

- [54] **CHAIN DRIVEN SPINNING, MAKE UP AND BREAK OUT TONGS**
- [72] Inventors: **Bela Geczy, Glendale; Carl Alfred Wilms, La Habra, both of Calif.**
- [73] Assignee: **Byron Jackson, Inc., Long Beach, Calif.**
- [22] Filed: **April 16, 1971**
- [21] Appl. No.: **134,554**
- [52] U.S. Cl. **81/57.14, 81/57.18**
- [51] Int. Cl. **B25b 17/00, B25b 21/00**
- [58] Field of Search.... **81/57.14, 57.18, 57.19, 57.21, 81/57.39**

2,649,283	8/1953	Lundeen.....	81/57
2,650,070	8/1953	Lundeen.....	81/57
2,573,212	10/1951	Martois	81/57

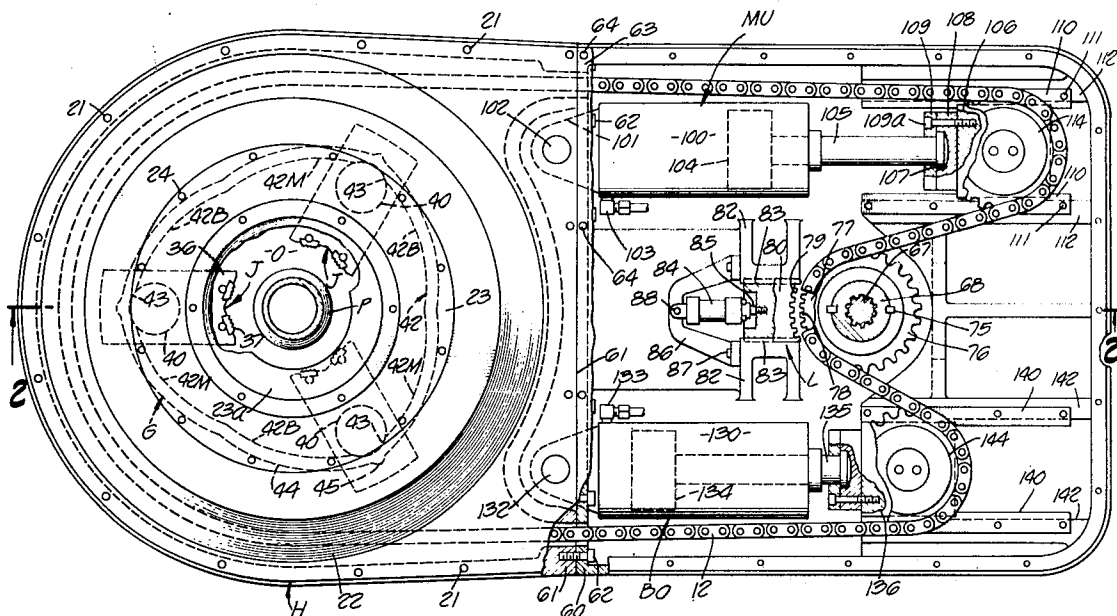
Primary Examiner—James L. Jones, Jr.
Attorney—Donald W. Banner, William S. McCurry and John W. Butcher

[57] **ABSTRACT**

A tong for spinning, making up and breaking out pipe joints, in which a chain drives the rotatable pipe gripping means and the chain is driven by a rotary fluid motor for spinning a pipe, and the motor is locked to anchor the chain during final make up and initial break out of the pipe joint, the chain being actuated by pressure responsive actuator cylinders engaging runs of the chain between the pipe gripping means and the rotary motor to apply high make up and break out torque to the pipe gripping means.

20 Claims, 11 Drawing Figures

- [56] **References Cited**
- UNITED STATES PATENTS**
- 2,879,680 3/1959 Beeman et al.....81/57
- 2,618,468 11/1952 Lundeen.....81/57



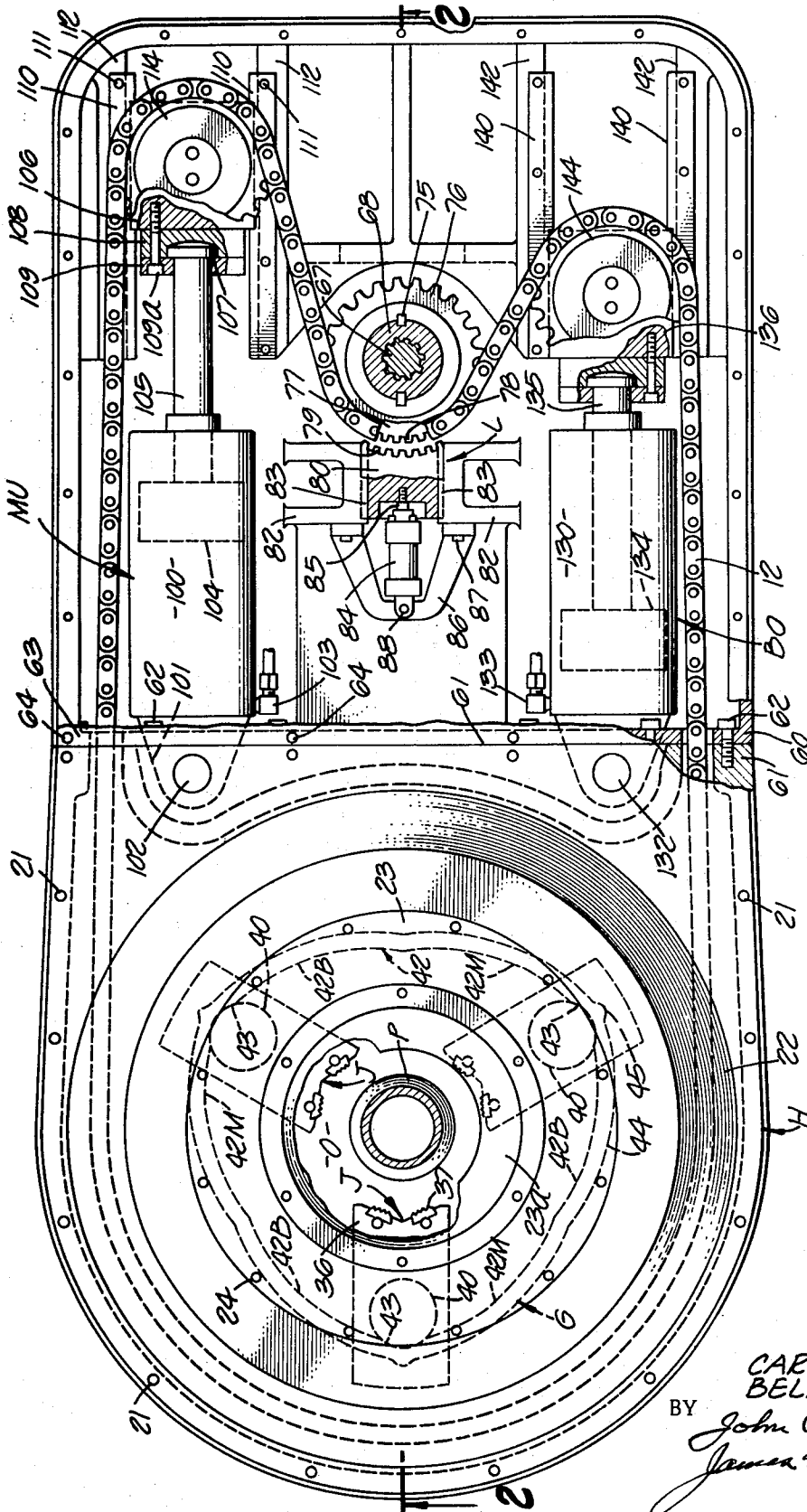


FIG. 1.

