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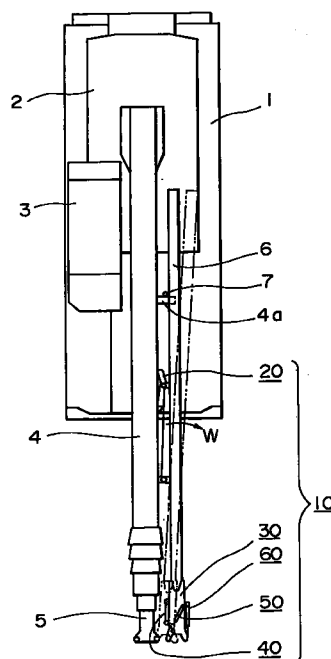
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(54) METHOD AND DEVICE FOR AUTOMATICALLY STRETCHING AND STORING A SUB-JIB FOR A CRANE

(57) The invention resides in a method and a device for automatically stretching and storing a sub-jib for a crane which needs fewer man-hours for preparation and less manual work and which enables a sub-jib to be stretched and stored within a short period of time in an easy, secure and safety fashion. To this end, the device comprises a laterally holding device (20) for oscillating a sub-jib (6) in a lateral direction, a rotational bracket portion (30) for separating or connecting the sub-jib from or to a top boom (5), a first locking device (40) and a second locking device (60) for locking the top boom and the rotational bracket portion, and a rotating device (50) for rotating the rotational bracket portion relative to the boom.

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Description

TECHNICAL FIELD

The present invention relates to a method and a device for stretching and storing a sub-jib of a boom device for use in a vehicle-mounted crane.

BACKGROUND ART

In a prior art vehicle-mounted crane (rough terrain crane), as shown in Figs. 23 and 24, an upper turret 2 including a cab 3 is mounted on a vehicle body 1. A boom 4 capable of extending and contracting in multiple stages is attached to the upper turret 2 in such a manner as able to rise and lower slantly. When the crane is in a running posture, the boom 4 is positioned to lie substantially horizontally or incline slightly downward toward its front end. In the running posture, a sub-jib 6 attached to the distal end of a top boom 5 is stored along a side of the boom 4 in parallel relation. Under working, as shown in Fig. 25, the sub-jib 6 is stretched to extend from the distal end of the top boom 5 and the work is then performed by extending or contracting and raising or lowering the boom 4 as desired.

One known method for stretching and storing a sub-jib is proposed in Japanese Patent Publication No. 4-6640. With this proposed method, a stored sub-jib is stretched by the steps of removing a storage pin, swinging the sub-jib outward, inserting a fulcrum pin, making a set pin on the extended side free, setting a boom to a predetermined angle of elevation, tilting the sub-jib to a position where it is substantially parallel to the axis of the fulcrum pin, turning the sub-jib by a sub-winding winch, and inserting a coupling pin, thereby completing the stretching operation.

With the above method, however, because the sub-jib is turned with a wire using the sub-winding winch, a sub-winding rope must be reset beforehand and a lot of time is required for preparation. Also, because the steps of swinging the sub-jib in a lateral direction, inserting the fulcrum pin, making the set pin on the extended side free, and inserting the coupling pin are manually performed, man power is required and the operation of, e.g., confirming the positions of pin holes takes time. Therefore, operators are much fatigued and a risk of interference between parts may happen due to erroneous operations.

DISCLOSURE OF THE INVENTION

The present invention has been accomplished with a view of solving the above-mentioned problems in the prior art, and its object is to provide a method and a device for automatically stretching and storing a sub-jib for a crane which needs fewer man-hours for preparation and less manual work and which enables a sub-jib to be stretched and stored within a short period of time in an easy, secure and safety fashion.

A first aspect of the method for automatically stretching and storing a sub-jib for a crane according to the present invention is featured in that when the sub-jib is to be stretched, the sub-jib is oscillated in a lateral direction to be swung out to a predetermined position with the force exerted between a boom and the sub-jib, the sub-jib is thereafter locked to the distal end of the boom on its lateral side locating closer to the sub-jib when the sub-jib and the boom are in juxtaposed relation, a rotational bracket portion is then rotated to stretch forwardly of the boom by the force acting to turn the same relative to the boom, and the sub-jib is locked to the distal end of the boom on its lateral side locating farther from the sub-jib when the sub-jib and the boom are in juxtaposed relation.

A second aspect of the method for automatically stretching and storing a sub-jib for a crane is featured in that when the sub-jib is to be stored, the sub-jib is separated from the distal end of a boom on its lateral side locating farther from the sub-jib when the sub-jib and the boom are in juxtaposed relation, a rotational bracket portion stretching forwardly of the boom is then rotated to a predetermined position by the force acting to turn the same relative to the boom, the sub-jib is separated from the distal end of the boom on its lateral side locating closer to the sub-jib when the sub-jib and the boom are in juxtaposed relation, and the boom is thereafter oscillated in a lateral direction to be stored into a predetermined position with the force exerted between the boom and the sub-jib.

A third aspect of the method for automatically stretching and storing a sub-jib for a crane is featured in that when the sub-jib is to be stretched, the sub-jib is oscillated in a lateral direction to be swung out to a predetermined position with the force exerted between a boom and the sub-jib after raising the boom slantly by a predetermined angle, the sub-jib is locked to the distal end of the boom on its lateral side locating closer to the sub-jib when the sub-jib and the boom are in juxtaposed relation, the sub-jib is then tilted downward, the rotational bracket portion is then rotated to stretch forwardly of the boom by the force acting to turn the same relative to the boom, and the sub-jib is locked to the distal end of the boom on its lateral side locating farther from the sub-jib when the sub-jib and the boom are in juxtaposed relation.

A fourth aspect of the method for automatically stretching and storing a sub-jib for a crane is featured in that when the sub-jib is to be stored, the sub-jib is tilted downward after raising a boom slantly by a predetermined angle, the sub-jib is then separated from the distal end of the boom on its lateral side locating farther from the sub-jib when the sub-jib and the boom are in juxtaposed relation, a rotational bracket portion stretching forwardly of the boom is thereafter rotated to a predetermined position by the force acting to turn the same relative to the boom, the sub-jib is then separated from the distal end of the boom on its lateral side locating closer to the sub-jib when the sub-jib and the boom are

in juxtaposed relation, and the boom is thereafter oscillated in a lateral direction to be stored into a predetermined position with the force exerted between the boom and the sub-jib.

A fifth aspect of the method for automatically stretching and storing a sub-jib for a crane is featured in comprising the steps of, when the sub-jib is to be stretched, (1) oscillating the sub-jib in a lateral direction to start operation of engaging a slot formed in the rear end of a rotational bracket portion, attached to a base end of the sub-jib, on one side in a transverse direction with a top boom pin fixed to the distal end of a top boom of the boom on one side in the transverse direction, after detecting means has detected that the top boom is in a certain contracted position, (2) locking the rotational bracket portion and the top boom pin by a first locking device after detecting means has detected that the slot of the rotational bracket portion is engaged with the top boom pin, (3) extending the top boom after detecting means has detected that the first locking device has completed the locking operation, (4) stretching the rotational bracket portion after detecting means has detected that the top boom has been extended to a predetermined length, and (5) locking the distal end of the top boom on the other side in the transverse direction and the rear end of the rotational bracket portion on the other side in the transverse direction by a pin, after detecting means has detected that the rotational bracket portion has been rotated to a predetermined position.

A sixth aspect of the method for automatically stretching and storing a sub-jib for a crane is featured in comprising the steps of, when the sub-jib is to be stretched, (1) starting unlocking operation of a second locking device which locks the distal end of a top boom of a boom on the other side in a transverse direction and the rear end of a rotational bracket portion on the other side in the transverse direction by a pin, after detecting means has detected that the top boom has reached a predetermined length, (2) rotating the rotational bracket portion for storage after detecting means has detected that the second locking device has completed the unlocking operation, (3) contracting the top boom after detecting means has detected that the rotational bracket portion has been rotated to a predetermined position, (4) starting unlocking operation of a first locking device which engages a top boom pin fixed to the distal end of the top boom on one side in the transverse direction with a slot formed in the rear end of the rotational bracket portion on one side in the transverse direction into a locked state, after detecting means has detected that the top boom has been contracted to a predetermined position, and (5) starting to store the sub-jib after detecting means has detected that the first locking device has completed the unlocking operation,

With the first to sixth aspects of the methods for automatically stretching and storing a sub-jib for a crane, the sub-jib is stretched and stored as follows. In the case of stretching the sub-jib from a stored state, the

sub-jib is oscillated in a lateral direction so as to separate from the boom and the first locking device is then actuated to perform the locking operation. Subsequently, when the operator extends the top boom by a predetermined amount, the rotational bracket portion is rotated for stretching and the second locking device is then actuated to perform the locking operation. On the other hand, in the case of storing the sub-jib from a stretched state, when the top boom is set to a predetermined length, the second locking device is actuated to perform the unlocking operation. The rotational bracket portion is then rotated for storage. Subsequently, when the operator contracts the top boom, the first locking device is actuated to perform the unlocking operation and the sub-jib is then stored. Many of these steps are automatically carried out.

A first aspect of the device for automatically stretching and storing a sub-jib for a crane according to the present invention is featured in comprising a laterally holding device for oscillating the sub-jib in a lateral direction, a rotational bracket portion for separating or connecting the sub-jib from or to a top boom of a boom, a first locking device and a second locking device for locking the top boom and the rotational bracket portion, and a rotating device for rotating the rotational bracket portion relative to the boom. The first locking device may be a device for engaging a slot formed in the rotational bracket portion on one side in the transverse direction with a top boom pin fixed to the top boom on one side in the transverse direction into a locked state, and the second locking device may be a device for locking a lateral side of the rotational bracket portion on the other side in the transverse direction and a lateral side of the top boom on the other side in the transverse direction by a pin. The laterally holding device may comprise a lever having a slot engaging a pin fixed to the sub-jib in one position and pivotally attached to the boom in one position, a laterally holding cylinder disposed to interconnect the boom and the lever, a bracket having a slot engaging a pin fixed to the sub-jib in the other position and fixedly attached to the boom in the other position, a hook pivotally attached to the bracket and engaging the pin fixed to the sub-jib in the other position, and a rod interconnecting the lever and the hook. The rotational bracket portion may have a slot formed in the rear end thereof on one side in the transverse direction for engaging a top boom pin vertically fixed to the distal end of the top boom on one side in the transverse direction, a pin hole formed in the rear end thereof on the other side in the transverse direction for engaging a vertical coupling pin fixed to the distal end of the top boom on the other side in the transverse direction, a pin hole formed in the front end thereof for mounting of the sub-jib in such a manner as able to rise and lower slantly, and a pin provided on the upper surface thereof for attachment of a rotating cylinder adapted to turn the rotational bracket portion relative to the boom. The first locking device may comprise a lock link pivotally attached to the rotational bracket portion

for holding the top boom pin in cooperation with the slot of the rotational bracket portion in sandwiching relation, and a first lock cylinder attached to the rotational bracket portion for operating the lock link. The rotating device may comprise a first lever rotatably connected at its one end to a pin fixed to the rear end of the rotational bracket portion on the upper surface thereof, a second lever rotatably connected at its one end to the other end of the first lever and having a slot formed in its opposite end to be engageable with a rotation support pin fixed to the top boom, and a rotating cylinder disposed to interconnect the first lever and the rotational bracket portion. The second locking device may comprise vertically spaced two coupling pins for coupling the top boom and the rotational bracket portion to each other, a lever pivotally attached at its central portion to the rotational bracket portion, a second lock cylinder disposed to interconnect the lever and the rotational bracket portion, and two links for respectively interconnecting both ends of the lever and the two coupling pins. The device may further comprise detecting means for detecting the positions of the boom and the top boom, detecting means for detecting the position of the laterally holding device, detecting means for detecting the separation or connection the rotational bracket portion, detecting means for detecting the completion of locking or unlocking made by the first locking device and the second locking device, and detecting means for detecting the rotative position of the rotating device. For the detecting means, respective display means for displaying results detected by the detecting means may be provided in a cab equipped on the vehicle. When the rotational bracket portion is rotated under a condition where the boom is raised slantly by a predetermined angle and the sub-jib is tilted to a predetermined position, the centroid position of the sub-jib may lie substantially on a vertical line passing the center of an axis about which the rotational bracket portion is rotatable.

With the foregoing arrangement, the device for automatically stretching and storing a sub-jib for a crane comprises the rotational bracket portion, the laterally holding device operated by a hydraulic device to oscillate the sub-jib in the lateral direction, the first and second locking devices for locking the top boom and the rotational bracket portion, and the rotating device for rotating the rotational bracket portion. Also, when required, the detecting means (e.g., limit switches) are provided for detecting the completion of operation of the associated devices and the display means are provided in the cab for displaying results detected by the detecting means. These component allow the operator to perform the operation of stretching and storing the sub-jib while confirming the detected results in the cab. Further, when the sub-jib is tilted after raising the boom slantly by a predetermined angle, the centroid position of the sub-jib lies substantially on a vertical line passing the center of an axis about which the rotational bracket portion is rotatable and, therefore, the rotational bracket portion can be rotated with smaller torque. In addition,

since the sub-jib can be automatically stretched with the boom kept raised slantly at a predetermined angle, it is possible to easily and safely stretch the sub-jib on narrow roads, etc.

A second aspect of the device for automatically stretching and storing a sub-jib for a crane is featured in further comprising a tilt lever for raising and lowering the sub-jib slantly, a directional control valve operated by the tilt lever, a first solenoid switching valve for switching over between a tilting circuit and a laterally holding circuit, a solenoid control valve for a laterally holding cylinder, a second solenoid switching valve for switching over between the tilting circuit and a circuit in which a first lock cylinder, a second lock cylinder and a rotating cylinder are disposed, a solenoid control valve for the first lock cylinder, a solenoid control valve for the second lock cylinder, and a solenoid control valve for the rotating cylinder. A one-way valve may be disposed in one of circuits interconnecting the directional control valve and the solenoid control valve for the laterally holding cylinder, and one of circuits interconnecting the directional control valve and the solenoid control valve for the second lock cylinder. The solenoid control valve for the first lock cylinder, the solenoid control valve for the rotating cylinder, the solenoid control valve for the second lock cylinder, and the second solenoid switching valve may be mounted on the rotational bracket portion. The solenoid control valve for the first lock cylinder, the solenoid control valve for the rotating cylinder, the solenoid control valve for the second lock cylinder, and the second solenoid switching valve may be interconnected by a serial circuit.

With the foregoing arrangement, there is disposed a solenoid switching valve for switching over between the tilting circuit and the laterally holding circuit. Also, hydraulic circuits for the stretching and storing operation are connected to solenoid control valves for respective hydraulic cylinders so that the sub-jib is stretched and stored by shifting the solenoid control valves in sequence. Therefore, the operator can automatically perform the operation of stretching and storing the sub-jib by operating a changeover switch and a tilt lever in the cab. Further, since the sub-jib is stretched and stored by operating the tilt lever in one direction, safety during the operation is increased. Additionally, since the solenoid control valves for the rotating device and the first and second locking devices are mounted on the rotational bracket portion, i.e., on the distal end side where the rotational bracket portion is turned relative to the boom, only two reels are required for hydraulic hoses and the number of hose lines to be arranged on the rotational bracket portion is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view of a crane on which a sub-jib automatically stretching and storing device according to an embodiment of the present invention is mounted,

Fig. 2 is a plan view showing a condition where a laterally holding device and a sub-jib are disengaged from each other in the embodiment,

Fig. 3 is a plan view showing a condition where the sub-jib is swung out by the laterally holding device in the embodiment,

Fig. 4 is a plan view showing a condition where the sub-jib is stored by the laterally holding device in the embodiment,

Fig. 5 is a plan view of a rotational bracket portion, the view showing a condition where a rotating device has completed its rotation for stretching the sub-jib in the embodiment,

Fig. 6 is a side view of the rotational bracket portion taken from one side in the direction of arrow A in Fig. 5, the view showing a condition where a first locking device has completed its locking operation,

Fig. 7 is a side view of the rotational bracket portion taken from the other side in the direction of arrow B in Fig. 5, the view showing a condition where a second locking device has completed its locking operation,

Fig. 8 is a perspective view showing the structure of the rotational bracket portion in the embodiment,

Fig. 9 is a perspective view showing the structure of the rotating device in the embodiment,

Fig. 10 is a perspective view showing the structure of the first locking device in the embodiment,

Fig. 11 is a plan view showing a condition where the first locking device has completed its unlocking operation in the embodiment,

Fig. 12 is a plan view showing a condition where the first locking device has completed its locking operation in the embodiment,

Fig. 13 is a plan view showing a condition where the rotating device has completed its rotation for storage in the embodiment,

Figs. 14A and 14B show a condition where the rotating device has completed its rotation for storing the sub-jib in the embodiment, in which: Fig. 14A is a plan view of essential parts on the top boom side and Fig. 14B is a plan view of essential parts on the rotational bracket portion side,

Fig. 15 is a side view showing a condition where the second locking device has completed its unlocking operation in the embodiment,

Fig. 16 is a hydraulic circuit diagram of the sub-jib automatically stretching and storing device according to the embodiment,

Fig. 17 is an electric system diagram of the sub-jib automatically stretching and storing device according to the embodiment,

Fig. 18 is a perspective view showing one example of mounting of limit switches in the embodiment,

Fig. 19 is an exploded perspective view showing another example of mounting of the limit switches to a different location in the embodiment,

Fig. 20 is a flowchart for a sub-jib stretching method according to an embodiment,

Fig. 21 is a flowchart for a sub-jib storing method according to an embodiment,

Fig. 22 is an explanatory view for the case where a boom is raised and the sub-jib is tilted when the rotational bracket portion is rotated in the embodiment,

Fig. 23 is a side view of a prior art vehicle-mounted crane in a running posture,

Fig. 24 is a plan view of the prior art vehicle-mounted crane in a running posture, and

Fig. 25 is a side view of the prior art vehicle-mounted crane in a working posture.

