

- [54] **BREAK OUT ELEVATORS FOR ROTARY DRIVE ASSEMBLIES**
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77024, by Joe R. Brown, executor
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- [51] **Int. Cl.²** **E21B 19/07**
- [58] **Field of Search** **175/85, 52; 166/77.5;**
173/163, 164; 214/2.5

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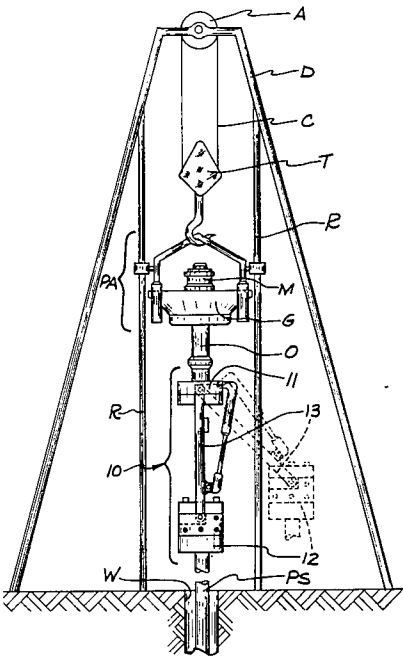
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Primary Examiner—David H. Brown
Attorney, Agent, or Firm—Torres & Berryhill

- [57] **ABSTRACT**
- Disclosed is a rotary drive assembly for manipulating

well pipe. The assembly, which is carried in a drilling derrick, provides means for both threaded and non-threaded connection with a well pipe. The threaded connection is used for imparting rotary motion to the pipe and an attached drill string during drilling. A break out elevator provides non-threaded connection used for manipulating pipe members and for making up or breaking out a connection between threaded pipe segments. The elevator is pivotally suspended by bails from a rotary powering mechanism which may be raised or lowered in the derrick. Powered cocking means are provided for pivoting the bails as required to move the elevator laterally. Powered gripping means may be used in the elevator to selectively grip or release a pipe member extending through the elevator. Cam surfaces acting with the gripping means automatically increase the gripping forces exerted on the pipe member as the forces tending to move the pipe relative to the elevator increase. A lost motion connection is employed between the bails and the powering mechanism to provide a rotary jarring force to the pipe gripped by the elevator. Several modified gripping assemblies for use in the elevator are described.