INVENTORS.
CARL A. WILMS
BELA GECZY
BY
John O. Evans, Jr.
James M. Koppa

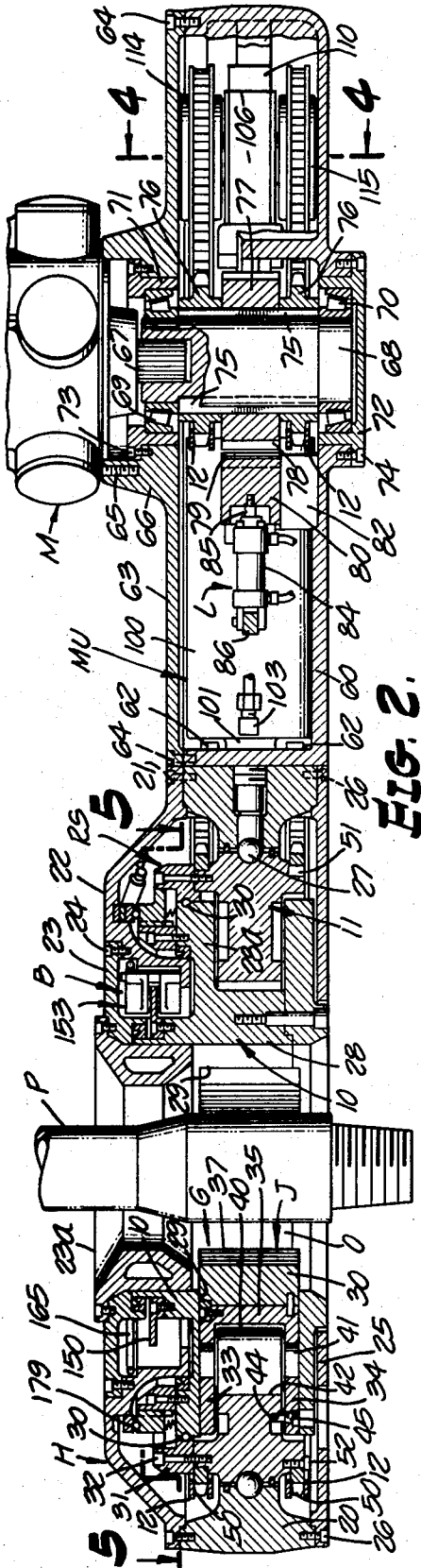


FIG. 2.

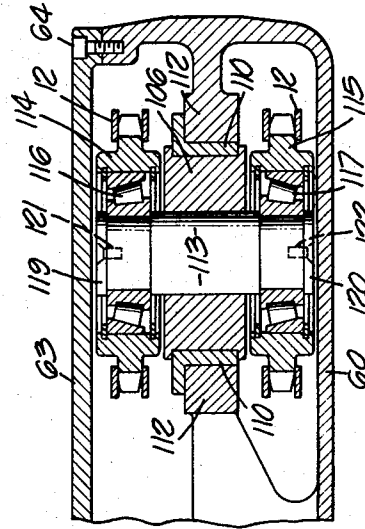


FIG. 4.

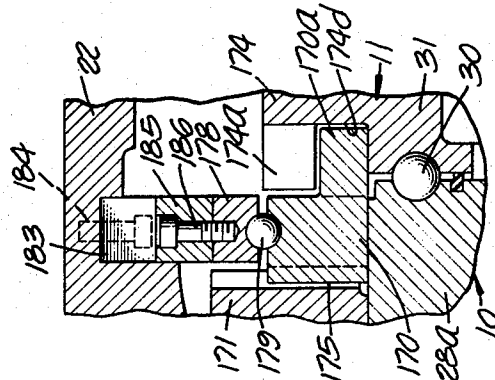


FIG. 10.

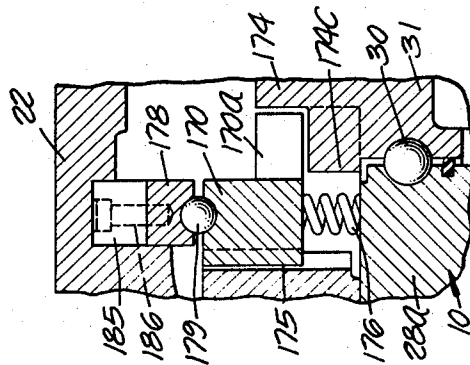


FIG. 9.

INVENTORS.
 CARL A. WILMS
 BELA GECZY
 BY John O. Evans, Jr.
 James M. Lippman

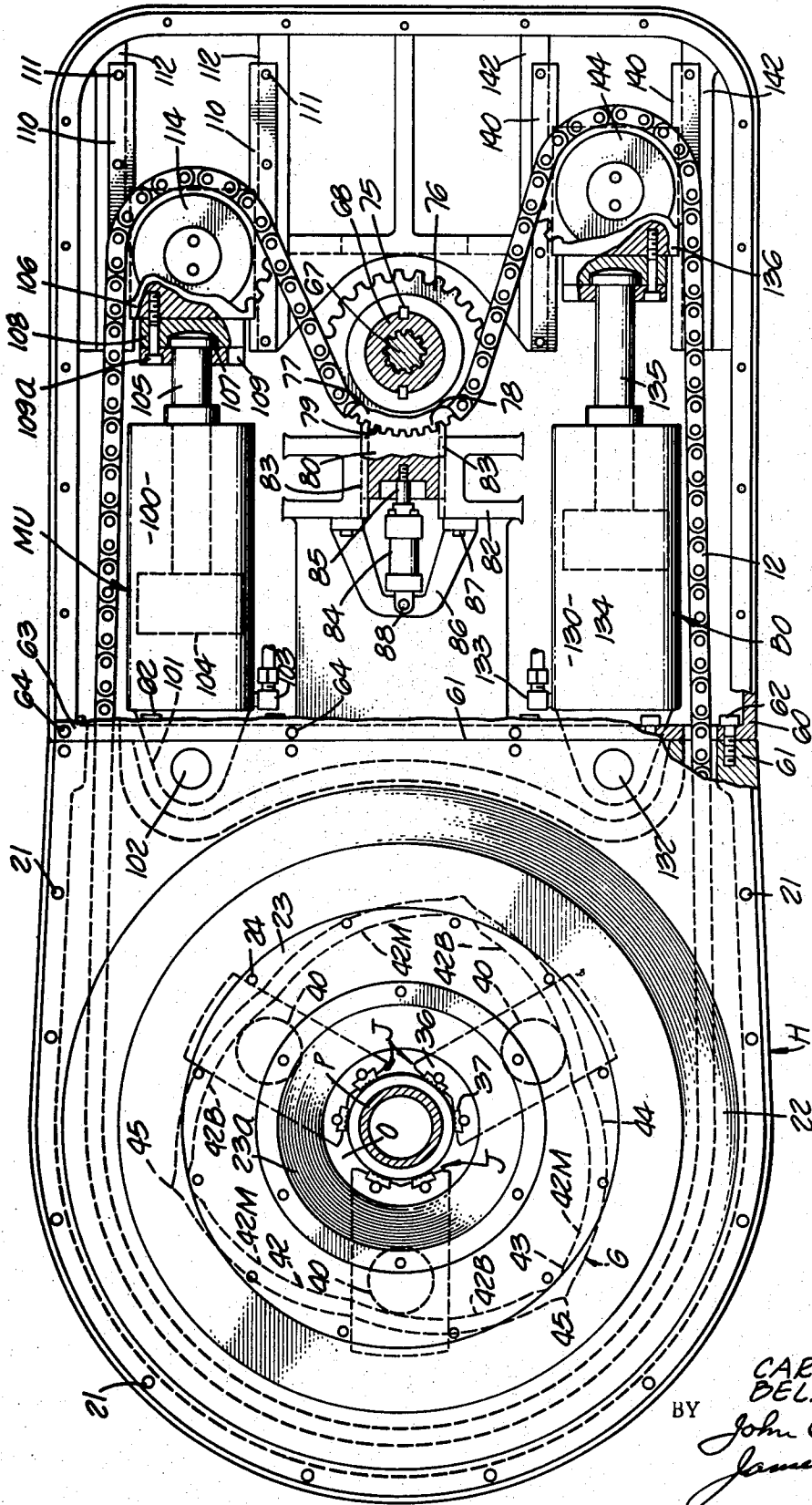


FIG. 3.