BEST MODE FOR CARRYING OUT THE INVENTION

A method and a device for automatically stretching and storing a sub-jib for a crane, according to the present invention, will be described below in detail in conjunction with a preferred embodiment by referring to the accompanying drawings.

Fig. 1 illustrates a vehicle-mounted crane equipped with a sub-jib automatically stretching and storing device 10 of this embodiment. An upper turret 2 including a cab 3 is turnably mounted on a vehicle body 1, and a multi-stage boom 4 capable of extending and contracting is attached to the upper turret 2 in such a manner as able to rise and lower slantly. Fig. 1 shows the crane in a running posture. Looking the crane in a running posture from side, the boom 4 is positioned to lie substantially horizontally or incline slightly downward toward its front end. The sub-jib automatically stretching and storing device 10 comprises a rotational bracket portion 30 for separating or connecting the sub-jib 6 from or to the top boom 5, a laterally holding device 20 operated by a hydraulic device (not shown) for oscillating the sub-jib in a lateral direction, a first locking device 40 and a second locking device 60 for locking the top boom 5 and the rotational bracket portion 30, and a rotating device 50 for rotating the rotational bracket portion 30 relative to the boom.

The sub-jib 6 attached to the distal end of the top boom 5 through the rotational bracket portion 30 is stored along a side of the boom 4 in juxtaposed relation and fixedly attached to the boom 4 by a storage pin 7 while the crane is running. In a stored state, the sub-jib 6 is not only supported by the laterally holding device 20, but also held by a bracket 4a fixed on the boom 4. The bracket 4a is preferably provided with rollers, bearings, etc. (not shown) for reducing the sliding resistance so that the sub-jib can be easily stretched. When stretching the sub-jib 6, it is oscillated by the laterally holding device 20 in a lateral direction (direction W in Fig. 1), i.e., swung out, as indicated by two-dot-chain lines.

Fig. 2 shows a condition where the sub-jib 6 is swung out as indicated by two-dot-chain lines in Fig. 1 and the top boom 5 is extended by a predetermined length to release engaged portions, described later, of the boom 4 and the sub-jib 6 from each other, allowing

the sub-jib 6 to be rotated with the rotational bracket portion 30.

The sub-jib 6 is swung out by contracting a hydraulic cylinder 25, described later, of the laterally holding device 20. A bracket 14 having a slot 15 formed therein is fixed to the boom 4 at one position (on the "upper side" as shown), and a hydraulic laterally holding cylinder 25 is attached at its bottom side to the bracket 14. Also, a lever 22 is pivotally attached at its central portion to the bracket 14 by a pin 24, and a slot 23 engaging a latch pin 21 fixed to the sub-jib 6 at one position is formed in one end of the lever 22. The other end 22a of the lever 22 is attached to the rod side of the laterally holding cylinder 25. Thus, the lever 22 and the boom 4 are interconnected by the laterally holding cylinder 25.

A bracket 16 having a slot 17 formed therein is fixed to the boom 4 at the other position (on the "lower side" as shown). A hook 27 engaging a latch pin 26 is pivotally attached to the bracket 16 by a pin 16a. The other end 22a of the lever 22 and the hook 27 are interconnected by a rod 28. In a stretched state, the sub-jib 6 is held in place with slots 31a, 31b, described later, of the rotational bracket portion 30 engaging a top boom pin 11 of the first locking device 40 (see Fig. 5).

When the top boom 5 is contracted by a predetermined length under the condition of Fig. 2, the sub-jib 6 is translated in the direction of arrow X, causing the pin 21 to engage the slot 23 of the lever 22 and the pin 26 to engage the slot 17 of the bracket 16, as shown in Fig. 3. The resulting condition of Fig. 3 also represents a state where the sub-jib 6 is just swung out by contracting the laterally holding cylinder 25 in the direction E. In other words, this state is a storable state.

When the laterally holding cylinder 25 is extended (opposite to the direction E) under the condition of Fig. 3, the lever 22 is rotated about the pin 24 and the sub-jib 6 is oscillated about the pin 26 to come closer to the boom 4 side, causing the pin 21 to engage the slot 15 of the bracket 14 and the hook 27 to swing through the rod for fixing the pin 26. The resulting condition represents a stored state. In this stored state, as shown in Fig. 1, inserting the storage pin 7 enables the sub-jib to be held in place in a safer manner while the crane is running.

Figs. 5 to 7 show a condition where the sub-jib 6 is stretched forwardly of the top boom 5. A top boom pin 11 and a rotation support pin 12 are fixed to the distal end of the top boom 5 on one side in a transverse direction, i.e., on its lateral side locating farther away from the sub-jib when the sub-jib and the boom are in juxtaposed relation. Also, a pair of vertically spaced pin holes 13a, 13b are formed at the distal end of the top boom 5 on the other side, i.e., on its lateral side locating closer to the sub-jib when the sub-jib and the boom are in juxtaposed relation.

The rotational bracket portion 30 is provided with the first locking device 40 on one lateral surface (i.e., its lateral side locating closer to the boom end when the sub-jib and the boom are in juxtaposed relation) (Fig. 5), the rotating device 50 on an upper surface (Fig. 6), and

the second locking device 60 on the other lateral surface (i.e., its lateral side locating farther away from the boom end when the sub-jib and the boom are in juxtaposed relation) (Fig. 7). Figs. 8 to 10 are perspective views of the rotational bracket portion 30, the rotating device 50 and the first locking device 40, respectively.

These components will be described below in detail. As shown in Fig. 8, the rotational bracket portion 30 has the slots 31a, 31b formed in its rear end on one side in the transverse direction for engaging the top boom pin 11 (see Fig. 6), and pin holes 32a, 32b formed in its rear end on the other side to be aligned with the pin holes 13a, 13b (see Fig. 5). Also, as shown in Fig. 6, the sub-jib 6 is attached to the distal end of the rotational bracket portion 30 by a pin 30a in such a manner as able to rise and lower slantly, and a bracket 30b is provided on the underside of the rotational bracket portion 30. A tilt cylinder 8 for raising and lowering the sub-jib 6 slantly is connected to a pin 30c which is attached to the bracket 30b. Further, as shown in Fig. 8, the rotational bracket portion 30 is provided on its upper surface (Fig. 8) with a pin 34 to which a rotating cylinder 55 (Fig. 9) is connected. The rotating cylinder 55 causes the rotational bracket portion 30 to turn about the top boom pin 11 (see Fig. 6) relative to the boom 4.

The first locking device 40 will now be described by referring Fig. 11 in the main, along with Figs. 6, 10 and 12. A lock link 41 having a recess 42 engageable with the top boom pin 11 is pivotally attached by a pin 43 to a bracket 32 which is fixed to the rear end of the rotational bracket portion 30 on one lateral side. A first lock cylinder 44 has a rod portion connected to the lock link 41 and a bottom portion connected to the rotational bracket portion 30. Thus, the lock link 41 is coupled to the rotational bracket portion 30 by the first lock cylinder 44.

When the first lock cylinder 44 is contracted, the top boom pin 11 is unlocked as shown in Fig. 11. On the other hand, when the first lock cylinder 44 is extended, the lock link 41 is pivoted about the pin 42 and the recess 42 engages the top boom pin 11. As a result, the lock link 41 locks the top boom pin 11 by holding it in cooperation with the slots 31a, 31b of the rotational bracket portion 30.

In the rotating device 50, as shown in Figs. 5, 9, 13 and 14B, one end 51a of a first lever 51 is pivotally connected to a pin 33 which is fixed to the rear end of the rotational bracket portion 30 at a position near one lateral side. Also, pivotally connected to the other end 51b of the first lever 51 is one end 52a of a second lever 52. A slot 53 engaging the rotation support pin 12 fixed to the top boom 5 is formed in the other end of the second lever 52. A spring 54 is provided to extend between the first lever 51 and the second lever 52. A slip-off preventing plate 5j is fixed to the top boom 5 so that the slot 53 of the second lever 52 is prevented from slipping off from the pin 12 except for a predetermined position during the rotation of the sub-jib. The rotating cylinder 55 is disposed to interconnect the pin 34 fixed to the rota-

tional bracket portion 30 and a central portion of the first lever 51. By extending and contracting the rotating cylinder 55, the rotational bracket portion 30 is rotated about the top boom pin 11.

Fig. 5 shows a condition where the rotating cylinder 55 is extended to complete the rotation of the sub-jib for stretching, and Fig. 13 shows a condition where the rotating cylinder 55 is contracted to complete the rotation of the sub-jib for storage. When storing the sub-jib 6, the sub-jib is supported by the laterally holding device 20 parallel to the boom 4 as shown in Fig. 4. At this time, as shown in Figs. 11, 14A and 14B, the lock link 41 of the first locking device 40 is made open to unlock the top beam pin 11. Upon this unlocking, the slots 31a, 31b of the rotational bracket portion 30 are disengaged from the top boom pin 11 and, simultaneously, the slot 53 of the second lever 52 is disengaged from the rotation support pin 12 of the top boom 5. Also, the slot 53 is retreated in a direction to become out of interference with the slip-off preventing plate 5j.

In Fig. 7 in which the second locking device 60 is operated to establish a locked state, the pin holes 32a, 32b of the rotational bracket portion 30 and the pin holes 13a, 13b of the top boom 5 are fixedly interconnected (locked in place) by coupling pins 61a, 61b, respectively. A lever 62 is pivotally attached at its central portion by a pin 62a to the rotational bracket portion 30. The lever 62 has one end 62b connected to the coupling pin 61a through a link 63a and a corner end 62c, on the other side, connected to the coupling pin 61b through a link 63b. A second lock cylinder 64 is disposed to interconnect an opposite end 62d of the lever 62 on the other side and the rotational bracket portion 30. When the second lock cylinder 64 is extended, the lever 62 is turned about the pin 62a at its central portion to establish the locked state, as shown in Fig. 7. On the other hand, when the second lock cylinder 64 is contracted, the coupling pins 61a, 61b are withdrawn from the pin holes 13a, 13b of the top boom 5 to come into an unlocked state, as shown in Fig. 15. A lock pin 65 is provided near the corner end of the lever 62 and inserted in place to prevent the further turning of the lever 62, as shown in Fig. 7, so that the coupling pins 61a, 61b are prevented from slipping off from the pin holes 13a, 13b of the top boom 5, thereby keeping the locked state. As a result, the sub-jib 6 is fixedly stretched forwardly of the distal end of the boom 4 and hence the operation of lifting goods high can be performed safely.

In a hydraulic circuit diagram of Fig. 16, denoted by numeral 70 is a tilt lever provided in the cab 3, 71 is a directional control valve pilot-operated by the tilt lever 70, 72 is a hydraulic pump, 73, 74 are reels, and 8 is a tilt cylinder for raising and lowering the sub-jib 6 slantly. In one tilting circuit 75 extending from the directional control valve 71 to the tilt cylinder 8, there are disposed a first solenoid switching valve 77, the reel 74, a second solenoid switching valve 82 and a counter balancing valve 86 successively. Also, in the other tilting circuit 76, there are disposed the reel 73 and a pilot-operated

check valve 87 successively.

The first solenoid switching valve 77 supplies pressure oil from the hydraulic pump 72 to the tilting circuit or a laterally holding circuit in a switching manner. The switching causes the pressure oil to flow, in the tilting circuit, into the reel 74 downstream of the valve 77 and, in the laterally holding circuit, into the laterally holding cylinder 25 through a solenoid control valve 78 which controls switchover between extension and contraction of the laterally holding circuit 25. Further, the solenoid control valve 78 and the other tilting circuit 76 are interconnected through a return circuit 80 in which a one-way valve 81 is disposed. Therefore, the oil returned from the laterally holding circuit 25 returns to a tank 88 through the return circuit 80 and the other tilting circuit 76.

The second solenoid switching valve 82 supplies the pressure oil from the hydraulic pump 72 to the tilting circuit or another circuit leading to the first locking device 40, the rotating device 50 and the second locking device 60 in a switching manner. The switching causes the pressure oil to flow, in the tilting circuit, into the counter balancing valve 86 downstream of the valve 82 and, in another circuit, into a solenoid control valve 85 for the first lock cylinder 44 of the first locking device 40, a solenoid control valve 84 for the rotating cylinder 55 of the rotating device 50, and a solenoid control valve 83 for the second lock cylinder 64 of the second locking device 60 successively in series. Further, the solenoid control valve 83 and the other tilting circuit 76 are interconnected through a circuit 89 in which a one-way valve 81a is disposed.

Because of the first and second solenoid switching valves 77, 82 disposed in the tilting circuit 75 and the one-way valve 81 disposed in the circuit 80 connecting the tilting circuit 76 and the solenoid control valve 78, when the first and second solenoid switching valves 77, 82 are in respective shift positions 77a, 82a, the tilt cylinder 8 is extended and contracted to raise and lower the sub-jib 6 slantly by operating the tilt lever 70 to shift the directional control valve 71. When the first solenoid switching valve 77 is moved to a shift position 77b and the directional control valve 71 is moved to a shift position 71a, the pressure oil is supplied to the laterally holding circuit. By shifting the solenoid control valve 78, therefore, the laterally holding cylinder 25 is extended and contracted to store and swing out the sub-jib 6. In this connection, if the directional control valve 71 is moved to a shift position 71c, no pressure oil is supplied to the laterally holding circuit. This means that the sub-jib 6 is swung out or stored by operating the tilt lever 70 in one direction.

Likewise, when the second solenoid switching valve 82 is moved to a shift position 82b and the directional control valve 71 is moved to the shift position 71a, the pressure oil is supplied to a first locking circuit, a second locking circuit and a rotating circuit. By shifting the solenoid control valves 83, 84, 85, therefore, the second lock cylinder 64, the rotating cylinder 55 and the first

lock cylinder 44 are extended and contracted, respectively. At this time, by shifting the solenoid control valves 83, 84, 85 successively, first locking, rotation and second locking of the sub-jib 6 can be performed successively in an automatic manner. As with the above case, if the directional control valve 71 is moved to its shift position 71c, no pressure oil is supplied to the laterally holding circuit. This means that the sub-jib 6 is swung out or stored by operating the tilt lever 70 in one direction.

In this embodiment, since the second solenoid switching valve 82 and the solenoid control valves 83, 84, 85 shown in Fig. 16 are mounted on the rotational bracket portion 30, reels required for hydraulic hoses are only two, i.e., 73 and 74, and the number of hose lines to be arranged on the rotational bracket portion 30 is reduced.

Fig. 17 is an electric system diagram. a stretching/storage changeover switch 90 is provided in the cab 3. With the switch 90 turned to a position 90a, the operation of stretching the sub-jib is performed and, with the switch 90 turned to a position 90b, the operation of storing the sub-jib is performed.

Denoted by 91a, 91b are respectively top boom extended and contracted position detecting limit switches for detecting the position of the top boom 5 relative to the boom 4 during the stretching operation. The limit switch 91a detects that the top boom 5 has been completely extended by a predetermined amount as shown in Fig. 2 and the limit switch 91b detects that the top boom 5 has been completely contracted by a predetermined amount as shown in Fig. 3. 92a, 92b are respectively top boom extended and contracted position detecting limit switches for detecting the displacements of the pins 21, 26 based on the position of the top boom 5 relative to the boom 4 during the storing operation. The limit switch 92a detects that the top boom 5 has been completely extended by a predetermined amount as shown in Fig. 2 and the limit switch 92b detects that the top boom 5 has been completely contracted by a predetermined amount as shown in Fig. 3.