18 Claims, 19 Drawing Figures



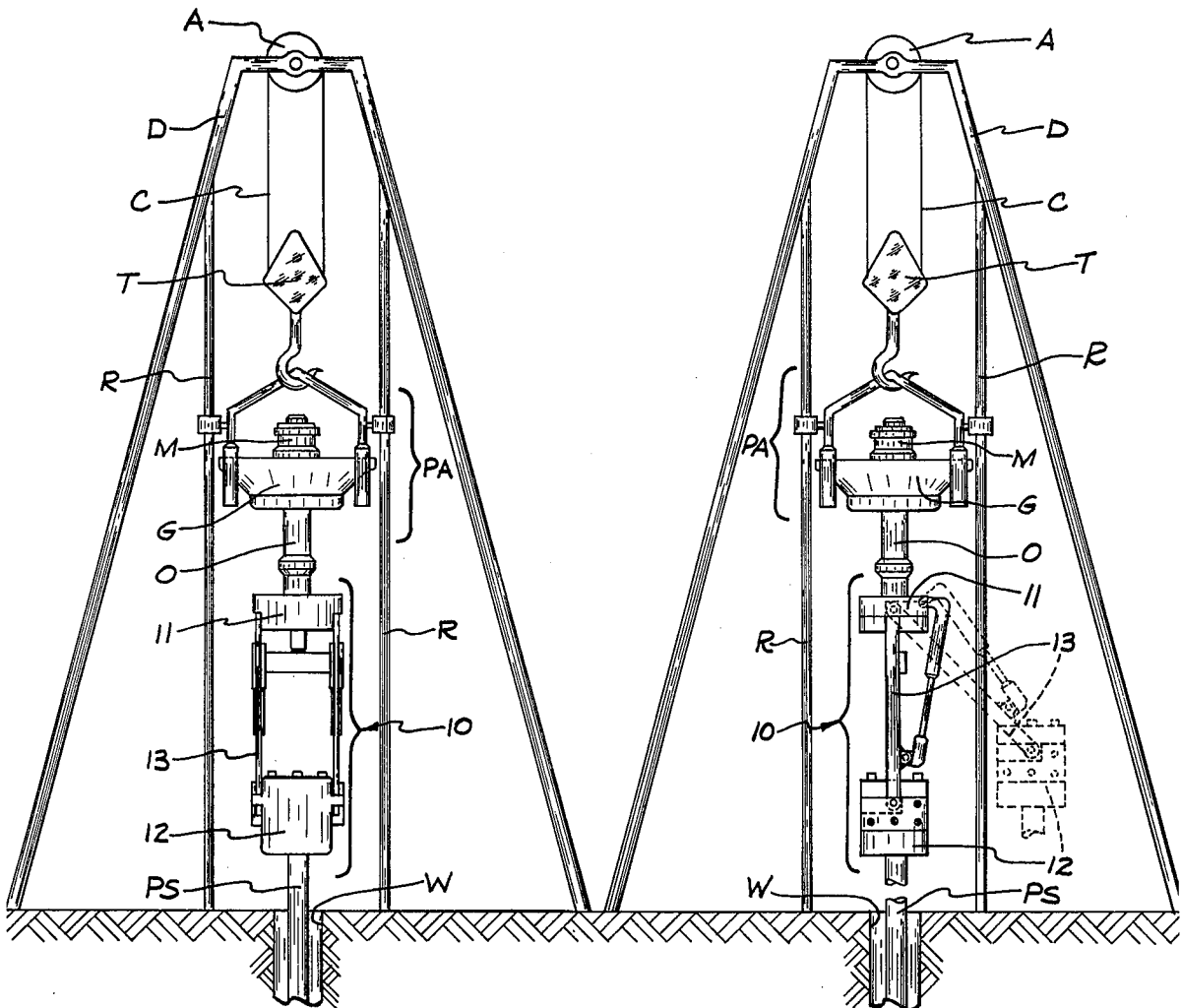


Fig. 1A

Fig. 1B

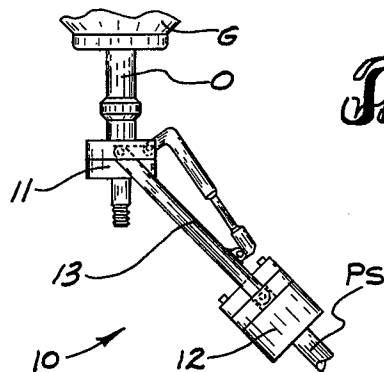
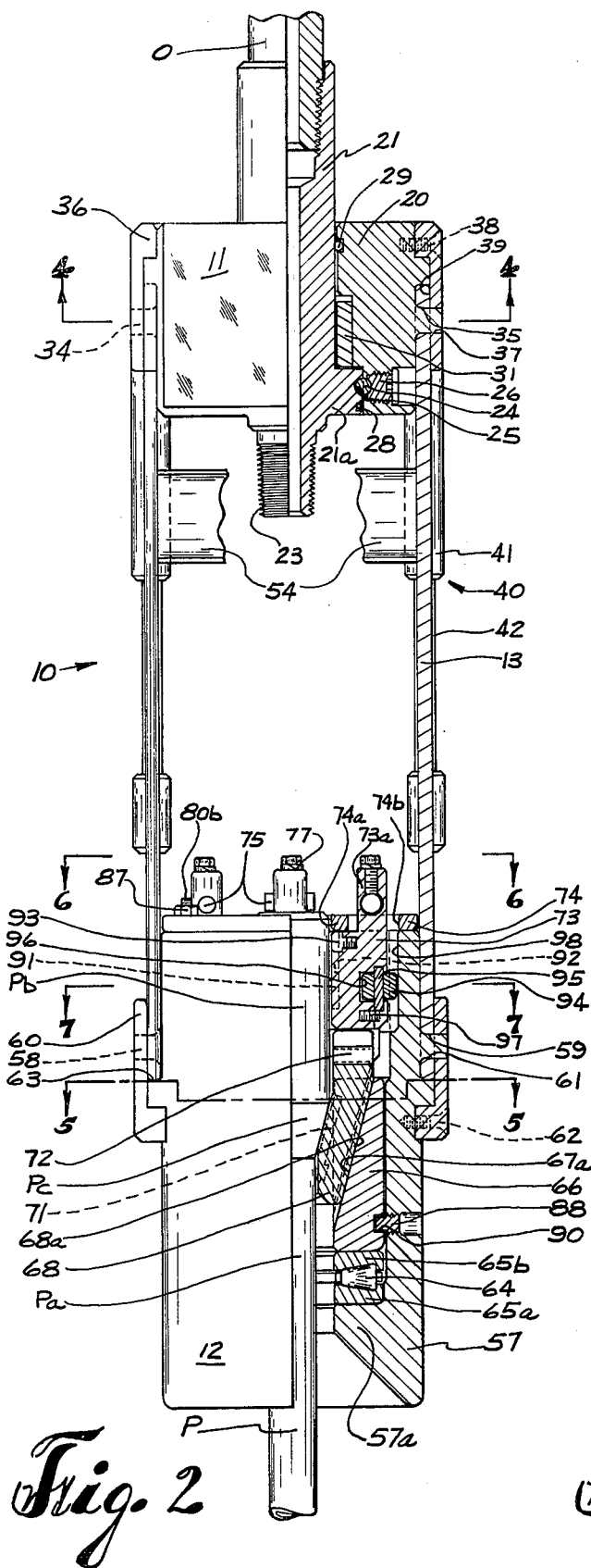
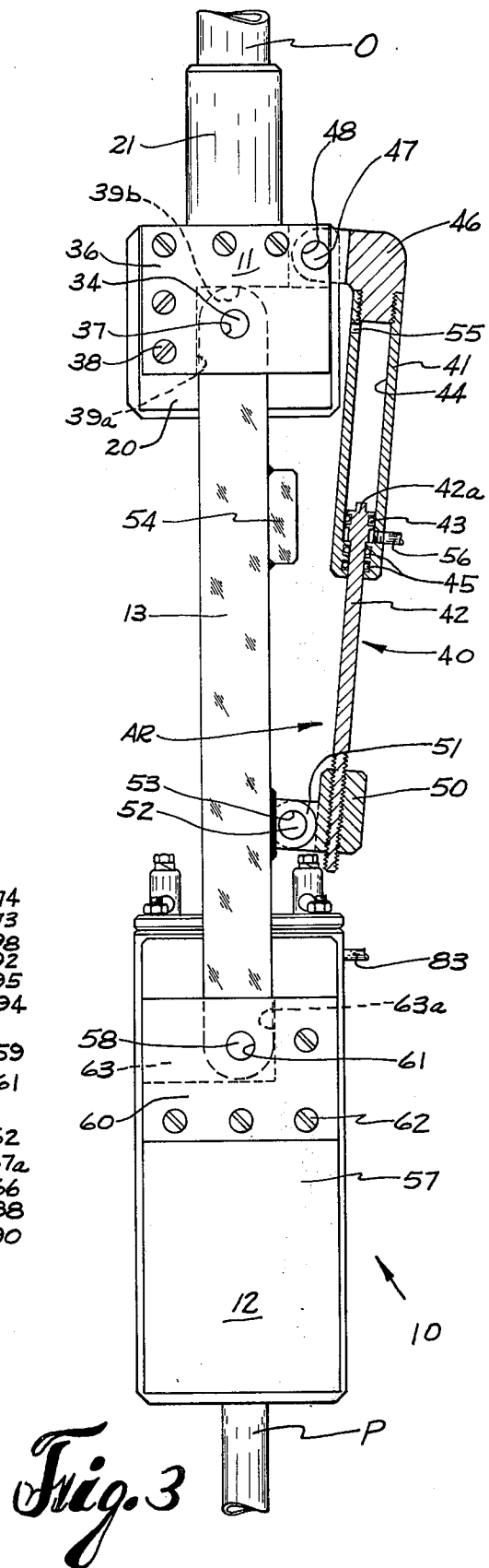