INVENTORS,
CARL A. WILMS
BELA GECZY
BY
John O. Evans, Jr.
James M. Lippard

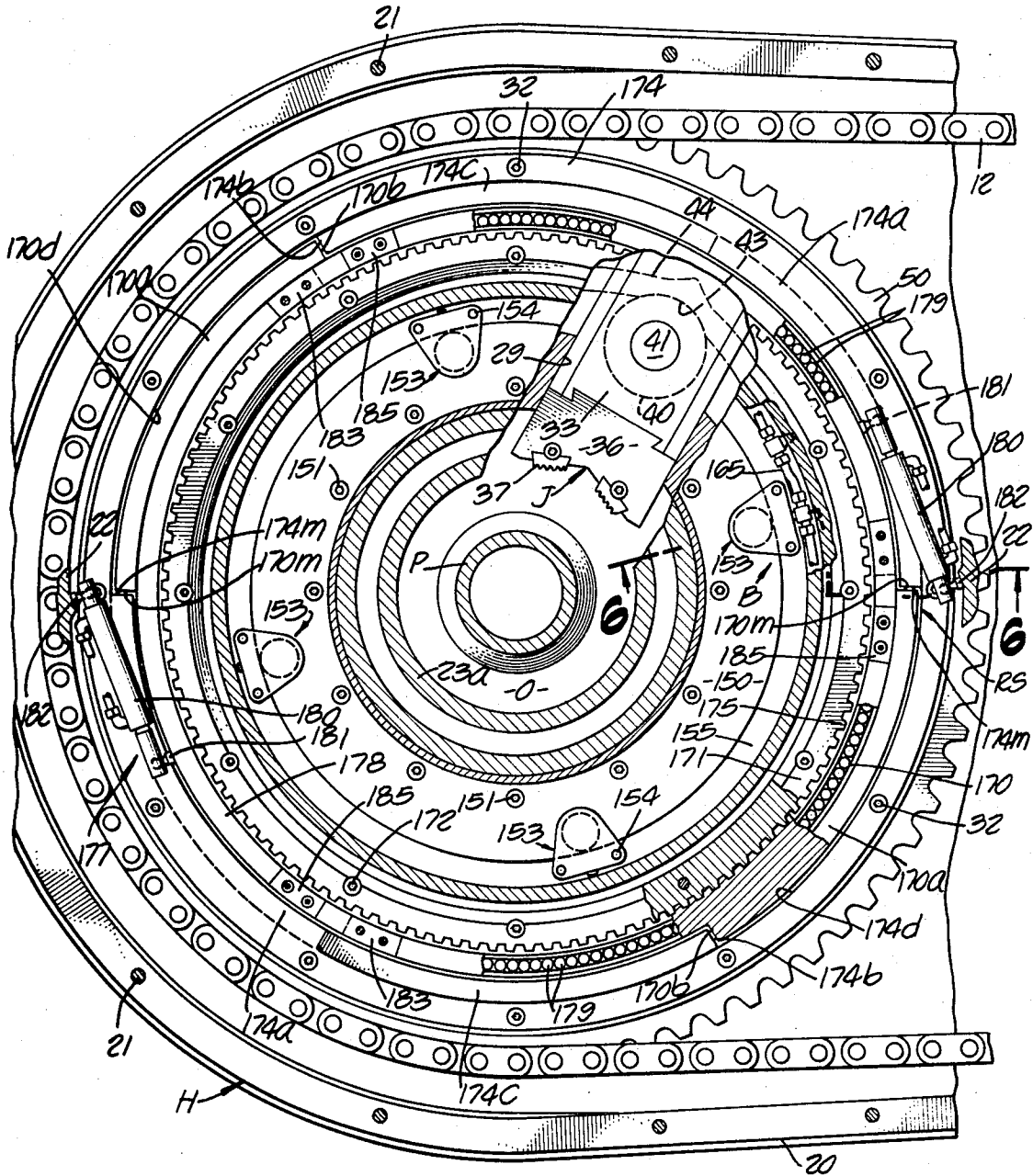


FIG. 5.

INVENTORS.
CARL A. WILMS
BELA GECZY
BY John O. Evans, Jr.
James M. Leppner

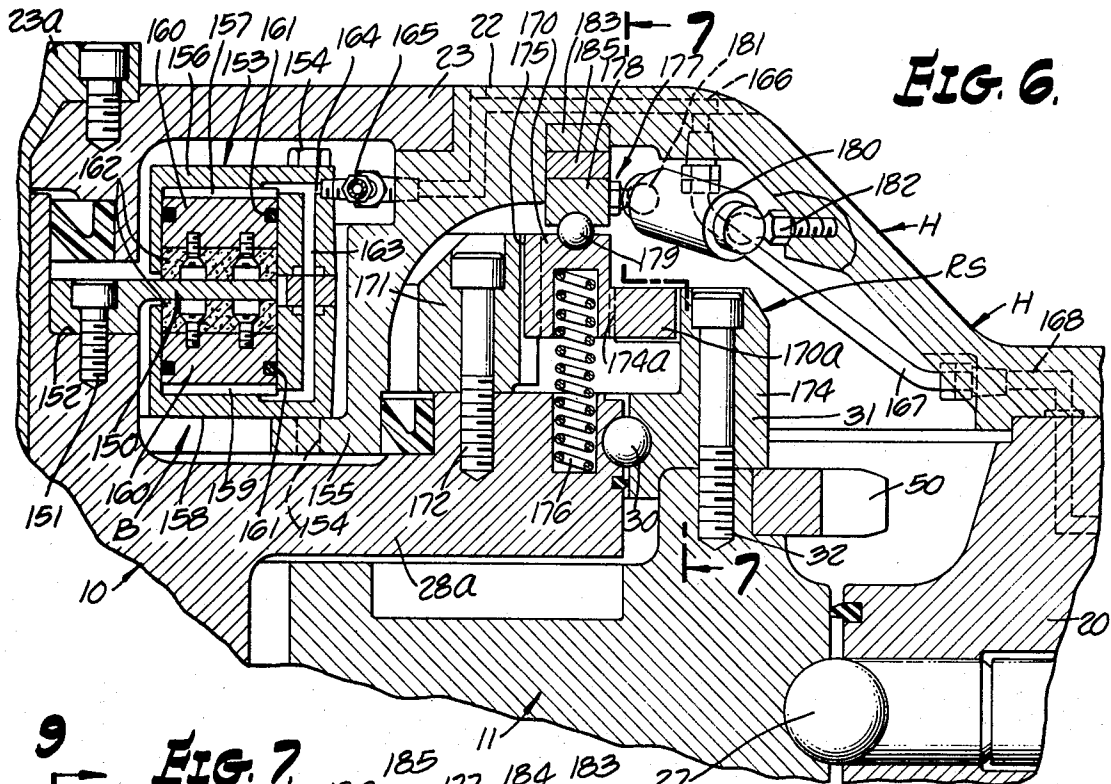


FIG. 6.

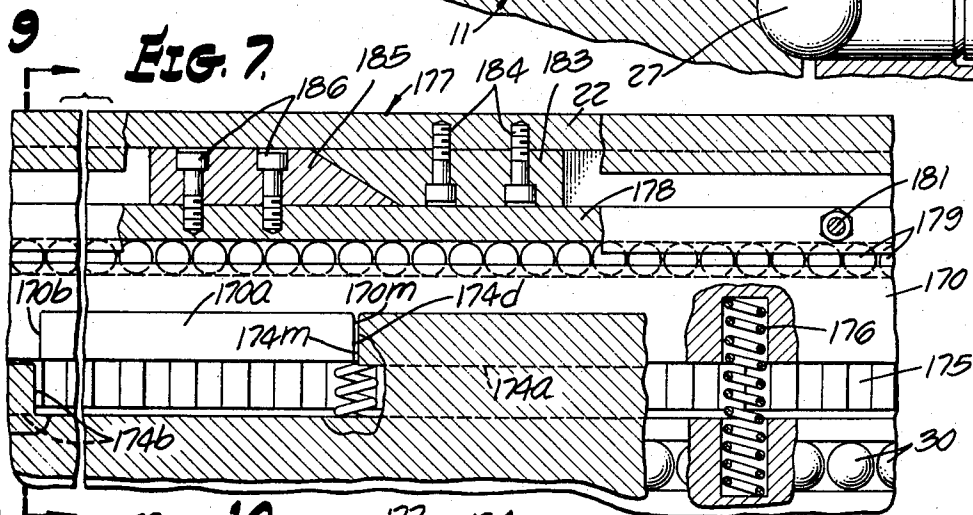


FIG. 7.