Denoted by 93a, 93b are limit switches for detecting the position of the sub-jib 6 swung by the laterally holding circuit 20. The limit switch 93a detects the swung-out state shown in Fig. 4, i.e., that the top boom pin 11 and the slots 31a, 31b are disengaged from each other as shown in Figs. 14A and 14B. On the other hand, the limit switch 93b detects the stored state shown in Fig. 3, i.e., that the top boom pin 11 and the slots 31a, 31b are engaged with each other as shown in Fig. 13. 94a, 94b are limit switches for detecting the lock and unlock positions of the second locking device 60. The limit switch 94a detects that the second locking device 60 has completed the locking operation as shown in Fig. 7, and the limit switch 94b detects that the second locking device 60 has completed the unlocking operation as shown in Figs. 14A and 14B.

Denoted by 95a, 95b are limit switches for detecting the stretching and storage rotative positions of the rotat-

ing device 50. The limit switch 95a detects that the rotating device 50 has been completely rotated for stretching as shown in Fig. 5, and the limit switch 95b detects that the rotating device 50 has been completely rotated for storage as shown in Fig. 13. 96a, 96b are limit switches for detecting the lock and unlock positions of the first locking device 40. The limit switch 96a detects that the first locking device 40 has completed the locking operation as shown in Fig. 12, and the limit switch 96b detects that the first locking device 40 has completed the unlocking operation as shown in Fig. 11.

Denoted by 97a, 97b, 97c and 97d are pilot lamps provided as detection indicating means in the cab 3. The pilot lamp 97a lights up when, during stretching of the sub-jib, the top boom 5 has been completely contracted, the laterally holding device 20 has been completely swung out the sub-jib, and the first locking device 40 has completed the locking operation. The pilot lamp 97b lights up when, during stretching of the sub-jib, the top boom 5 has been completely extended, the rotational bracket portion 30 has been completely rotated for stretching, and the second locking device 60 has completed the locking operation.

The pilot lamp 97c lights up when, during storage of the sub-jib, the top boom 5 has been completely extended, the second locking device 60 has completed the unlocking operation, and the rotational bracket portion 30 has been completely rotated for storage. The pilot lamp 97d lights up when, during storage of the sub-jib, the top boom 5 has been completely contracted, the first locking device 40 has completed the unlocking operation, and the laterally holding device 20 has completely stored the sub-jib. Incidentally, 98 is a diode.

Figs. 18 and 19 show examples of mounting of the limit switches which are adapted to detect the position of the top boom 5 relative to the boom 4 and the movement of the sub-jib 6 for stretching and storage. Other limit switches can also be similarly mounted in association with corresponding members to be controlled.

In Fig. 18, the limit switches 91a, 92a for detecting the extended position of the top boom 5 are mounted on the boom 4 to detect the position of a bracket 5m on the top boom 5, thereby detecting that the top boom 5 has been extended to a predetermined position. Conversely, the limit switches 91a, 92a may be mounted on the top boom 5 and the bracket 5m may be mounted on the boom 4.

In Fig. 19, the limit switches 91b, 92b for detecting the contracted position of the top boom 5 are mounted on the bracket 16 (shown in Fig. 2) fixed to the boom 4, thereby detecting the position of the latch pin 26. Further, the swung position detecting limit switch 93b for detecting the completion of storage of the sub-jib 6 and the swung position detecting limit switch 93a for detecting the completion of movement from the laterally held state to the swung-out state of the sub-jib 6 are mounted on the bracket 14 fixed to the boom 4, thereby detecting the moved position of the rod 28.

Alternatively, the moved position of the laterally holding

device 25 may be detected. While this embodiment employs limit switches for position detecting, a cylinder with a function of position detecting, e.g., a cylinder having a position detecting sensor provided on a cylinder rod, may be used.

Next, the method of stretching the sub-jib will be described with reference to Figs. 1, 16 and 17 following a flowchart shown in Fig. 20. Note that, in the flowchart of Fig. 20, the steps which are surrounded by double lines are automatically performed.

(1) In step 101, the operator removes the storage pin 7 (shown in Fig. 1).

(2) In step 102, the operator turns the changeover switch 90 (shown in Fig. 17) to the stretching position 90a.

(3) In step 103, the operator operates the tilt lever 70 (shown in Fig. 16) for moving the directional control valve 71 to the shift position 71a.

(4) In step 104, the limit switch 91b detects that the top boom 5 is in the contracted position. Upon this detection, the first solenoid switching valve 77 is moved to the shift position 77b and the solenoid control valve 78 is moved to the shift position 78a, the laterally holding cylinder 25 of the laterally holding device 20 is actuated to swing out the sub-jib 6 (in the direction W in Fig. 1). As a result, the top boom pin 11 and the slots 31a, 31b of the rotational bracket portion 30 are brought into engagement, and the rotation support pin 12 of the top boom 5 and the slot 53 in the second lever 52 of the rotating device 50 are brought into engagement.

(5) In step 105, the limit switch 93a detects that the sub-jib 6 has been completely swung out. Upon this detection, the first solenoid switching valve 77 is returned to the shift position 77a and the solenoid control valve 78 is returned to a neutral position 78b, thereby stopping the laterally holding cylinder 25. Then, by moving the second solenoid switching valve 82 to the shift position 82b and the solenoid control valve 85 to a shift position 85a, the first lock cylinder 44 of the first locking device 40 is actuated to lock the top boom pin 11.

(6) In step 106, the limit switch 96a detects that the first locking device 40 has completed the locking operation, whereupon the solenoid control valve 85 is returned to a neutral position 85b and the pilot lamp 97a is lit up.

(7) In step 107, the operator confirms the lighting-up of the pilot lamp 97a and shifts a not-shown valve associated with the boom to extend the top boom 5 by the predetermined amount until the latch pin 21 comes out of the slot 23 of the lever 22. At this time, the pilot lamp 97a is once lit out and then lit up again when the top boom 5 reaches a predetermined position.

(8) In step 108, the limit switch 91a detects that the top boom 5 has been completely extended, whereupon the solenoid control valve 84 is moved to a

shift position 84a to actuate the rotating cylinder 55 of the rotating device 50, thereby rotating the rotational bracket portion 30 for stretching.

(9) In step 109, the limit switch 95a detects that the rotational bracket portion 30 has been completely rotated for stretching, whereupon the solenoid control valve 83 is shifted to actuate the second lock cylinder 64 of the second locking device 60, causing the coupling pins 61a, 61b to be inserted into the respective pin holes 13a, 13b so that the top boom 5 and the rotational bracket portion 30 are locked to each other.

(10) In step 110, the limit switch 94a detects that the second locking device 60 has completed the locking operation, whereupon the pilot lamp 97b is lit up.

(11) In step 111, the operator confirms the lighting-up of the pilot lamp 97b, returns the tilt lever 70, and mounts the lock pin 65 (shown in Fig. 7) of the second locking device 60.

It is to be noted that the speed control, actuation and stop of each cylinder in the foregoing steps are made by the tilt lever 70.

While the above embodiment is described as detecting, by the limit switch 91b, that the top boom 5 is in the contracted position, swinging out the sub-jib 6 by the laterally holding cylinder 25, and engaging the top boom pin 11 with the slots 31a, 31b of the rotational bracket portion 30, the present invention is not limited to that embodiment. For example, it is also possible to extend the top boom 5 by a predetermined amount to the position where the top boom pin 11 and the slots 31a, 31b are engageable with each other, actuating the laterally holding cylinder 25 to swing out the sub-jib 6 for bringing the top boom pin 11 and the slots 31a, 31b into engagement, and then extending the top boom 5 again by a predetermined amount to the position where the latch pin 21 comes out of the slot 23 of the lever 22. This method enables the engaging position to be indexed more precisely and hence ensures more positive engagement.

Further, in the above embodiment, the top boom 5 is extended by the predetermined amount to the position where the latch pin 21 comes out of the slot 23 of the lever 22. However, the latch pin 21 may be disengaged from the slot 23 by sliding or pivoting the lever 22 while the top boom 5 is kept in the same position.

The above-described method of stretching the sub-jib is summarized as follows. The sub-jib 6 is laterally swung out to the predetermined position by the laterally holding cylinder 25 provided between the boom 4 and the sub-jib 6 and, after the swing-out, the first locking device 40 is actuated to lock the sub-jib 6 to the distal end of the boom 4 on its lateral side locating closer to the sub-jib when the sub-jib 6 and the boom 4 are in juxtaposed relation. After the locking, the rotational bracket portion 30 is stretched to extend forwardly of the boom 4 with the turning force exerted by the rotating cylinder

55 of the rotating device 50 relative to the boom 4. After the stretching, the second locking device 60 is actuated to lock the sub-jib 6 to the distal end of the boom 4 on its lateral side locating farther away from the sub-jib when the sub-jib 6 and the boom 4 are in juxtaposed relation.

Next, the method of storing the sub-jib will be described following a flowchart shown in Fig. 21.

(1) In step 201, the operator removes the lock pin 65 of the second locking device 60.

(2) In step 202, the operator turns the changeover switch 90 (shown in Fig. 17) to the storage position 90b.

(3) In step 203, the operator operates the tilt lever 70 (shown in Fig. 16) in the same direction as for stretching for moving the directional control valve 71 to the shift position 71a.

(4) In step 204, the limit switch 92a detects that the top boom 5 is in the extended position. Upon this detection, the second solenoid switching valve 82 and the solenoid control valve 83 are moved respectively to the shift positions 82b, 83c and the second lock cylinder 64 of the second locking device 60 is contracted. As a result, the coupling pins 61a, 61b are withdrawn from the respective pin holes 13a, 13b so that the top boom 5 and the rotational bracket portion 30 are unlocked to each other.

(5) In step 205, the limit switch 92b detects that the second locking device 60 has completed the unlocking operation, whereupon the solenoid control valve 84 is moved to a shift position 84c and the rotating cylinder 55 of the rotating device 50 is contracted to rotate the rotational bracket portion 30 for storage.

(6) In step 206, the limit switch 95b detects that the rotational bracket portion 30 has been completely rotated for storage, whereupon the pilot lamp 97c is lit up.

(7) In step 207, the operator confirms the lighting-up of the pilot lamp 97c and shifts the not-shown control valve associated with the boom to contract the top boom 5 by the predetermined amount. At this time, the pilot lamp 97c is once lit out and lit up again when the top boom 5 reaches a predetermined position.

(8) In step 208, the limit switch 92b detects that the top boom 5 has been completely contracted, whereupon the solenoid control valve 85 is moved to a shift position 85c to contract the first lock cylinder 44 of the first locking device 40, thereby unlocking the top boom pin 11.

(9) In step 209, the limit switch 96b detects that the first locking device 40 has completed the unlocking operation, whereupon the first solenoid switching valve 77 and the solenoid control valve 73 are moved respectively to the shift positions 77b, 78c to extend the laterally holding cylinder 25 of the laterally holding device 20, thereby storing the sub-jib 6.

(10) In step 210, the limit switch 93b detects that the sub-jib 6 has been completed stored, whereupon the pilot lamp 97d is lit up.

(11) In step 211, the operator confirms the lighting-up of the pilot lamp 97d, returns the tilt lever 70, and mounts the storage pin 65 (shown in Fig. 1).

The above-described method of storing the sub-jib is summarized as follows. First, by removing the lock pin 65 of the second locking device 60, the sub-jib 6 is separated from the distal end of the boom 4 on its lateral side locating farther from the sub-jib when the sub-jib 6 and the boom 4 are in juxtaposed relation. Then, the rotational bracket portion 30 stretching forwardly of the boom 4 is rotated relative to the boom 4 with the turning force exerted by the rotating cylinder 55. After the rotational bracket portion 30 has been rotated to the predetermined position, the first lock cylinder 44 is contracted to unlock and separate the sub-jib 6 from the distal end of the boom 4 on its lateral side locating closer to the sub-jib when the sub-jib 6 and the boom 4 are in juxtaposed relation. After the separation, the sub-jib 6 is laterally oscillated for storage into the predetermined position with the force of the laterally holding cylinder 25 provided between the boom 4 and the sub-jib 6.

As described above, the operation of stretching or storing the sub-jib 6 is automatically carried out by the operator simply operating the changeover switch, the boom control valve and the tilt lever while confirming a display unit in the cab. Accordingly, the sub-jib can be easily stretched or stored within a short period of time with the reduced number of steps for preparation and a less risk of interference between parts due to erroneous operations, without making the operator fatigued.

The foregoing embodiment is described in connection with the case where an ample space allowing the sub-jib 6 to turn at its full radius is utilized on flat ground. But when stretching or storing the sub-jib 6 in a narrow space, the rotational bracket portion 30 may be rotated while the boom 4 is raised slantly and the sub-jib 6 is tilted, as shown in Fig. 22. In this case, the elevation angle α of the boom 4 is from 24° to 26° . By fully contracting the tilt cylinder 8 in such a raised state, the sub-jib 6 is tilted in the direction of arrow from the position indicated by two-dot-chain lines to the position indicated by solid lines. At this time, the centroid position G of the sub-jib 6 lies substantially on a vertical line Y - Y passing the center position C of the top boom pin 11 as an axis about which the rotational bracket portion 30 is rotatable. Therefore, the rotational bracket portion 30 can be rotated with smaller torque.

The operation of stretching the sub-jib 6 in a narrow space is performed, by way of example, as follows. After raising the boom 4 slantly by a predetermined angle, the sub-jib 6 is laterally swung out to a predetermined position by the laterally holding cylinder 25 provided between the boom 4 and the sub-jib 6. After the swing-out, the first locking device 40 is actuated to lock the sub-jib 6 to the distal end of the boom 4 on its lateral

side locating closer to the sub-jib when the sub-jib and the boom are in juxtaposed relation. Then, the tilt cylinder 8 is contracted to tilt the sub-jib 6 downward and the rotational bracket portion 30 is stretched to extend forwardly of the boom 4 with the turning force exerted by the rotating cylinder 55. Subsequently, the second locking device 60 is actuated to lock the sub-jib 6 to the distal end of the boom 4 on its lateral side locating farther away from the sub-jib when the sub-jib and the boom are in juxtaposed relation.

The operation of storing the sub-jib in a narrow space is performed, by way of example, as follows. After raising the boom 4 slantly by a predetermined angle, the tilt cylinder 8 is contracted to tilt the sub-jib 6 downward. Then, by removing the lock pin 65 of the second locking device 60, the sub-jib 6 is separated from the distal end of the boom 4 on its lateral side locating farther to the sub-jib when the sub-jib and the boom are in juxtaposed relation. After the separation, the rotational bracket portion 30 stretching forwardly of the boom 4 is rotated relative to the boom 4 with the turning force exerted by the rotating cylinder 55 of the rotating device 50. After the rotational bracket portion 30 has been rotated to a predetermined position, the tilt cylinder 8 is extended to move the sub-jib 6 back to a position parallel to the boom 4. The first lock cylinder 44 of the first locking device 40 is then contracted to separate the sub-jib 6 from the distal end of the boom 4 on its lateral side locating closer to the sub-jib when the sub-jib and the boom are in juxtaposed relation. After the separation, the sub-jib 6 is laterally oscillated for storage into the predetermined position with the force of the laterally holding cylinder 25 provided between the boom 4 and the sub-jib 6.

INDUSTRIAL APPLICABILITY

According to the present invention, the operation of stretching and storing a sub-jib is automatically carried out by operating a changeover switch, a boom control valve and a tilt lever. Therefore, the present invention can be advantageously practiced as a method and a device of stretching and storing a sub-jib for a crane which enables the sub-jib to be easily stretched and stored within a short period of time with a less risk of interference between parts due to erroneous operations.

Claims

1. A method for automatically stretching and storing a sub-jib for a crane with which a rotational bracket portion is detachably attached to the distal end of a boom capable of extending and contracting in multiple stages and mounted on a vehicle in such a manner as able to rise and lower slantly, a sub-jib is attached to said rotational bracket portion in such a manner as able to rise and lower slantly, and said rotational bracket portion is rotated relative to said

boom to stretch said sub-jib forwardly of said boom during working and to store said sub-jib in juxtaposed relation to a lateral side of said boom during storage, wherein when said sub-jib is to be stretched, said sub-jib is oscillated in a lateral direction to be swung out to a predetermined position with the force exerted between said boom and said sub-jib, said sub-jib is thereafter locked to the distal end of said boom on its lateral side locating closer to said sub-jib when said sub-jib and said boom are in juxtaposed relation, said rotational bracket portion is then rotated to stretch forwardly of said boom by the force acting to turn the same relative to said boom, and said sub-jib is locked to the distal end of said boom on its lateral side locating farther from said sub-jib when said sub-jib and said boom are in juxtaposed relation.

2. A method for automatically stretching and storing a sub-jib for a crane with which a rotational bracket portion is detachably attached to the distal end of a boom capable of extending and contracting in multiple stages and mounted on a vehicle in such a manner as able to rise and lower slantly, a sub-jib is attached to said rotational bracket portion in such a manner as able to rise and lower slantly, and said rotational bracket portion is rotated relative to said boom to stretch said sub-jib forwardly of said boom during working and to store said sub-jib in juxtaposed relation to a lateral side of said boom during storage, wherein when said sub-jib is to be stored, said sub-jib is separated from the distal end of said boom on its lateral side locating farther from said sub-jib when said sub-jib and said boom are in juxtaposed relation, said rotational bracket portion stretching forwardly of said boom is then rotated to a predetermined position by the force acting to turn the same relative to said boom, said sub-jib is separated from the distal end of said boom on its lateral side locating closer to said sub-jib when said sub-jib and said boom are in juxtaposed relation, and said boom is thereafter oscillated in a lateral direction to be stored into a predetermined position with the force exerted between said boom and said sub-jib.

3. A method for automatically stretching and storing a sub-jib for a crane with which a rotational bracket portion is detachably attached to the distal end of a boom capable of extending and contracting in multiple stages and mounted on a vehicle in such a manner as able to rise and lower slantly, a sub-jib is attached to said rotational bracket portion in such a manner as able to rise and lower slantly, and said rotational bracket portion is rotated relative to said boom to stretch said sub-jib forwardly of said boom during working and to store said sub-jib in juxtaposed relation to a lateral side of said boom during storage, wherein when said sub-jib is to be stretched, said sub-jib is oscillated in a lateral direc-

tion to be swung out to a predetermined position with the force exerted between said boom and said sub-jib after raising said boom slantly by a predetermined angle, said sub-jib is locked to the distal end of said boom on its lateral side locating closer to said sub-jib when said sub-jib and said boom are in juxtaposed relation, said sub-jib is then tilted downward, said rotational bracket portion is then rotated to stretch forwardly of said boom by the force acting to turn the same relative to said boom, and said sub-jib is locked to the distal end of said boom on its lateral side locating farther from said sub-jib when said sub-jib and said boom are in juxtaposed relation.

4. A method for automatically stretching and storing a sub-jib for a crane with which a rotational bracket portion is detachably attached to the distal end of a boom capable of extending and contracting in multiple stages and mounted on a vehicle in such a manner as able to rise and lower slantly, a sub-jib is attached to said rotational bracket portion in such a manner as able to rise and lower slantly, and said rotational bracket portion is rotated relative to said boom to stretch said sub-jib forwardly of said boom during working and to store said sub-jib in juxtaposed relation to a lateral side of said boom during storage, wherein when said sub-jib is to be stored, said sub-jib is tilted downward after raising said boom slantly by a predetermined angle, said sub-jib is then separated from the distal end of said boom on its lateral side locating farther from said sub-jib when said sub-jib and said boom are in juxtaposed relation, said rotational bracket portion stretching forwardly of said boom is thereafter rotated to a predetermined position by the force acting to turn the same relative to said boom, said sub-jib is then separated from the distal end of said boom on its lateral side locating closer to said sub-jib when said sub-jib and said boom are in juxtaposed relation, and said boom is thereafter oscillated in a lateral direction to be stored into a predetermined position with the force exerted between said boom and said sub-jib.

5. A method for automatically stretching and storing a sub-jib for a crane with which a rotational bracket portion is detachably attached to the distal end of a boom capable of extending and contracting in multiple stages and mounted on a vehicle in such a manner as able to rise and lower slantly, a sub-jib is attached to said rotational bracket portion in such a manner as able to rise and lower slantly, and said rotational bracket portion is rotated relative to said boom to stretch said sub-jib forwardly of said boom during working and to store said sub-jib in juxtaposed relation to a lateral side of said boom during storage, said method comprising the steps of, when said sub-jib is to be stretched:

(1) oscillating said sub-jib in a lateral direction to start operation of engaging a slot formed in the rear end of said rotational bracket portion, attached to a base end of said sub-jib, on one side in a transverse direction with a top boom pin fixed to the distal end of a top boom of said boom on one side in the transverse direction, after detecting means has detected that said top boom is in a certain contracted position,
 (2) locking said rotational bracket portion and said top boom pin by a first locking device after detecting means has detected that the slot of said rotational bracket portion is engaged with said top boom pin,
 (3) extending said top boom after detecting means has detected that said first locking device has completed the locking operation,
 (4) stretching said rotational bracket portion after detecting means has detected that said top boom has been extended to a predetermined length, and
 (5) locking the distal end of said top boom on the other side in the transverse direction and the rear end of said rotational bracket portion on the other side in the transverse direction by a pin, after detecting means has detected that said rotational bracket portion has been rotated to a predetermined position.

6. A method for automatically stretching and storing a sub-jib for a crane with which a rotational bracket portion is detachably attached to the distal end of a boom capable of extending and contracting in multiple stages and mounted on a vehicle in such a manner as able to rise and lower slantly, a sub-jib is attached to said rotational bracket portion in such a manner as able to rise and lower slantly, and said rotational bracket portion is rotated relative to said boom to stretch said sub-jib forwardly of said boom during working and to store said sub-jib in juxtaposed relation to a lateral side of said boom during storage, said method comprising the steps of, when said sub-jib is to be stored:

(1) starting unlocking operation of a second locking device which locks the distal end of a top boom of said boom on the other side in a transverse direction and the rear end of said rotational bracket portion on the other side in the transverse direction by a pin, after detecting means has detected that said top beam has reached a predetermined length,
 (2) rotating said rotational bracket portion for storage after detecting means has detected that said second locking device has completed the unlocking operation,
 (3) contracting said top boom after detecting means has detected that said rotational bracket portion has been rotated to a predetermined

position,

(4) starting unlocking operation of a first locking device which engages a top boom pin fixed to the distal end of said top boom on one side in the transverse direction with a slot formed in the rear end of said rotational bracket portion on one side in the transverse direction into a locked state, after detecting means has detected that said top boom has been contracted to a predetermined position, and
(5) starting to store said sub-jib after detecting means has detected that said first locking device has completed the unlocking operation,

7. A device for automatically stretching and storing a sub-jib for a crane which comprises a rotational bracket portion detachably attached to the distal end of a boom capable of extending and contracting in multiple stages and mounted on a vehicle in such a manner as able to rise and lower slantly, a sub-jib attached to said rotational bracket portion in such a manner as able to rise and lower slantly, and a device for rotating said rotational bracket portion relative to said boom to stretch said sub-jib forwardly of said boom during working and to store said sub-jib in juxtaposed relation to a lateral side of said boom during storage, said device further comprising a laterally holding device for oscillating said sub-jib in a lateral direction, a rotational bracket portion for separating or connecting said sub-jib from or to a top boom of said boom, a first locking device and a second locking device for locking said top boom and said rotational bracket portion, and a rotating device for rotating said rotational bracket portion relative to said boom.

8. A device for automatically stretching and storing a sub-jib for a crane according to Claim 7, wherein said first locking device is a device for engaging a slot formed in said rotational bracket portion on one side in the transverse direction with a top boom pin fixed to said top boom on one side in the transverse direction into a locked state, and said second locking device is a device for locking a lateral side of said rotational bracket portion on the other side in the transverse direction and a lateral side of said top boom on the other side in the transverse direction by a pin.

9. A device for automatically stretching and storing a sub-jib for a crane according to Claim 7, wherein said laterally holding device comprises a lever having a slot engaging a pin fixed to said sub-jib in one position and pivotally attached to said boom in one position, a laterally holding cylinder disposed to interconnect said boom and said lever, a bracket having a slot engaging a pin fixed to said sub-jib in the other position and fixedly attached to said boom in the other position, a hook pivotally attached to

said bracket and engaging said pin fixed to said sub-jib in the other position, and a rod interconnecting said lever and said hook.

10. A device for automatically stretching and storing a sub-jib for a crane according to Claim 7, wherein said rotational bracket portion has a slot formed in the rear end thereof on one side in the transverse direction for engaging a top boom pin vertically fixed to the distal end of said top boom on one side in the transverse direction, a pin hole formed in the rear end thereof on the other side in the transverse direction for engaging a vertical coupling pin fixed to the distal end of said top boom on the other side in the transverse direction, a pin hole formed in the front end thereof for mounting of said sub-jib in such a manner as able to rise and lower slantly, and a pin provided on the upper surface thereof for attachment of a rotating cylinder adapted to turn said rotational bracket portion relative to said boom.

11. A device for automatically stretching and storing a sub-jib for a crane according to Claim 7 or 8, wherein said first locking device comprises a lock link pivotally attached to said rotational bracket portion for holding said top boom pin in cooperation with the slot of said rotational bracket portion in sandwiching relation, and a first lock cylinder attached to said rotational bracket portion for operating said lock link.

12. A device for automatically stretching and storing a sub-jib for a crane according to Claim 7, wherein said rotating device comprises a first lever rotatably connected at its one end to a pin fixed to the rear end of said rotational bracket portion on the upper surface thereof, a second lever rotatably connected at its one end to the other end of said first lever and having a slot formed in its opposite end to be engageable with a rotation support pin fixed to said top boom, and a rotating cylinder disposed to interconnect said first lever and said rotational bracket portion.

13. A device for automatically stretching and storing a sub-jib for a crane according to Claim 7 or 8, wherein said second locking device comprises vertically spaced two coupling pins for coupling said top boom and said rotational bracket portion to each other, a lever pivotally attached at its central portion to said rotational bracket portion, a second lock cylinder disposed to interconnect said lever and said rotational bracket portion, and two links for respectively interconnecting both ends of said lever and said two coupling pins.

14. A device for automatically stretching and storing a sub-jib for a crane according to Claim 7, further comprising detecting means for detecting the posi-

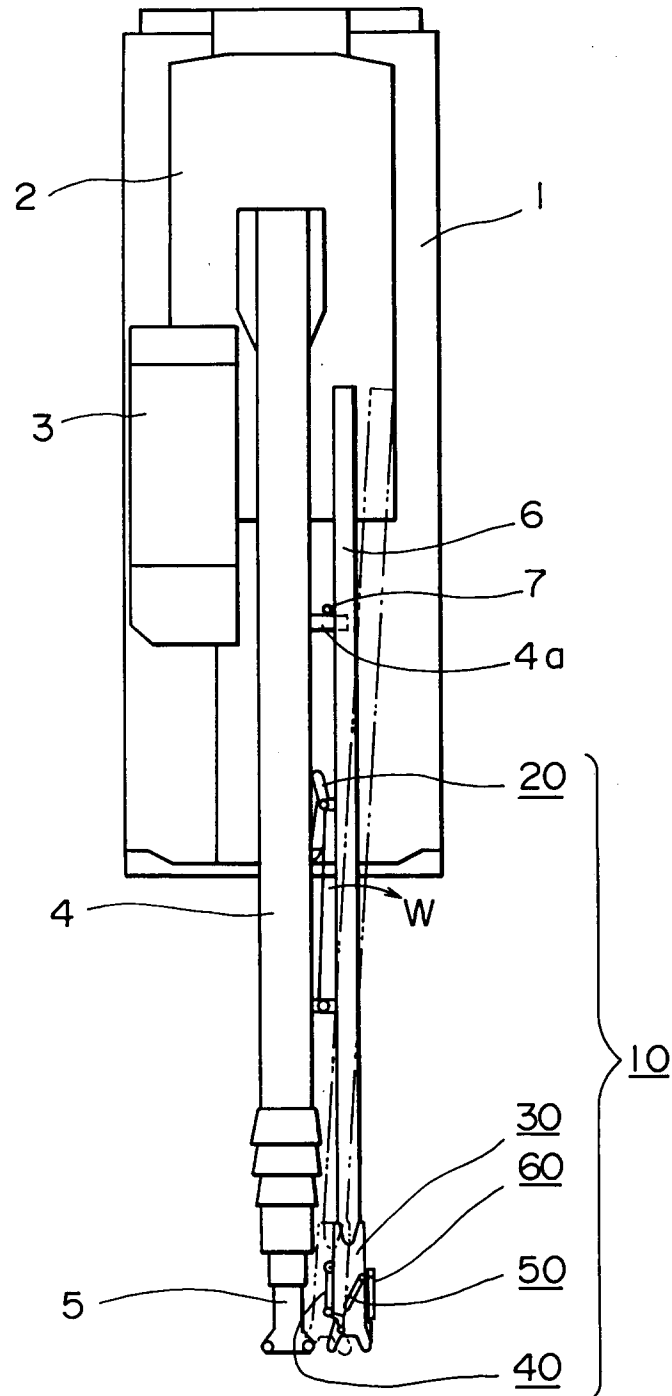
tions of said boom and said top boom, detecting means for detecting the position of said laterally holding device, detecting means for detecting the separation or connection said rotational bracket portion, detecting means for detecting the completion of locking or unlocking made by said first locking device and said second locking device, and detecting means for detecting the rotative position of said rotating device.

15. A device for automatically stretching and storing a sub-jib for a crane according to Claim 14, wherein display means for displaying results detected by said detecting means are provided in a cab equipped on said vehicle.
16. A device for automatically stretching and storing a sub-jib for a crane according to Claim 7, wherein when said rotational bracket portion is rotated under a condition where said boom is raised slantly by a predetermined angle and said sub-jib is tilted to a predetermined position, the centroid position of said sub-jib lies substantially on a vertical line passing the center of an axis about which said rotational bracket portion is rotatable.
17. A device for automatically stretching and storing a sub-jib for a crane which comprises a rotational bracket portion detachably attached to the distal end of a boom capable of extending and contracting in multiple stages and mounted on a vehicle in such a manner as able to rise and lower slantly, a sub-jib attached to said rotational bracket portion in such a manner as able to rise and lower slantly, and a device for rotating said rotational bracket portion relative to said boom to stretch said sub-jib forwardly of said boom during working and to store said sub-jib in juxtaposed relation to a lateral side of said boom during storage, said device further comprising a tilt lever for raising and lowering said sub-jib slantly, a directional control valve operated by said tilt lever, a first solenoid switching valve for switching over between a tilting circuit and a laterally holding circuit, a solenoid control valve for a laterally holding cylinder, a second solenoid switching valve for switching over between said tilting circuit and a circuit in which a first lock cylinder, a second lock cylinder and a rotating cylinder are disposed, a solenoid control valve for said first lock cylinder, a solenoid control valve for said second lock cylinder, and a solenoid control valve for said rotating cylinder.
18. A device for automatically stretching and storing a sub-jib for a crane according to Claim 17, wherein a one-way valve is disposed in one of circuits interconnecting said directional control valve and said solenoid control valve for said laterally holding cylinder, and one of circuits interconnecting said direc-

tional control valve and said solenoid control valve for said second lock cylinder.

19. A device for automatically stretching and storing a sub-jib for a crane according to Claim 17, wherein said solenoid control valve for said first lock cylinder, said solenoid control valve for said rotating cylinder, said solenoid control valve for said second lock cylinder, and said second solenoid switching valve are mounted on said rotational bracket portion.
20. A device for automatically stretching and storing a sub-jib for a crane according to Claim 17 or 19, wherein said solenoid control valve for said first lock cylinder, said solenoid control valve for said rotating cylinder, said solenoid control valve for said second lock cylinder, and said second solenoid switching valve are interconnected by a serial circuit.

FIG. 1



2. G. I. F.

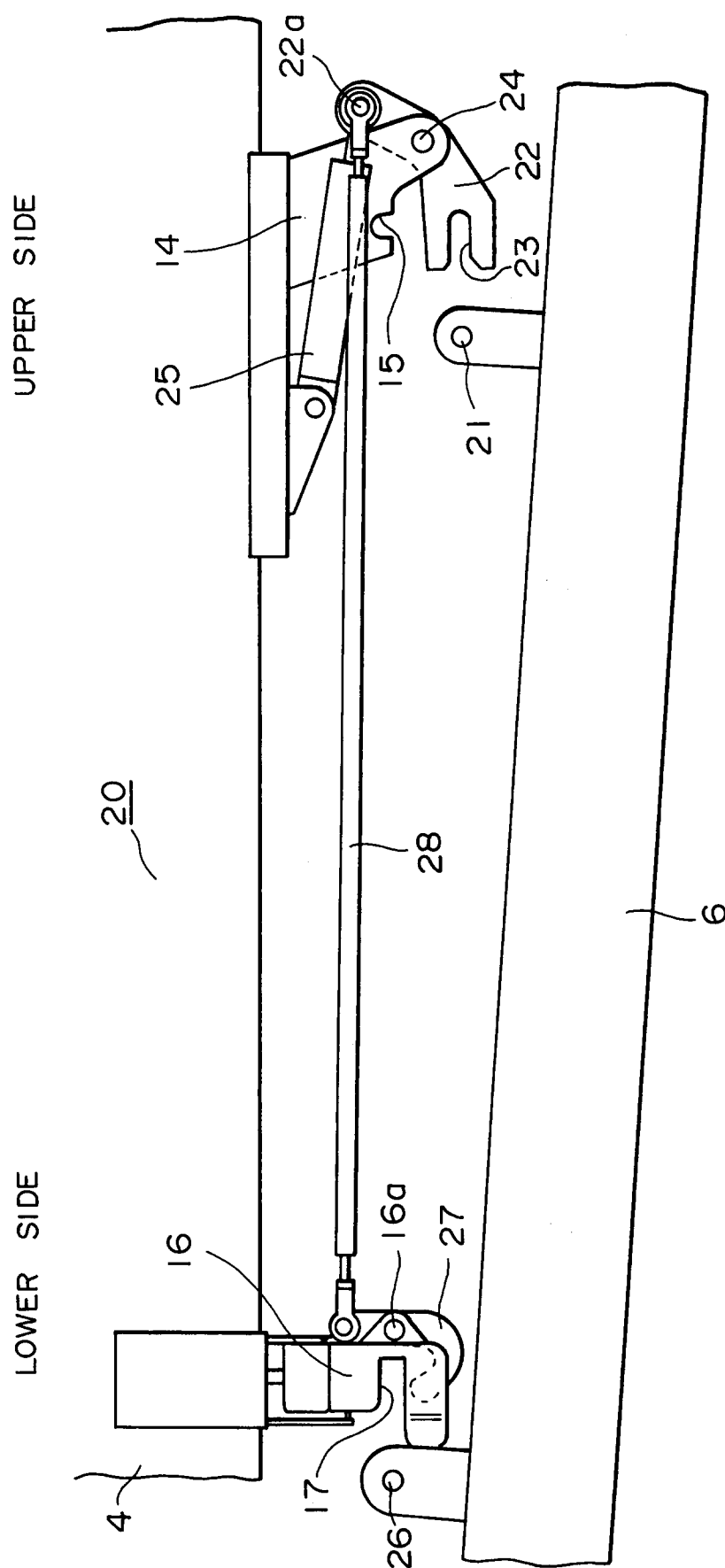


FIG. 3

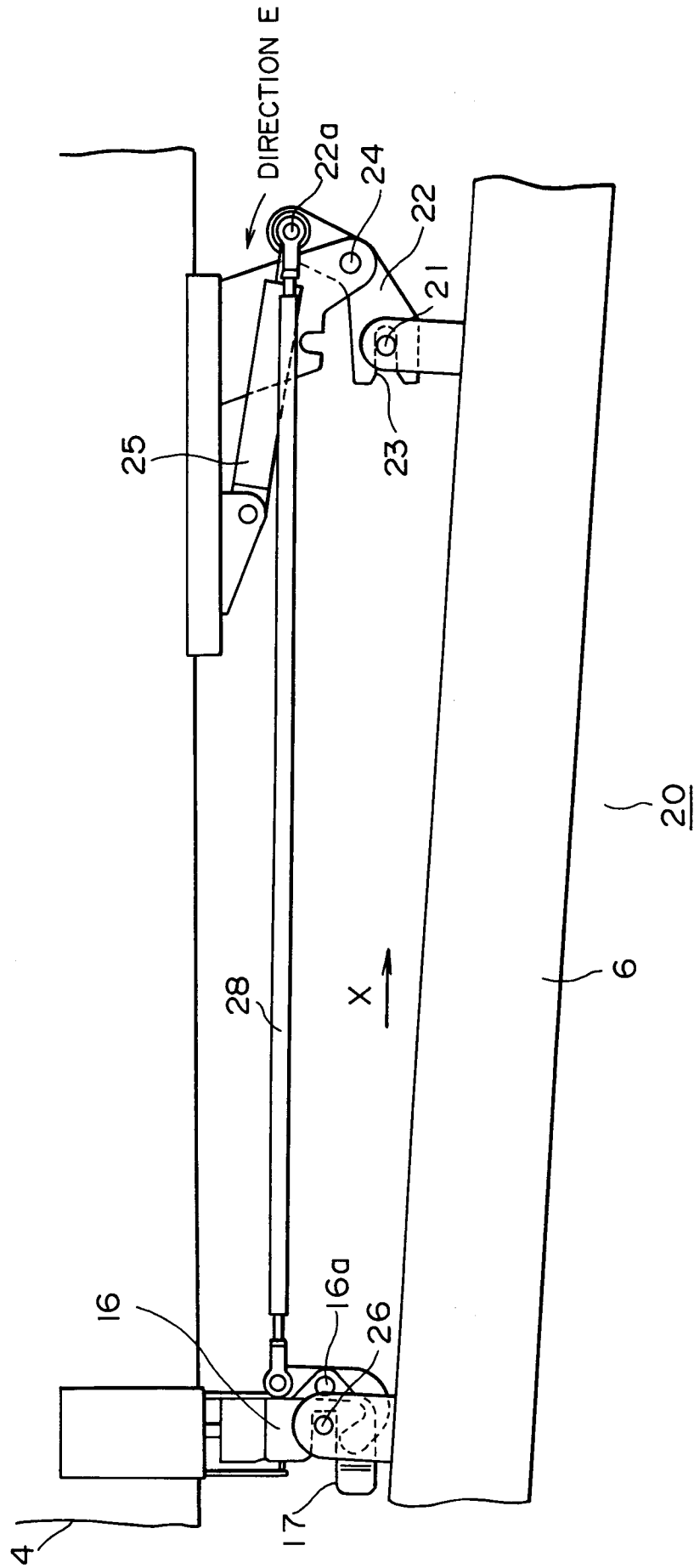


FIG. 4

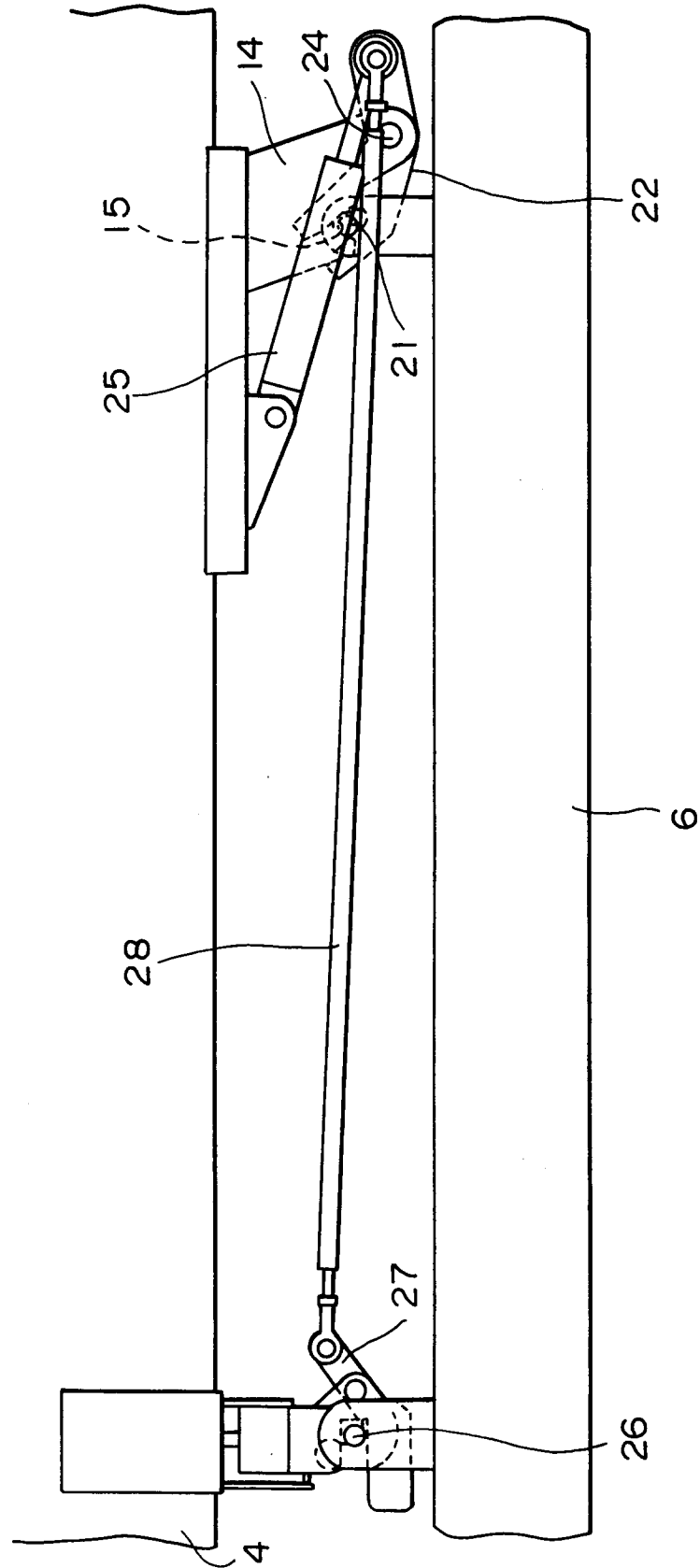


FIG. 5

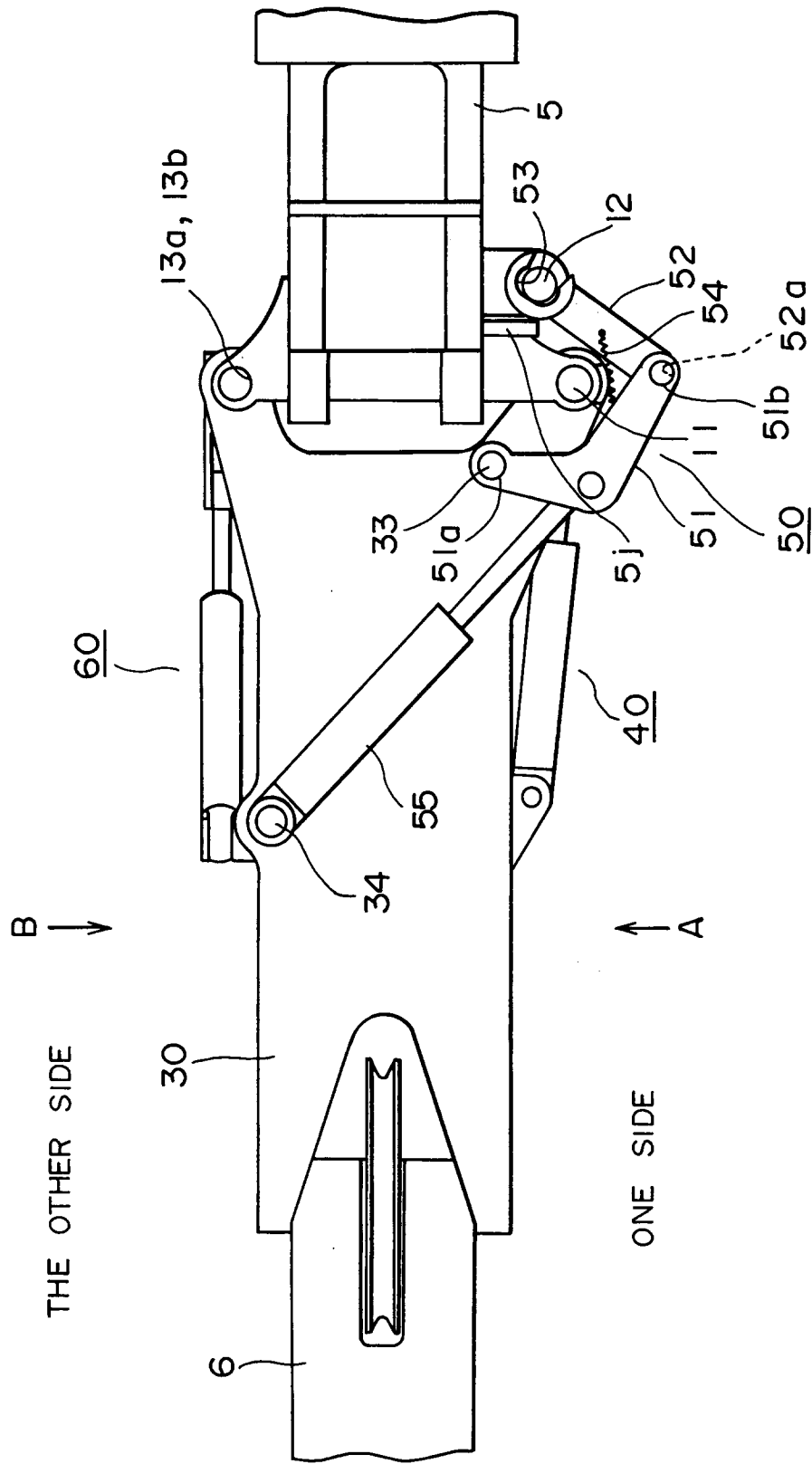


FIG. 6

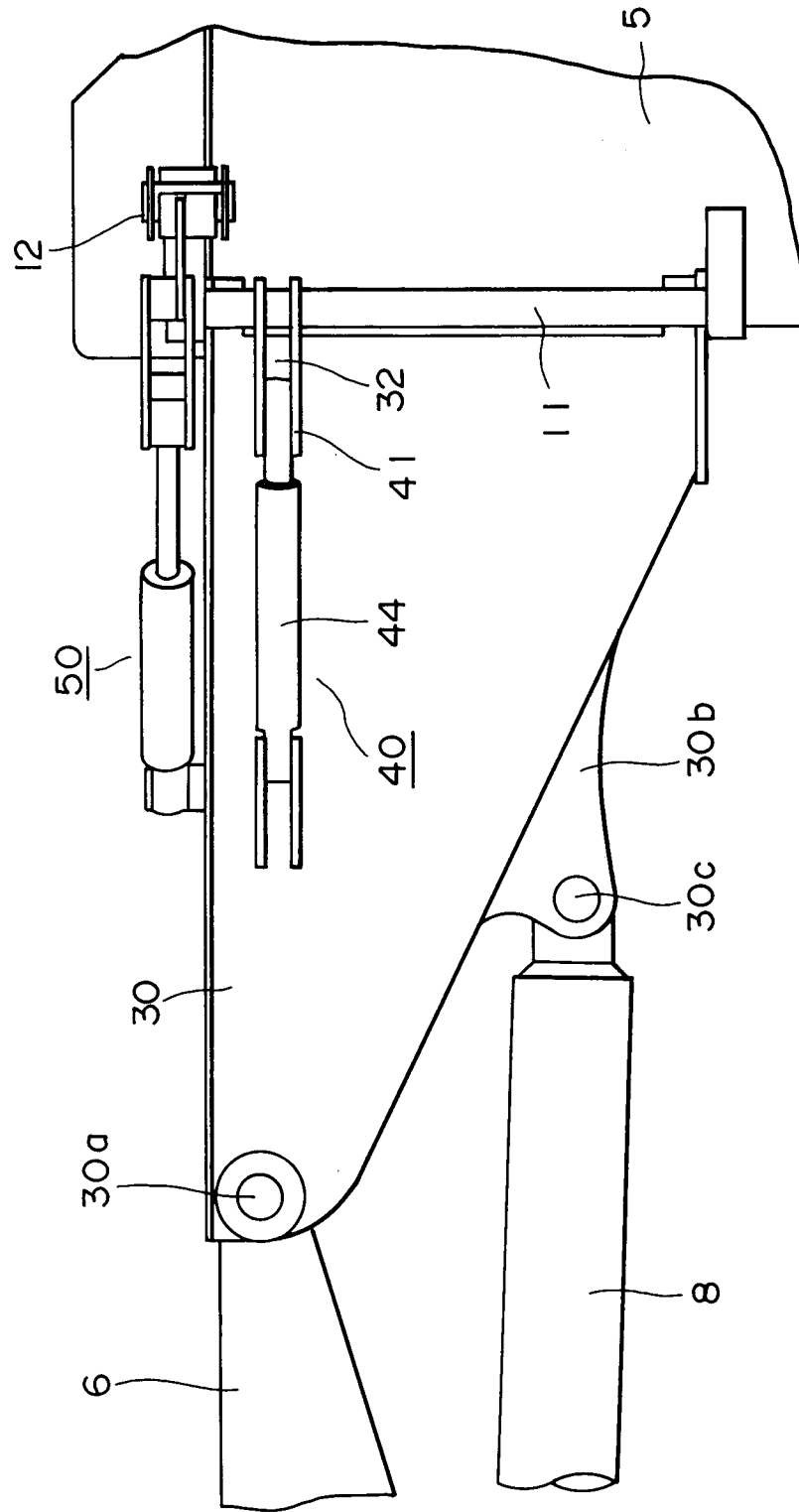


FIG. 7.

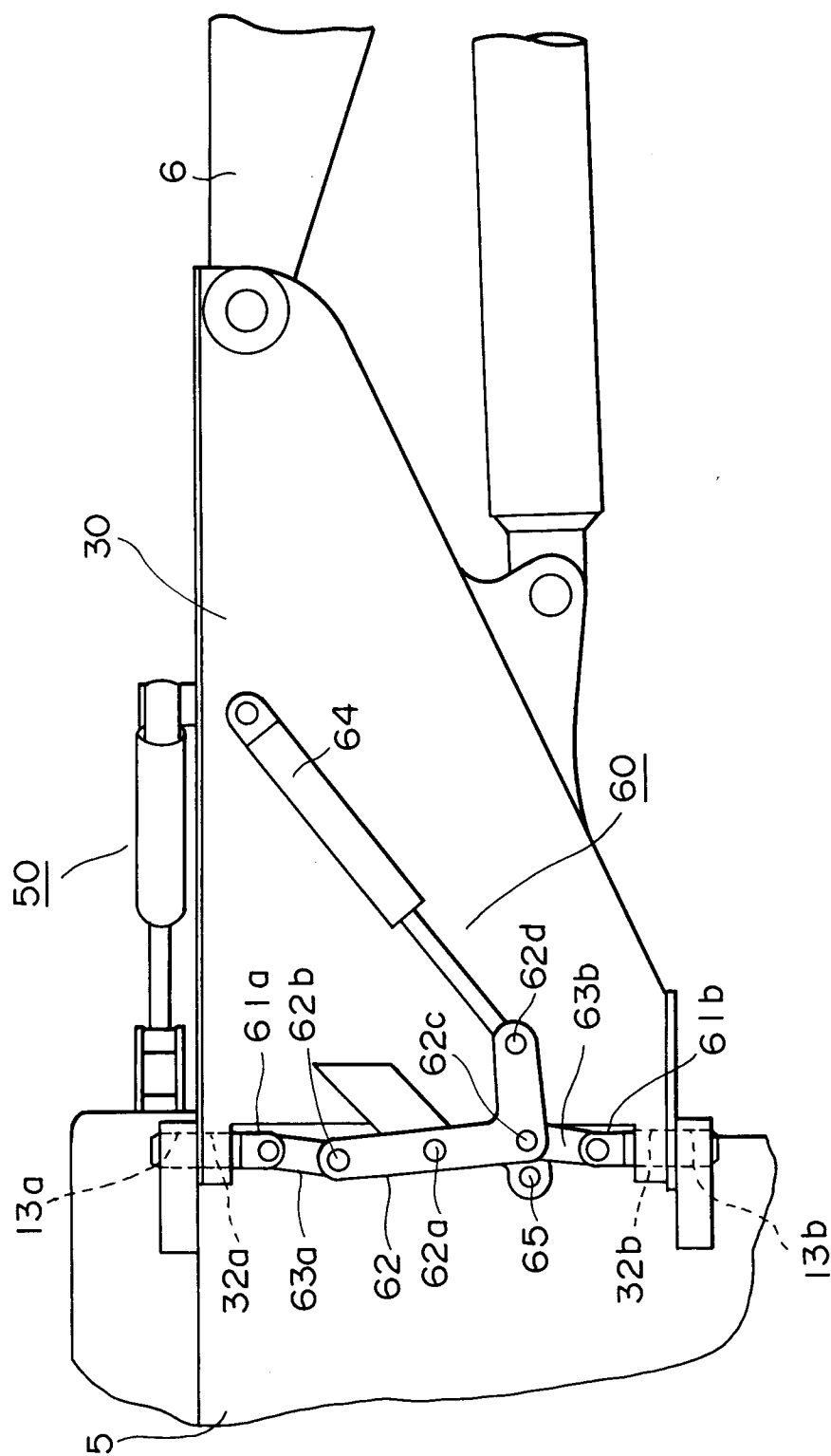


FIG. 8

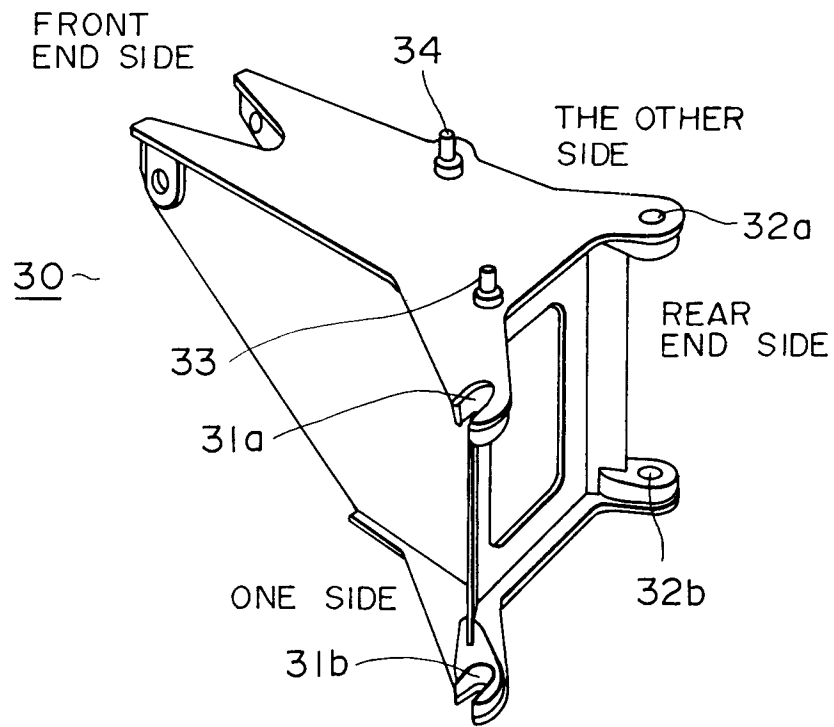


FIG. 9

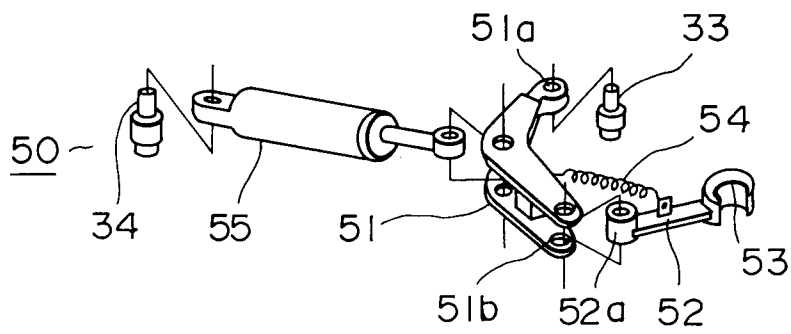


FIG. 10

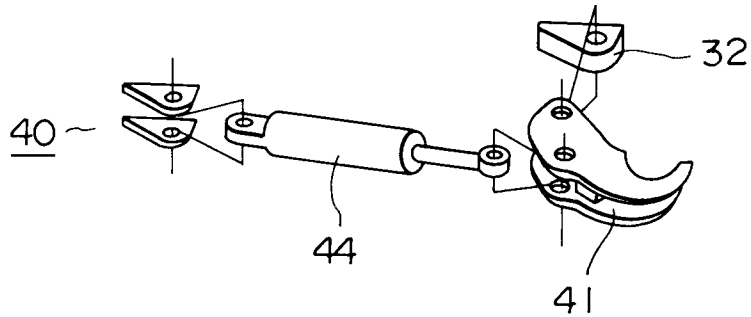


FIG. 11

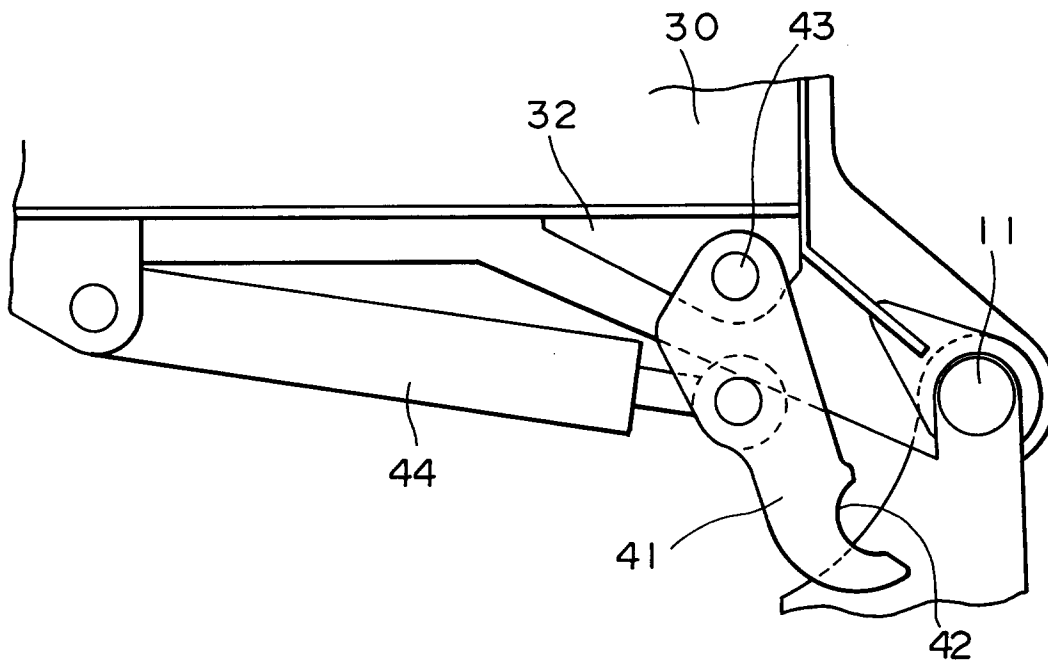


FIG. 12

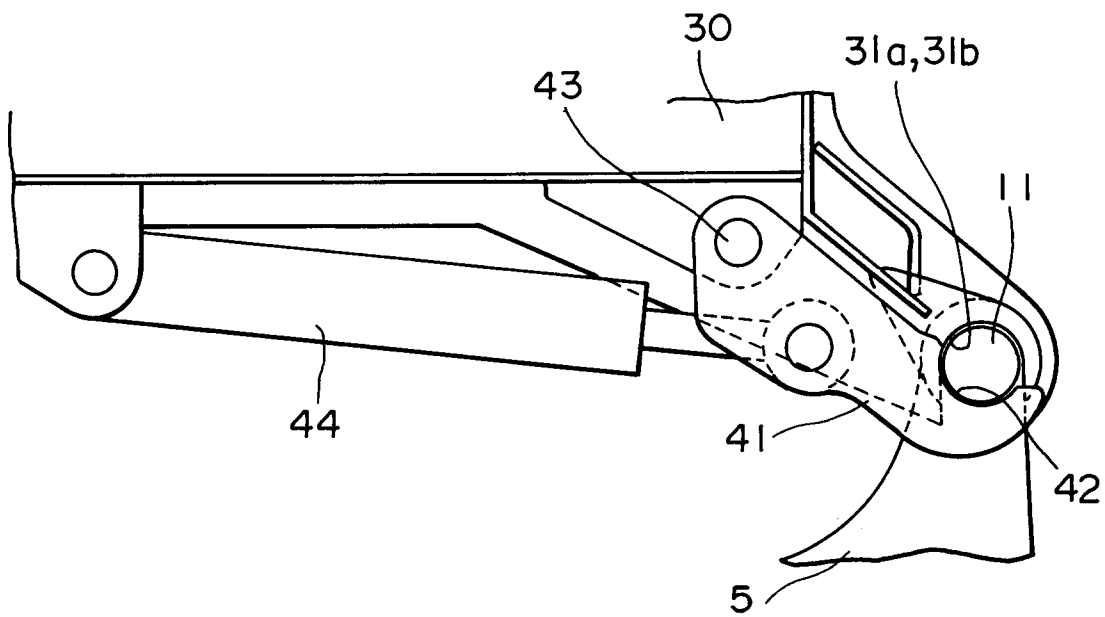


FIG. 13

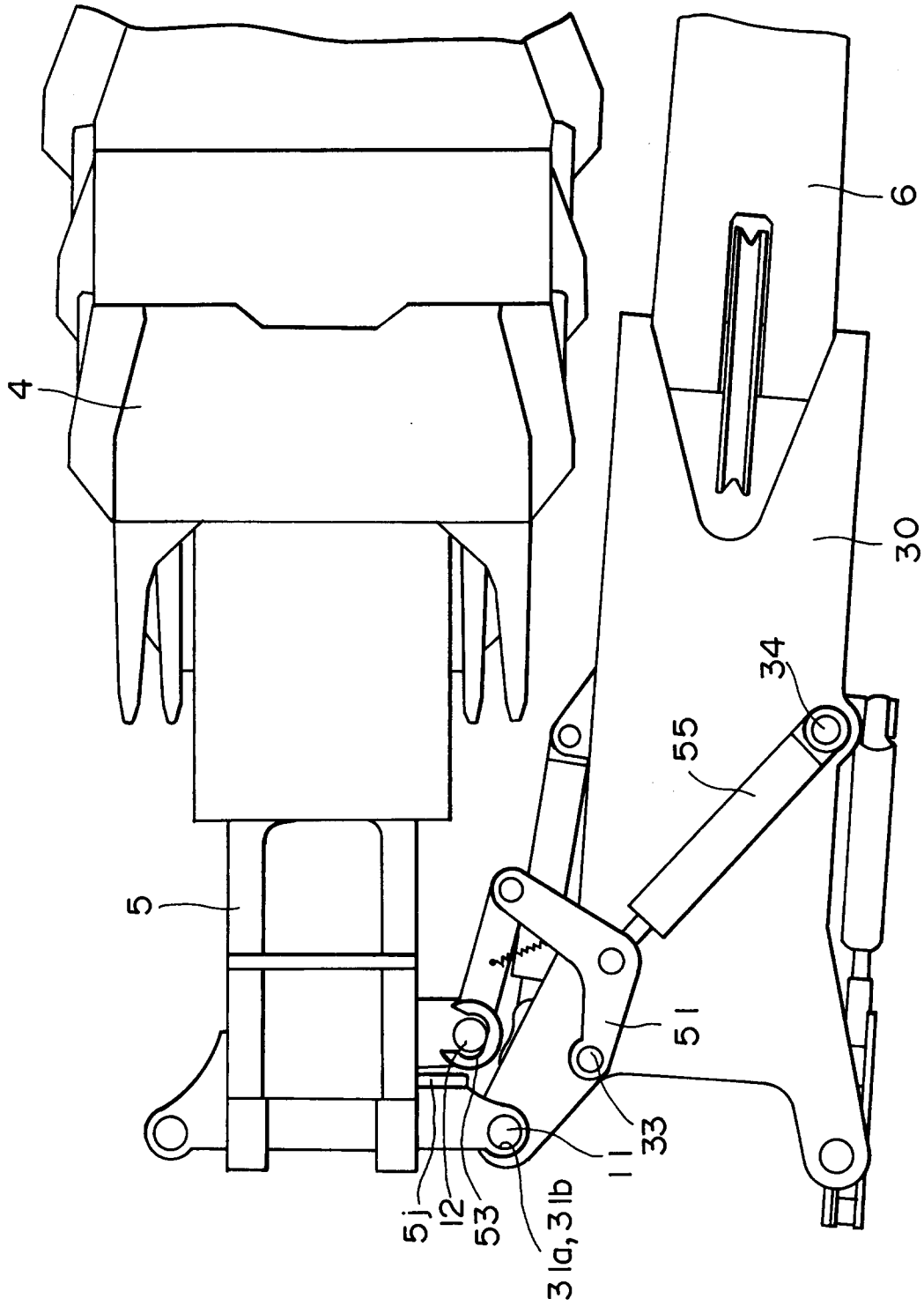


FIG. 14A

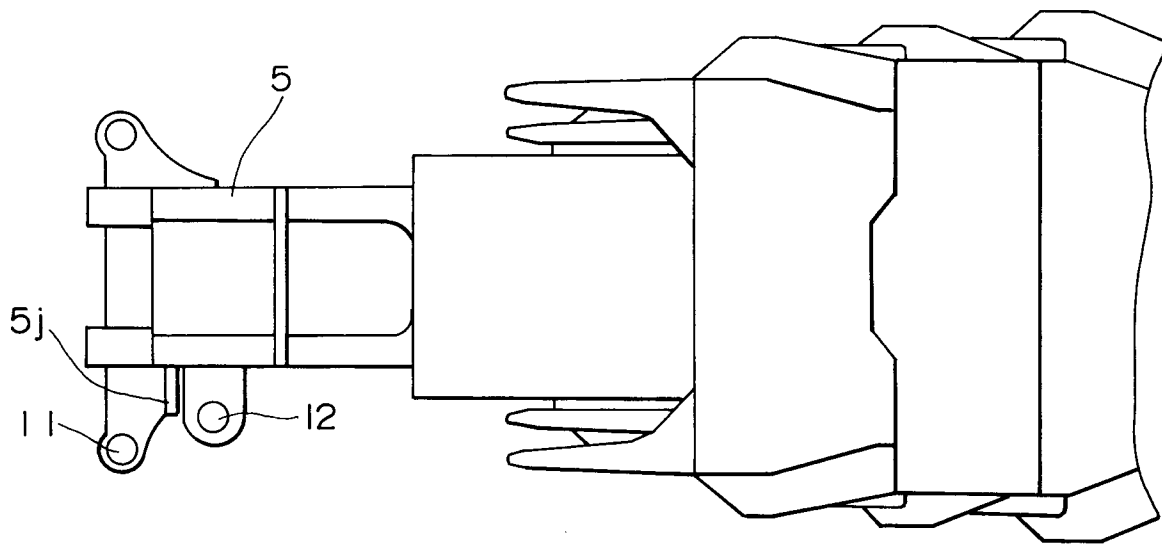


FIG. 14B

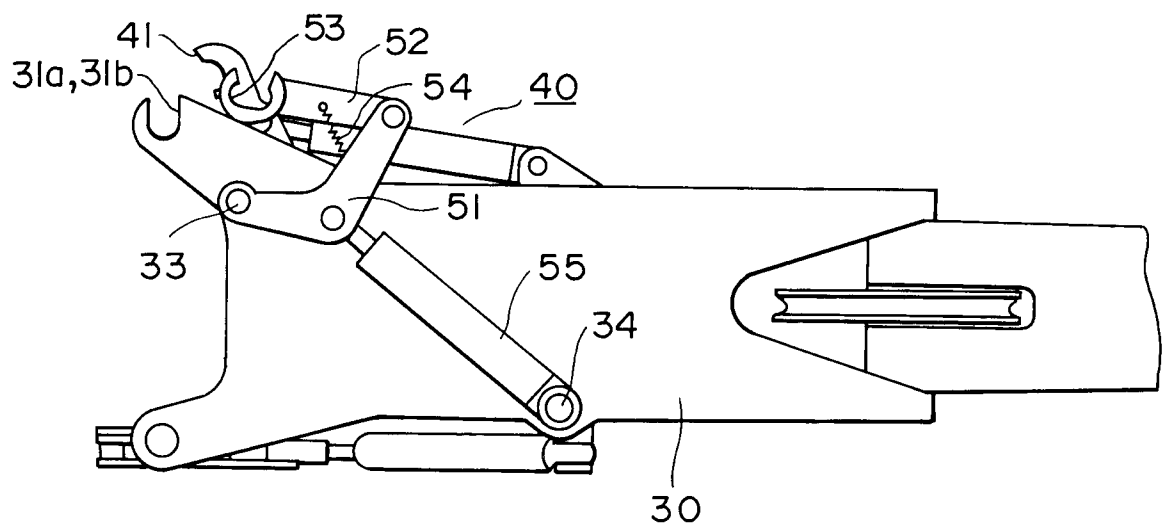


FIG. 15

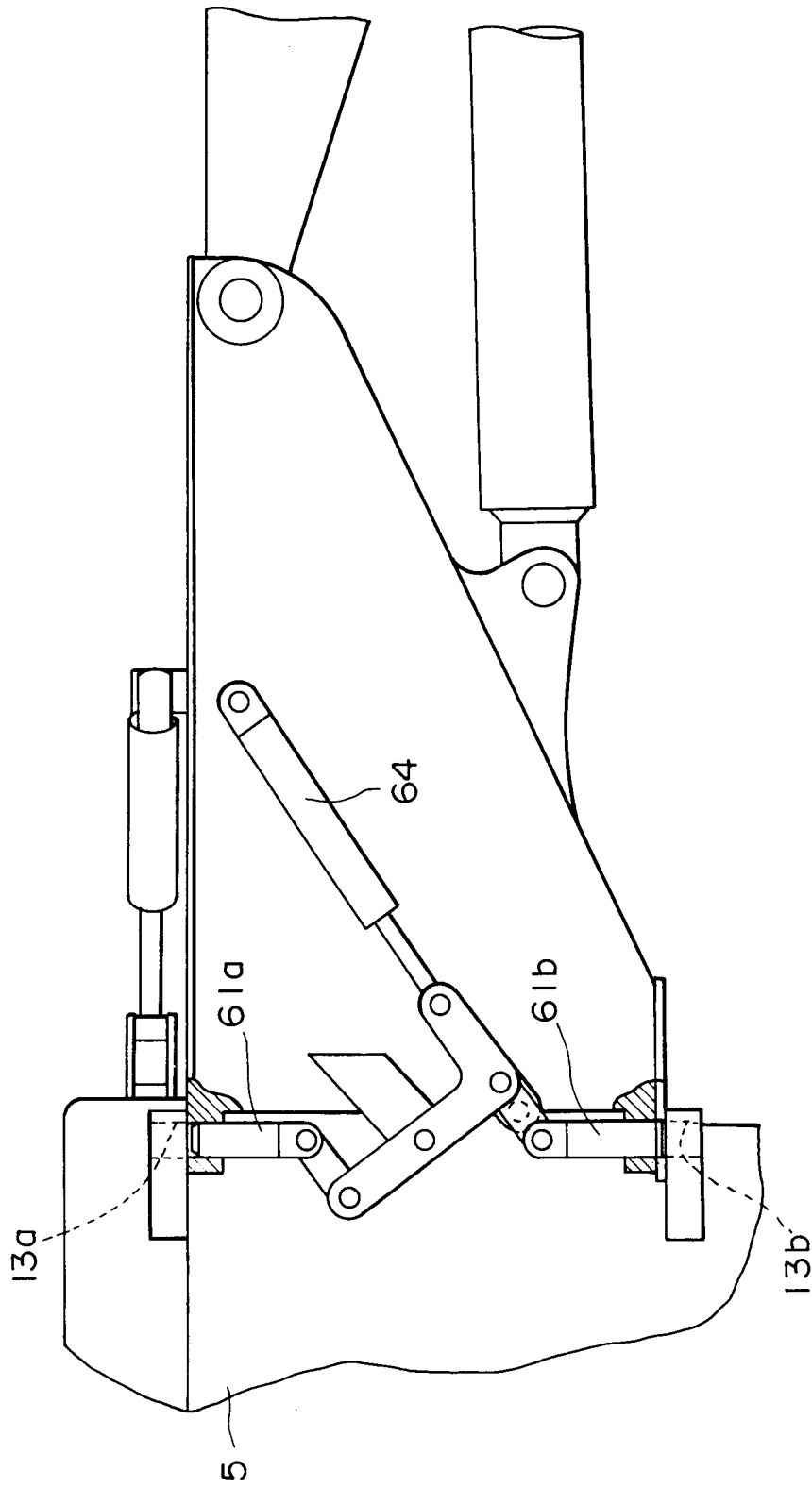


FIG. 16

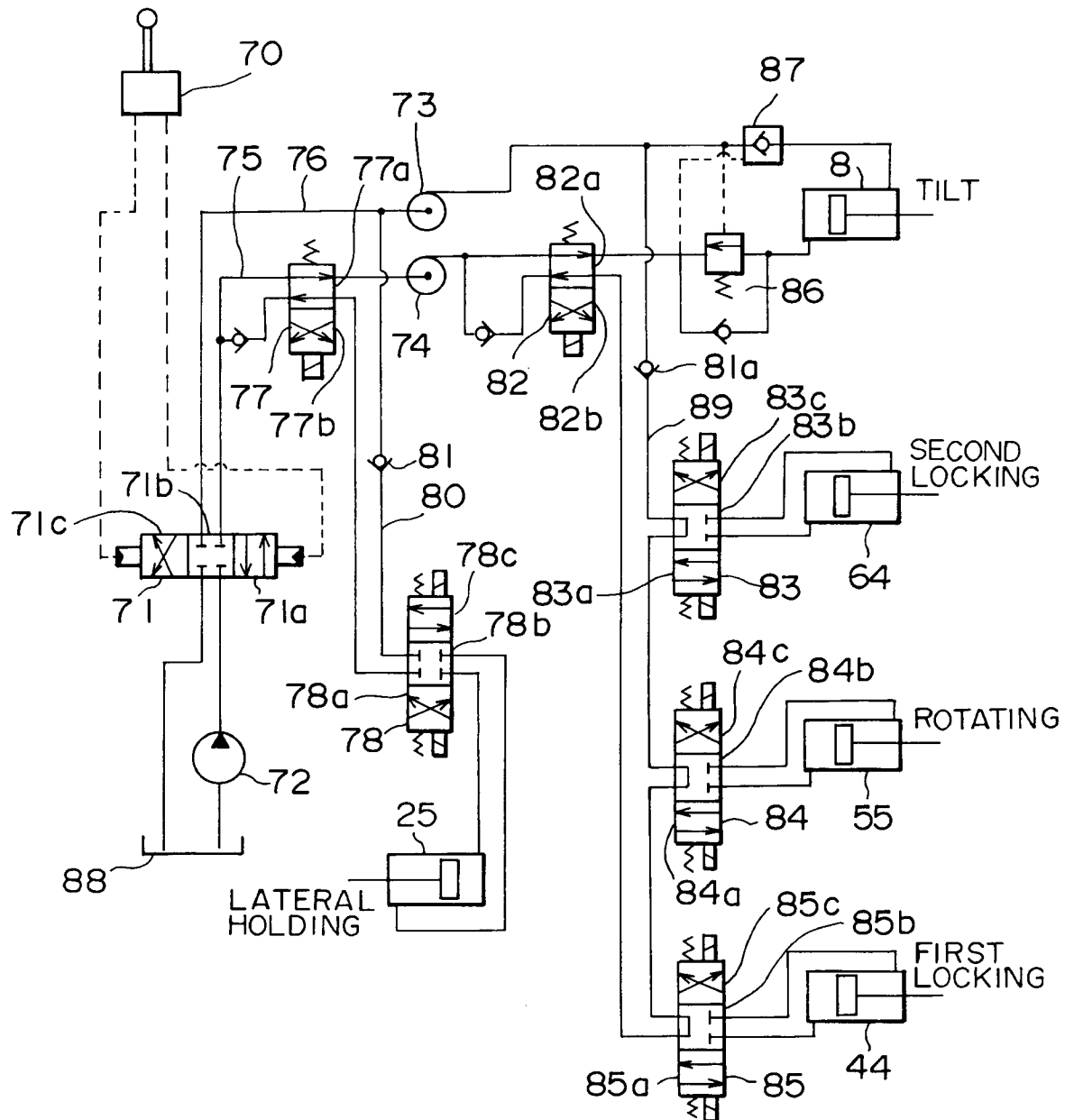


FIG. 17

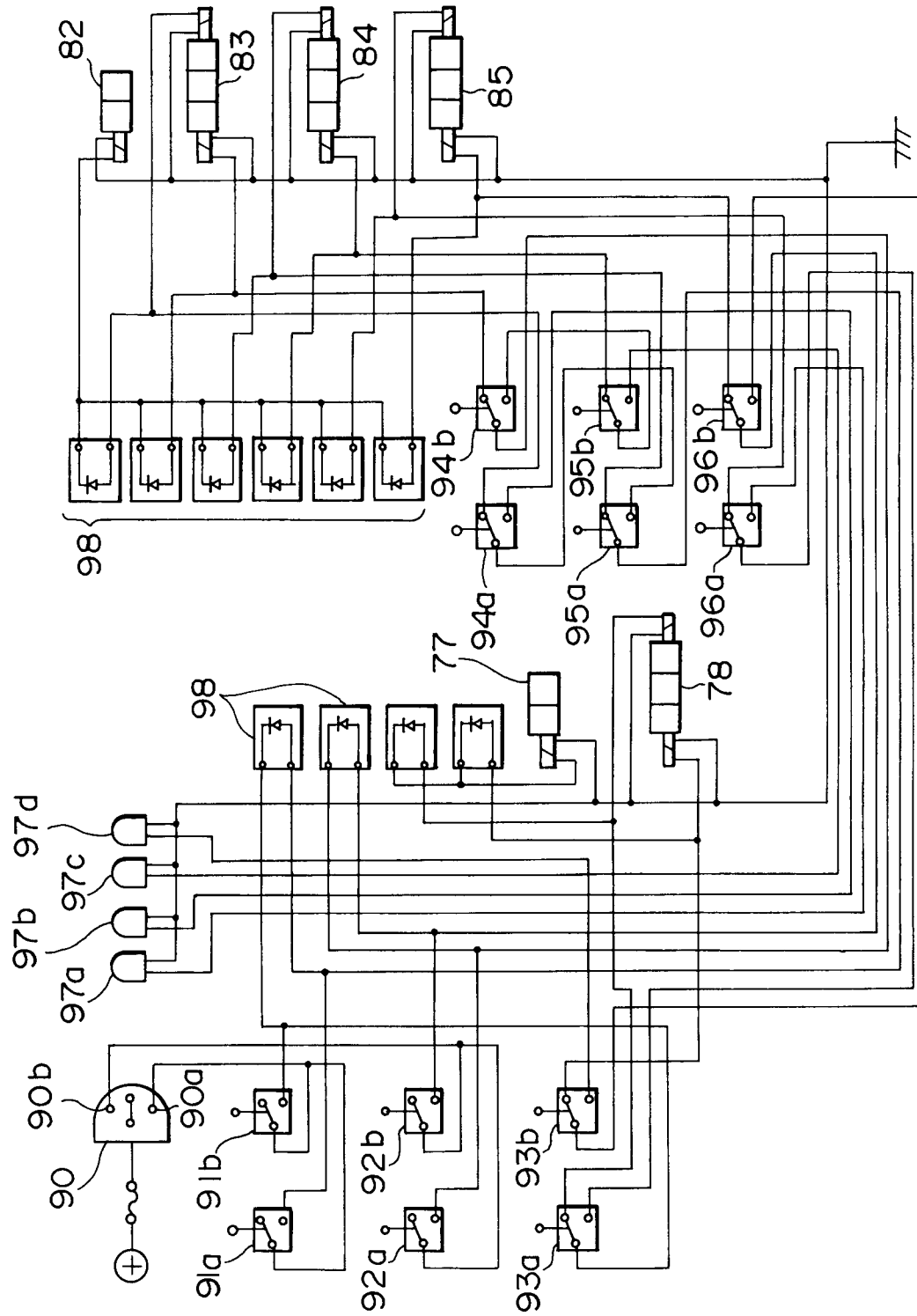


FIG. 18

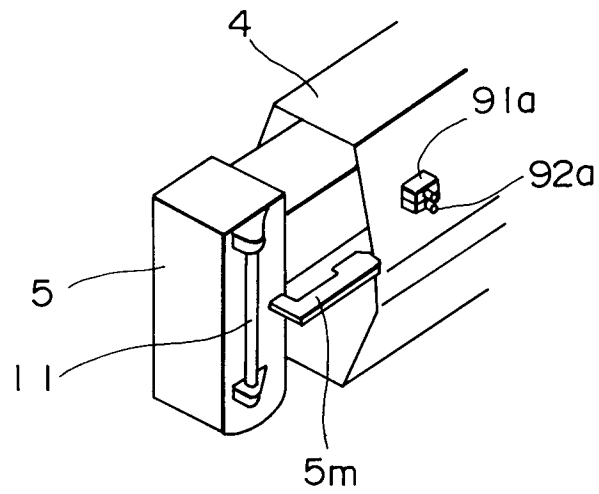


FIG. 19

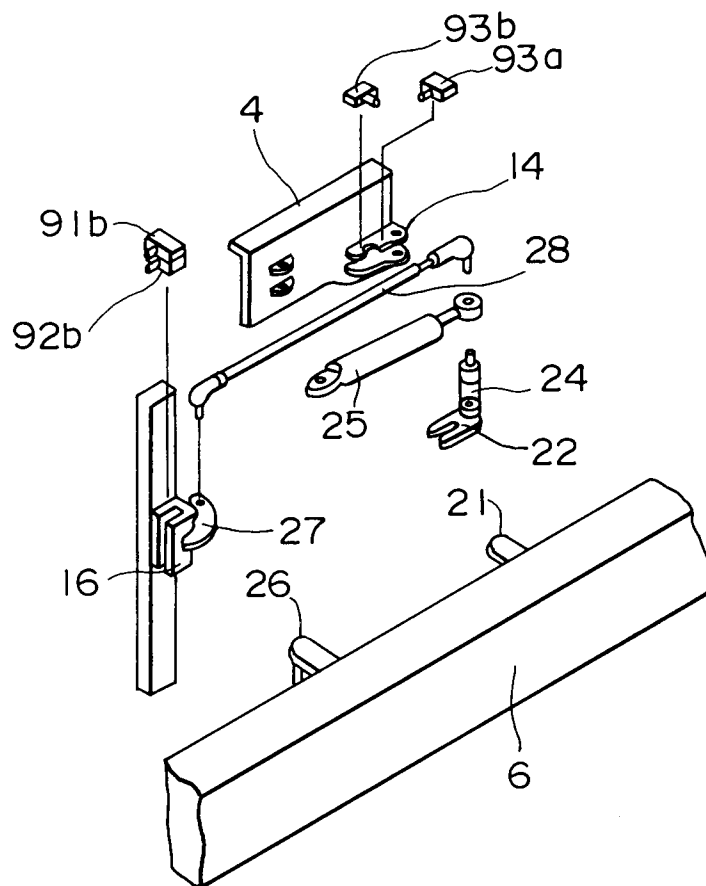


FIG. 20

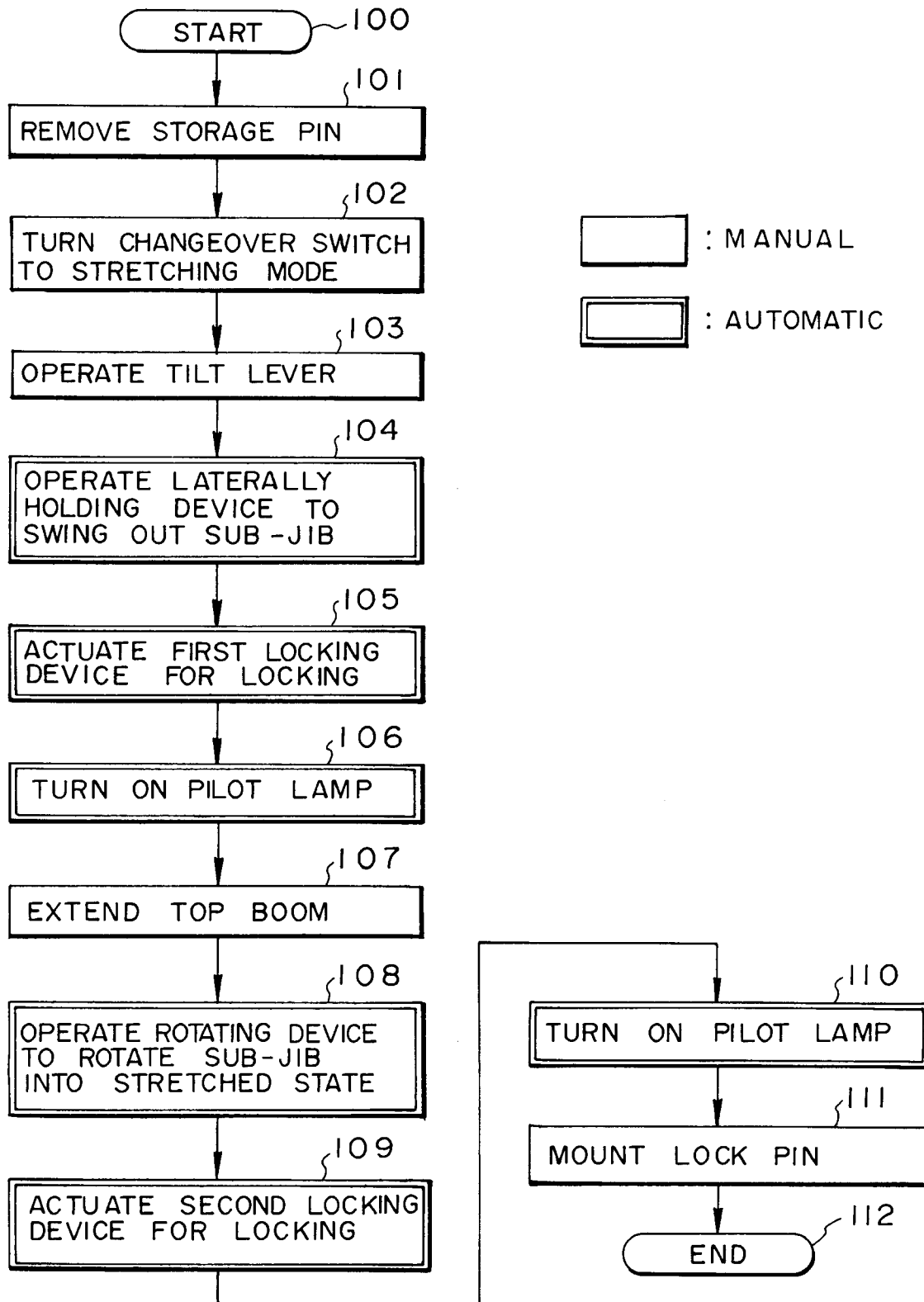


FIG. 21

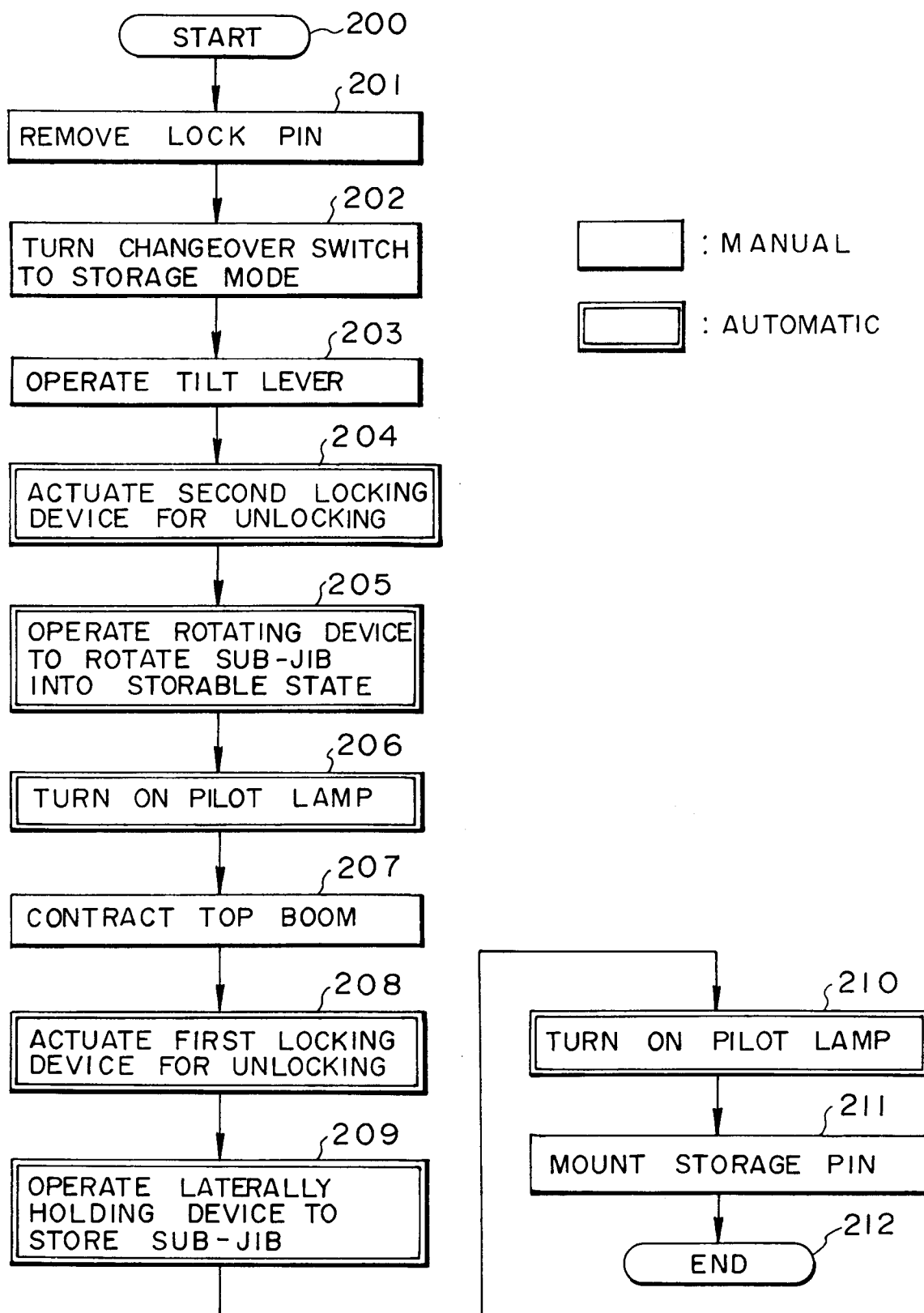


FIG. 22

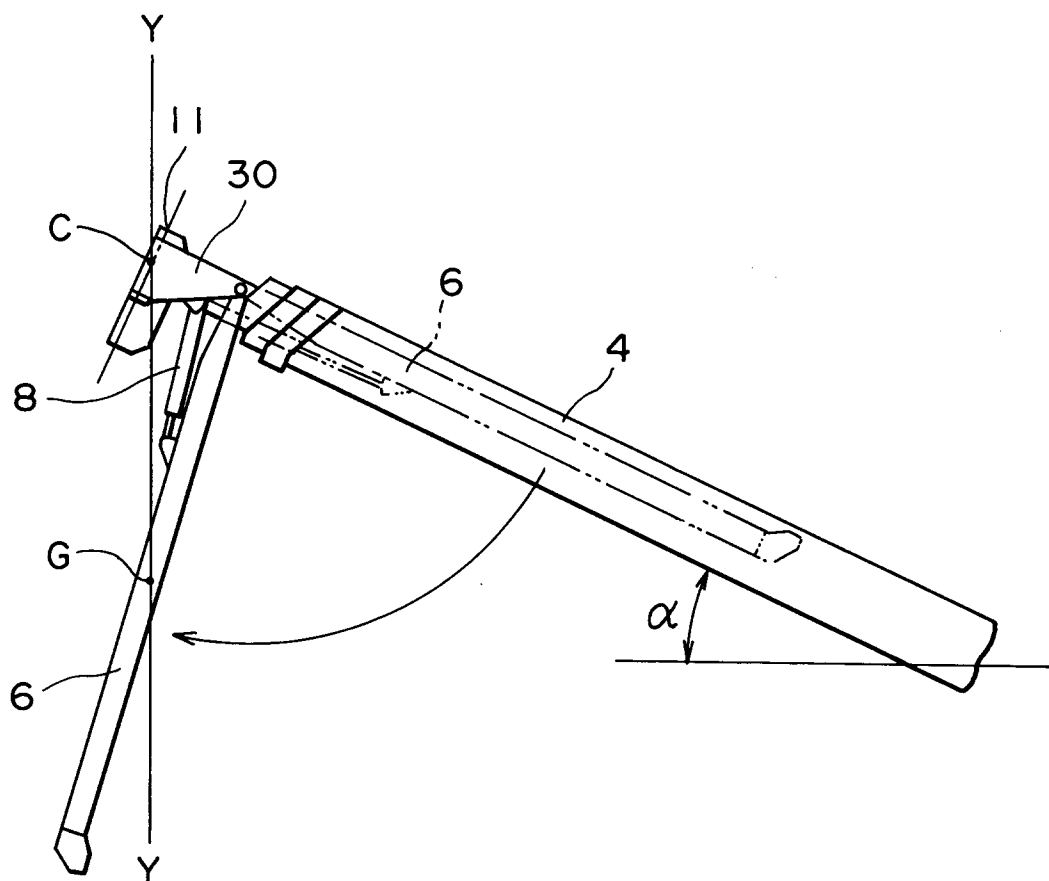


FIG. 23
PRIOR ART

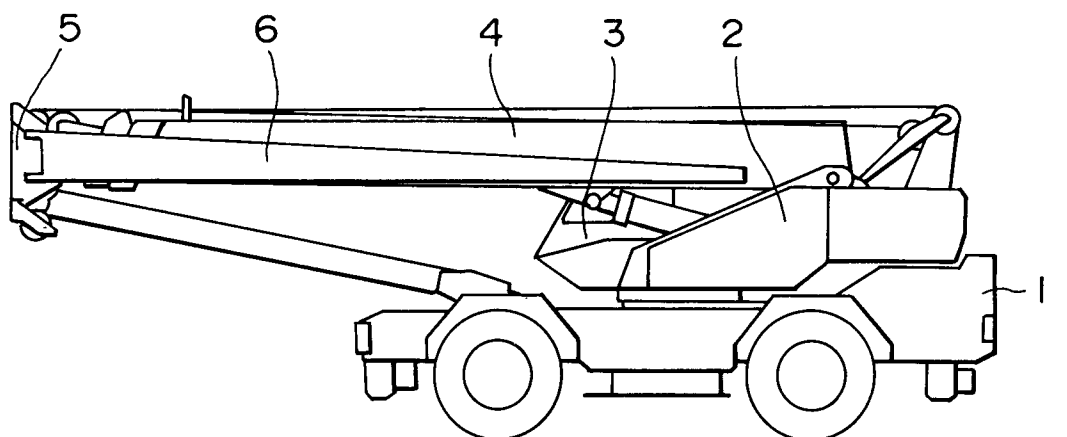


FIG. 24
PRIOR ART

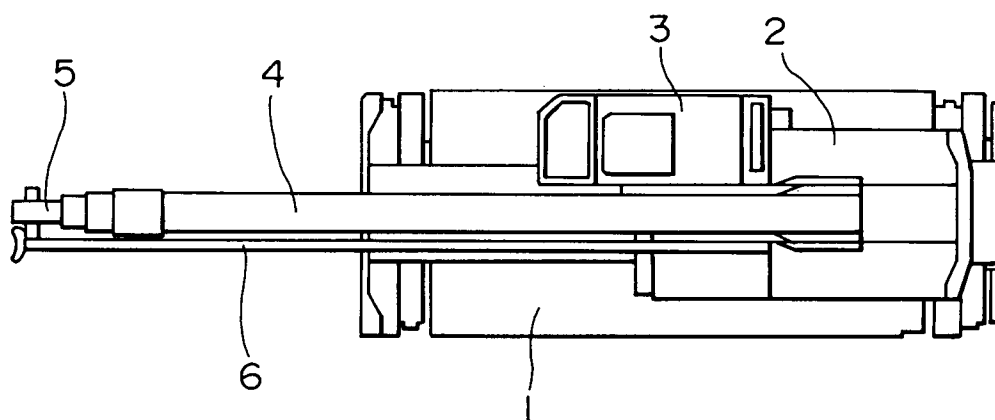
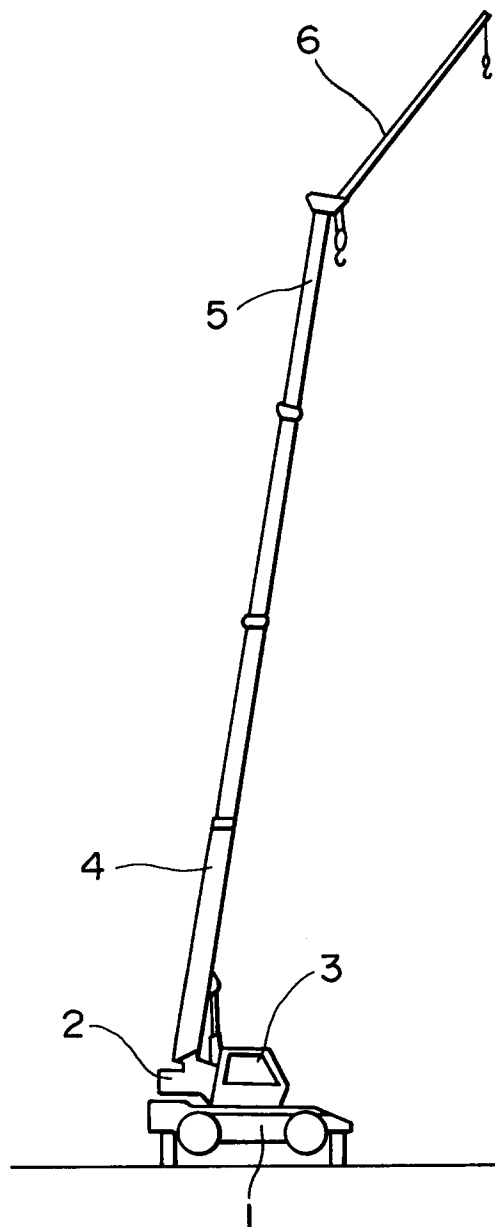


FIG. 25
PRIOR ART



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP95/00252

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl ⁶ B66C23/70		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
Int. Cl ⁶ B66C23/70		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Jitsuyo Shinan Koho 1926 - 1995		
Kokai Jitsuyo Shinan Koho 1971 - 1995		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 6-76283, U (Sumitomo Construction Co., Ltd.), April 2, 1993 (02. 04. 93) (Family: none)	1 - 16
Y	JP, 4-6640, B2 (Tadano Corp.), February 6, 1992 (06. 02. 92) & EP, 254510, A1 & US, 4828124, A	3, 4
A	JP, 52-137469, U (Tadano Corp.), October 19, 1977 (19. 10. 77) (Family: none)	5, 6, 14, 15
A	JP, 6-239582, A (Kobe Steel, Ltd.), August 30, 1994 (30. 08. 94) (Family: none)	15
Y	JP, 62-103595, U (Kobe Steel, Ltd.), July 1, 1987 (01. 07. 87) (Family: none)	16
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
May 12, 1995 (12. 05. 95)		May 30, 1995 (30. 05. 95)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)