Fig. 1C



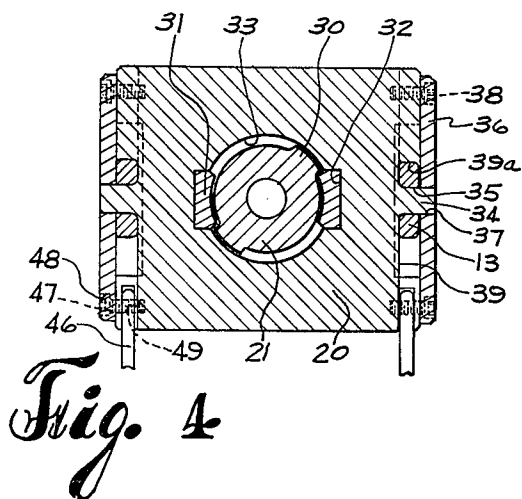
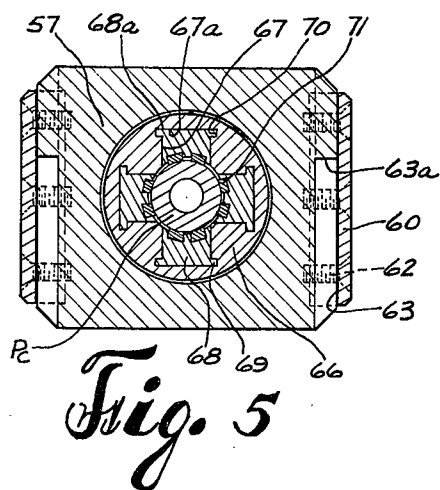
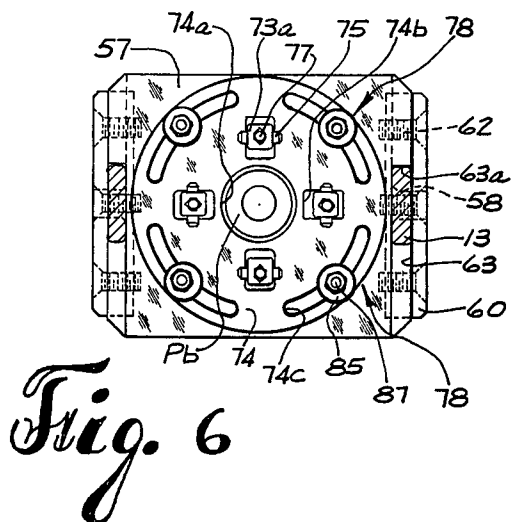
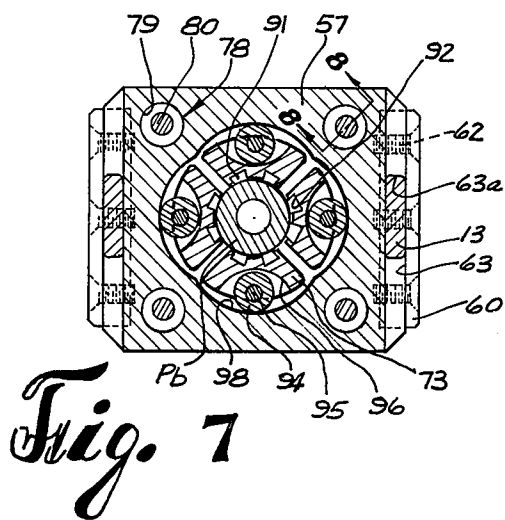
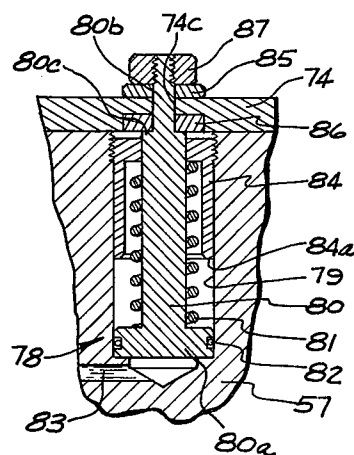
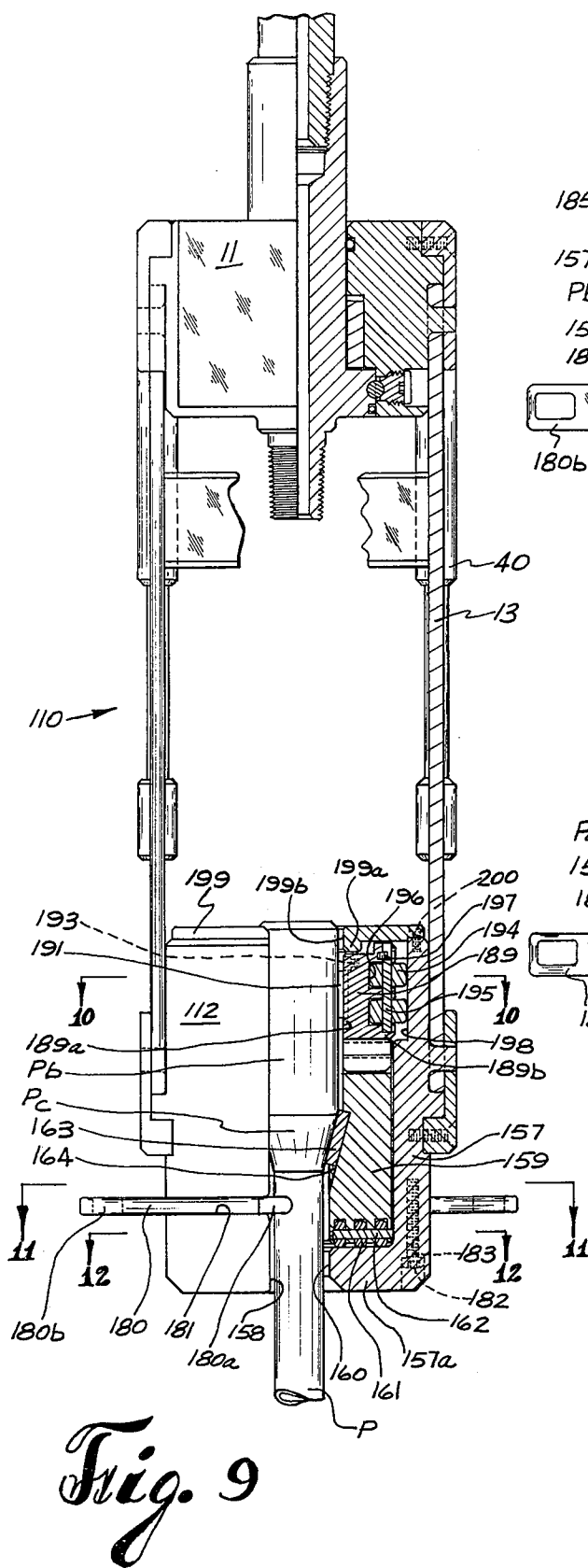
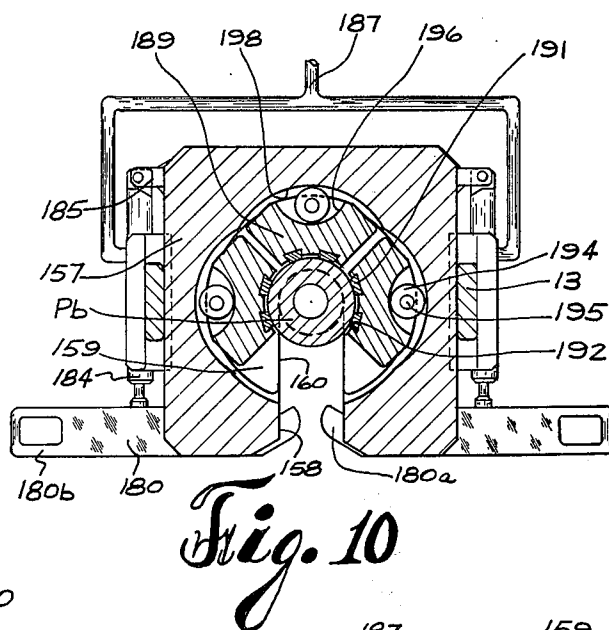
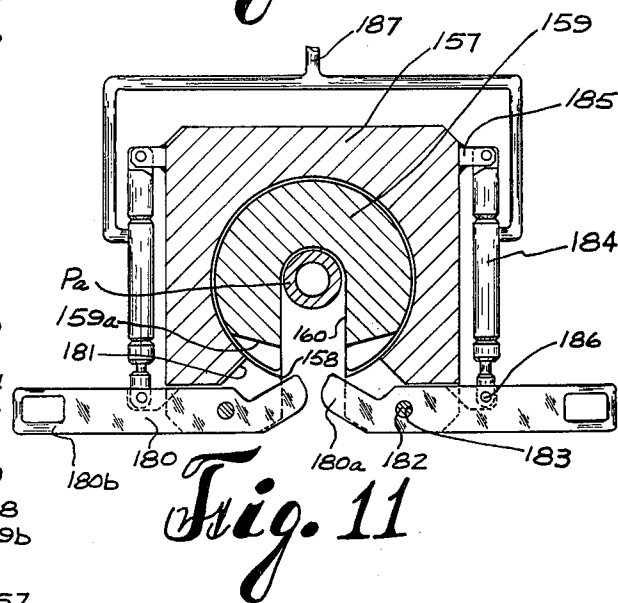
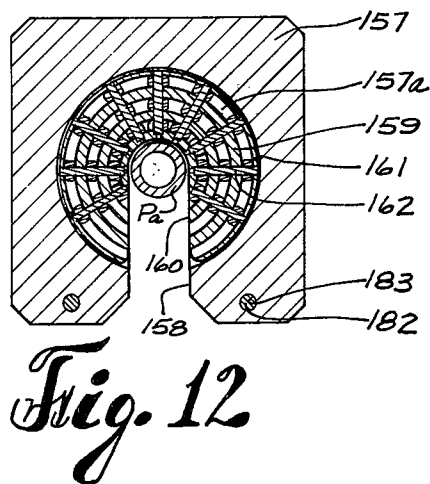
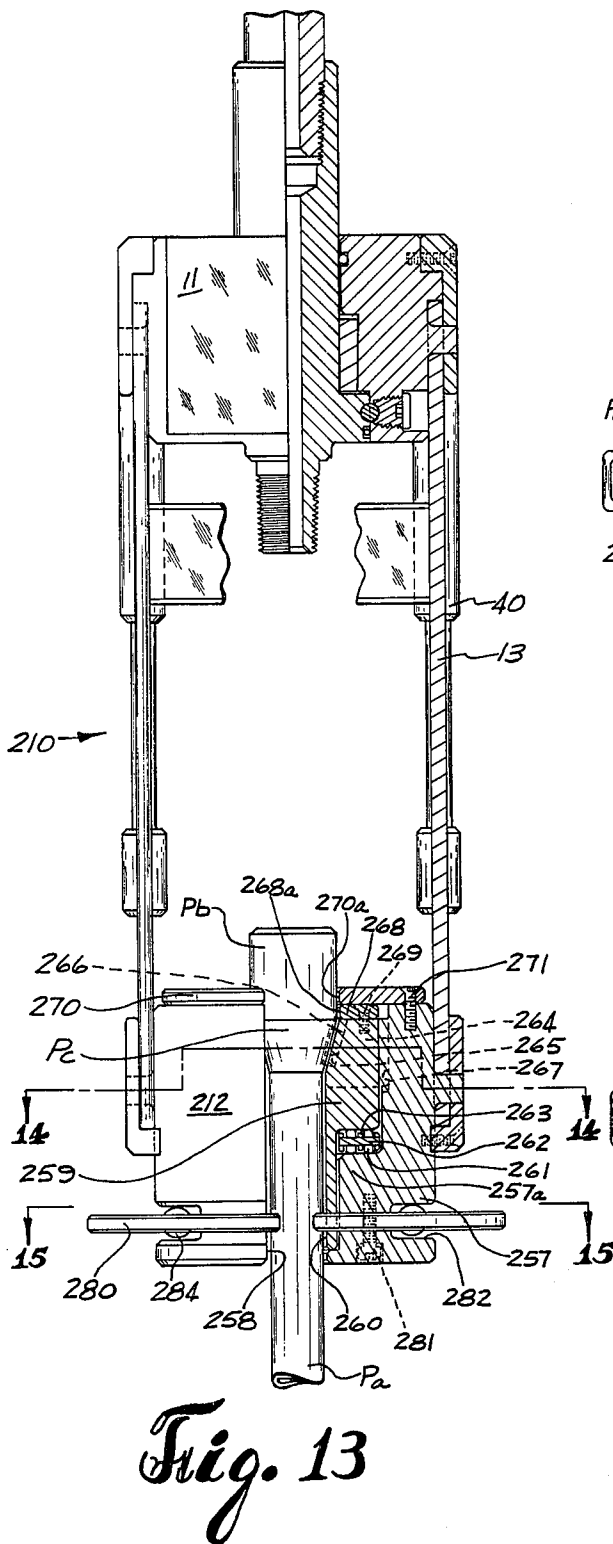
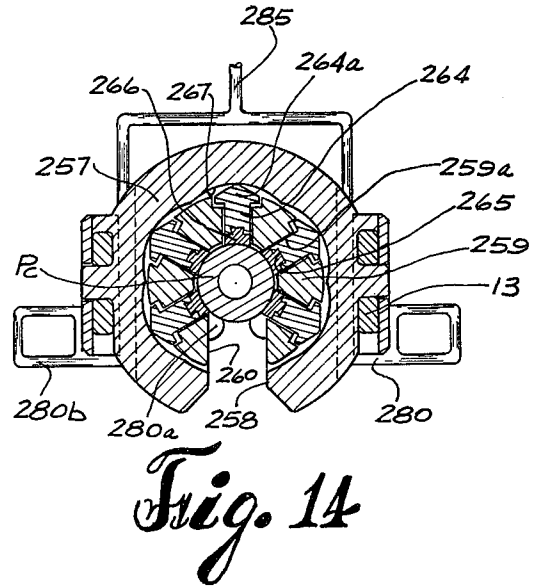
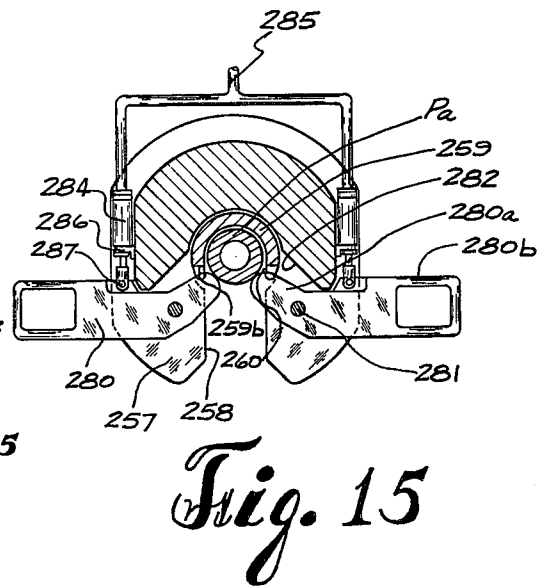


Fig. 8







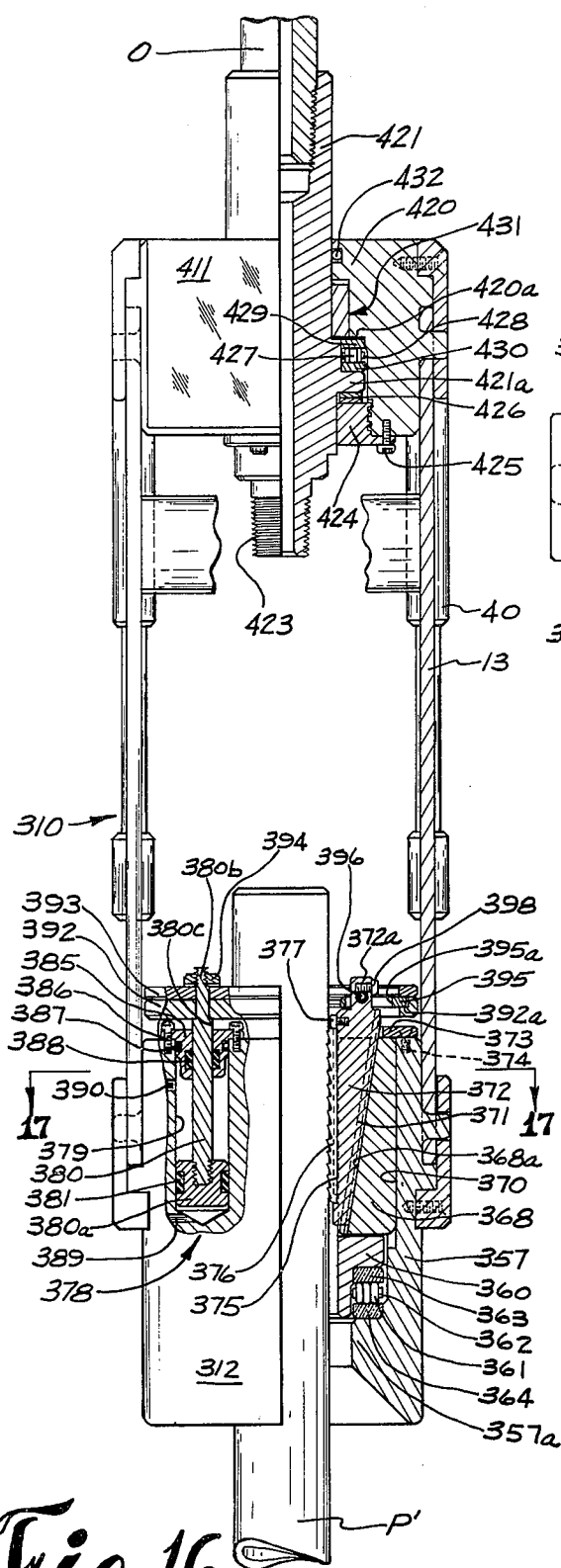


Fig. 16

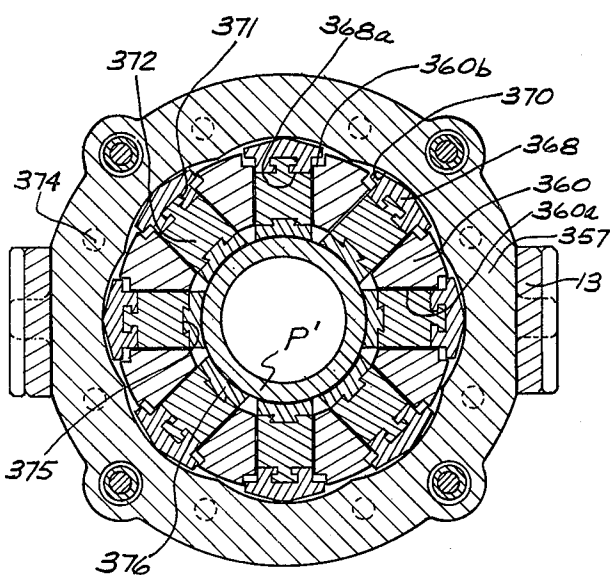


Fig. 17

BREAK OUT ELEVATORS FOR ROTARY DRIVE ASSEMBLIES

CROSS REFERENCE TO RELATED CASES

This application is related to U.S. Pat. Nos.: 3,776,320; 3,766,991; 3,467,202; 3,774,697; and U.S. patent application Ser. No. 418,065 filed Nov. 21, 1973.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains generally to the drilling and production of petroleum wells. More specifically, the invention pertains to derrick-mounted driving apparatus for rotating a drill string and for manipulating pipe members being run into or removed from a well.

2. Brief Description of the Prior Art

In the conventional method of drilling wells, large internal combustion engines or other power sources are employed to rotate a rotary table set in the floor of a drilling derrick. Slidingly engaging a square hole in the rotary table is a square kelly member to which rotary motion is imparted by the table while the kelly is free to slide vertically therethrough. The lower end of the kelly is threadedly connected to the upper end of a string of drill pipe and the rotary motion is carried to a bit located at the lower end of the string.

As lengths of pipe are added to or removed from the drill string, it is necessary to employ auxiliary equipment such as wrenches, tongs, elevators, ropes, and chains to threadedly connect and disconnect the pipe members employed in the string. This technique, which is well known, is slow and extremely dangerous.

In my U.S. Pat. Nos. 3,467,202, 3,774,697, **3,766,991** and 3,776,320 and in my U.S. patent application Ser. No. 418,065, filed Nov. 21, 1973, new and improved methods and apparatuses for drilling wells are disclosed in which the heavy rotary table, the chain drive connections, large internal combustion engines, tongs, spinning chains, manually set slips and other appurtenances of conventional well drilling equipment are eliminated. In these improved systems, a rotary power device, such as an electric motor, is supported from the traveling block of a drilling derrick for imparting rotary motion to the drill string. The rotary power device is equipped with a rotatable output shaft which may be provided with a threaded pin for connection to the upper end of a drill string.

U.S. Pat. No. 3,766,991, describes a connector device which may be connected to the output shaft of the power source to provide non-threaded engagement with the upper end of a pipe string. The connector includes a tubular housing adapted to coaxially receive the upper end of the pipe string and a set of pipe gripping shoes rockably mounted in the housing for angular movement into and out of gripping engagement with the upper end of the well pipe in accordance with the direction of angular movement of the housing relative to the pipe string. Thus, the pipe string may be rotated by the connector for drilling or joints of pipe may be connected and disconnected from the string as they are run into or removed from the well.

U.S. Pat. No. 3,776,320 disclosed an improved drive connector featuring a tubular housing having a longitudinal section removed therefrom to form a side opening through which a pipe member may be laterally placed

in the housing. In many applications, this technique of encircling the pipe member with the connector may prove to be more convenient than the method of inserting the pipe member from the bottom of the connector, as required by the aforementioned patent, particularly where the pipe has an enlarged upset end that is to be so inserted.

SUMMARY OF THE INVENTION

10 The break-out elevators of the present invention are equipped with means for moving the elevators laterally without the need for pivoting the power drive assembly from which the elevators are suspended. To this end, fluid powered cocking cylinders are employed to cock 15 the bails supporting the elevator so that the elevator swings laterally away from the vertical.

The bails mounting the elevator are also provided with a lost motion connection to the rotary drive stem of the power drive assembly so that a jarring rotary im- 20 pact may be delivered to the elevator.

The elevator may be used with powered drive means for positively moving gripping elements in the elevator into and out of engagement with a pipe which is encircled by the elevator. By this means, a firm grip may be 25 obtained even with a stationary pipe and without the need for any rotary motion. Once the gripping elements engage the pipe, cam surfaces automatically increase the gripping force exerted by the gripping means as the forces tending to rotate or draw down the pipe relative 30 to the elevator increase.

These and other features and advantages of the invention may be more fully appreciated by reference to the specification and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a front elevation schematically illustrating the drive connector assembly of the present invention, suspended below a power swivel in a well derrick; FIG. 1B is a side elevation of the present invention with the 40 drive connector assembly in a rotated position, and illustrating the cocking of the elevator; FIG. 1C is a partial side elevation of the elevator of the present invention, in cocked position, and pivoted for engaging an 45 inclined pipe;

FIG. 2 is a front elevation, in quarter-section, illustrating an exemplary embodiment of the drive connector assembly of the present invention;

FIG. 3 is a side elevation, partially in section, of the 50 assembly of FIG. 2;

FIG. 4 is a horizontal cross-section taken along the line 4—4 of FIG. 2;

FIG. 5 is a horizontal cross-section taken along the line 5—5 of FIG. 2;

FIG. 6 is a horizontal cross-section taken along the line 6—6 of FIG. 2;

FIG. 7 is a horizontal cross-section taken along the line 7—7 of FIG. 2;

FIG. 8 is an enlarged scale, partial vertical cross-section of a cylinder assembly employed in the connector assembly of the present invention taken along the line 8—8 of FIG. 7;

FIG. 9 is an elevation, in quarter-section, illustrating a modified drive connector assembly of the present in- 65 vention;

FIG. 10 is a horizontal cross-section taken along the line 10—10 of FIG. 9;

FIG. 11 is a horizontal cross-section taken along the line 11—11 of FIG. 9;

FIG. 12 is a horizontal cross-section taken along the line 12—12 of FIG. 9;

FIG. 13 is an elevation, in quarter-section, illustrating another modification of the drive connector assembly of the present invention;

FIG. 14 is a horizontal cross-section taken along the line 14—14 of FIG. 13;

FIG. 15 is a horizontal cross-section taken along the line 15—15 of FIG. 13;

FIG. 16 illustrates another modification of a drive connector assembly of the present invention; and

FIG. 17 is a horizontal cross-section taken along the line 17—17 of FIG. 16.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

The drive connector assembly of the present invention is illustrated generally at 10 in FIGS. 1A and 1B supported within conventional well derrick D. A crown block A, fixed at the top of the derrick D, supports a traveling block T by a cable C which in turn supports a rotary power assembly PA comprised of a gear assembly G powered by an electric motor M. The power assembly PA provides rotary motion to pipe and other equipment which is used in drilling or completing a well W. The assembly PA is raised and lowered by the traveling block T. Guide tracks R guide the assembly PA as it moves vertically to prevent the assembly from swinging or rotating in the derrick.

The gear assembly G is provided with a rotatable output shaft O which transmits rotary movement to the drive connector assembly 10 attached thereto. The drive connector includes a drive means or drive head 11 connected directly to the output shaft O and a gripping means or elevator 12 suspended by bails 13 from the drive head 11. The elevator 12 is illustrated gripping a pipe string PS. Rotary and vertical movements of the drive head 11 are transmitted to the pipe string PS as required to drill the well or to make up or break out pipe sections in the string. An important feature of the present invention is the ability of the assembly 10 to move the elevator 12 laterally, back and forth, relative to the central axis of the output shaft O from the position illustrated in FIG. 1A into the position illustrated in FIG. 1B. As will be hereinafter explained in greater detail, the elevator 12 is pivotally supported by the bails 13 from the drive head 11 and a powering means is provided for moving the elevator, and any pipe or equipment carried by the elevator, about the elevator's pivotal support. Such movement or orientation is required, for example, when picking up or laying down pipe segments being added to or removed from the pipe string PS.

FIGS. 2-8 illustrate details in the construction of the drive head 11 and the elevator 12. Referring initially to FIGS. 2 and 3, the drive head 11 includes a drive head housing 20 partially enclosing a tubular drive head stem 21. The stem 21 is threadedly engaged to the gear assembly output shaft O. The threaded bottom 23 of the stem 21 protrudes below the drive head housing 20 for making a threaded connection with a pipe P as required for drilling or other purposes. When the threads 23 are engaged with a drill string, the rotation of the shaft O is imparted directly to the string and drilling fluid is permitted to flow from the shaft O to the drill

string. Where fluid flow is not required and where operations other than drilling are required, the elevators 12 may be employed to impart vertical, lateral and rotary movements of the assembly 10 to well pipe or other equipment gripped by the elevators.

The housing 20 is equipped with a plurality (only one shown) of large ball bearings 24 which ride in an annular groove 25 formed in a stem shoulder 21a. The bearings 24 prevent the housing from moving axially along the stem 21 but permit limited rotational movement between the stem and housing as required for the jarring action which is to be described. Set screws 26, equipped with concave end faces, retain the bearings 24 in position. Lower and upper O-ring seals 28 and 29, respectively, prevent dirt and other debris from entering the area between the stem and housing and also retain lubricants in the enclosed area.

Referring jointly to FIGS. 2 and 4, the assembly 10 is provided with means for imparting a jarring rotary force to pipe or other equipment secured to the elevator 12. To this end, the stem 21 is equipped with splines 30 which are adapted to strike impact keys 31 carried in slots 32 formed in the housing 20. The splines 30 are free to move in pathways 33 formed between the impact keys to permit rotational movement between the stem 21 and the housing 20.

When the stem 21 is rotated relative to the stationary housing 20, the splines 30 collide with the impact keys 31. The impact of the splines with the keys produces a jarring effect in the elevator 12 which is transmitted to pipe or other equipment secured by the elevator 12. This jarring force may be repeated by slowly reversing the stem rotation to move the splines until they are adjacent the keys and then rapidly reversing the direction of stem rotation moving the splines into engagement with the opposite sides of the keys. It will be appreciated that the jarring rotational force, which may be imparted in either direction to the elevator 12, is beneficial in breaking or making-up tightly threaded connections in pipe strings. Any suitable means (not illustrated) may be employed for providing a back-up force tending to hold the lower member in the threaded connection stationary during the jarring movements. Also, suitable means may be provided to prevent the stem 21 from unthreading from the shaft O so that the shaft may be rotated in either forward or reverse directions.

Trunions 34 on the housing 21 pivotally suspend the bails 13. The trunions pass through bores 35 provided at the upper ends of the bails. Trunion caps 36, equipped with openings 37 for the trunion ends, are employed to hold the bails in place. The trunion caps 36 are secured to the drive head housing 20 with screws 38.

The upper ends of the bails 13 are positioned in rectangular recesses 39 formed between the housing 20 and the trunion caps 36. As best seen in FIG. 3, each recess 39 has a vertical end wall 39a which limits rotation of the bail. The bails 13 are rotatable, from their lowermost position illustrated in FIG. 3, counterclockwise in the direction of the arrow AR until they engage a second shoulder 39b.

Bail rotation is controlled by a pair of fluid pressure cylinder mechanisms, indicated generally at 40. Each cylinder mechanism 40 includes a cylinder 41 and a piston rod 42 connected to a piston head 42a. The head 42a is equipped with an O-ring seal 43 which forms a slidable seal with the internal bore 44 of the cylinder

41. O-ring seals 45 at the base of the cylinder 41 provide a slidable seal with the smooth cylindrical surface of the piston rod. The top of the cylinder 41 connects to an L-shaped member 46 which in turn is rotatably anchored by a pivot pin 47. The pin 47 extends through a bore 48 in the associated trunion cap 36 and threadedly engages the drive head housing 20 in a threaded bore 49 (FIG. 4).

The lower end of each piston rod 42 is also pivotally connected to its respective bail 13 at a point along the lower half of the bail by an L-shaped connecting member 50. The connecting member is threadedly secured to the rod 42 and is pivotally connected to the bails 13. The latter connection is provided by means of clevis jaws 51 which are welded to the bails and have a pivot pin 52 which passes through the member 50 and through bores 53 in the clevis jaws. A tie bar 54 joins the two bails 13 to assure their coordinated movement, and to reduce twisting of the drive connector 10 when it is being rotated by the power assembly PA (FIG. 2).

A bore 55 in the upper end of each cylinder 41 permits air to pass in and out of the cylinder as the piston head 42a moves through the cylinder 41 to prevent an air lock. Pressurized fluid for driving the piston through the cylinder is introduced into the cylinder 41 through a connector 56. Sealed rotary fluid connectors, such as the type shown in my U.S. Pat. No. 3,766,991, previously mentioned, may be employed to provide the necessary connections between stationary fluid sources (not illustrated) and rotating fluid lines, such as the connector line 56. Controlled fluid pressure is applied to both cylinder devices 40 simultaneously, preferably from a common source, causing them to elongate and contract in unison. As the members 40 contract, the bails 13 are forced to rotate about their pivot pins 34. This movement causes the elevator 12 to cock, that is, to rise and move laterally along an arcuate path relative to the central axis of the output shaft O. When the fluid pressure acting in the cylinder is reduced sufficiently, the weight of the elevator, and any equipment secured thereto, forces the bails 13 back to a vertical orientation.

With controlled application of pressurized fluid to the connectors 56, the piston heads 42a may be held in any desired position within the cylinders 41 so that the elevator 12 may be held or moved to a desired lateral position relative to the central axis of the output shaft O. The drive connector assembly 10 may be rotated by the power assembly PA to any angular position, which coupled with the lateral motion capability of the elevator 12 provides a wide range of movement.

The elevator 12 includes an elevator housing 57, on two opposite sides of which are located trunions 58. The trunions are rotatable within bores 59 formed in the lower ends of the respective bails 13, so that the bails pivotally support the elevator 12. The bails are held on the trunions 58 by trunion caps 60 equipped with bores 61 through which the trunions 58 extend. The caps 60 are fixed to the elevator housing 57 by screws 62.

The lower ends of the bails 13 are positioned in recesses 63 formed between the housing 57 and the trunion caps 60. As best seen in FIG. 3, each recess 63 has a vertical end wall 63a which limits the extent of rotation of the bail 13 with respect to the housing 57. As the bails 13 are pivoted upwardly by the action of the cylinder devices 40, the elevator 12 is lifted and moved

laterally. During this movement, the weight of the elevator tends to cause the elevator to hang vertically by the trunions 58 as indicated in FIG. 1B. The elevator may be manually pivoted about the trunions 58 into the operative position shown in FIG. 1C as required to engage a pipe or other equipment which is non-vertically oriented. Similarly, pipe or equipment carried in the elevator 12 may be swung or pivoted into a non-vertical position as required.

With reference specifically to FIGS. 2 and 5-7, it may be seen that the elevator housing 57 is generally tubular, and includes a central opening through which pipe members P or other equipment may be inserted from below. As will be explained, the elevator housing contains gripping means which are movable radially into an open position as required to receive a pipe and then are movable to close and grip the pipe for transmitting to it the movement of the elevator. The gripping equipment is mounted above a radially inwardly extending annular housing shoulder 57a which supports a plurality of tapered roller bearings 64 positioned between a lower raceway 65a, resting directly on the housing shoulder 57a, and an upper raceway 65b. A cylindrical slip bowl 66 rests on the upper raceway 65b, and is rotatably movable, to a degree, with respect to the housing 57 for a purpose to be described.

The slip bowl 66 is equipped with four mount guides 67 within which four slip mounts 68 are movably carried. Wings 69 on the slip mounts slide in grooves 70 in the side of the mount guides. Each of the guides 67 has an inclined rear bearing surface 67a which engages an oppositely inclined bearing surface 68a formed on the slip mounts 68. As the slip mounts move upwardly through the mount guides 67, the wing and groove engagement of the slip mounts 68 forces the slip mounts to move radially away from the central axis of the slip bowl 66. Pipe gripping slip dies 71, having horizontally extended teeth, are carried in the mounts 68 and are moved by the mounts into and out of pipe gripping engagement with the pipe P extending through the bowl 66 in a manner to be described. The slip dies are conventional except to the extent that the teeth extend horizontally rather than vertically.

The top of each of the four slip mounts 68 forms a sliding T-head and slot union 72 with the bottom of a cam shoe 73 which is also a part of the pipe gripping means of the elevator 12. The unions 72 are designed to permit relative radial movement between each slip mount 68 and the cam shoe 73 with which it is engaged. All other relative movements between the two components are prevented.

FIGS. 2 and 6 best illustrate an annular keeper plate 74 with a central, circular aperture 74a which is positioned at the top of the elevator housing 57. Each of the four cam shoes 73 is equipped with an upwardly extending rectangular shaft 73a which passes through an oversized slot 74b in the keeper plate 74. As will be explained, the gripping elements contained within the housing 57 are moved into and out of gripping engagement with a pipe extending through the housing by raising and lowering the plate 74 relative to the housing 57. Upward movement of the plate 74 is transmitted to a lift pin 75 which passes laterally through each shaft 73a and is held in place in the shaft by a bolt and lock washer combination 77. As seen in FIG. 6, the lift pins 75 extend laterally beyond the oversized slots 74b to prevent the keeper plate 74 from moving upwardly past

the pins. The bodies of the cam shoes 73 are too large to pass through the plate slots 74b and the cam shoes are thus constrained to move vertically upwardly and downwardly with the plate 74.

Vertical movement of the plate 74 is controlled by four fluid pressure piston-cylinder assemblies, shown generally at 78, in FIGS. 6, 7 and 8. The cylinders are formed by bores 79 in the elevator housing 57. Each of the assemblies 78 includes a piston rod 80 with a piston head 80a which is biased downwardly in each cylinder 79 by a spring 81. Each piston head 80a is movingly sealed in its cylinder 79 by a slidable O-ring seal 82. Pressurized fluid from an external source (not shown) enters the cylinder bore 79 below the piston head 80a through a fluid connection 83, and drives the piston rod 80 upwardly, compressing the spring 81. The lower end 84a of a sleeve retainer 84, threadedly engaged with the elevator housing 57, limits the upward movement of the piston head 80a.

Each piston rod 80 end 80b extends through a curved slot 74c formed in the keeper plate 74. Washers 85 and 86 are positioned above and below the keeper plate 74, respectively, and a nut 87 is secured to the threaded end of each piston rod. The lower washer 86 abutts on a shoulder 80c of the piston rod 80 at the base of the shaft 80b. The washers 85 and 86 act as retainers which prevent relative vertical or axial movement between the plate 74 and the piston rods 80 but permit the rods to move laterally along the curved slots 74c. Such relative motion occurs when the housing 57 and cylinder assemblies 78 rotate relative to the keeper plate 74 as will be explained hereinafter.

When fluid pressure drives each piston 80 upwardly, the piston shoulders 80c on which the lower washers 86 are resting lift the washers and the keeper plate 74 away from the top of the housing 57; with a decrease in the pressure of the driving fluid, the piston 80 is allowed to fall by gravity and the return force of the spring 81, and, the keeper plate 74 likewise falls. A second fluid supply connection (not shown) may be provided to introduce pressurized fluid into the cylinder 79 above the piston head 80a to positively drive the piston 80 and the keeper plate 74 downwardly. In the latter event, the sleeve retainer 84 as well as the piston 80 are appropriately fluid sealed in the cylinder 79 above such second connection.

The four pistons 80 are linked together by the keeper plate 74 and are operated in unison. To this end, all of the assemblies 78 are preferably supplied with pressurized fluid from a common supply line (not shown).

Referring to FIG. 2, it is noted that the pipe P, which is conventional, has three parts: a relatively narrow body Pa; a larger-diameter collar Pb; and a frusto-conical or tapered section Pc joining the collar with the body. In order to receive the pipe P, the gripping mechanism within the elevator 12 must be retracted sufficiently to permit the collar Pb to enter the bottom and pass out through the top of the elevator. Then, in order to grip and support the pipe, the gripping means must be closed sufficiently to engage the pipe. The initial retraction is accomplished by pressurizing the assemblies 78 to raise the plate 74 away from the top of the housing 57. As the plate is raised, the four cam shoes 73 are also raised. The cam shoes 73, acting through the T-head and slot unions 72, raise the slip mounts 68 upwardly through the mounting guides 67 and the wing and groove connections between the mounts 68 and

the guides 67 force the slip mounts radially outwardly as they are being raised. In this way, the central portion of the elevator 12 is cleared for the enlarged upset portion Pb of the pipe P. The slip bowl 66 is unable to move upwardly with the plate 74 because of one or more set screws 88, which are engaged in the elevator housing 57, and project into a lateral groove 90 formed in the slip bowl 66. The set screws 88 permit limited relative rotational motion between the slip bowl 66 and the housing 57 but prevent any relative axial movement between the two bodies.

Each cam shoe 73 is fitted with a pair of slip dies 91, inserted from the top into dove tail grooves 92 formed in the inner faces of the cam shoes. (FIGS. 2 and 7). The lower ends of the dies 91 are supported by the base of the grooves 92 and screws 93 threadedly engaged with the cam shoes 73 hold the dies in their grooves. The slip dies 91 are similar to the slip dies 71 except that the dies 91 have vertically extending teeth as required to best transmit rotary motion and the dies 71 have horizontally extending teeth as required to best provide vertical support.

Each of the cam shoes 73 is also fitted with a roller 94 mounted on a vertical shaft 95. The shaft and roller are set in a recess 96 in the outer surface of each cam shoe with the shaft being held in place by a screw 97. As seen best by joint reference to FIGS. 2 and 7, each roller 94 contacts and rides on an arcuate cam surface 98 formed along the internal surface of the housing 57.

In operation, the plate 74 is raised away from the housing 57 so that the center of the elevator 12 is opened sufficiently to permit the entire pipe head Pb to be passed completely through the elevator. When the plate 74 is returned to the top of the housing 57, the cam shoes 73 and the attached slip mounts 68 are forced to move downwardly and the slip mounts move radially inwardly as they are forced to slide along the inclined bearing surfaces 67a. The elevator 12 is then raised, of the pipe P is lowered, until inclined slip dies 71 engage the tapered section Pc of the pipe P as illustrated in FIG. 2. In this position, the dies 71 and slip mounts 68 provide vertical support for the pipe. When relative rotary forces are developed between the pipe and the elevator, the slip bowl 66 begins to rotate relative to the housing 57. The relative movement causes the camming surfaces 98 to move rotationally relative to the rollers 94 which in turn causes the dies 91 to engage the pipe section Pb as the camming forces the shoes 73 to move radially inwardly. As this inward movement occurs, the radial gripping forces exerted by the dies 91 against the gripped pipe increase which reduces the possibility of slippage between the dies and the pipe. As a consequence, the described assembly provides an increasingly radially directed force as the force tending to rotate the pipe relative to the elevator increases. Such relative movement may occur when the elevator 12 is rotating or attempting to rotate the pipe P or when the elevator is attempting to hold a rotating or torqued pipe stationary. Because of the shape and placement of the cam surfaces, the described effect occurs for rotation in either direction. The previously described T-head and slot connections between the slip mounts 68 and the cam shoes 73 accommodate the radial movement of the cam shoes which occurs while the mounts are radially fixed. Rotational movement of the housing 57 relative to the slip bowl 66, which is fixed

rotationally relative to the cam shoes 73, is accommodated by the set screw 88 and groove 90 connection.