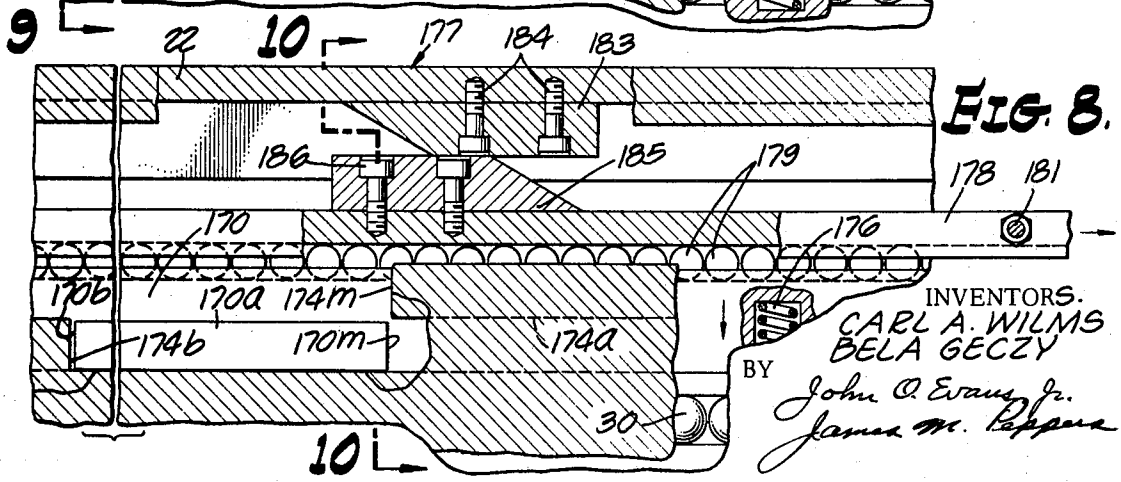
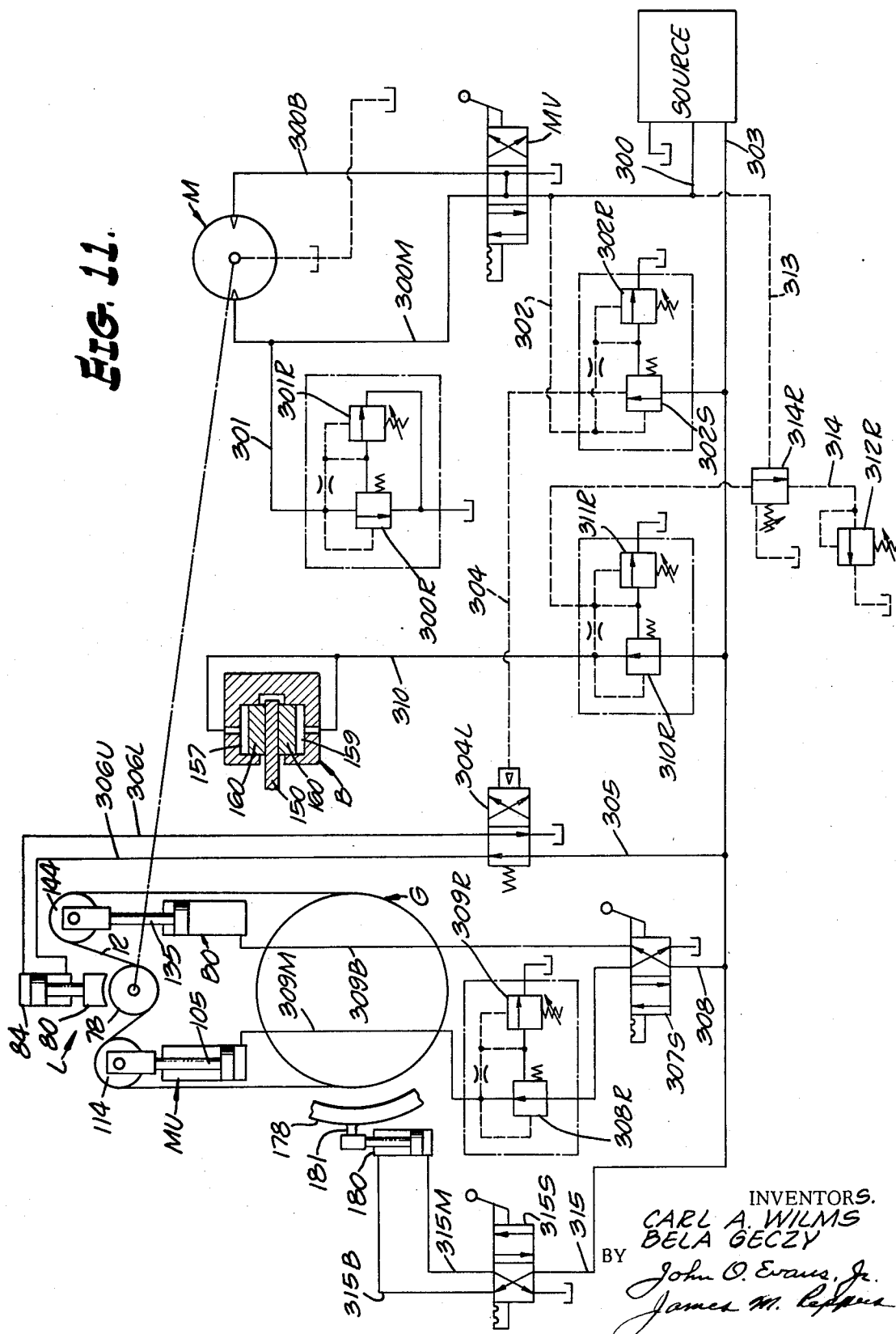


FIG. 8.

INVENTORS.
CARL A. WILMS
BELA GECZY
BY
John O. Evans, Jr.
James M. Pappas

FIG. 11.



INVENTORS.
CARL A. WILMS
BELA GECZY
BY John O. Evans, Jr.
James M. Leppner

CHAIN DRIVEN SPINNING, MAKE UP AND BREAK OUT TONGS

BACKGROUND OF THE INVENTION

Power tongs have been provided for facilitating the making up and breaking out of the threaded joints or couplings of well pipe, such as drill pipe and casing. Such tongs, generally, include a pipe gripping head or jaw mechanism which is actuated into gripping engagement with the pipe and then driven rotatively to rotate the pipe engaged thereby, while the complementary pipe is held stationary, say, by a back up tong in the case of drill pipe, or by the rotary table slips in the case of well casing.

Relatively high torque must be imposed on the rotating pipe to finally make up the tool joints in drill pipe or initially break out such tool joints, as well as to make up tapered threaded casing couplings. However, particularly when the drill pipe is being "round tripped", or pulled from the well to enable replacement of the bit and then returned into the well, much time is spent rotating the "stand" or length of drill pipe suspended in the derrick, either to initially shoulder the tool joint parts or to disconnect the parts after initial break out. Thus, it is desirable that the tong be capable of "spinning" the joint in or out, in order to save time, at a relatively high rate of speed. The use of change speed mechanisms to enable the high speed, low torque spinning of tool joints and the low speed, high torque make up and break out of tool joints is expensive, and such tongs are generally quite bulky.

More recently, there has been developed a chain actuated tong in which the pipe gripping means are actuated by a chain which is moved by one or more pressure operated actuator cylinders, as more particularly disclosed in the co-pending U.S. Pat. application, Ser. No. 134,553, filed Apr. 16, 1971, in the name of Carl A. Wilms.

SUMMARY OF THE INVENTION

The present invention provides a novel and unobvious power pipe tong drive which employs the high torque final make up and initial break out characteristics of the tong of the above-mentioned application in combination with a high speed rotary motor drive for the chain to spin up and spin out joints of pipe.

More particularly, the present invention provides a power pipe tong in which the pipe gripping mechanism is driven by a continuous chain which is powered by a rotary fluid motor for spinning the pipe, and the rotary motor and motor drive to the chain are locked when the joint is to be finally made up or initially broken out, while a reciprocating pressure operated actuator cylinder acts on the chain intermediate the gripping mechanism and the point at which the chain is locked to apply high torque to the pipe gripping means to finally make up the joint or initially break out a joint. Such tong apparatus is capable of applying relatively high torque to the pipe with a mechanically simple system, which is, therefore, comparatively inexpensive, as compared with the usual change speed gear mechanism, and the drive is rugged and requires comparatively small space for the capabilities in pipe joint spinning, make up and break out.

This invention possesses many other advantages, and has other purposes which may be made more clearly

apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan of a power tong made in accordance with the invention, with portions of the housing broken away, to expose the interior structure, with the gripping jaws retracted;

FIG. 2 is a vertical section, as taken on the line 2—2 of FIG. 1;

FIG. 3 is a view corresponding to FIG. 1, but showing the gripping jaws in pipe gripping positions and the actuator means shifted to break out a joint of pipe;

FIG. 4 is an enlarged vertical section, as taken on the line 4—4 of FIG. 2, and showing a typical actuator slide construction;

FIG. 5 is a horizontal section, as taken on the line 5—5 of FIG. 2, with parts broken away to show the reverse stop and brake means;

FIG. 6 is an enlarged fragmentary, vertical section, as taken on the line 6—6 of FIG. 5;

FIG. 7 is a fragmentary vertical section, as taken on the line 7—7 of FIG. 6, showing the reverse stop means in a make up condition;

FIG. 8 is a view generally corresponding to FIG. 7, but showing the reverse stop means actuated to the break out condition;

FIG. 9 is a vertical section, as taken on line 9—9 of FIG. 7;

FIG. 10 is a vertical section, as taken on the line 10—10 of FIG. 8; and

FIG. 11 is a schematic diagram of the control and operating system for the tong.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As seen in the drawings, the tong assembly comprises a body or housing H defining an opening O for a pipe and in which is rotatably supported pipe gripping means G, including a number of circumferentially spaced gripping jaws J, carried by an inner, jaw-carrying ring or rotatable member 10, and actuatable radially of the assembly from retracted positions, as seen in FIG. 1, to pipe gripping positions, as seen in FIG. 3, in response to rotation of an outer rotative member or cam ring 11, by drive means including one or more drive chains 12, a fluid pressure operated, rotary, chain driving, spinning motor M, and, depending on whether the tong is being used to make up or break out pipe joints, break out actuator cylinder means BO and a make up actuator cylinder means MU, each of which actuator cylinder means operatively engages a portion or run of the chain or chains 12 between the motor M and the outer ring 11, whereby extension of the respective cylinder means will apply a pull to the respective run of the chain and effect angular movement of the outer ring 11 in one direction or the other, while the motor M or its chain drive shaft is locked by lock means L.

More particularly, as best seen in FIG. 2, the housing H comprises an annular body 20 to which is suitably affixed, as by fasteners 21, a top annular plate 22. Centrally of the plate 22 is a guide ring support 23, attached to the plate 22 by fasteners 24 and having a guide insert 23a defining the open top of the pipe opening O. A bottom plate 25, affixed to the body 20 by fasteners 26, combines with the body 20 and the top plate 22 to form an annular space in which the inner ring 10 and outer ring 11 are concentrically disposed for rotation.

The annular body 20 supports the outer ring 11 for rotative movement on suitable ball bearings 27. The inner ring 10 is a composite assembly, including an annular central section 28 which defines the pipe opening O and has radial windows 29 through which the jaws J are radially reciprocable between retracted and pipe gripping positions. Formed on or otherwise provided on the central section 28 of the inner ring 10 is an outwardly extended flange 28a, at the outer periphery of which are suitable ball or other bearings 30 engaged with a retaining race member 31 attached to the outer ring 11, as by fasteners 32. Thus, it is seen that the outer ring 11 is revoluble within the housing body 20 on the bearings 27 and the outer ring 11 is revoluble relative to the inner, jaw-carrying ring 10 for a purpose which will be later described.

The gripping jaws J are box-like and comprise a top wall 33, a bottom wall 34 and an inner end wall 35, the latter being adapted, as customary, to receive an assortment of die carriers 36 having pipe gripping dies 37 removably carried thereby. Further details of the die carriers are not germane to the present invention, and it will be understood that the use of die carriers of different dimensions radially of the pipe opening O enables effective use of the tong on pipe of a wide range of diameters. In order to actuate the jaws J to pipe gripping positions, from retracted positions, each jaw has a cam roller 40 journaled between the top and bottom walls 33, 34 on a pin 41, or other suitable support, and the outer ring 11 has a cam surface 42 which defines the inner periphery of the outer ring. Such as cam and roller, tong jaw-actuating means is well known, as are other jaw-actuating means responsive to relative rotation of the inner and outer rings of tongs. As is well known in power tongs useful in making up and breaking out pipe joints, without requiring that the tong be rolled over top to bottom, the cam surface 42 is compound, as seen in FIG. 1, for example. This is to say that operable on the roller 40 of each jaw the cam surface 42 includes a make up ramp 42M and a break out ramp 42B at opposite sides of central portions 43, these latter portions being indented to allow full retraction of the jaws J at the midpoint of the compound cams 42M and 42B. The illustrated tong assembly has means for effecting positive retraction of the jaws J, as distinguished from spring loaded retraction, in the form of an outer cam surface 44 having portions which parallel the make up and break out ramps 42M and 42B and a cam follower pin 45 carried by each jaw and engaged with the cam surface 44.

It will now be understood that actuation of the jaws J to the pipe gripping positions, from the retracted positions, is caused by relative rotation of the inner and outer rings 10 and 11, respectively, and in the embodiment shown, such relative rotation is caused by rota-

tion of the outer ring by the chain means 12 about the inner, jaw-carrying ring 10, in either direction, due to the compound nature of the cam surface 42.

Break means are customarily provided to initially hold the inner ring 10 stationary, until the jaws J are locked up on a pipe or are being retracted from engagement with the pipe. In addition, reverse stop means are customarily provided to limit reverse relative rotation of the inner and outer rings 10 and 11 to a point at which the jaws are fully retracted and to prevent reclosure of the jaws on the pipe, as might otherwise be caused by continued relative rotation of the inner and outer rings, say, so that the jaw rollers 40 would travel down to make up ramps 42M, during retraction of the jaws J following for making up of a joint, and continue on past the central depressions 43 and up the break out ramps 42B of the cam surface 42. Break means are herein shown at B, and reverse stop means are shown at RS, the details of both of which will be hereinafter more fully described.

In order to drive the outer ring 11, it is provided with sprocket means, including a pair of vertically spaced sprocket rings 50, 50 extending about the outer periphery of the outer ring 11 and affixed thereto for rotation therewith by a number of pins 51 and retaining fasteners 52. Each sprocket 50 is engaged by one of the drive chains 12, and these chains are driven by power operated means now to be described, and including the reversible fluid motor M and the make up actuator cylinder MU and the break out actuator cylinder BO.

Included in the tong body or housing H is a base section 66 for the power means, this base section being suitably secured to a rear portion 61 of the body member 20, as by fastenings 62. A cover plate 63 is provided for the base housing section 60 and is secured to the latter by fasteners 64. The fluid motor M is suitably mounted on the top plate 63, as by fasteners 65 which engage in a mounting flange 66 of the top plate.

To drive the chains 12, the fluid motor M has its output shaft 67 splined or otherwise drivingly connected to a sprocket drive shaft 68 which is journaled in an upper bearing 69 and a lower bearing 70, these bearings being interposed between the sprocket shaft 68 and removable bearing caps 71 and 72 affixed to the housing by respective fasteners 73 and 74.

Fixed on the sprocket shaft 68 for rotation with the latter, as by keys 75, are a pair of drive sprockets 76, 76 which are engaged with the chains 12 to drive the latter in response to the rotation of the motor output shaft 67 in either direction. Disposed between the sprockets 76 on the sprocket shaft 68 and fixed on the shaft for rotation with the latter by the keys 75 is a sprocket shaft locking gear 77 forming part of the locking means L, previously referred to, by which the chains 12 are anchored during final make up and initial break out of a pipe joint. This locking gear has teeth 78 adapted for engagement by complementary teeth 79 on the confronting end of a locking dog 80. The dog 80 is reciprocable between a retracted position and a position at which its teeth 79 mesh with the teeth 78 of the locking gear 77, as generally seen in FIGS. 1 and 3, respectively, ears 82, 82 formed in the base 60 and having tongue and groove connections at 83, 83 with the dog 80 support the latter for reciprocation, and actuator means, in the illustrated form of a pressure operated

actuator cylinder 84 having an extensible rod 85 are adapted to actuate the lock dog or slide 80 between its two positions. Suitable support and anchor means for the actuator cylinder 84 are shown as a yoke member 86 affixed to the ears 82 by fasteners 87 and to which one end of the cylinder 84 is pivotally connected at 88.

It is now apparent that the fluid motor M is capable of driving the chain drive oppositely, when the lock dog 80 is retracted, to spin the gripping means G of the tong in either direction when spinning up and spinning out pipe joints. In addition, the motor drive, when locked by the dog 80, anchors the chains 12 so that the runs of the chains between the locked sprockets 78 and the outer ring 11 may be actuated by the actuator cylinder means MU and BO to also actuate the gripping means G through an arc of motion sufficient and at sufficient torque to finally make up or initially break out a pipe joint.

As seen in FIGS. 1, 3 and 4 to best advantage, the make up actuator cylinder means MU includes a pressure cylinder 100 which has an ear 101 at one end pivotally connected or otherwise affixed by a pin 102 to the tong housing H. The cylinder 100 has a fluid connector 103 for the admission and exhaust of pressure fluid. A piston 104 within the cylinder 100 has a rod which projects from the other end of the cylinder 100 and is connected to a slide block 106 by an enlarged head 107 on the rod 105, seating in the retained in a set block 108 by a retainer 109 which is fastened to the slide block 106 by suitable fasteners 109a. The slide block 106 rides slidably between a pair of parallel rails 110 which are secured by fasteners 111 to supporting flanges 112 which extend longitudinally within the base 60 of the housing H.

Extending vertically through the block 106 is a sprocket shaft 113 having upper and lower idler sprockets 114 and 115, respectively, mounted for rotation on suitable bearings 116 and 117 which are retained in place by keeper plates 119 and 120 affixed to the shaft ends by respective fasteners 121 and 122. The runs of the chains 12 between the spinning motor sprockets 78 and the outer ring sprockets 50 engage the idler sprockets 114 and 115, and, upon extension and retraction of the cylinder 100 and rod 105, are extended in loops along a plane parallel to the plane of the axes of the outer ring sprockets 50 and the motor sprockets 114 and 115 to avail of the mechanical advantage, as well as to increase the total angular movement of the gripping means G for a given actuator stroke, with resultant savings in overall size of the tong assembly.

The break out actuator cylinder means BO are essentially the same as the make up actuator cylinder means MU, just described. Thus, as seen in FIGS. 1 and 3, the break out actuator cylinder means BO includes a pressure cylinder 130, an end ear 131 of which is connected in the case H by a pin 132. A fitting 133 enables the supply and exhaust of pressure fluid to and from the cylinder 130 to cause the piston 134 to extend the rod 135 or allow retraction of the rod, as the slide block 136 is moved along guide rails 140 carried on flanges 142 within the case base 60. This slide block 136 carries a sprocket shaft on which sprockets like the sprockets 114 and 115 are rotatably supported, only the upper sprocket 144 being seen in FIGS. 1 and 3.

Since the details of the idler sprocket and slide assembly of the break out actuator cylinder means correspond to those of the make up actuator cylinder means MU, no further specific description is believed to be necessary, except to note that the break out actuator cylinder means acts on the runs of chains 12 between the spinning motor sprocket 78 and the outer ring sprockets 50 to move the outer ring 11 in the opposite direction from the direction in which the outer ring 11 is moved by the make up cylinder means MU, when pressure fluid is supplied to either the make up cylinder 100 or the break out cylinder 130, alternately, as will be later described.

The brake means B, previously referred to, for initially holding the inner jaw carrying ring or member 10 against rotation with the outer ring, in order to set the jaws J in gripping engagement with the pipe, are best seen in FIGS. 2, 5 and 6.

More particularly, the brake means B comprises a brake disc or ring member 150 affixed at its inner periphery by fasteners 151 to a shoulder 152 on the inner ring and extending radially in a horizontal plane, and means for braking engagement with the opposing faces of the brake disc 150, in the form of a plurality of caliper type brake units 153 suitably spaced about and affixed by fasteners 154 to a radial flange 155 formed on the top plate 22 on the tong housing H.

Each brake unit 153, as best seen in FIG. 6, comprises a horizontally split body providing an upper cylinder section 156 having a piston chamber 157 opening towards the upper face of the brake disc 150 and a lower cylinder section 158 providing a piston chamber 159. Each of the piston chambers 157 and 159 contains a piston 160 provided with a suitable annular seal 161, whereby the pistons are adapted to be forced by fluid pressure admitted to the chambers 157 and 159 toward one another. Friction pads 162 are provided on the pistons 160 for frictional engagement with the disc 150. Fluid under pressure is admitted to the piston chambers 157 and 159 by means of a passage 163 which communicates with both chambers and with an inlet 164 to which fluid is supplied from a supply conduit 165. Since it is desired that the brake units 153 be simultaneously engaged with the disc 150 or effectively released, the conduit 165 is connected to each of the brake units, and a common source supplies pressure fluid to all chambers 157 and 159 of all units 153. For example, in FIG. 6, the housing flange 22 is ported at 166 and a supply conduit 167 communicates with the port 166 and with additional supply porting 168 in the housing H to conduit fluid from a source to the brake fluid conduit 165, under the control of means which control the braking action, as will be later described in respect of the control system of FIG. 11.

As previously indicated, the reverse stop means RS are provided to limit rotation of the outer or cam ring 11 relative to the inner or jaw carrying ring in a reverse direction to open the jaws J after a pipe joint is made up or broken out. To accomplish this, the reverse stop means permits the outer ring 11 to rotate relative to the inner ring 10 in a selected direction, clockwise for making up joints and counter clockwise for breaking out joints, so that cam surfaces 42M or 42B, respectively, may force the jaws J inwardly to pipe gripping positions, while the brake means B holds the jaw carrying,

inner ring 10 stationary, and thereafter the entire gripping assembly G rotates in the selected direction. The reverse stop means RS then functions to prevent rotation of the outer ring 11 relative to the inner ring 10 in the reverse, jaw retracting direction, past the location at which the jaws are fully retracted, and the cam roller 35 of the jaws J are in the depressions 43 of the cam surface 42.

The reverse latch means RS are best seen in FIGS. 2 and 5 through 10. More particularly, the reverse stop means includes a stop member 170 in the form of a ring concentrically mounted upon a support flange 171 which is secured by fasteners 172 to the inner or jaw carrying ring 10 and a companion stop member in the form of a ring 174 on the outer ring 11, herein shown as an upward extension of the bearing ring 31 which provides a race for the ball bearings 30 on which the inner and outer rings 10 and 11 relatively revolve.

In FIGS. 6-10, it will be seen that the stop ring 170 is vertically shiftable and has a splined connection 175 with the flange 171 on the jaw carrying ring 10. A suitable number of coiled compression springs 176 are interposed between the stop ring 170 and an opposing portion of the inner ring 10 to provide means for biasing or moving the stop ring 170 to an upper, normal position, as seen in FIGS. 6, 7 and 9, and actuator means 177 are provided for shifting the stop ring 170 downwardly to a position, as seen in FIGS. 8 and 10, the upper position being the make up stop position and the lower position being the break out stop position.

The actuator means 177 includes an angularly shiftable ring 178 disposed above the stop ring 170. Bearing means, such as balls 179, are interposed between the actuator ring 178 and the stop ring 170 to facilitate rotation of the latter relative to the former, since the stop ring 170 is carried by the revolvable gripping assembly G.

Double acting fluid pressure operated cylinder means, including a pair of cylinders 180, 180, FIGS. 5 and 6, are connected with the actuator ring 178 at 181 and with the housing top flange 22 at 182, so as to effect angular movement of the actuator ring 178 in opposite directions relative to the housing.

Means are provided comprising a suitable number of fixed cams 183 formed on or affixed to the housing top plate 22 by fasteners 184, and a corresponding number of traveling cams 185, formed on or affixed to the actuator ring 178 by fasteners 186, whereby angular movement of the actuator ring 178 in the direction of the arrow in FIG. 8 will effect downward movement of the stop ring 170 from the upper position of FIGS. 7 and 9 to the lower position of FIGS. 8 and 10, as indicated by the arrow in FIG. 7. Obviously, movement of the actuator ring 178 from the position of FIGS. 8 and 10 to that of FIGS. 7 and 9, allows the springs 176 to return the stop ring 170 to the normal or upper position. Such actuation will be further described hereinafter in relation to the control system of FIG. 11.

The stop ring 170, on its outer periphery, has a pair of circumferentially extended stop lugs 170a, herein shown in FIG. 5 as extending substantially 60° about the ring 170 and diametrically spaced. On the end of each lug 170a facing in a counter clockwise direction is a stop face or abutment 170m, which, as will later appear, stops rotation of the outer ring 11 relative to the

inner ring 10 when the tong is being used to make up joints and the jaws J are fully retracted. At the other end of each lug 170a facing in a clockwise direction, is a face or abutment 170b, which, as will later appear, stops rotation of the outer ring 11 relative to the inner ring 10 when the tong is being used to break out joints and the jaws J are fully retracted.

The reverse stop ring or member 174 cooperates with the stop lugs 170a to limit jaw-opening relative rotation of the inner ring 10 and the outer ring 11, and for this purpose, the ring 174 has upper stop lugs 174a and lower stop lugs 174c extending circumferentially on the inner periphery of the ring 174 and arranged so that these lugs are alternately located about the ring 174 at opposite sides of diametrically spaced vertical spaces or slots 174d having an angular extent substantially the same or slightly greater than the angular extent of the respective stop lugs 170a on the stop ring 170, whereby the lugs 170a may move vertically in the slots 174 between the upper and lower stop positions, previously referred to.

When the reverse stop actuator means is conditioned, as seen in FIGS. 5, 6, 7 and 9, for making up joints with the tong, with the reverse stop ring 170 in the upper position, the upper stop lugs 174a on the ring 174 provide, on their ends 174m facing in a clockwise direction, abutments cooperative with the ends 170m of the stop lugs 170a of the stop ring 170 to stop counter clockwise rotation of the outer ring 11 relative to the inner ring 10 at a location with the jaws retracted, but the lugs 170a will pass above the lower stop lugs 174c (See FIG. 9), so that the outer ring 11 is free to rotate in a clockwise direction relative to the inner ring 10 to close the jaws on and rotate a pipe. Alternatively, when the stop ring 170 is actuated to the lower position of FIGS. 8 and 10, for breaking out joints with the tong, the lower stop lugs 174c on the ring 174 provide on their ends 174b facing in a counter clockwise direction abutments cooperative with the ends 170b of the stop lugs 170a of the stop ring 170 to limit clockwise rotation of the outer ring 11 relative to the inner ring 10 at a location at which the jaws J are retracted, but the lugs 170a will pass beneath the upper stop lugs 174a (See FIG. 10), so that the outer ring 11 is free to rotate in a counter clockwise direction to close the jaws J and rotate a pipe.

In the illustrated tong, three jaws J are shown and the outer ring 11 may move through an arc of approximately 60° in either direction from a jaw retracted position to a position at which the jaws engage the pipe. Thus, the stop lugs 170a on the stop ring 170 and the stop lugs 174a and 174c on the stop ring 174 are angularly spaced to provide slots 174d of about 60° extent and themselves extend about 60°, so that in the illustrated tong, a stop lug 174a, an adjacent slot 174d and a stop lug 174c, each of about 60° in extent are located on each diametrically opposed half of the stop ring 174. Other arrangements are possible depending on the number of jaws and the angular motion necessary to actuate the jaws. In any event, however, the reverse stop means is very rugged and capable of withstanding heavy shock, say when the jaws are opened at high speed, and the mass of the outer ring 11 is great.

In the use of the tong apparatus thus far described, the motor M is operated, in either direction, to rotate

the pipe gripping means G at relatively high speed. To effect initial engagement of the jaws J with a pipe, the brake means B must be applied, to hold the inner, jaw carrying ring 10 against rotation with the outer ring 11 until the gripping of the pipe by the jaws is sufficient to rotate the pipe, at which time self energization of the cam roller system works to assist in the gripping action. After the pipe is gripped, high braking effort is not desirable since the brake must be overcome by the tong motor M. Thus, the brake means B is preferably pressured to an extent determined by torque transmitted through the gripping means to the pipe. In addition, the lock means L should be released automatically when the spinning motor M is operated, and the lock means L should be engaged with the spinning motor locking gear 78 when the spinning motor is not operating to lock the spinning motor shaft, and more particularly, to lock the chain sprockets 76, when either of the actuator cylinder means MU or BO is being operated.

The following is a description of the illustrative tong control system of FIG. 11, whereby the tong is operated as above described.

In order to operate the system, to make up and break out joints of pipe, a conduit 300 is connected to a suitable pressure source for supplying hydraulic pressure fluid from the source to a main motor control valve MV which has a neutral position and selective positions for controlling fluid flow to the motor M in either direction, whereby the drive sprocket 78 for the chain means 12 will be driven in a selected direction to drive the gripping means G correspondingly. Thus, when the main motor control valve MV is shifted to the right, as seen in FIG. 11, pressure fluid is supplied to conduit 300M to drive the motor M in a make up direction, and when the valve MV is shifted to the left, pressure fluid supplied via a conduit 300B to drive the motor M in a break out direction, in which case the motor is subjected to full source pressure from conduit 300. In the make up condition of the system, however, the maximum pressure supplied to the motor M via conduit 300M and therefore, the maximum motor torque output, or stall torque, is controlled by a motor torque limiting relief valve 300R connected to the make up conduit 300M by a conduit 301. The maximum pressure in the conduit 301 is adjustable by a variable regulator valve 301R which holds the relief valve 300R closed until the pressure acting on the regulator valve 301R relieves the bias pressure from the relief valve 300R.

Operating fluid pressure from conduit 300 is supplied via a conduit 302 to provide pilot pressure to a sequency valve 302S which is normally closed to shut off the supply of fluid pressure from a supply conduit 303 to a pilot pressure conduit 304 which leads from the sequence valve 302S to a pilot operated valve 304L which controls the flow of pressure fluid from the source conduit 303 via a conduit 305 to one or the other of the conduits 306L and 306U by which the lock means L, previously described, are operated to lock the motor M or release the lock. The sequence valve 302S is controllable or adjustable by means of a variable regulator 302R which determines at what pressure in conduit 302, and hence, conduit 300, the sequence valve will open to supply pilot pressure to the lock control valve 304L to shift the latter from the normal posi-

tion as shown to the alternate position to automatically pressurize the lock actuating cylinder 84 and engage the lock gear 78 with the lock dog 80. Thus, when the motor M stalls when spinning up pipe joints and greater torque is needed to further turn the pipe, the sequence valve 302S, responsive to increased pressure in the motor supply conduit will be operated to allow pressure to shift the lock control valve 304L to admit pressure to the lock cylinder 84 via conduit 306L to lock or anchor the chain 12 at the motor M, so that the make up actuator cylinder MU may be operated to finally make up the pipe joint. On the other hand, if a joint is to be broken out, the main motor valve MV will be operated to drive the motor in the break out direction and the motor may stall, without initially breaking out the pipe joint, in which case, the sequence valve 302S will also be operated to admit pressure to the lock valve conduit 304 to shift the pilot operated lock valve 304L to the lock engaging position, in which fluid flows to the cylinder 84 via conduit 306L, and then the break out cylinder BO may be actuated to break out the joint.

The make up and break out actuators MU and BO, respectively, are controlled by a selector valve 307S to which fluid is supplied via a conduit 308 from the source conduit 303.

In the position shown, the selector valve 307S directs pressure fluid from the conduit to the break out cylinder conduit 309B to cause extension of the rod 135, whereby the pipe gripping means G will be moved counter clockwise, as fluid returns to the tank from the make up actuator cylinder MU via the conduit 309M. In the alternate position, of course, the pressure applied in the reverse direction will extend actuator rod 105, and fluid will be discharged back through conduit 309B. Since it is desired that the usual joints be made up to a prescribed torque limit, adjustable torque limiting valve means are provided in the pressure conduit leading to the make up actuator cylinder MU. Thus, a normally open valve 308R is interposed between the source of pressure and the actuator cylinder MU and is controlled by an adjustable, pressure responsive relief valve 309R which allows the valve 308R to close, when pressure in line 309M exceeds a selected level. On the other hand to allow full torque application to the pipe when breaking out joints, the conduit 309B is exposed to the full pressure of source conduit 303.

The system includes brake control means, as previously indicated, for the brake means B. This control means functions to admit high pressure to the respective piston chambers 157 and 159 to force the pistons 160 toward the brake disc 150 or to reduce the pressure applied to the brake chambers 157, 159, depending upon whether more or less radial loading of the jaws J into gripping engagement with the pipe is necessary to prevent slipping of the gripping dies during engagement with the pipe and during spinning or make up or break out of the joint, as the case may be.

More particularly, fluid pressure is supplied to the brake chambers 157, 159 via a conduit 310 leading from the source conduit 303 under the control of a normally open reducing valve 310R which is regulated by an adjustable high pressure relief valve 311R or an adjustable low pressure relief valve 312R, depending upon the pressure of fluid in the supply conduit 300 for the motor M. Thus, a pilot pressure conduit 313 leads

from the motor conduit 300 to an adjustable, normally closed relief valve 314R in a conduit 314 leading between the high pressure relief valve 311R and the low pressure relief valve 312R. When the relief valve 314R is closed, as shown, fluid is supplied through the normally open valve 310R at full source pressure from conduit 303 to apply a high braking force, limited only by the adjustment of the relief valve 311R, even though the motor M is inactive. When the motor control valve MV is opened to operate the tong gripping means, the pressure in motor source conduit 300 will increase as the gripping means encounters resistance upon closure of the jaws on the pipe. Since the greater the encountered resistance, the greater the force applied by the cam ring 11 on the jaws J to grip the pipe, the pressure in the brake chambers is preferably reduced so that high brake force need not be overcome. The pressure in conduit 313, as it increases, will open the normally closed valve 314R, when the pressure equals the setting of the valve 314R, so that the reducing valve 310R tends to close, reducing the applied brake pressure in chambers 159. Thus, the brake control system is effective to maintain a high brake force to assure that the pipe gripping means securely grips the pipe without slipping thereabout, but when the high braking force is not needed, the pressure is relieved. This characteristic assures longer life of the pipe gripping dies 37 and minimized damage to the pipe due to skidding of the dies around the pipe.

Additionally, the control system includes means for selectively operating the reverse stop actuator cylinders 180, only one of which is shown in FIG. 11, for simplicity. The source conduit 303, in the illustrated system, leads to a conduit 315 which is connected to a suitable selector valve 315S. In the position shown, the valve 315S directs pressure fluid to the actuator 180 via a conduit 315M to retract the actuator rod, and thereby position the reverse stop ring 178 in the make up position, as seen in FIGS. 5, 6, 7 and 9, and in the alternate position of the valve 315S, pressure fluid will be supplied via a conduit 315B to shift the actuator rod to an extended position and move the reverse stop actuator ring 178 in its alternate or break out position of FIGS. 8 and 10.

While the main control valve MV for the motor M, the make up and break out actuator selector valve 307S, and the reverse stop actuator selector valve 315S have been herein shown, simply, as manually operated valves, it will be understood that the tong may be operated at a control console having suitable means, electrical, pneumatic, or hydraulic for remotely operating the system or for integrating the system in an automatic well drilling rig.

From the foregoing, it is believed that no further description of the mode of operation of the present tong is necessary, and that it is now apparent that the invention provides a novel, rugged and versatile power pipe tong.

What is claimed is:

1. In a power pipe tong comprising: a body having an opening for a pipe, a pair of relatively rotatable members rotatably disposed in said opening, one of said members carrying a plurality of pipe gripping jaws shiftable between retracted positions and pipe gripping positions in said opening, the other of said members

having means cooperative with said jaws for shifting said jaws to said pipe gripping positions responsive to relative rotation of said members, and drive means for rotating one of said members relative to the other to shift said jaws to said pipe gripping positions and for rotating said members in said opening, said drive means including a chain engaged with said one of said members, and power actuated means for driving said chain, the improvement wherein said power actuated means comprises a rotary fluid motor for driving said chain at high speed, and means for applying a pull on a run of said chain between said motor and said one of said members to further rotate said latter member when said motor is stopped.

2. In a power tong as defined in claim 1, lock means for holding said motor against rotation when said motor is stopped.

3. In a power tong as defined in claim 1, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction.

4. In a power tong as defined in claim 1, lock means for holding said motor against rotation when said motor is stopped, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, means for releasing said lock means when said motor is operating in either direction and for automatically operating said lock means to hold said motor when said motor is stalled.

5. In a power tong as defined in claim 1, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, said means for applying a pull on a run of said chain when said motor is stopped including means to apply said pull to either run of said chain to further rotate said one of said members in either direction.

6. In a power tong as defined in claim 1, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, said means for applying a pull on a run of said chain when said motor is stopped including means to apply said pull to either run of said chain to further rotate said one of said members in either direction, and including lock means for holding said motor against rotation in either direction when said motor is stopped.

7. In a power tong as defined in claim 1, means for locking said chain between said motor and said means for applying a pull to said run of said chain when said motor is stopped.

8. In a power tong as defined in claim 1, said means for applying a pull on a run of said chain comprising extensible pressure operated actuator cylinder means having an idler engaged with said run of said chain.

9. In a power operated tong as defined in claim 1, said motor and said one of said members having chain sprockets engaged by said chain and rotatable on axes disposed on a common plane, and said means for applying a pull to a run of said chain comprising extensible fluid pressure operated cylinder means extensible in a plane parallel to the plane of the axes of said sprockets and having an idler engaging said run of said chain and moving said run of said chain in a loop extending in a

plane substantially parallel to said plane of the axes of said sprockets.

10. In a power operated tong as defined in claim 1, said motor and said one of said members having chain sprockets engaged by said chain and rotatable on axes disposed on a common plane, said means for applying a pull to a run of said chains comprising guide means extending in a plane parallel to the plane of said axes, a slide in said guide means, idler means carried by said slide and engaged with said chain, and power actuated means for shifting said slide to pull a loop in said run of said chain.

11. In a power tong as defined in claim 1, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, said means for applying a pull to said run of said chains including first and second power operated means to apply a pull to a run of said chain to move said one of said members in either direction.

12. In a power tong as defined in claim 1, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, said means for applying a pull to said run of said chains including first and second power operated means to apply a pull to a run of said chain to move said one of said members in either direction, each of said power operated means including extensible pressure operated actuator cylinder means connected at one end to said body and having at its other end an idler engaged with a run of said chain to extend said run of said chain upon extension of one of said actuator cylinder means.

13. In a power tong as defined in claim 1, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, said means for applying a pull to said run of said chains including first and second power operated means to apply a pull to a run of said chain to move said one of said members in either direction, each of said power operated means including extensible pressure operated actuator cylinder means connected at one end to said body and having at its other end an idler engaged with a run of said chain to extend said run of said chain upon extension of one of said actuator cylinder means, and means for selectively extending one of said actuator cylinder means.

14. In a power tong as defined in claim 1, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, said means for applying a pull to said run of said chains including first and second power operated means to apply a pull to a run of said chain to move said one of said members in either direction, each of said power operated means including extensible pressure operated actuator cylinder means connected at one end to said body and having at its other end an idler engaged with a run of said chain to extend said run of said chain upon extension of one of said actuator cylinder means, and means for selectively extending one of said actuator cylinder means and allowing retraction of the other actuator cylinder means.

15. In a power tong as defined in claim 1, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, said means for applying a pull to

said run of said chains including first and second power operated means to apply a pull to a run of said chain to move said one of said members in either direction, each of said power operated means including extensible pressure operated actuator cylinder means connected at one end to said body and having at its other end an idler engaged with a run of said chain to extend said run of said chain upon extension of one of said actuator cylinder means, and including guide means for said idler of each of said actuator cylinder means for guiding said idlers along planes parallel to the plane of the axis of rotation of said one of said members to pull a loop in said chain.

16. In a power tong as defined in claim 1, lock means for holding said motor against rotation when said motor is stopped, said lock means comprising a lock dog, said motor having a shaft having a lock gear thereon, and means for actuating said dog into and from engagement with said lock gear.

17. In a power tong as defined in claim 1, lock means for holding said motor against rotation when said motor is stopped, said lock means including a lock member shiftable between a motor locking position and a released position, and actuator means for shifting said lock member.

18. In a power tong as defined in claim 1, lock means for holding said motor against rotation when said motor is stopped, said lock means including a lock member shiftable between a motor locking position and a released position, and actuator means for shifting said lock member automatically between said positions to lock said motor when said motor applies a selected torque to said rotatable members.

19. In a power tong as defined in claim 1, lock means for holding said motor against rotation when said motor is stopped, said lock means including a lock member shiftable between a motor locking position and a released position, and actuator means for shifting said lock member automatically between said positions to lock said motor when said motor applies a selected torque to said rotatable members, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, said means for applying a pull to said run of said chains including first and second power operated means to apply a pull to a run of said chain to move said one of said members in either direction.

20. In a power tong as defined in claim 1, lock means for holding said motor against rotation when said motor is stopped, said lock means including a lock member shiftable between a motor locking position and a released position, and actuator means for shifting said lock member automatically between said positions to lock said motor when said motor applies a selected torque to said rotatable members, said means for shifting said jaws to said pipe gripping positions being operable upon relative rotation of said members in either direction, said means for applying a pull to said run of said chains including first and second power operated means to apply a pull to a run of said chain to move said one of said members in either direction including extensible pressure operated actuator cylinder means, and means for selectively supplying pressure fluid to said cylinder means.

* * * * *

65

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,691,875 Dated September 19, 1972

Inventor(s) BELA GECZY ET AL

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

- Col. 3, line 43, "as" should be --a--.
Col. 4, line 4, "Break" should be --Brake--.
line 14, "to" should be --the--
line 15, "for" should be --the--.
line 17, "Break" should be --Brake--.
Col. 5, line 29, "the", second occurrence, should be --and--;
same line, "set" should be --seat--.
Col. 6, line 51, "conduit" should be --conduct--.
Col. 7, line 7, "roller" should be --rollers--.
Col. 8, line 56, "extend" should be --extent--.
Col. 9, line 36, after "fluid" insert --is--.
line 54, "sequency" should be --sequence--.
Col. 11, line 29, "minimized" should be --minimizes--.

Signed and sealed this 15th day of May 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents