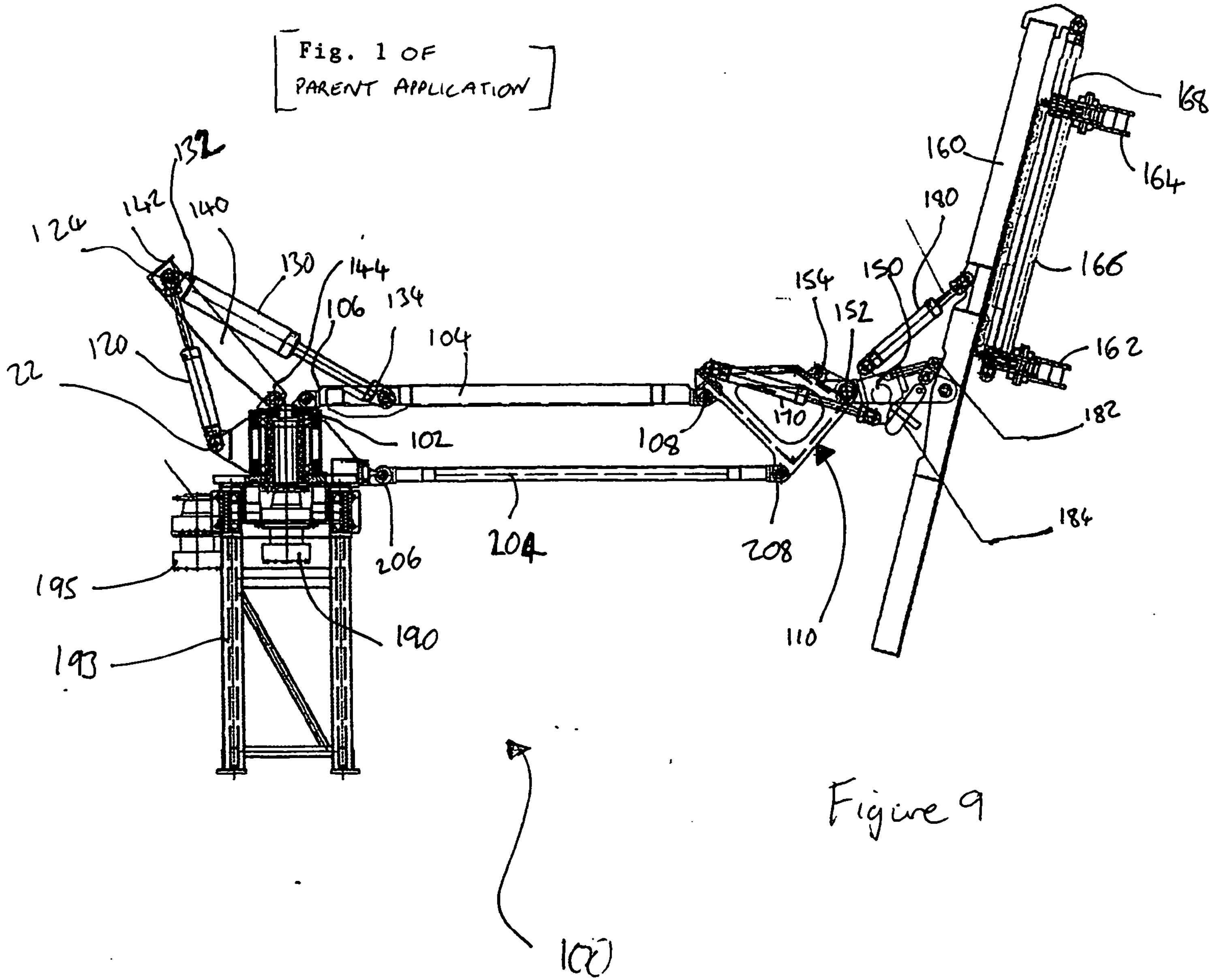


Figure 9

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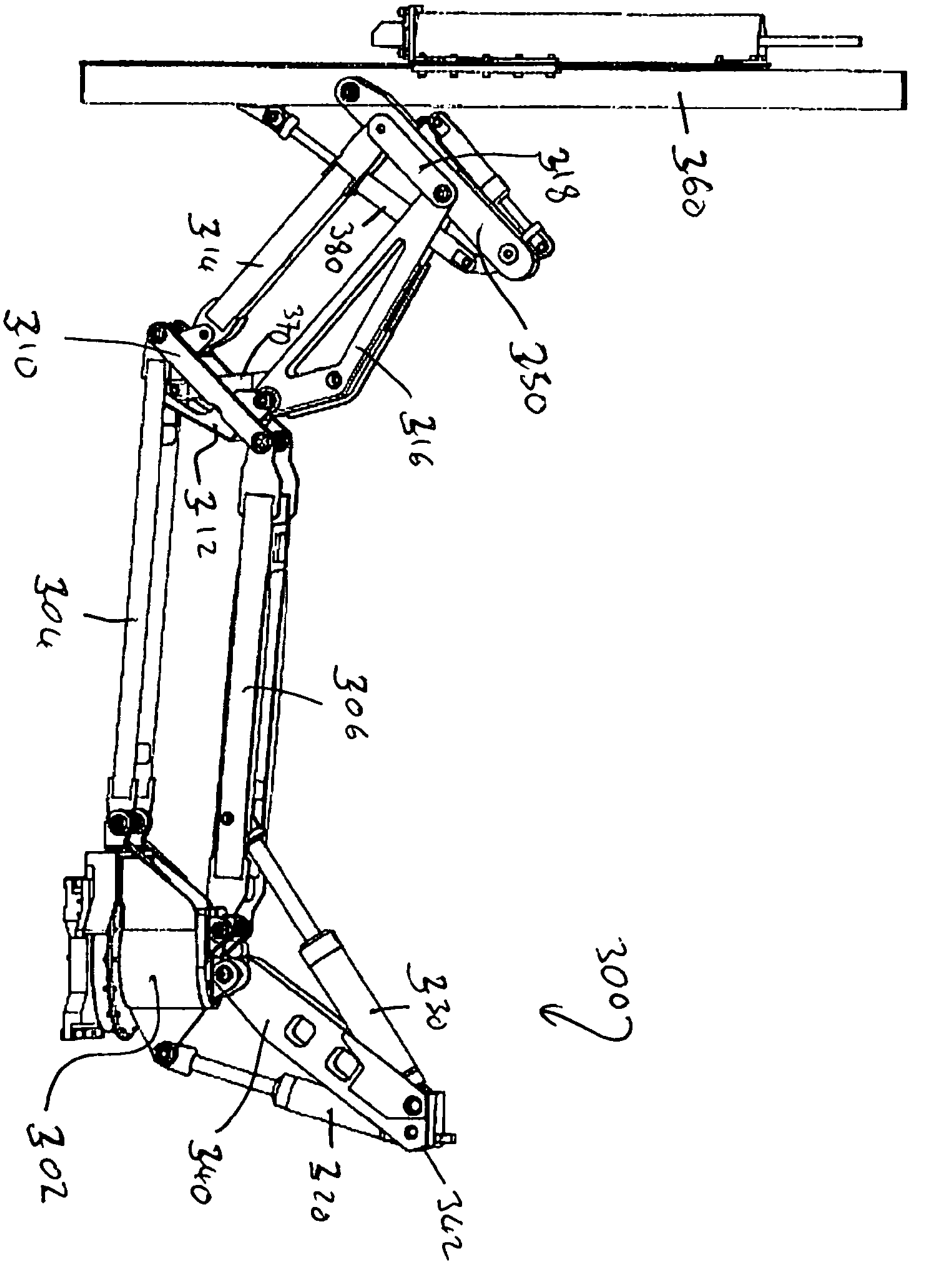

Figure 10a

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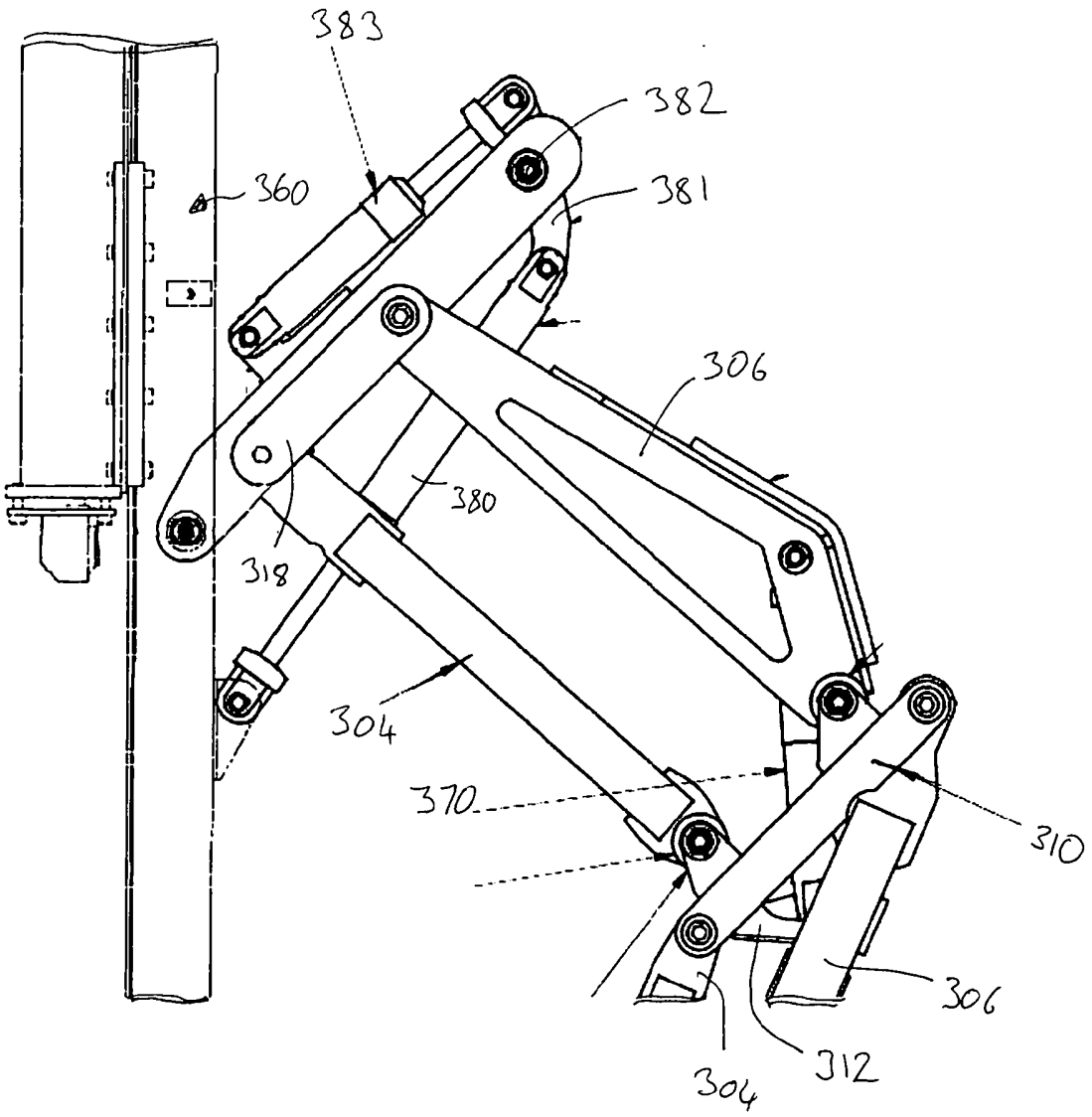

Figure 10b

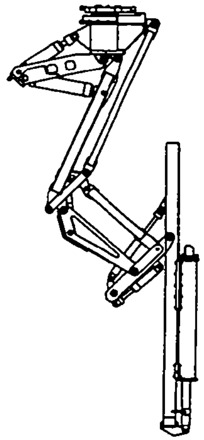
Fig. 11a

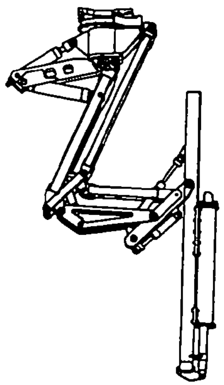
Fig 11b

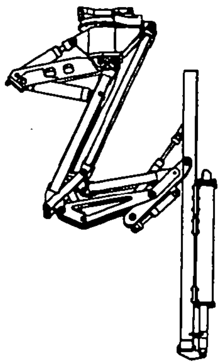
Fig 11c

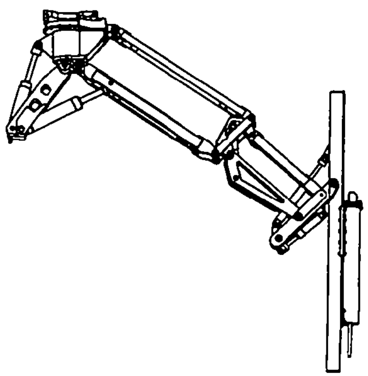
Fig 11d

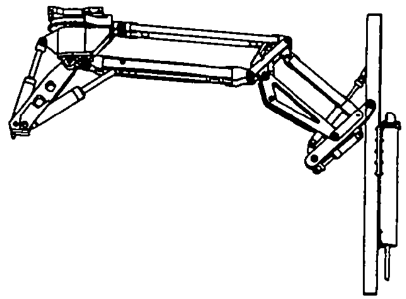
Fig 11e

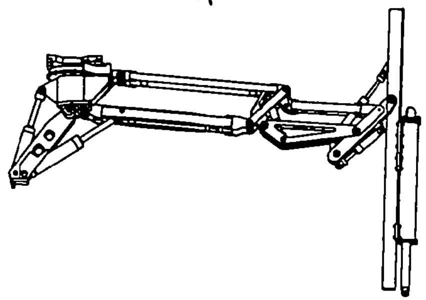
Fig 11f

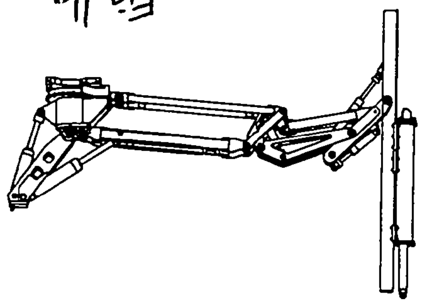
Fig. 11g

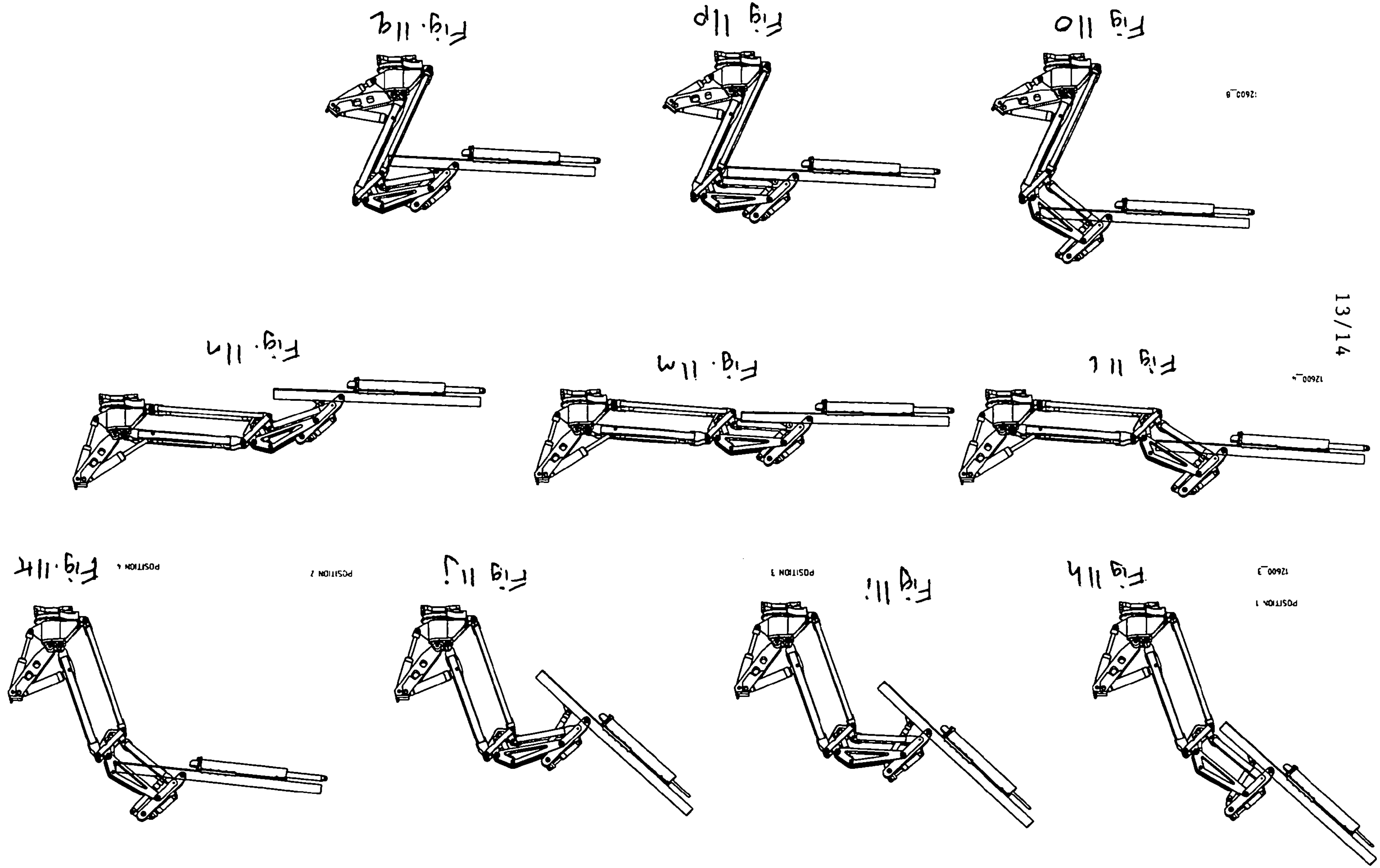
Fig 11o
12600_8
Fig 11p
Fig. 11q
Fig 11l
Fig. 11m
Fig. 11n
POSITION 1
12600_3
Fig 11h
POSITION 3
Fig 11i
POSITION 2
Fig 11j
POSITION 4
Fig. 11k

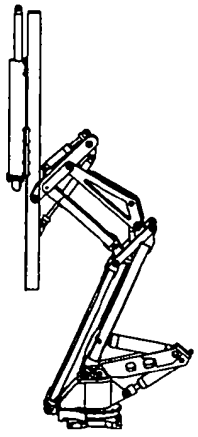

Fig. 11r

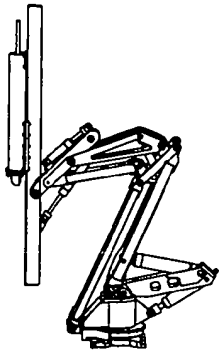

Fig. 11s

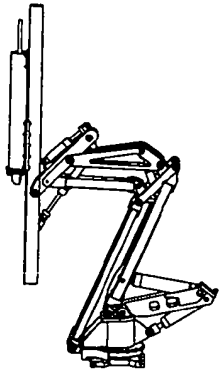

Fig. 11t

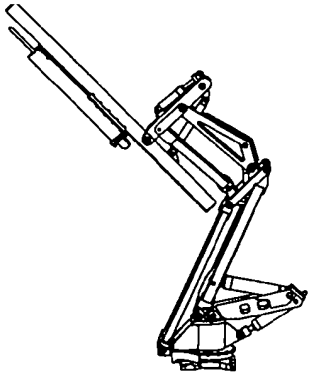

Fig. 11u

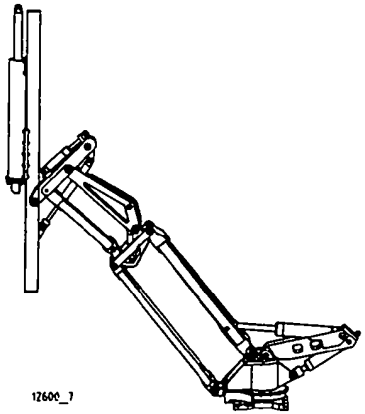

Fig 11v

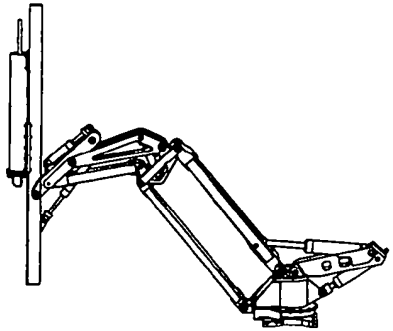

Fig. 11w

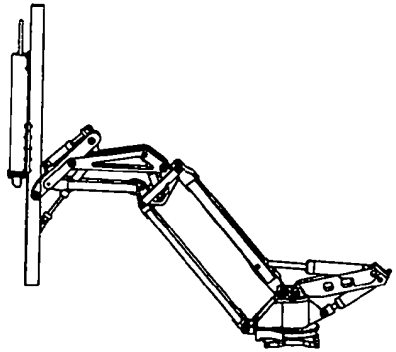

Fig. 11x