Another embodiment of a drive connector with an elevator 112 designed to accommodate pipe members with enlarged ends is shown generally at 110 in FIGS. 9-12. The drive head 11, bails 13, fluid cylinder devices 40, and the mode of suspending the elevator 112 for lateral movement and jarring movement are the same as described with reference to the assembly 10. The elevator 112 is provided with a housing 157 which is generally tubular in construction with a side opening 158, which extends the length of the housing. The elevator 112 is thus "open-faced" to allow pipe members P to be placed into the elevator housing 157 from the side rather than having to be inserted from the bottom. A radially inwardly constructed housing shoulder 157a supports a slip mount 159. The mount 159 is provided with a vertical cut-away slot 160 (FIG. 11) which may be aligned with the side opening 158 in the elevator housing 157 to receive or release a pipe member P. The slip mount 159 rides rotatably on the elevator housing shoulder 157a on a plurality of roller bearings 161 mounted in sets (FIG. 12) on shafts 162.

As best seen in FIG. 9, the inner surface of the slip mount 159 broadens toward the top to accommodate the frustro-conical portion Pc of the pipe member P, and, at the top, the enlarged collar end of the pipe Pb. Three slip dies 163, of the type described previously, are mounted in grooves formed in the slip mount 159 and are held in place by keeper members 164 which are welded to the mount.

To assist in the insertion and removal of pipe members P, the elevator 112 is equipped with a pair of latch bars 180, extending partially into slots 181 in the face of the elevator housing 157. The bars 180 are pivotally connected to the housing 157 by pivot pins 182 introduced from the bottom of the housing 157 into threaded bores 183. Fluid cylinder assemblies 184 (FIG. 11) are mounted on the elevator housing 157 by brackets 185 and joined to the latch bars 180 by pivot pins 186. The assemblies 184 may be activated in unison by pressurized fluid supplied from a common fluid pressure line 187 to drive the inner ends 180a of the latch bars into the elevator opening 158. The outer ends of the latch bars provide handles 180b for manual operation.

The edges of the recesses 181 in the elevator housing 157 limit the rotation of the latch bars 180. When the latch ends 180a are in their outermost position, as illustrated in FIGS. 10 and 11, they block the side opening 158 to prevent a pipe member P within the elevator 112 from coming out of the elevator through the opening. When the latch bars 180 are pivoted inwardly about the pivot pins 182, the latch ends 180a swing inwardly into the housing recess 181 to clear the side opening 158 to permit the passage of pipe members P therethrough. When the latch bars 180 are pivoted inwardly, if the mount opening 160 is not aligned with the housing opening 158, they will engage cam surfaces 159a on the mount 159 to rotate the mount opening into proper position for receiving or ejecting a pipe.

Resting on the top of the slip holder 159, and joined thereto by T-head and slot unions, are three cam shoes 189, (FIGS. 9 and 10). Each cam shoe 189 is fitted with a pair of slip dies 191, inserted from the top into dove-tail grooves 192. The slip dies 191 rest on shoulders 189a at the bottom of the grooves 192, and are re-

strained from sliding out of the top of the grooves by screws 193. Each of the cam shoes 189 is fitted with a pair of rollers 194 mounted on a roller shaft 195 set in the cam shoe, and fitted within a recess 196. The shaft 195 and rollers combinations are supported by shoulders 189b and held in place by screws 197. The rollers 194 ride on arcuate camming surfaces 198 cut in the elevator housing 157.

A keeper plate 199, joined on the top of the elevator housing 157 with screws 200, is provided with an internal, annular shoulder 199a, which projects downwardly into the elevator housing, and limits the inward radial movement of the cam shoes 189. A radial opening or slot 199b extends from the central plate opening to the edge of the plate to permit lateral passage of an enlarged pipe section Pb into or out of the elevator 112.

The camming operation provided by the assembly 110, whereby the housing camming surfaces 198 force the cam shoes 189 to move inwardly against pipe end Pb to cause the dies 191 to grip the pipe sufficiently to transmit torque thereto, is the same as that described for the embodiment 10. However, because of the open-faced design of the assembly 110, there is no need to retract the slip dies 163 to clear the pipe-holding area for receiving or ejecting a pipe member P.

Another drive connector embodiment 210 with an open-faced elevator 212 is illustrated in FIGS. 13 to 15. Again, the drive head 11, bails 13, fluid cylinder devices 40, and the mode of suspending the elevator 212 for lateral movement are the same as described previously for the embodiments 10 and 110. As with the previously described open-faced elevator 112 (FIGS. 9 to 12), the elevator 212 has a generally tubular housing 257 with a slide opening 258. The opening 258 is wide enough to permit passage of the narrow shank Pa of the pipe member P, but not large enough to accommodate the wider pipe sections Pb and Pc.

An internal housing shoulder 257a supports a slip mount 259 which has a vertical slot 260 designed to align with the housing opening 258 to permit the passage of pipe members P therethrough (FIGS. 13 and 15). The slip mount 259 is rotatably supported on the elevator housing shoulder 257a by a plurality of roller bearings 261 secured to shafts 262 (only one illustrated) by washers 263. Five cam shoes 264 with T-heads 264a are slidably fitted into vertical mounting slots 259a in the slip mount 259. The inner face of each cam shoe 264 is inclined and holds, in a dove-tail union 265, a slip die 266. The dies 266 are similar to the dies 71 and 163 previously described but function to provide both vertical support and to transmit torque. The T-heads 264a of the cam shoes 264 have radially outwardly-pointed vertical edges that may slide around arcuate camming surfaces 267 cut in the elevator housing 257 (FIGS. 13 and 14). A keeper ring 268 is secured to the top of the slip holder 259 by screws 269 to prevent the slip dies 266 from being lifted out of their slots. A keeper plate 270 is held to the elevator housing 257 by screws 271. Both the keeper ring 268 and the keeper plate 270 are provided with slots 268a and 270a, respectively, to permit the pipe P to be received by or ejected from the elevator.

When rotational motion is imparted to the elevator housing 257, resistance to rotation by the pipe P results in relative rotational motion between the housing 257, and the cam shoes 264. The T-heads 264a slide along the camming surfaces 267 during this relative motion

and are driven radially inwardly, forcing the slip dies 266 to grip the frustro-conical pipe surface Pc sufficiently to be able to impart the elevator rotation to the pipe member P. Cessation of the rotation of the elevator 212 allows the release of the pipe member P, while rotation in the opposite direction results in the T-heads 264a riding the camming surfaces 267 in the other direction, and the slip dies 266 again grip the frustro-conical pipe section Pc.

The elevator 212 is also fitted with a pair of latch bars 280 to serve the dual purpose of blocking passage of a pipe member P through the housing opening 258 and of aligning the slip mount opening 260 with the housing opening. This latter function is achieved by the latch ends 280a sliding on the cam surfaces 259b (FIG. 15). The latches 280 are pivoted on pins 281 mounted in the elevator housing 257, and are positioned within a lateral, annular recess 282 in the outer periphery of the elevator housing 257. Also within the recess 282 are a pair of fluid cylinder assemblies 284, powered in unison through a common fluid pressure connector line 285. The assemblies 284 are used to pivot the latch bars about on their pivot pins 281 to align the slip mount 259 and to close or open as required to hold a pipe within or eject it from the elevator 212. The cylinder assemblies 284 are fixed to the elevator housing 257 by brackets 286 and connected to the latch bars 280 by pivot pins 287. Handles 280b are also provided on the latch bars 280 for manual operation and the ends 280a of the bars are bent inwardly to assist in aligning a pipe with the elevator side openings before the bars are opened.

FIGS. 16 and 17 illustrate a drive connector 310 with a fourth embodiment of an elevator 312. The assembly 310 is designed specifically for handling well casing or drill collars or other smooth surface pipe members P'. The elevator 312 is supported by bails 13, and moved laterally by fluid pressure cylinder systems 40 in the manner described previously. The elevator housing 357 is tubular, with an internal annular shoulder 357a formed at its bottom. A slip bowl 360 rides on a plurality of roller bearings 361 mounted on shafts 362. The bearings 361 are supported between an upper raceway 363, on which the slip bowl directly sits, and a lower raceway 364, which rests directly on the housing shoulder 357a.

Mounting slots 360a in the slip bowl 360 support and guide eight movable bearing members 368. As shown in FIG. 17, each bearing member 368 includes a T-head, fitted in the mounting slot 360a. The radially outward surface of each member 368 forms a vertical bearing surface which slides around an arcuate camming surface 370 cut in the elevator housing 357. Rotational motion of the members 368 and the slip bowl 360 relative to the housing 357 causes the members 368 to be forced radially inwardly until the T-head wings engage recessed areas 360b formed at the outer edges of the slots 360a. The radially inner face 368a of each bearing member 368 is inclined as illustrated in FIG. 16 and holds, by a T-head and slot union 371, a tapered slip amount 372. Each slip mount 372 is rotatable with its associated bearing member 368, and movable upwardly and radially outwardly, along the T-head and slot union 371. A retainer ring 373, fastened to the top of the elevator housing 357 by screws 374, overlaps the top of the bearing members 368 to hold them fixed axially within the housing.

Each slip mount 372 holds, along its radially inner face, by a vertical dove-tail union 375, a slip die 376. The slip dies 376 provide vertical support and transmit rotary motion or torque to a well casing member P' within the elevator 312. A screw 377 holds each slip die 376 in place.

As the camming action previously described drives the bearing member 368 radially inwardly, the slip mounts 372 and slip dies 376 are forced inwardly also, causing the slip inserts to grip the well casing member P' located within the housing 357. The inclined bearing surfaces acting between the slip mount 372 and the bearing member 368 produce a wedging effect which tends to increase the radially directed gripping forces exerted by the slip dies 376 as the force tending to move the pipe P' down relative to the elevator 312 increases.

Four fluid cylinder assemblies, shown generally at 378, are positioned in the outer periphery of the elevator housing 357. Each of the assemblies includes a cylinder 379, a piston rod 380, a piston head 380a, an annular packing seal 381, a cylinder cap 385 secured by screws 386, an O-ring cap seal 387 and a piston rod packing seal 388. Fluid pressure from an external source (not shown) enters the cylinder bore 379 through a fluid pressure connection 389 to drive the piston head 380a upwardly. A second fluid pressure connection 390 above the piston head 380a provides pressurized fluid to drive the piston downwardly. All four pistons are moved in unison, by pressurized fluid supplied from the same fluid pressure source (not shown).

The ends 380b of each piston rod 380 pass through a generally annular lift plate retainer 392 and a keeper ring 393. Nuts 394 are engaged to the threaded ends 380b of the piston rods 380 to hold the rods to the lift plate and keeper ring. The lift plate retainer 392 sits on shoulder 380c formed on the piston rod 380, and in turn supports a lift plate 395 which is sandwiched between the annular, radially inwardly constructed shoulder 392a of the lift plate retainer and the bottom of the keeper ring 393. When the piston rods 380 are driven up or down by pressurized fluid introduced into the cylinder bore 379, the lift plate retainer 392, the lift plate 395, and the keeper ring 393 are driven with the piston rods.

Each slip mount 372 has an extension 372a which passes upwardly through the lift plate retainer 392 and through a rectangular aperture 395a in the lift plate 395. The extension is fitted with a horizontal lift bolt 396 which spans the aperture 395a. A screw 398 locks the bolt 396 in place.

As the pistons 380 are driven upwardly by the introduction of fluid pressure into the cylinders 379 through the lower connections 389, the lift plate 395 is raised, and in turn raises the slip mounts 372 by their left bolts 396. As the mounts 372 rise, they are guided radially outwardly by their respective T-head and slot unions 371. This retracts the slip dies 376 from the center region of the elevator 312. Reversing the operation by introducing fluid into the cylinders 379 through the upper connections 390 to drive the piston heads 380a downwardly causes the slip-dies 376 to move downwardly and radially inwardly to grip the well casing member P'.

A second embodiment of a drive head 411, providing a variation of the suspension system of the drive stem

compared to that previously described, is also shown in FIG. 16. The drive head housing 420 partially encloses a tubular drive head stem 421 which is threadedly engaged to the rotary output shaft O. The threaded bottom of the stem 423 protrudes below the drive head housing 420 for threaded connection to pipe for drilling purposes.

An annular collar 424 is threadedly engaged to the bottom of the drive head housing 420, and locked against rotational motion by screws 425 threadedly engaged with the housing. The collar 424 supports a stacked pair of annular brass washer bearings 426 to bear the load of the drive stem 421 in drilling and other operations.

An annular stem shoulder 421a rests on the washer bearings 426. A plurality of roller bearings 427 are mounted on shafts 428 and constrained between an upper raceway 429 adjacent an internal housing shoulder 420a and a lower raceway 430 adjacent the drive stem shoulder 421a.

A jarring mechanism, shown generally at 431, of the type described previously, and an O-ring seal 432 complete the connection between the drive stem 421 and the drive head housing 420. The bails 13 and fluid pressure cylinder devices 40, are the same as described previously.

As used herein, the term "fluid" is intended to include both liquids and gasses. Thus, it will be appreciated that the powering devices for cocking the elevator assemblies and for moving the elevator gripping means may be powered hydraulically or pneumatically. It will also be appreciated that such powering devices may be mechanical or electrical devices and need not necessarily be fluid powered devices. Similarly, the derrick suspended powering assembly used to provide rotary power for rotating the elevators may be electrically, mechanically or fluid operated, or otherwise, without departing from the scope of the present invention.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape and materials as well as in the details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A well drilling and completion system for manipulating well equipment comprising:

- a. a vertically movable power drive assembly for providing rotary movement in a well derrick;
- b. a longitudinally extending output shaft rotatably powered about its longitudinal axis by said power drive assembly and movable vertically therewith;
- c. a connector assembly carried by said power drive assembly and rotatably powered thereby;
- d. elevator means included in said connector assembly for engaging well equipment; and
- e. powered cocking means carried by said powered drive assembly for moving said elevator means laterally relative to said output shaft.

2. A system as defined in claim 1 further including jarring means connected between said power drive assembly and said elevator means for imparting a sharp jarring force from said power drive assembly tending to rotate said elevator means.

3. A system as defined in claim 2 wherein said jarring means includes a lost motion connection between said output shaft and said elevator means.

4. A system as defined in claim 1 wherein said connector assembly is carried by said output shaft and said cocking means is included in said connector assembly.

5. A system as defined in claim 4 further including:

- a. a drive head connected to and rotatably carried by said output shaft;
- b. bails pivotally carried by said drive head and pivotally secured to said elevator means; and
- c. extensible and contractable fluid actuated cylinder and piston assemblies, included as a part of said cocking means, connected between said bails and said drive head, for moving said bails and attached elevator means laterally relative to said output shaft.

6. A system as defined in claim 4 wherein said elevator means includes radially movable gripping means for selectively gripping well equipment engaged by said elevator means.

7. A system as defined in claim 6 further including jarring means, including a lost motion connection between said output shaft and said elevator means, for imparting a sharp jarring force from said output shaft to said elevator means tending to rotate said elevator means.

8. A system as defined in claim 7 wherein said elevator means includes:

- a. a tubular housing means having a side access opening for receiving equipment within said elevator means; and
- b. powered latch means for opening or closing said access opening.

9. A system as defined in claim 6 wherein said gripping means includes rotary camming means for increasing the radially directed gripping force exerted on said equipment by said gripping means as the forces tending to rotate said equipment and said elevator means relative to each other increases.

10. A system as defined in claim 4 wherein said radially movable gripping means includes wedging means for moving said gripping means radially as said gripping means are moved axially.

11. A system as defined in claim 10 further including:

- a. a drive head connected to and rotatably carried by said output shaft;
- b. bails pivotally carried by said drive head and pivotally secured to said elevator means; and
- c. extensible and contractable fluid actuated cylinder and piston assemblies, included as a part of said cocking means, for moving said bails and attached elevator means laterally relative to said output shaft.

12. A system as defined in claim 11 further including jarring means for imparting a sharp jarring force from said output shaft to said elevator means tending to rotate said elevator means, said jarring means including a lost motion connection between said output shaft and said drive head permitting limited rotational movement of said output shaft relative to said elevator means.

13. A system as defined in claim 9 wherein said radially movable gripping means includes inclined slip means movable radially to engage and grip inclined surfaces on said equipment.

14. A system as defined in claim 13 further including:

- a. a drive head connected to and rotatably carried by said output shaft;
- b. bails pivotally carried by said drive head and pivotally secured to said elevator means; and

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c. extensible and contractable fluid actuated cylinder and piston assemblies, included as a part of said cocking means, for moving said bails and attached elevator means laterally relative to said output shaft.

15. A system as defined in claim 14 further including jarring means for imparting a sharp jarring force from said output shaft to said elevator means tending to rotate said elevator means, said jarring means including a lost motion connection between said output shaft and said drive head permitting limited rotational movement of said output shaft relative to said elevator means.

16. A system as defined in claim 11 wherein said elevator means includes:

- a. a tubular housing means having a side access opening for receiving equipment within said elevator means; and
- b. powered latch means for opening or closing said access opening.

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17. A well drilling and completion system for manipulating well equipment comprising:

- a. a vertically movable power drive assembly for providing rotary movement in a well derrick;
- b. a longitudinally extending output shaft rotatably powered about its longitudinal axis by said power drive assembly and movable vertically therewith;
- c. a connector assembly carried by said power drive assembly and rotatably powered thereby;
- d. elevator means included in said connector assembly for engaging well equipment; and
- e. jarring means connected between said power drive assembly and said elevator means for imparting a sharp jarring force from said power drive assembly tending to rotate said elevator means.

18. A system as defined in claim 17 wherein said jarring means includes a lost motion connection between said output shaft and said elevator means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,915,244 Dated October 28, 1975

Inventor(s) CICERO C. BROWN

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 8, line 40, "of" should be -- or --;

Column 11, line 62, "amount" should be -- mount --;

Column 14, line 38, "4" should be -- 9 --;

Column 15, line 13, "11" should be -- 15 --.

Signed and Sealed this

tenth Day of *February* 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks