

[54] **METHOD FOR INSERTING FLEXIBLE PIPE INTO WELLS**

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Related U.S. Application Data

[62] Division of Ser. No. 300,831, Oct. 25, 1972, abandoned.

[52] **U.S. Cl.** **166/315; 166/77; 166/84**

[51] **Int. Cl.²** **E21B 23/00; E21B 33/03; E21B 43/00**

[58] **Field of Search** **166/77, 315, 82, 84, 71**

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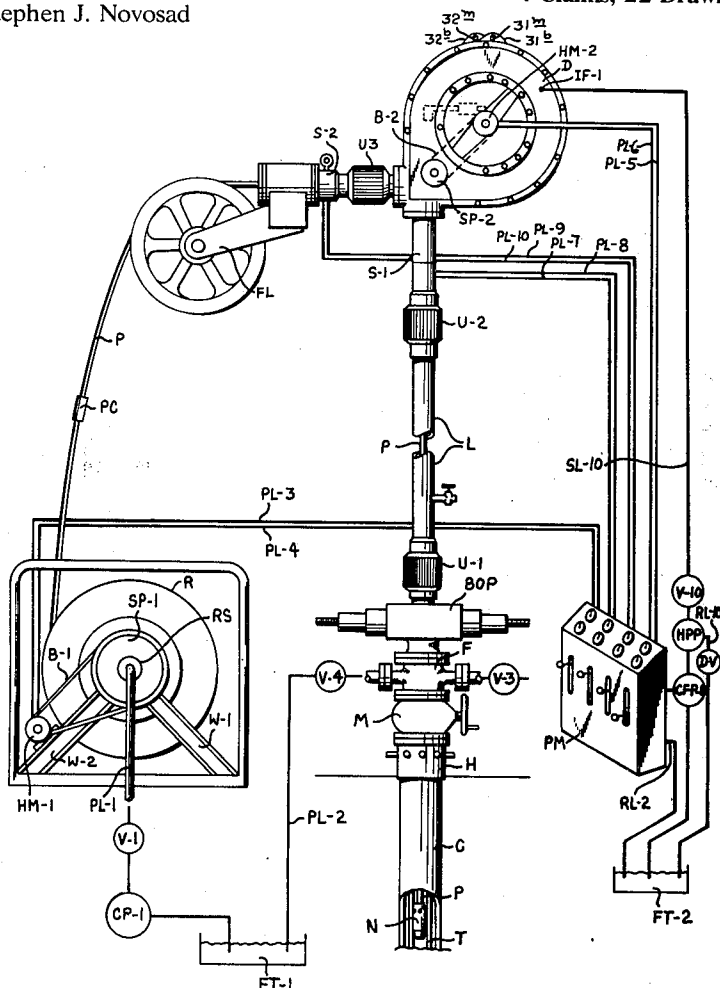
Primary Examiner—Stephen J. Novosad

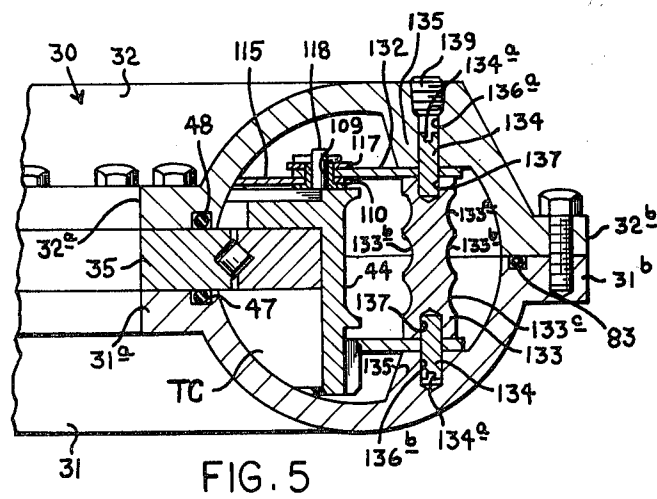
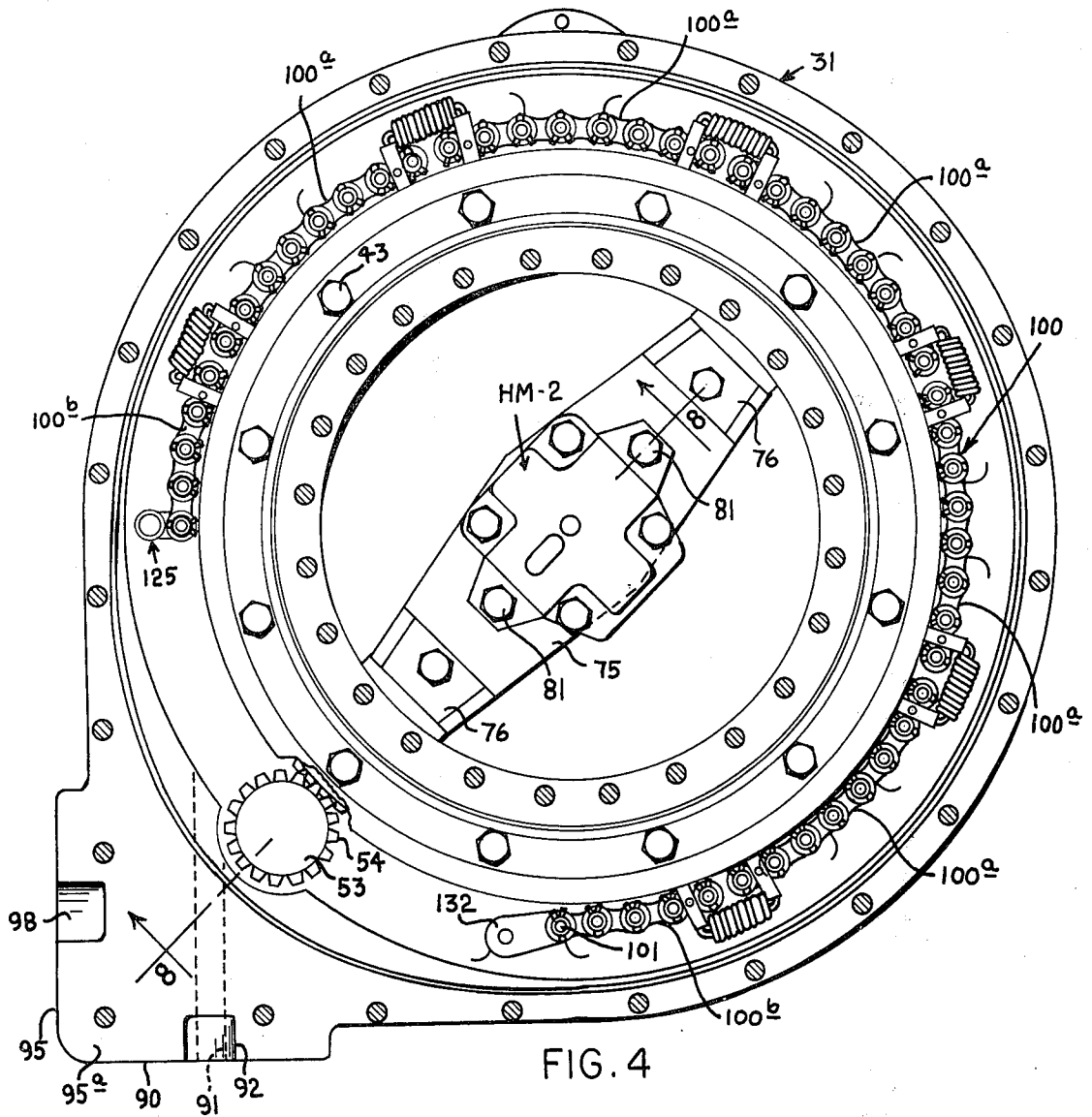
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ABSTRACT

A method for inserting soft flexible pipe or hose into oil and gas wells or the like under pressure. A capstan type drive mechanism is provided in combination with a pair of stuffing boxes and a reel for guiding a soft flexible pipe or hose into the well. The capstan pulls the pipe or hose from a storage reel into a sealed pressure chamber of the capstan drive mechanism and delivers it through a wiper type stuffing box into the well bore. Fluids are preferably forced through the flexible pipe as the same is moved into the well bore and directed outwardly into the well bore through a jet nozzle which serves to pull the lower end of the pipe into the well and to maintain the pipe under tension as it is injected. The capstan drive provides for positive movement of the pipe without damaging the same, while the pipe is filled with liquid to prevent its collapsing as it is moved through the capstan drive into the well. Special couplings are provided between lengths of the soft flexible pipe or hose which will pass through the stuffing boxes, capstan drive and into the well without difficulty. The capstan drive is enclosed in a toroid pressure chamber into which the soft flexible hose or pipe is moved in a tangential direction into the toroid chamber onto the capstan drive in a tangential direction from the capstan drive out of the toroid chamber into the well.

4 Claims, 22 Drawing Figures





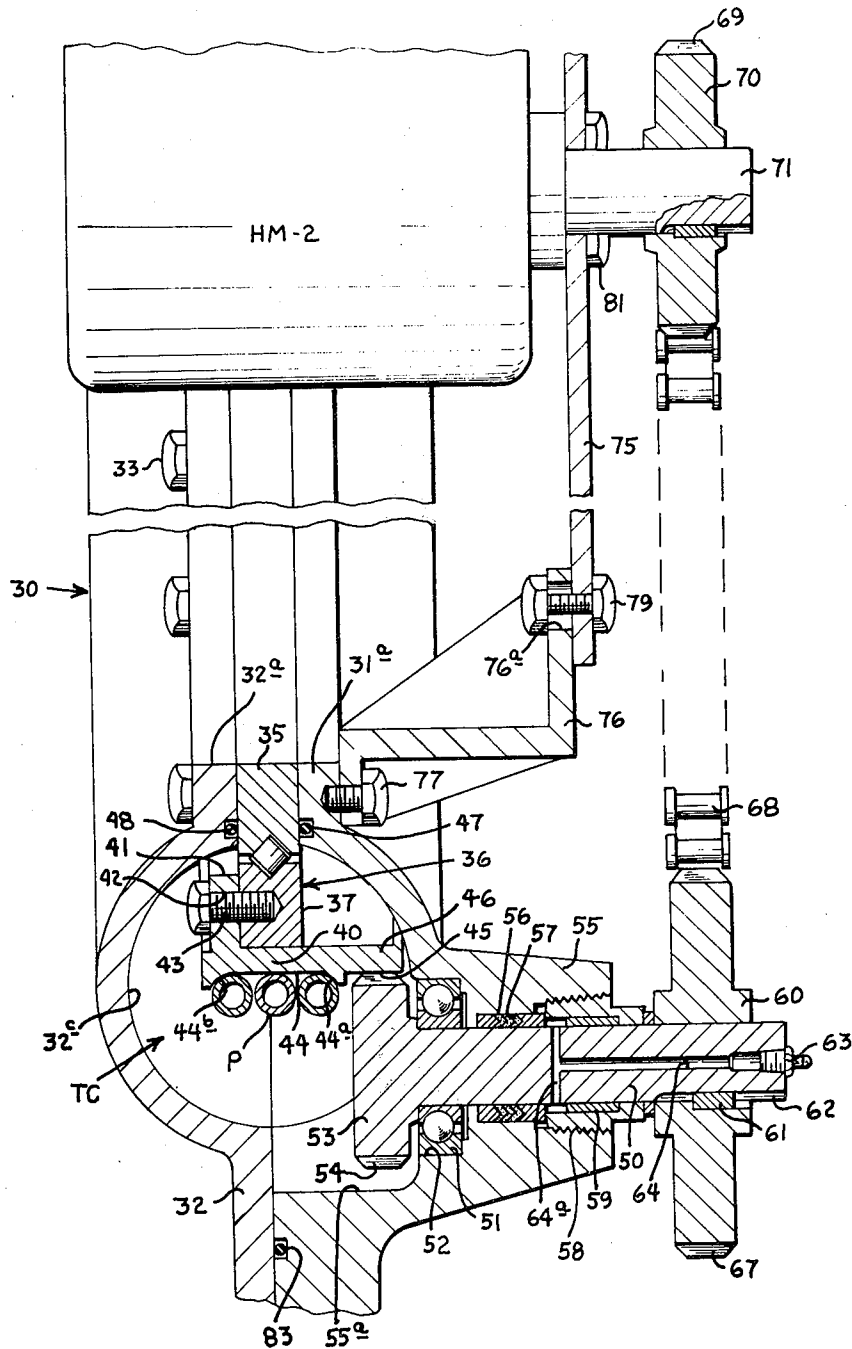


FIG. 8

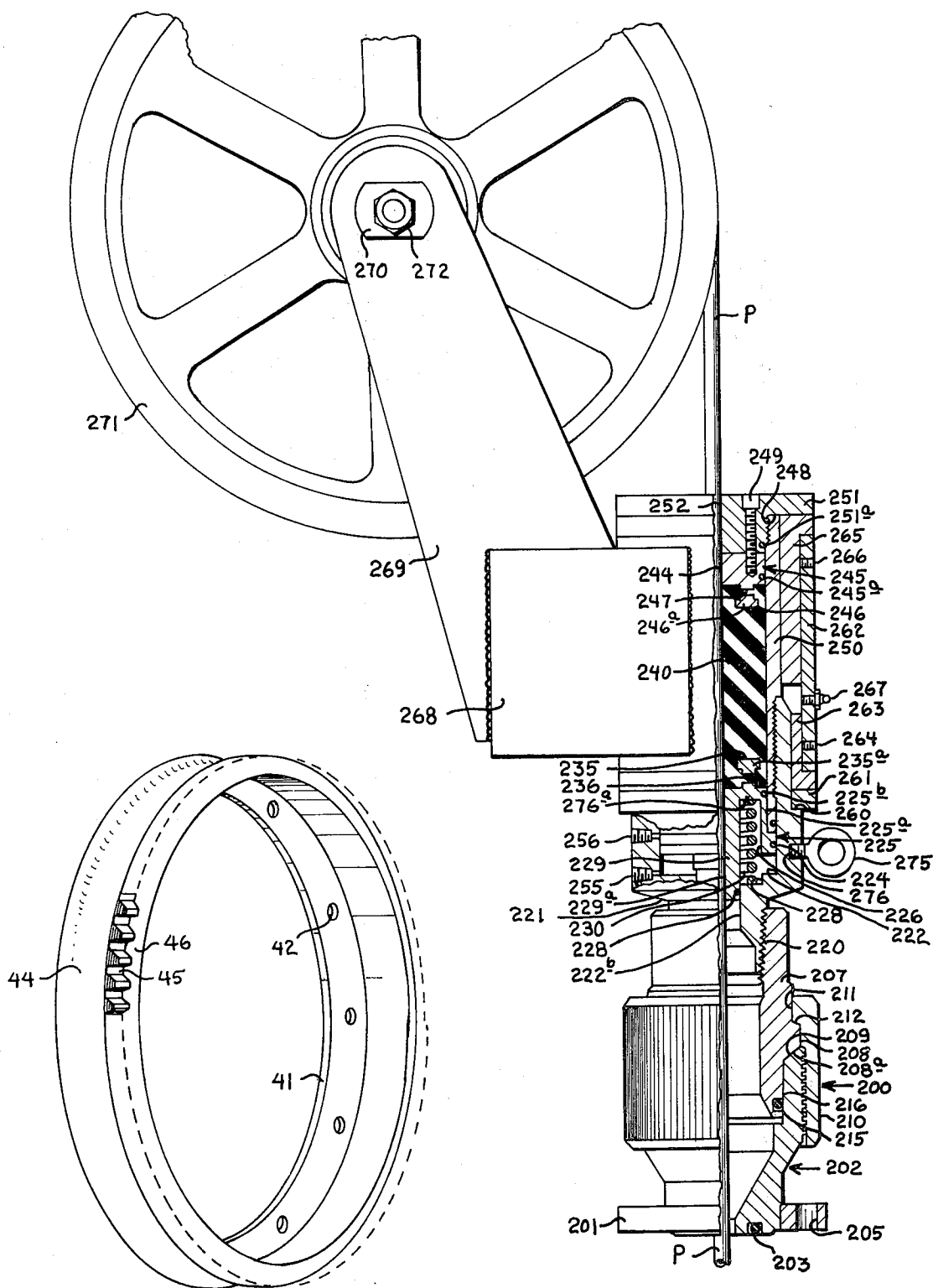


FIG. 9

FIG. 10

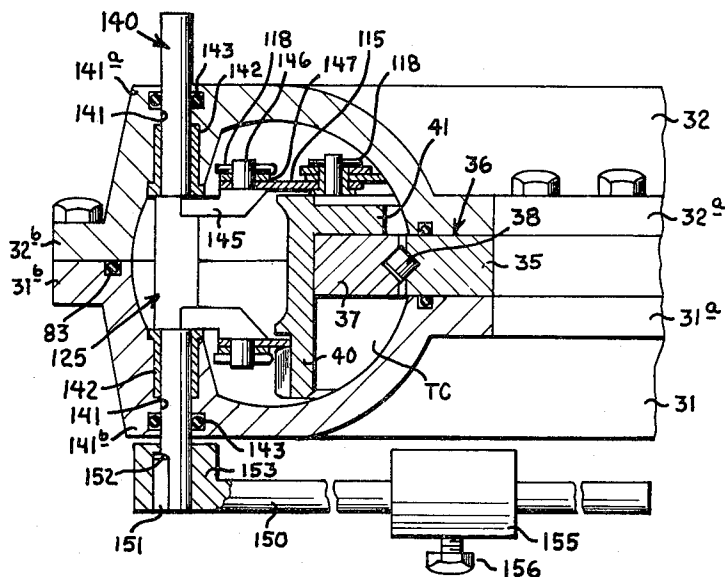


FIG. 6

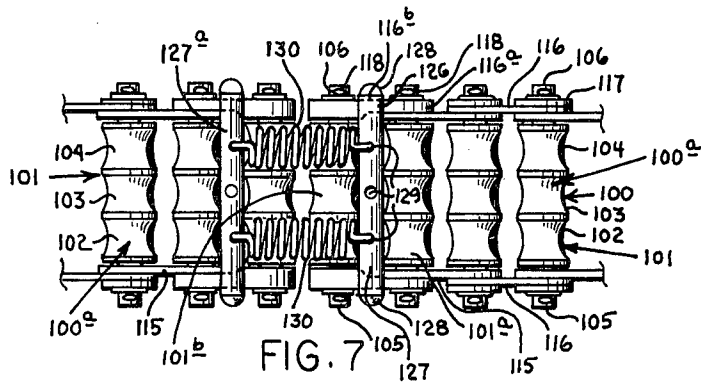


FIG. 7

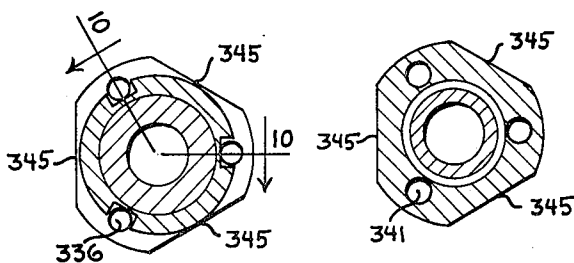


FIG. 12

FIG. 13

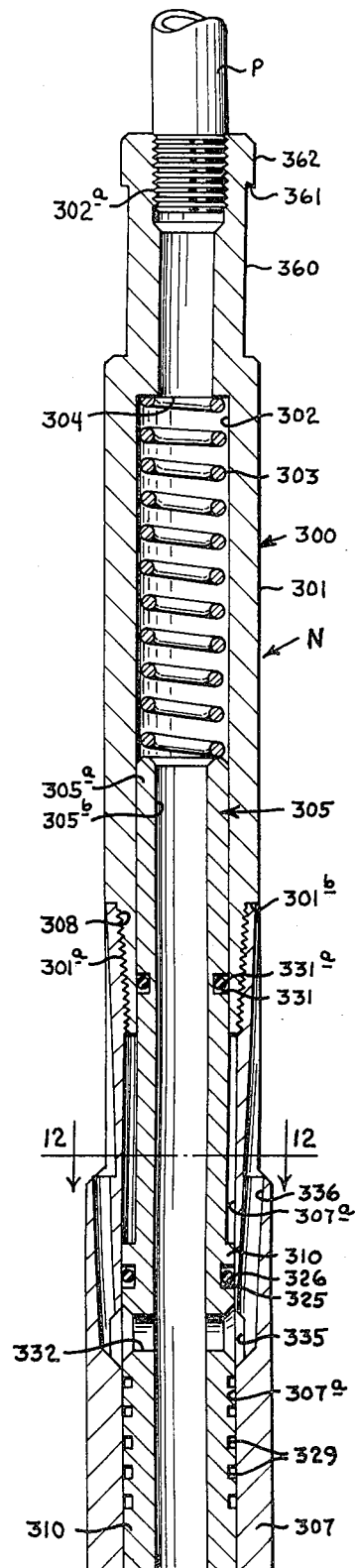


FIG. 11A

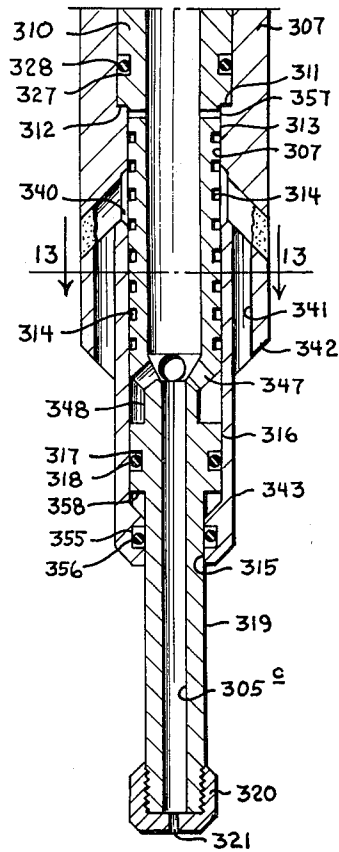


FIG. 11B

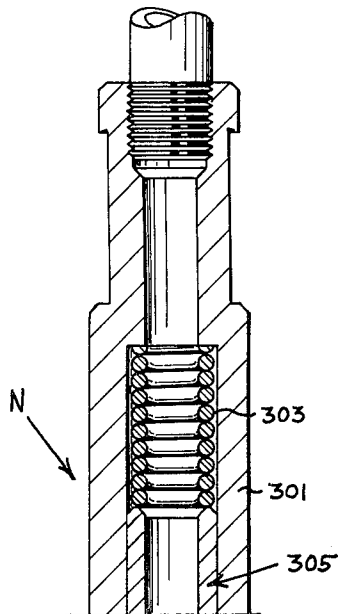


FIG. 14A

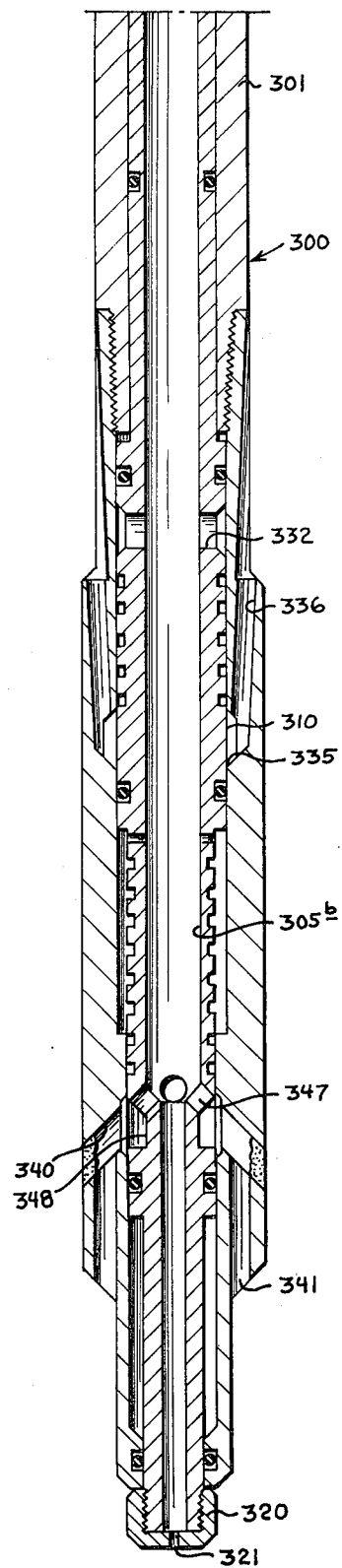


FIG. 14B

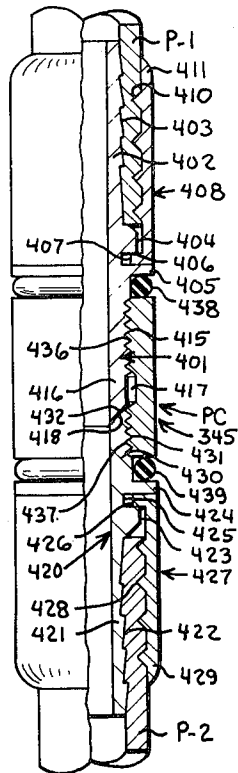


FIG. 15

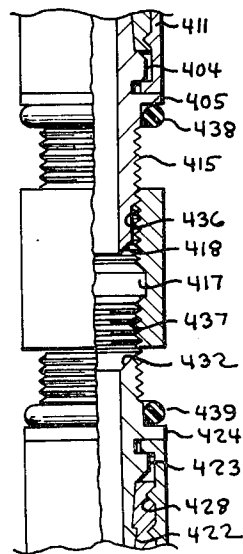


FIG. 16

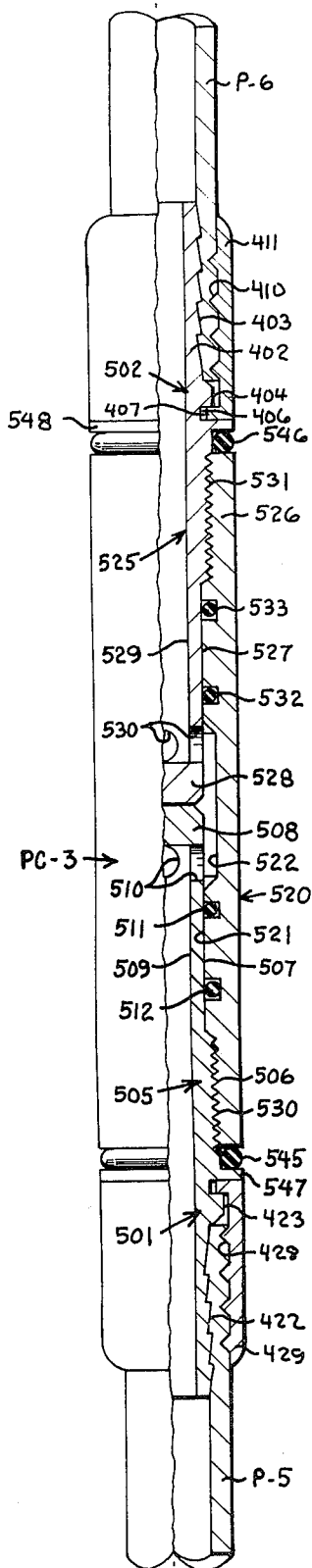


FIG. 19

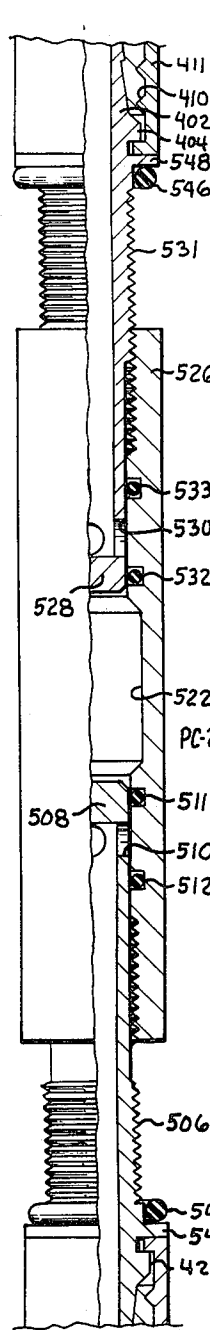


FIG. 20

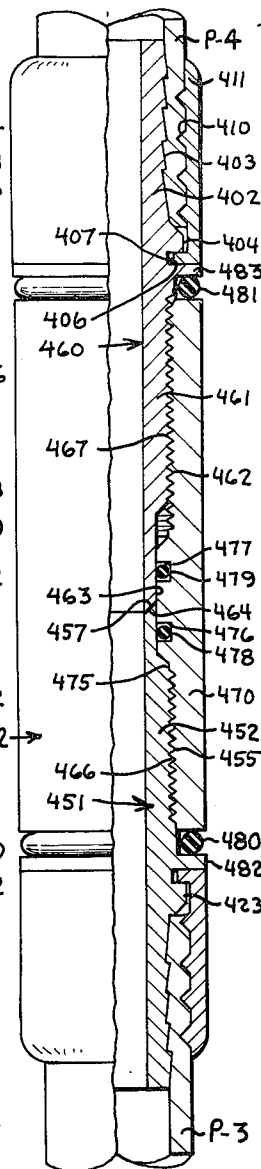


FIG. 17

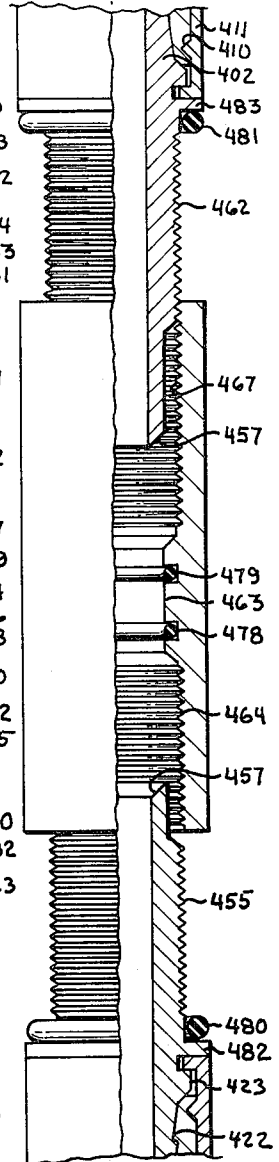


FIG. 18

METHOD FOR INSERTING FLEXIBLE PIPE INTO WELLS

This application is a division of application Ser. No. 300,831 filed Oct. 25, 1972, now abandoned.

This invention relates to new and useful methods for inserting soft flexible pipe or hose into wells under pressure.

It is one object of the invention to provide a new and improved method for injecting a soft flexible pipe or hose into a well under pressure.

A particular object of the invention is to provide a method for installing soft flexible pipe or hose in a well under pressure in which a minimum of hoisting equipment or other heavy machinery is utilized in effecting the injection of the pipe, and wherein the pipe, hose or conductor is readily movable into the well with a minimum of manual labor and a maximum of efficiency and control.

Still a further object of the invention is to provide a method of injecting pipe or hose into wells under pressure, wherein the pipe is moved while filled with fluid and with a minimum of crushing or damaging of the pipe or conductor as it is moved into the sealed well under pressure.

A particular object of the invention is to provide method of the character described which permits continuous circulation of fluids into the well through the pipe, hose or conductor being injected while the same is being moved into or out of the well, if desired.

Still another object of the invention is to provide an improved method of inserting flexible conduits into the well and which utilizes a jet injector nozzle which has means for directing a stream of fluid rearwardly from the leading end of the flexible conductor or hose for drawing the conductor or hose along the well pipe or well bore into which the conductor is being flow and which is provided with means for automatically transferring the direction of flow of the fluids being pumped through the conductor into the well from a rearward direction to a forward direction to wash out bridges or plugs of debris, or detritus, or sand or the like, in the well bore to permit the soft flexible conductor to be positively moved completely into the well bore, and which also is provided with means for automatically returning the nozzle to the position in which the jets are directed rearwardly from the tip of the flow conductor to cause the flexible xlow conductor or hose to be drawn further into the well bore after the blockage has been removed by washing or the like, so that the jet nozzle causes the entrant end of the soft flexible conductor or hose to automatically advance into the well bore as long as the well bore is clear therebelow and fluid is being circulated through the soft flexible conductor into the well.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a method of inserting a flexible conductor in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIG. 1 is a schematic view of a well having an apparatus constructed in accordance with the invention for carrying out the method of the invention for inserting soft flexible pipe into a well bore under pressure;

FIG. 2 is an enlarged sectional view partly in elevation and partly in section, of the drive mechanism and

stuffing box structures for the apparatus for carrying out the methods;

FIG. 3 is a fragmentary isometric view of the drive mechanism with the stuffing boxes separated therefrom;

FIG. 4 is a further enlarged view partly in elevation and partly in section, with one side of the housing removed;

FIG. 5 is a fragmentary transverse sectional view taken through the drive mechanism on the line 5—5 of FIG. 2;

FIG. 6 is a view similar to FIG. 5, showing a fragmentary transverse sectional view taken on the line 6—6 of FIG. 2;

FIG. 7 is an enlarged fragmentary view of the friction chain rollers of the drive mechanism;

FIG. 8 is an enlarged fragmentary sectional view taken on the line 8—8 of FIG. 4 showing the power mechanism for driving the capstan of the drive mechanism;

FIG. 9 is a perspective view of the capstan and inter-gal gear of the drive mechanism;

FIG. 10 is an enlarged view, partly in elevation and partly in section, of the fair lead stuffing box of the system through which the soft flexible hose or conductor is drawn into the capstan drive mechanism;

FIG. 11A is a longitudinal sectional view of the upper portion of a jet nozzle for drawing the soft flexible hose or conductor downwardly into the well bore showing the same in extended or advancing position;

FIG. 11B is a longitudinal sectional view of the lower portion of the nozzle of FIG. 11A;

FIG. 12 is a horizontal cross sectional view taken on the line 12—12 of FIG. 11A;

FIG. 13 is a horizontal cross sectional view taken on the line 13—13 of FIG. 11;

FIG. 14A is a view similar to FIGS. 11A and 11B showing the upper portion of the jet nozzle in retracted washing position after encountering an obstruction in the well;

FIG. 14B is a continuation of the vertical sectional view of the jet nozzle in FIG. 14A;

FIG. 15 is a longitudinal sectional view of a coupling joining two sections of a soft flexible conductor or hose for installation into a well bore, showing the same in coupled condition;

FIG. 16 is a fragmentary sectional view similar to FIG. 15 showing the coupling uncoupled;

FIG. 17 is a view similar to FIG. 15 showing a modified form of coupling;

FIG. 18 is a fragmentary view similar to FIG. 16 showing the modified form of coupling uncoupled;

FIG. 19 is a view similar to FIG. 17 showing a further modified form of coupling in coupled condition; and

FIG. 20 is a view similar to FIGS. 16 and 18 showing the last mentioned coupling in uncoupled condition.

In the drawings, FIG. 1, a well having a casing C therein extending downwardly to the well producing formation (not shown) also has a tubing string T within its bore extending downwardly in the well to such producing zone. At the top of the casing is a well head H, above which is a master valve M with a flow cross F having the usual lateral flow wings thereon for conducting well fluids from the annulus or other flow conductors in the well away from the well. Above the flow cross F is a blow out preventer BOP of the usual type for sealing between a flow conductor inserted into the well when desired. Above the blow out preventer is a

lubricator L of the usual type joined to the preventer by a union U-1, and above the lubricator another union U-2 connects the lubricator to a stuffing box S-1 which is connected at its upper end to a toroid capstan drive mechanism D. The capstan drive has a second stuffing box S-2 connected therewith by a union U-3 which also supports a sheave or pulley assembly or fair-lead FL.

A soft flexible conduit, conductor hose or pipe P extends from a reel R on which the pipe is wound over the fair-lead pulley into the stuffing box S-2 and through the drive mechanism and stuffing box S-1 into the lubricator and downwardly through the lubricator into the well bore through the tubing string T. On the lower end of the soft flexible hose or pipe P in the well is a nozzle N which is used for circulating fluids from the soft flexible pipe P into the bore of the tubing string T and for drawing the flexible pipe into the bore of the tubing string and downwardly in the well bore, as will be hereinafter more fully explained.

The reel R is rotated by a hydraulic motor drive HM-1 which drives a chain or belt B-1 and sprocket or pulley SP-1 which turns the reel R. The reel has a hollow shaft of the usual type which is connected to the extreme inner end of the soft flexible pipe or hose P, and a circulating fluid pressure line PL-1 extends from a circulating pump CP-1 through a valve V-1 which controls pressure of circulating fluid from a circulating fluid tank FT-1 through the pipe PL-1 to the reel shaft. The circulating fluid flows through the shaft into the flexible hose or pipe P and into the bore of the tubing string T, then upwardly therein and outwardly through the side wing of the flow cross F and a return circulating fluid pressure line PL-2 back to the tank FT-1. The pump CP-1 may be operated by any suitable source of power (not shown) and flow of fluids from the pump is controlled by the valve V-1 which similarly controls circulation of fluids through the flexible hose P and the tubing string T.

The reel R is supported on a frame W having angularly disposed supporting members W-1 and W-2 on the lower portion thereof for supporting the shaft of the reel R. The hydraulic motor HM-1 for driving the reel is shown to be mounted on one of the support members W-2 and a chain or belt drive B-1 extends from the motor to the drive pulley SP-1 for the reel. The shaft RS of the reel is hollow, and the pressure line PL-1 is connected to the end of the shaft through a swivel sleeve connection of the usual type which permits rotation of the reel on the shaft with the pressure line PL-1 connected thereto. The soft flexible pipe P is connected at its innermost end to a suitable fitting on the shaft on the reel in the usual manner to provide fluid communication between the pressure line PL-1 and the pipe or hose P so that fluid can be pumped through the pipe while the reel is rotating and the pipe is being moved into or out of the well bore.

For controlling the movement of the hose or pipe into the well, a pressure control manifold PM is connected to a control fluid pressure pump CFP-1, which likewise has a communication with a source of control fluid pressure or tank FT-2. A return line extends to the tank FT-1 from the manifold PM-1. From the pressure control fluid manifold PM, a hydraulic pressure line PL-3 extends to the hydraulic motor HM-1 which drives the reel R. A return line PL-4 returns the fluid from the motor to the manifold and to the tank FT-2 and the flow of fluids through the lines PL-3 and PL-4 control the direction of movement and speed of move-

ment of the motor HM-1. A similar, a second hydraulic motor HM-2 mounted on the toroid capstan drive mechanism D drives a chain or belt B-2 which in turn drives a drive pulley or sprocket SP-2 which turns a capstan member in the toroid drive mechanism D for driving the flexible hose P, as will hereinafter be more fully explained. The motor HM-2 is connected to the manifold PM by a pressure line PL-5 and a pressure line PL-6 which direct the fluids to and from the motor and to and from the manifold PM for controlling the direction and speed of movement of the motor HM-2. In addition, the sealing assembly of the stuffing box S-1 is moved into and out of sealing wiping engagement with the soft flexible pipe or hose P by a hydraulic fluid mechanism operated by control fluid pressure lines PL-7 and PL-8 connected to the stuffing box S-1 and to the manifold PM-1 for directing control fluid from and to the control fluid pump CFP-1 to and from the stuffing box for actuating the sealing assembly therein, as will be hereinafter more fully explained. Similarly, the fair-lead stuffing box S-2 is actuated into sealing or wiping engagement with the soft flexible pipe P-1 extending and moving therethrough by hydraulic fluid actuating mechanism controlled by pressure fluid lines PL-9 and PL-10, respectively, extending from the pressure manifold PM to the stuffing box S-2 for directing control fluid pressure from the control fluid pump CFP-1 to and from the stuffing box S-2, as will also be hereinafter more fully explained.

From the foregoing it will be seen that the assembly illustrated in FIG. 1 provides for hydraulic control of movement of a soft flexible hose or pipe P through an entrant or fair-lead stuffing box S-2 into a toroid capstan drive mechanism D and from the toroid drive mechanism through a stuffing box S-1 into the lubricator L and the tubing string T supported by the casing head H or hanger in the well. The stuffing boxes are moved into and out of wiping sealing engagement with the soft flexible pipe by hydraulic fluid actuated mechanisms within the stuffing boxes to be hereinafter more fully explained, and the toroid capstan drive mechanism D is driven by the hydraulic motor H-2 whose speed and direction of the rotation is controlled from the pressure manifold PM. Similarly, the hydraulic motor HM-1 for the reel R is controlled by hydraulic fluid lines therefrom the pressure manifold PM extending to such hydraulic motor for controlling the direction and speed of rotation of the storage reel R on which the string of soft flexible pipe is wound or wrapped.

It will be seen, therefore, that the soft flexible hose or pipe may be moved into or out of the well under pressure without loss of well fluid pressure from the well bore by virtue of the provision of the stuffing boxes S-1 and S-2 and the enclosed toroid capstan drive mechanism D. It will also be seen that circulating fluid may be pumped from the circulating fluid pump CP-1 through the pressure line PL-1 into the bore of the soft flexible hose or pipe through the hollow hub RS of the reel R and be circulated downwardly therethrough to the nozzle N and outwardly from the nozzle N into the bore of the tubing string T and upwardly in the tubing string to the flow cross F, then outwardly through the side flow wing of the flow cross to the return to the tank FT-1, or the usual slush pit or the like, as desired.

Valves V-3 and V-4 are connected to the side outlets or wings of the flow cross F in the usual manner for controlling the escape of fluid from the flow cross or

the return circulation from the tubing string back to the tank FT-1.

It will be seen, therefore, that means has been provided for inserting soft flexible hose or pipe into a well bore or removing the pipe from the well bore without the use of heavy hoisting equipment, winches, derricks, or the like, and that the pipe may be run into the well and removed from the well continuously and without making up or breaking out joints or couplings. Also, the pipe is stored on the reel R for ease in handling. The nozzle N provides for assisting the entry of or injection of the pipe into the well and, at the same time, as will be hereinafter more fully explained, may be used for cleaning out obstructions, bridges or plugs of sand or other foreign matter in the bore of the tubing as the soft flexible pipe is moved downwardly therein. Therefore, the soft flexible pipe may be quickly and expeditiously run into the well for washing out sand plugs, or other accumulations in the bore of the tubing or the well bore, or for otherwise treating the well with fluids circulated through the soft flexible hose or pipe and the nozzle and the other flow conductors in place in the well.

A particularly important element of the system is the toroid capstan type drive mechanism D, which is illustrated in greater detail in FIGS. 2 through 9, inclusive. As best shown in FIGS. 3, 5 and 6, the drive mechanism has an enclosed toroid housing 30 formed of two halves 31 and 32, a drive slide 31 and a cover side 32, respectively.

Each of the housing halves has a concave annular recess 31c and 32c, respectively, formed in its inner surfaces and these recesses or openings mate to form a substantially torous shaped chamber TC in the housing 30 in which the capstan and the drive elements of the drive assembly are disposed for operation. The two halves of housing are bolted together by bolts 33 and bolts 34 extending through openings in the internal and external flanges 32c and 32b of the cover side 32 of the housing, and threaded into threaded apertures in the internal and external flanges 31a and 31b, respectively, of the drive half of the housing. The inner flanges 31a and 32a of the housing halves are spaced apart to receive the inner race 35 of the X-bearing 36 having an inner race 35 and outer race 37 confining a plurality of alternately oppositely disposed roller bearing members 28 in the V-type raceways therebetween. The bearing 36 therefore absorbs both radial and axial thrusts during rotation of the outer raceway 37 on the bearing rollers 38.

Supported on the outer race 37 and bolted thereto is a capstan cylinder 40 having an internal flange 41 provided with bolt holes 42 for receiving bolts 43 which secure the capstan member to the outer race 37 of the bearing 36. The outer cylindrical surface of the capstan member 40 has an annular friction surface 44 formed with concave inner and outer edges flanges 44a and 44b, respectively, to provide side guides for the friction surface 44 thereon. The inner flange 44a also has gear teeth 45 cut therein, as best shown in FIG. 9. The teeth are spaced outwardly from the friction groove surface 44 on the lateral extension flange 46 on the capstan on the side thereof opposite the internal annular flange 41. The gear teeth 45 provide means by which the capstan member 40 may be rotated on the bearing 36.

Annular seal ring grooves 47 and 48 are provided in the inner flanges 31a and 32a of the drive half and cover half of the housing and O-ring seal members dis-

posed in those annular grooves seal between the body halves and the inner bearing race member 35, as clearly shown in FIGS. 5, 6 and 8. An annular seal ring groove 83 formed in the outer flange 31b of the cover half receives an O-ring seal member which seals between the outer flanges 31b and 32b of the housing, to enclose the toroid chamber TC.

For rotating the capstan, a drive shaft 50 is mounted on a roller bearing 51 disposed in an annular receptacle 52 in the drive half 31 of the housing, as clearly shown in FIG. 8. The shaft 50 has an integral gear 53 on its inner end having teeth 54 mating with the teeth 45 on the flange 46 of the capstan member, whereby when the shaft 50 is rotated the engagement of the teeth 54 on the gear 53 with the teeth 45 on the flange 46 of the capstan causes rotation of the capstan member 40 on the bearing 36 in the housing 30. The drive gear 53 is mounted in a suitable recess 55a in the drive half 31 of the housing which provides clearance between the gear and the housing. Thus, the entire chamber TC is enclosed and sealed to confine the capstan drive and its associated parts in sealed relation in the housing.

The shaft 50 extends outwardly through a boss 55 on the drive half 31 of the housing and a plurality of seal rings of a seal assembly 56 are disposed in an internal annular sealing recess 57 in the boss, being retained therein by a gland nut 58 having a bearing or bushing 59 secured in its bore and closely surrounding and supporting the projecting end of the shaft 50. Mounted on the projecting end of the shaft is a sprocket gear 60 which is held against rotation thereon by a key 61 fitting in a key slot 62 formed in the exterior projecting portion of the shaft 50. A lubricating fitting 63 is secured in the outer end of a lubricating passageway 64 extending axially inwardly of the shaft 50 to radially outwardly extending cross passages 64a extending to the exterior of the shaft between the bearing 59 in the housing 59 and the seal assembly 56.

The sprocket 60 is driven by a roller chain 68 which engages over teeth 67 on the sprocket and similar teeth 69 on a drive sprocket 70 mounted on the shaft 71 of the hydraulic motor unit HM-2 which is supported on a supporting plate 75 carried by a pair of diametrically opposed brackets 76 secured to the inner flanges 31a of the motor half of the housing by bolts 77 extending through apertures in the bracket and the flanges 31a and 32a of the housing as well as through the inner race 35 of the bearing 36. Bolts 79 extend through apertures in the motor mount 75 and in the bracket 76, the apertures 76a in the bracket 76 being elongated to permit adjustment of the position on the motor HM-2 on the brackets to provide for adjusting the tightness of the chain 68 extending between the sprockets 70 and 60. Bolts 81 extend through the motor mount 75 to the motor HM-2 to hold the same rigidly on the motor mount in the usual manner.

Thus, it will be seen that the hydraulic motor HM-2, when energized by hydraulic fluid delivered thereto through the pressure lines PL-5 and PL-6 from the pressure manifold PM, will cause rotation of the shaft 71 of the hydraulic motor to similarly drive the sprocket 70, the chain 68 and the sprocket 60 to cause the shaft 50 to turn and so turn the integral gear 53 on its inner end and drive the capstan member 40 in the housing.

An exit flange or boss 90 is formed on the exterior of the drive half 31 of the housing 30 and an exit opening 91 is drilled through the exit flange 90 in a direction to

position or direct the wall of the opening 91 in tangential relationship to the friction surface 44 of the capstan member 40, whereby the soft flexible hose or pipe P wound on the capstan friction surface 44 may pass directly from the capstan surface 44 outwardly through the exit opening 91 without bending or flexing. Similarly, the cover member 32 is formed with an inlet flange or boss 95 having an inlet opening 96 formed therein and disposed in a direction which causes the flexible hose P to move into the chamber TC of the housing to engage the friction surface 44 of the capstan member 40 tangentially of such surface. Suitable cylindrical positioning or aligning projections 92 and 97 are formed on the flanges 90 and 95, respectively, and these cylindrical projections are received in corresponding cylindrical positioning or aligning recesses 94 and 98 in the mating surfaces of the portions of the flanges 90 and 95, respectively, formed in the two housing halves 31 and 32, respectively. The external cylindrical portions 92 and 97, respectively, extend only part of the distance inwardly toward the chamber TC and engage in the aligning recesses 94 and 98 formed in the mating surfaces in the abutting planar surfaces 90a and 95a, respectively, of the bosses 90 and 95 of the housing halves.

As has been explained, the openings 91 and 96 extend inwardly through the bosses into the bore of the chamber TC, the inlet opening 96 extending inwardly into the chamber to direct the soft flexible hose or pipe P into engagement with the frictional surface 44 adjacent the flange 44b of the capstan member 40, while the exit opening 91 extends outwardly through the boss 90 from a tangential position in which the pipe leaves the capstan surface 44 adjacent the flange 44a thereon. The width of the capstan surface 44 is preferably equal to approximately three times the diameter of the soft flexible hose or pipe so that three rounds of the soft flexible hose may be wound on the capstan surface simultaneously, and the hose will progress inwardly through the inlet opening 96 onto the capstan surface adjacent the flange 44b to be wound on the surface approximately three times and then to exit from the friction surface 44 through the exit opening 91 at a tangential position adjacent the flange 44a of the capstan friction surface. Thus, the hose enters through the openings into the chamber TC and is directly tangentially onto the capstan friction surface and exits from the capstan friction surface through the opening 91 in a tangential direction therefrom.

The stuffing box S-1 is connected to the exit flange 90 on the drive half 31 of the housing and the fair-lead stuffing box S-2 is secured to the entrance flange 95 on the cover member 32, as shown in FIG. 1 and FIG. 2, and these stuffing boxes seal around the flexible hose or pipe as will be hereinafter more fully explained to completely close the chamber TC of the housing against fluid leakage therefrom while the hose is in place, or is being moved into or out of the well.

While it is believed possible that the hose would frictionally engage the capstan sufficiently when wound thereon to be driven by rotation of the capstan, being pulled inwardly through the fair-lead inlet stuffing box S-2 into the chamber TC in the housing and wound around the capstan to leave the chamber TC through the outlet opening 91 through the stuffing box S-1, it is desirable that additional frictional roller bearing pressure means be provided within the housing to assure a desired frictional engagement of the soft flexible hose

or pipe with the capstan friction surface 44. Such a structure is clearly shown in FIGS. 2 and 4 through 7. The friction pressure means comprises an elongate roller chain member 100 consisting of a plurality of roller members 101 having three concave guide surfaces 102, 103 and 104 formed thereon and supported by axially projecting stub shafts 105 and 106 which extend through apertures 108 and 109 in flanged bearing members 110 which are secured in openings in inner and outer chain links 115 and 116, respectively, extending between the stub shafts on each side of the adjacent rollers. A retaining washer 117 is mounted on the outer end of the flanged bearing 110 and held in place thereon by a suitable cotter pin or other retaining means 118 in the customary manner of link chains. The concave surfaces 102, 103 and 104 of the roller members 101 are disposed to engage the three wrappings or rounds of the flexible hose or pipe supported on the friction surface 44 of the capstan member 40 to press the hose tightly against the surface as will be hereinafter more fully explained.

The roller chain pressure member 100 is formed of a plurality of interconnected inner sections 100a, and short end sections 100b at its ends for connecting the same to the housing 30 and to a tensioning crank mechanism 125. The sections 100a each comprise a plurality of the rollers having the concave guide surfaces 102, 103 and 104 thereon with the axial stub shafts at the opposite ends thereof engaged in the side links 115 and 116 of the chain as already described. The end links 116a of each inner section 100a of the chain are thicker than the links 115 and 116, as clearly shown in FIG. 7. The portion of the outer link 116a connected to the roller 101a just inwardly from the end roller 101b has a thickness equal to the thickness of the side link 116 and the flange of the washer 117, and is secured on the bearing 110 by cotter keys 118, in the same manner as the washers and side links 115 and 116 are connected to the other rollers. The opposite end portion of the link 116a is equal in thickness to the thickness of the two links 115 and 116 and the washer 117, and fits over the flange bearing 110 and is held in place thereon by a cotter key 118 in the same manner as the other links are secured to the other rollers of the chain pressure member. Between the stub shafts 105 and 106 of the two end rollers 101a and 101b, the outer surface of each link 116a is provided with a transverse groove 116b which receives a downwardly extending arm 126 of a U-shaped connector member 127 secured to each of the side links 116a on opposite sides of the rollers by suitable bolts 128. Each of the connector members 127 is provided in its base 127a with a plurality of holes 129, substantially overlying the concave guide surfaces 102, 103 and 104 of the rollers, for receiving tensioning springs 130. The holes 129 receive the curved ends of the helical tensioning springs 130 and the connecting members 127 at the end of each section 100a of the pressure member 100 are thus resiliently connected to permit elongation of the roller chain pressure member 100 so that coupling members, to be hereinafter described, may move readily through the capstan drive member D between the roller pressure member and the capstan friction surface 44. The springs permit the rollers of the chain pressure member to move outwardly to accommodate the larger diameter of the coupling members between the pressure member 100 and the capstan friction surface.

One end section **100b** of the roller chain pressure member **100** is secured to the housing **30** and has elongated outer side links **132** connected to the stub shafts **105** and **106** of the end roller **101** of the section **100b**, held in place on the bearing **110** by the usual washer **117** and cotter key **118**. The outer ends of the elongate outer side links **132** are connected by bearing pins **134** to internal bosses **135a** and **135b** in the concave bores **31c** and **32c** of the housing members **31** and **32**, respectively, and axially aligned openings **136a** and **136b** are provided in the bosses **135a** and **135b** for receiving the bearing pins **134** which extend into counterbores **137** in each end of a fixed roller member **133** for rotatably supporting the fixed roller member in the chamber TC, and for connecting such end of the pressure member **100** to the housing so that the opposite end may be drawn under pressure to tightly engage and held the soft flexible pipe in frictional contact with the friction surface **44** of the capstan member **40** in the chamber. The opening **136a** in the body cover member **32** extends completely outwardly through another external boss **138** and is threaded in its outer portion to receive a retaining plug member **139** for closing the bore **136a** and for holding the pins in place in the bores **136a** and **136b** of the two housing halves. If desired, the bearing pins **134** may be threaded into the bores **137** in the opposite ends of the roller member **133**, the ends of the bearing pins being provided with slots **134a** for receiving a blade for turning the pins into threaded bores in the roller member.

The plug **139** in the outer end of the opening **136** in the cover half **32** of the housing also provides means for aligning the openings **136a** and **136b** to permit the pins **134** to be readily inserted into the openings as the halves of the housing are joined together to close the housing. The opposite end portion **100b** of the pressure member **100** is identical to the shorter section **100b** just described, but the inner links **115** on each side of the roller **101** at the end of the section are joined to a crank member **125** having elongate end shaft portions **140** which extend through aligned openings **141** in bosses **141a** and **141b** formed externally of each of the housing halves **31** and **32**. The shaft portions are supported by bearing inserts **142** disposed in the openings **141** for free rotatable movement about their axis. O-ring seals are disposed in annular grooves **143** in the bores **141** for each of the housing halves for sealing around the shaft ends **140** for preventing fluid leakage through the openings **141** from within the chamber TC. The crank member has a pair of crank arms **145** medially thereof extending radially from the shafts and provided with stub-trunnion members **146** extending perpendicularly to the crank arms **145** and parallel to the crank shafts **140**. The trunnions **146** extend through the links **115** at the end of the chain section **100b** and a washer **147**, and a cotter key **118** holds the washer and the link **115** on each of the trunnions, as clearly shown in FIG. 6.

An exteriorly positioned weight arm **150** is secured on the projecting end of one of the shafts **140**, and a hub **153** on the weight arm receives the shaft and supports the weight arm **150**, being held against rotation on the shaft by a key **151** disposed in a slot **152** in the shaft. The weight arm has a weight member **155** adjustably secured to the arm by a bolt **156**, whereby the weight **155** controls the force applied through the crank member **125** to the roller chain pressure member **100**. Obviously, if desired, hydraulic cylinder operator means (not shown) or any other means may be used to

move the crank to vary the force applied to the pressure member **100** and the flexible hose or pipe engaging the capstan friction surface **44** to vary the friction with which the hose engages the friction surface.

The fixed roller member **133** is also formed with a plurality of concave grooves **133a**, **133b** and **133c** conforming substantially to the concave grooves of the other rollers **101** of the pressure member **100**. These grooves provide space for passage of couplings between the pressure friction surface **44** of the capstan member **40** and the roller and also serve to guide the couplings in their movement around the capstan in the housing chamber TC.

For closing the inlet opening **96** into the housing chamber TC, and the outlet opening **91** from the housing chamber of the drive assembly, the stuffing boxes S-1 and S-2 are provided. The stuffing box S-2 is the fair-lead stuffing box at the inlet opening **96** and comprises a union or coupling assembly **200** having a flange **201** on one half **202** of the union for connecting the same to the planar surface **99** of the boss **95** surrounding the inlet opening **96**. A seal ring groove **203** is provided in the face of the flanged portion of the union female half **202** having an O-ring seal therein sealing between the union half and the boss **95** of the drive assembly housing **30**. Bolts **204** extend through openings **205** in the flange and into threaded openings (not shown) in the boss **95**. The union assembly **200** has a second male half **207** which has an external flange **208** forming a beveled shoulder **208a** thereon for engaging in a beveled seat **209** in the female half **202** for providing a stop limiting the coengagement of the members. A threaded clamping sleeve **210** having an internal annular flange **211** thereon engaging a shoulder **212** on the flange **208** securely clamps the two halves of the union assembly together. An external annular groove **215** is provided in the reduced projecting end portion **216** of the union male half **207**, and an O-ring seal disposed therein prevents fluid escaping from within the bores of the half members in the usual manner. The outer end of the union male half **207** is internally threaded and receives a reduced boss portion **220** of the stuffing box housing **221**. The bore **222** of the housing is enlarged in its outer portion to provide a chamber **223** in which a piston **225** having an external seal ring **224** thereon is longitudinally slidable. The piston has a counterbore **226** in which a helical coil spring **230** is disposed to be confined between the bottom **226a** of the counter bore and a shoulder **222a** at the inner end of the enlarged bore **222** of the housing. A protruding cylindrical nose **229** of the piston **225** engages in the reduced bore **222b** in the boss portion of the housing and an O-ring seal is mounted in an external annular groove **228** on the nose **229** of the piston for sealing therebetween and closing the chamber between the piston nose and the housing in such reduced bore. A seal ring disposed in an external annular groove **224** in the piston **225** seals between the exterior of the piston **225** and the enlarged bore **222** of the housing. The piston **225** has a longitudinally projecting annular cylindrical flange or sleeve **235** on its outer end which is provided with a plurality of circumferentially spaced radial openings **236**. An elongate cylindrical or tubular sealing sleeve **240** is connected at one end to the sleeve **235** of the piston by being bonded thereto with portions of the sleeve extending through the radial openings **236** and engaging beneath a T-shaped head **235a** at the extreme outer end of the projecting annular flange or sleeve

235. Thus, the sealing sleeve is securely fixed or bonded to the piston 225 and movable at that end of the sealing member with the piston. The opposite end of the sealing 240 is bonded or otherwise secured to a retainer bushing 245 which has an annular cylindrical projecting flange 246 substantially identical to the flange 235 of the piston and provided with a plurality of radially extending openings 247 and a T-shaped head 246a to which the end of the sleeve is securely bonded. The sealing sleeve is disposed within a packing sleeve 250 which is threaded into the upper end of the bore 222 of the housing 221 and has internal threads 248 in the outer end of its bore 222 of the housing 221 and has internal threads 248 in the outer end of its bore for receiving a gland member 251 for confining the retainer bushing 245 and packing sleeve 240 in the bore of the packing sleeve. A bolt 249 extends through the flanged gland member 251 and into a threaded bore in the retaining bushing 245. An external annular packing recess 245a is formed in the retainer bushing 245 and an O-ring seal is disposed therein for sealing between the retainer bushing and the sleeve 250. Similarly, an external annular groove 251a is provided in the inner end of the flanged gland member 251 for sealing between the gland member and the bore of the sleeve 250. The gland member 251 has a bore 252 which is substantially identical to the bore 244 of the packing retainer bushing 245 and the bore 299a extending through the nose 229 of the piston 225.

Fluid control pressure flow openings 255 and 256 are provided through the wall of the housing 221 communicating with the enlarged bore 222 of the housing below the piston 225 and above the piston seal ring 224 of the piston 225. The upper portion 225a of the piston 225 is reduced in diameter slightly to fit within the bore of the sleeve 250 and has an external annular groove 225b on its upper end in which an O-ring seal is mounted for sealing between the reduced upper portion 225a of the piston and the bore of the sleeve 250. The inlet 256 communicates with the bore 222 of the housing 221 above the seal ring 224 while the inlet 255 communicates with the bore 222 of the housing below the piston seal ring 224. Thus, fluid pressure entering the bore 222 on opposite sides of the piston seal ring 224 will move the piston in opposite directions in the bore 222 and either elongate or compress the sealing sleeve or packing 240 to cause the same to securely engage around the soft flexible hose or pipe being moved through the stuffing box, or to move it out of engagement therewith as desired. The outer end of the housing 221 of the stuffing box is reduced on its exterior to provide a stop shoulder 260 against which a spacer ring 261 is engageable for supporting a swivel sleeve 262 having a bearing bushing 263 in one end secured therein by a set screw 264 and riding on the exterior of the reduced outer portion of the housing. The swivel has an outer end bushing 265 which is disposed in the bore of the sleeve 262 and secured therein by a set screw 266. The end bushing 265 engages beneath the flange 251 of the gland member 251 so that the swivel sleeve 262 is rotatable about the longitudinal axis of the packing cylinder sleeve 250. An arm 268 secured to the swivel sleeve 262 by welding or the like supports a yoke 269 projecting at an angle therefrom on the outer end of which a shaft 270 rotatably supports a sheave 271. Suitable bearings are provided on the shaft 270 between the shaft and the sheave and a lubricating fitting 272 provides for lubrication of the sheave for rotatable

movement on the shaft. The sheave has a groove sufficiently large to accommodate the soft flexible pipe or hose P and the couplings or connector members PC joining connector lengths of the pipe P for guiding the same around the sheave and into the stuffing box S-2. A lubricating fitting 267 in the swivel sleeve 262 provides for lubrication of the bore of the swivel sleeve for free movement thereof on the exterior of the housing 221 and the packing cylinder sleeve 250.

A supporting eye-bolt member 275 is threaded into a bore 276 in the exterior of the housing 221 near the inner end of the swivel sleeve to permit handling of the drive mechanism by means of suitable hooks, chains or the like and associated hoisting equipment. Similar eye-members 31m and 32m are provided on the external flanges 31b and 32b, respectively, of the drive housing 30 of the toroid drive mechanism D. Therefore, suitable hoisting equipment may be connected to the housing and to the fair-lead stuffing box S-2 to lift the same for positioning them on the wellhead above the blow out preventer BOP. The flanged eye-member 31m on the drive half 31 of the housing also provides means for supporting the drive member while the cover half 32 is removed therefrom. The eye flange 32m on the cover member 32 permits lifting the same while the drive half member 31 is supported by means of the eye-member 31m to facilitate handling of the assembly and parts thereof.

The stuffing box S-1 is generally identical to the stuffing box S-2, with the exception that there is no swivel sleeve or sheave and that the packing cylinder sleeve 250x, which is otherwise identical to the packing cylinder sleeve 250, has an external annular flange connector 280 welded to its upper inner end to provide means for connecting the stuffing box to the planar surface 90b of the boss 90 having the outlet opening 91 therein formed on the cover half 32 of the body 30 of the drive mechanism. Bolts 281 extend through suitable apertures 282 in the flange and are threaded into the face 90b of the boss 90 for securing the stuffing box to the toroid drive mechanism. Within the bore of the packing cylinder sleeve 250x the gland member 251x is shortened and the end flange omitted, and the gland member threads into the threaded upper end of the bore of the packing cylinder sleeve 250x for holding the retaining member 244 having the packing sleeve 240x secured thereto in place in the bore of the packing cylinder sleeve. The gland member 251x has an annular groove 251y formed in its end surface for receiving an O-ring seal for sealing between the gland member 251x and the face 90b of the boss 90 when the flange 280 on the packing cylinder sleeve is connected to the boss to hold the stuffing box in sealing position on the toroid drive mechanism. The housing 221x also does not have the external annular flange forming the shoulder 260 thereon, but is otherwise identical to that of the form first described, as are the packing assembly and the piston within the housing and the packing cylinder sleeve. Lateral flow control fluid openings 285 and 286 communicate with the bore of the housing 221x above and below the seal member 224x on the piston 225x in the housing for moving the piston in either direction in the housing to compress or elongate the packing sleeve 240x in the stuffing box. A spring 230x normally biases the piston in a direction to compress the packing slightly to seal around the pipe P extending through the stuffing box. The male union half 207x is identical to that of the stuffing box S-2, as are the female union half

202x and the threaded collar sleeve **210x** for connecting the sections of the union **220x**. The female half **202x** of the union is threaded on its bore and does not have an external annular flange thereon. However, the threaded bore at the outer end of the female half receives the upper externally threaded end of the lubricator **L** for connecting the union to the lubricator. The stuffing box **S-1** is otherwise identical in its construction and operation to that of the stuffing box **S-2** previously described.

Since the sealing sleeve elements of the stuffing boxes are positively connected at their opposite ends to the bushing and to the piston positive longitudinal stretching of the sealing element may be effected by movement of the piston in the cylinder to cause the sealing sleeves to retract from sealing engagement with the pipe or coupling to permit movement of the pipe or coupling therethrough without damaging the sealing element, but at the same time this structure also positively assures that when the piston is moved to compress the packing element it is again moved into sealing engagement with the pipe or the couplings as they pass through the system. This obviously reduces the wear on the sealing element in use and prevents escape of well fluids and resulting pollution or discharge of contaminants from the well into the atmosphere or adjacent water or land areas. Also, wear on the sealing sleeve may be compensated for by the hydraulic operation of the piston in the stuffing boxes.

From the foregoing, it will be seen that a method and an apparatus for installing a soft flexible hose or pipe into a well bore under pressure has been disclosed. A positive drive for moving the soft flexible pipe into the well and for sealing between the pipe and the well casing or the like has been shown and described, which permits positive movement of the pipe into the well under pressure and without injury or damage to the pipe. The drive mechanism provides a positive capstan frictional engagement with the soft flexible pipe, and the pressure means assures proper contact of the pipe with the capstan friction surface without deformation, while the means for circulating fluid through the pipe as it is being installed into the well further prevents deformation or damage to the pipe or hose. In addition, the sealing sleeve members of the stuffing boxes are movable hydraulically into and out of sealing engagement with the pipe and the couplings **PC** to control the pressure with which the sealing sleeves engage the pipe and the couplings passing therethrough the confine well fluids within the well bore below the drive mechanism. If desired, it is readily apparent that a suitable lubricant liquid may be confined within the toroid housing **30** of the drive mechanism between the stuffing boxes to maintain the driving elements in proper functional order and cut of contact with dirt or the like produced from the well formation. It will also be seen that the drive mechanism and stuffing box assemblies are readily movable into position on the well head and removable therefrom without requiring the use of heavy lifting or hoisting equipment, derricks or the like. Also, it is readily apparent that, if desired or necessary, the cover half of the housing may be removed for servicing the drive mechanism in the housing while the drive half of the housing and the lubricator portion thereof are still connected to the well. Also, it will be readily apparent that the lubricator **L** may be disconnected from the wellhead at the lower union **U-1** to permit servicing of

the system or insertion of other tools into the well, if desired.

In order to assure positive movement of the lower end of the soft flexible hose or pipe **P** into the well bore, a nozzle **N** is attached to the entrant end of the pipe **P**. The nozzle includes an elongate tubular body **300** formed of an upper section **301** having internal threads **302a** for connecting the same to the soft flexible hose **P**, and having an enlarged bore **302** in which a resilient helical coiled spring **303** is confined between a downwardly facing shoulder **304** at the upper end of the bore and the upper end of a slidable tubular piston member **305** disposed in such bore. A lower tubular body section **307** has a bore **307a** in the upper portion thereof internally threaded at **308** to thread onto the reduced lower end **301a** of the upper section **301** to abut against the shoulder **301b** at the upper end of such reduced portion. The tubular piston sleeve member **305** has an enlarged piston section **310** intermediate its ends which is slidable in the enlarged upper portion of the bore **307a** of the lower section **307** of the housing. The lower portion **307b** of the bore of the lower housing section **307** is reduced in diameter and provides an upwardly facing internal annular stop shoulder **311** which is engageable by the shoulder **312** at the lower end of the enlarged piston portion **310** of the tubular piston member **305**, as shown in FIG. 11. The lower portion **313** of the elongate tubular piston member below the piston section **310** is reduced in external diameter and slides in the reduced bore **307b** of the lower housing section **307**, and the exterior portion of such reduced portion **313** of the tubular piston member **305** is provided with a plurality of external annular grooves **314** which permit sand or the like to pass through the reduced lower portion **307b** of the bore of the lower housing member **307**. The extreme lower end of the bore of the lower housing member **307** is further reduced at **315** to provide a retaining means for retaining the tubular piston member in the housing at the lower end of the movement thereof, and a lower external annular power piston flange **316** on the reduced lower nozzle end **314** of the tubular piston member has an external annular groove **317** thereon within which an O-ring seal **318** is disposed to seal between the bore **307b** of the lower housing section and seal between the bore **307b** of the lower housing section and power piston **316** on the lower reduced nozzle nose end **319** of the piston member **305**. The extreme lower end of the nose end **319** is externally threaded and has a cap **320** threaded thereon and provided with an orifice **321** which provides for ejection of a jet of liquid from the nozzle forwardly ahead of the nozzle as the same is lowered into the well bore. The intermediate enlarged piston portion **310** of the piston member **305** has in its upper portion an external annular groove **325** within which an O-ring seal member **326** is disposed for sealing with the bore **307a** of the lower housing member **307**, while the lower portion of the enlarged central piston portion **310** has an external annular groove **327** formed therein within which an O-ring seal **328** is disposed to seal between the lower end portion of the piston member and the lower portion of the bore of the lower housing. A plurality of external annular grooves **329** are formed in the exterior of the central piston portion **310** of the elongate piston sleeve member **305** to permit sand or other foreign matter trapped in the bore of the housing to be moved therewith to maintain the bore of the housing in good sealing condition during movement and to pre-

vent scarfing of the bore. The reduced neck end **305a** of the piston sleeve member **305** also has an external annular groove **331** formed therein and an O-ring seal member **331a** is disposed in the groove to seal between the neck **305a** and the bore wall of the bore **302** of the upper housing member **301**.

Substantially medially of the bore **307a** of the lower housing member **307** is an internal annular recess **335** having a plurality of upwardly divergent jet wash openings **336** formed therein at circumferentially spaced positions and extending upwardly and outwardly to the exterior of the housing. The enlarged piston portion **310** of the piston member **305** has a plurality of lateral openings **332** therein disposed in registry with the recess **335** to permit fluid circulated downwardly through the soft flexible pipe **P** into the bore **301a** of the housing and the bore **305b** of the piston member **305** to pass outwardly through the lateral openings **332** into the annular recess **335** and upwardly and outwardly through the jet openings **336** along the exterior of the nozzle member **N** to provide a frictional pulling force for drawing the lower end of the soft flexible hose or pipe downwardly in the well bore. The rearward direction of the jets from the nozzle openings **226** also creates a forward or downward thrust on nozzle assisting to draw the hose downwardly in the well bore.

The lower reduced portion **307b** of the bore of the lower housing section is also provided with an internal annular recess **340** and a plurality of longitudinally extending jet openings **341** communicate with the recess and open downwardly therefrom through the shoulder **342** at the upper end of the reduced lower portion **343** of the lower housing section. As shown, the jet openings **341** are designed to direct fluid downwardly longitudinally exteriorly of the reduced portion **343** of the lower housing section. In addition, the lower housing portion is provided with a plurality of longitudinally extending circumferentially spaced flats **345a** and **345b** on its exterior between the jet openings **341** and the jet openings **336**, respectively, to permit bypassing of fluids from the forward end of the nozzle upwardly past the nozzle member. The lower reduced portion **305c** of the bore **305b** of the tubular piston **305** has a plurality of downwardly and outwardly inclined lateral openings **347** formed in its wall above the lower piston **316** communicating the bore **305b** of the piston member with the exterior of the lower reduced portion **313** of the piston member above the lower piston **316**. An external annular recess **348** is formed on the piston member between the reduced lower piston section **313** and the lower piston member **316** and, when the elongate tubular piston member **305** is moved upwardly to the position shown in FIG. 14, this external annular groove **348** is moved into communication with the internal annular groove or recess **340**, whereby fluids moving downwardly through the bore of the elongate piston member will pass outwardly through the openings **347** into the annular recess **340**, and then downwardly and outwardly through the longitudinally extending downwardly directed jet openings **341**. In the upper position shown in FIG. 14, the lateral openings **332** in the enlarged piston portion **310** are moved out of communication with the internal annular recess **335** and the lateral upwardly and rearwardly directed jet openings **336**, so that all fluid is directed downwardly through the downwardly directed jet openings **341** and the nozzle orifice **321** below and ahead of the nozzle member. Upward movement of the piston member **305** in the

housing **300** will occur when the projecting nozzle nose portion **319** having the cap **320** thereon encounters sand, or bridges or accumulation of any foreign matter which would prevent further downward movement of the nozzle and the soft flexible pipe connected thereto in the well bore. The jet force of the circulated fluid passing outwardly through the upwardly and rearwardly directed openings **336** moves the housing **300** downwardly, with respect to the piston member **305** until the cap **320** at the lower end of the nose end of the piston member engages the lower reduced end of the lower housing section **307** as shown in FIG. 14. The spring **303** permits telescoping movement of the piston member in the housing from the position shown in FIG. 11 to the position shown in FIG. 14. When the bridge or other accumulation of sand or foreign matter has been washed out by the downwardly directed jets from the openings **341**, the spring **303** and the fluid pressure in the housing acting on the piston member will again move the piston member downwardly in the housing to the projecting position shown in FIG. 11, and fluids will again be directed outwardly and rearwardly upwardly through the outlets **336** to cause the nozzle to move further downwardly into the well and to draw the soft flexible hose or pipe with it into the well bore, assisting the drive mechanism **D**.

The reduced bore **315** at the lower end of the lower housing member **307** has in its wall an internal annular groove **355** in which an O-ring seal member **356** is disposed for sealing between the housing and the reduced nose enlarged **319** of the elongate piston member. Also, a plurality of radial openings are provided in the wall of the nose portion below the lower piston portion **316** to permit movement of the nose portion and piston in the housing without creating a vacuum or pressure pocket within the housing as the piston moves from the position shown in FIG. 11 to the position shown in FIG. 14 and vice versa. Similarly, a plurality of lateral openings **357** are formed in the wall of the elongate piston member just below the enlarged central piston section **310** to communicate with the enlarged bore **307a** of the housing member to prevent creation of vacuum or pressure pocket in such bore.

It will be noted that a wire line pulling tool fishing neck **360** is formed on the upper end of the upper housing section **301**, which provides a head **362** having a downwardly facing undercut shoulder **361** therebelow for engagement by a retrieving tool to permit recovery of the nozzle member **N** from the well bore should it become separated from the flexible pipe **P**.

For coupling the ends of lengths of the soft flexible hose or pipe **P** to provide a conduit or conductor of the desired length, a pipe coupling **PC** is provided. Such a coupling is shown in FIGS. 15 and 16 and comprises a male union member **401** which has a body **402** provided with an elongate exterior surface with a plurality of longitudinally spaced buttress-like external annular flanges **403** thereon which is inserted into the bore of one of the pipe sections **P-1** of the pipe until an external stop flange **404** formed on the tubular body portion is abutted by the end of the pipe section. A second external annular flange **405** is formed on the exterior of the body spaced longitudinally from the flange **404** and providing an external annular groove **406** on the body into which an internal annular flange **407** of a ferrule **408** is forced by a shrinking or swaging action of a swaging tool (not shown) of the usual commercial type which compresses the ferrule **408** on the exterior of the

end of the pipe section P-1. The bore of the ferrule has a plurality of annular gripping teeth 410 which engage the exterior of the pipe outwardly of the body 402 from the stop shoulder 404 and coact with the serrated exterior surface 403 of the body to securely grip and hold the end of the pipe section P-1 in place on the body and secure the male member 401 fixedly to the end of the pipe section. The ferrule is convexly tapered at the end 411 thereof, the exterior of the ferrule 408 thus merging with the exterior of the pipe section P-1. Beyond the flange 405, the exterior of the body 402 the projecting nose end 416 of the male union member 401 nose end is slightly enlarged in diameter and provided with external screw threads 415 extending substantially to the projecting seat end 417 of the nose end 416 of the male union member, where the reduced seat end 417 has an inwardly-beveled male seating section surface 418 formed thereon.

The other section P-2 of the pipe to be joined to the section P-1 has a female union member 420 provided with a projecting body portion 421 having external its serrated surface also formed with a plurality of longitudinally spaced buttress-like external annular flanges 422 thereon adapted to enter the bore of the open end of the pipe section P-2, and an external annular stop shoulder flange 423 which is engaged by the end of the pipe section P-2. Spaced longitudinally from the flange 423 is an external annular flange 424 with the stop flange 423 provides an external annular groove 425 on the body of the female union member which receives an internal annular flange 426 on the end of a ferrule member 427 having internal annular gripping teeth 428 formed in its bore for gripping the exterior of the end of the pipe section P-2 on the body 421 of the female union member. The ferrule member is compressed into tight gripping engagement with the exterior of the pipe section P-2 so that the flange 426 enters the groove 425, and the flanges 422 on exterior of the body 421 of the female union member and the teeth 428 in the ferrule securely hold the female union member on the end of the pipe section P-2. The end 429 of the ferrule member 429 is convexly shaped to merge smoothly into the exterior of the pipe section P-2. The projecting nose portion 430 of the female union member has a slightly larger diameter than the body 421 and is provided with external threads 431 which extend from adjacent the flange 424 to the end of the nose portion 430. The end of the female union member has an internal frusto-conical seat 432 formed therein for mating in sealing engagement with the frusto-conical male seat section 418 of the male union member 401, as clearly shown in FIG. 15.

For securely holding the male and female union members in coupled condition, an external annular coupling or connecting sleeve 435 is provided with internal screw threads at each end. The internal threads 436 which mate with the external threads 415 on the male union member are of one lead or are helically formed in one direction while the internal threads 437 at the opposite end of the coupling member which engage with the external threads 431 of the female union member are of the opposite lead or direction of thread. Thus, the threads 431 on the female member and the threads 437 in the coupling sleeve may be right hand threads, while the threads 415 on the male union member and the threads 436 in the coupling sleeve may be left hand threads, or vice versa. Thus, the coupling sleeve 435 may be rotated in a single direction to make

up the union members 401 and 420 into tight sealing engagement of the seats 418 and 432; and the coupling sleeve may be turned in the opposite direction to effect separation of the two union members and the pipe sections to which they are secured.

The threads 437 on the female union member end of the coupling sleeve 435 are shown to be shorter in extent than the threads 436 on the end connected with the male union member 401, so that the coupling sleeve remains in threaded engagement with the male union member 401 after the threads 437 have been disengaged from the threads 431 of the female union member. Thus, the female union member may be disconnected from the coupling sleeve while the coupling sleeve remains connected on the male union member, and in this position the coupling sleeve protects the male seat surface 418 of the male union member.

Obviously, from the foregoing, it will be seen that the coupling sleeve 435 may be rotated in one direction to uncouple the sections of pipe P-1 and P-2 without rotation of the pipe sections with respect to each other about their longitudinal axis, so that no twist or torque is applied to the pipe sections during the coupling or uncoupling operation. Similarly, the coupling sleeve may be rotated in the opposite direction to make up the connection between the male and female union members without rotating or twisting the pipe about its longitudinal axis. This permits joining a number of lengths of soft flexible hose or pipe into an elongate string which may be inserted into a well of great depth, or installed on the reel, or without the necessity of rotating the entire length of flexible hose or pipe during the coupling or uncoupling operation.

An O-ring 438 is disposed between one end of the coupling sleeve 435 and the flange 405 of the male union member to seal between the coupling sleeve and the flange to prevent entry of dirt or other foreign matter to the threads 415 and 436, and to seal against fluid pressure leakage inwardly of the threads. Similarly, an O-ring seal member 439 is disposed between the opposite end of the coupling sleeve and the flange 424 on the female union member 420 for preventing entry of foreign matter, sand or the like to the threads 431 and 437 of the female union member and the coupling sleeve, and to seal against inward pressure passage along the threads into the bore of the pipe coupling member PC. In addition, the O-ring seal members 438 and 439 fill the gap between the ends of the coupling sleeve 435 and the flanges 405 and 424 of the pipe coupling member PC as the coupling member passes through the stuffing box assemblies S-1 and S-2 to prevent damage to the sealing elements in the stuffing box assemblies as the coupling member PC passes therethrough. Also, the coupling member PC is sufficiently short that it will pass readily through the toroid capstan drive mechanism D without damage to the coupling member and without damage to the drive mechanism assembly, and will not diminish to any great extent the frictional engagement of the capstan drive with the pipe as the pipe is moved by the drive mechanism. Likewise, the smooth convex ends of the ferrules facilitate entry and passage of the coupling members through the sealing elements of the stuffing boxes S-1 and S-2.

A modified form of pipe coupling PC-2 is shown in FIGS. 17 and 18, wherein the male union member 451 has a nose member and a ferrule connection to the pipe section P-3 identical to that of the form of FIG. 15. The

nose portion 452 of the male union member is elongated and provided with external threads 455 on its exterior and an elongated external cylindrical sealing surface 456 extending from the outer end of the threads to the inwardly tapered external frusto-conical seating surface 457 at the end of the male union member.

Similarly, the female union member 460 is provided with a nose portion and a ferrule connection to the pipe section P-4 identical to that of the female union member 420 shown in FIGS. 15 and 16, and has an elongated nose portion 461 having external threads 462 thereon and an elongated cylindrical sealing surface 463 extending outwardly from the outer end of the threads to the inwardly beveled internal frusto-conical seat 464 at the end of the nose described, the external threads 455 on the nose 452 of the male union member are longer than the external threads 462 on the nose 461 of the female union member 460. Also, the coupling sleeve 470 has a reduced bore 475 in its mid-portion between the internal threads 446 engageable with the external threads 455 on the male union member nose portion and the shorter internal threads 467 engageable with the external threads 462 of the female union member 460, and the bore 475 is provided with a pair of longitudinally spaced internal annular recesses or grooves 476 and 477 which receive O-ring seal members 478 and 479, respectively, adapted to engage the external sealing surface 456 on the male union member and the external sealing surface 463 on the female union member for sealing between the coupling sleeve and the sealing surfaces of said union members to prevent fluid leakage from within the union and the soft flexible pipe to which they are connected. These O-ring seal members supplement the seating surfaces 467 and 464 which engage each other in the same manner as the seating surfaces of the form first described. In addition, this form of the device is provided with an external O-ring seal member 480 which seals between one end of the coupling sleeve or connecting member 470 and the flange 482 on the male union member 451 and an O-ring seal member 481 which seals between the coupling sleeve and the flange 483 on the female union member 460, in the same manner as the O-rings 438 and 439 of the form first described. The oppositely directed internal threads in the bore of the coupling sleeve member 470 remain engaged with the external threads 455 on the male union member 451 while the threads 467 are disengaged from the external threads 462 on the female union member 460 to permit disconnection of the pipe sections P-3 and P-4 from each other without rotation of the pipe sections on their longitudinal axis. The internal O-ring seals 478 and 479 provide a supplemental seal between the male and female union members assuring a prevention of leakage past the seat members 457 and 464 of such members. All other advantages of the coupling member PC-2 are identical to those of the form first described.

A still further modified form of coupling member PC-3 is shown in FIGS. 19 and 20. In this form of the coupling member, the ends of the pipe sections P-5 and P-6 are joined to similarly formed union members 501 and 502, respectively. The union member 501 has a body portion and a ferrule connection to the pipe section P-5 identical to that of the forms previously described. However, the nose portion 505 of the union member is elongated and has external threads 506 thereon and a projecting cylindrical sealing surface section 507 extending outwardly from the threads and ter-

minating at its end in a closure head 508 providing a closure for the bore 509 of the coupling union member. A plurality of radial flow ports 510 are formed in the wall of the nose 507 adjacent the closure member 508 for providing flow communication between the bore 521 of the nose and the exterior thereof in the bore 521 of the coupling connector or sleeve member 520 which has an enlarged section 522 in its medial portion providing an annular flow passage in the bore of the coupling sleeve member between longitudinally spaced pairs of O-ring seal members 511 and 512 and 532 and 533 disposed in internal annular grooves formed in the bore 521 of the coupling sleeves near the internal threads 530 and 531, respectively therein. The O-rings are adapted to engage the sealing surface 507 on the nose 505 of the union member 501 and the sealing surface 527 on the nose 525 of the union member 502. The union member 502 has external threads 526 on its nose 525 and the projecting cylindrical sealing surface 527 ending in a closure member 528 which closes the bore 529 of the union member. A plurality of radial openings 530 are formed in the wall of the cylindrical sealing surface 527 adjacent the closure 528 to provide flow communication between the bore 529 of the union member and the exterior thereof in the enlarged internal annular bore 522 of the coupling sleeve. Thus, flow communication is established in the enlarged bore 522 between the lateral ports 510 and 530 of the two union members 501 and 502, respectively. The O-ring seal members 532 and 533 disposed in the grooves in the bore 521 of the coupling sleeve member 520 adjacent the internal threads at the ends thereof seal between the bore of the coupling sleeve member and the external cylindrical sealing surfaces 507 and 527 of the union members 501 and 502, and the internal threads 530 and 531 formed in the bore of the coupling sleeve member 520 mate with the external threads 506 and 526 on the union members 501 and 502. The threads 506 and 530 have an opposite lead or hand or turn to that of the threads 526 and 531, so that the coupling sleeve or connector member 520 may be turned in one direction to draw the two union members together and in the opposite direction to disconnect the two union members. One pair of mating threads in the coupling member 520 is of lesser length than the other pair of mating threads so that the longer pair of threads remain engaged when the shorter threads are disengaged. In addition, O-ring seal members 545 and 546 may be disposed between the opposite ends of the coupling sleeve or connector member 520 and the flange 547 of the union member 501 and the flange 548 of the union member 502. These O-rings perform the same function as the O-rings on the exterior of the coupling members PC and PC-2. When the coupling connector or sleeve member 520 is made up to completely join the union members 501 and 502, the closure plugs 508 and 528 at the ends of the cylindrical sealing surfaces of the noses of the union members abut each other and limit the further inward movement of the noses of the union members toward each other. This also positions the radial ports 510 and the radial ports 530 within the enlarged internal annular recess 522 in the bore 521 of the coupling sleeve or connector member between the seal rings 511 and 532, respectively. When the coupling sleeve is rotated to move the union members toward disengagement, the lateral openings or radial ports 510 are moved to a position between the O-ring seals 511 and 512 to close off flow in either direction

through said ports. Likewise, the lateral openings or radial ports 530 are moved to a position between the O-ring seals 532 and 533 to close off flow therethrough. Thus, the pipe coupling PCO3 functions as a valve to close off flow through the conduit or pipe when the sleeve and union members are in such positions. The pair of mating threads which is shorter in length may thereafter be disengaged and the union member having the shorter threads removed from within the coupling sleeve 520 to disconnect the sections of pipe. In such event, the ports in the sealing surface of such union member will of course be opened to permit flow of fluids. However, the mating threads having the greater length will remain engaged with the lateral openings or radial ports still disposed between the O-ring seals to prevent flow therethrough and thus prevent escape of fluids from that section of conduit to which the union member is connected. All other structure of the pipe coupling PC-3 is the same as those previously described, and the pipe coupling functions in the same manner, although this form of the coupling member is slightly longer than the forms previously described.

It will be therefore seen that each form of the pipe couplings provides for joining adjacent sections of soft flexible conduits, hose or pipe P into flow communicating sealed condition without the necessity of turning the sections of hose or pipe about the longitudinal axes thereof and, therefore, facilitate coupling and uncoupling the sections while the hose or pipe is wound on the reel or while the same is disposed within a well or extending through the drive mechanism D. In addition, the couplings are designed to pass through the drive mechanism D and the stuffing boxes S-1 and S-2 of the assembly without damaging the sealing mechanism or the drive elements of the drive mechanism. Thus, any number of lengths of soft flexible hose or pipe may be connected together by these couplings, or the pipe couplings may be used to join the severed ends of two parts of a section of hose or pipe after a damaged portion thereof has been removed, it being unnecessary to remove the entire string of hose or pipe from within the well bore of from the reel to make such repairs.

Also, since it is desirable in all cases that a length of the soft flexible hose or pipe be left in the drive mechanism in operative position on the capstan friction drive surface between such surface and the pressure roller chain with the ends of the hose or pipe extending outwardly from the drive mechanism through the stuffing boxes, coupling members should be connected to the projecting ends of the hose or pipe to provide for ready connection of additional lengths of the soft flexible hose thereto. Thus, it is not necessary to disassemble the drive mechanism to thread the soft flexible hose therethrough at the beginning of each service job in which the mechanism is installed on a well.

If desired, a body of lubricant such as oil or light grease may be confined within the drive mechanism between the stuffing boxes and exteriorly of the soft flexible hose to prevent entry into the drive mechanism of foreign matter which may tend to damage the elements within the toroid chamber of the drive mechanism. This lubricant would also provide for a less dangerous method of applying well fluid pressure to the toroid chamber of the drive mechanism so that the pressure on opposite sides of the stuffing box S-1 may be more readily equalized when the assembly is connected to the lubricator L and the wellhead H for running the soft flexible pipe into the well under pressure. In addition, such lubricant may be directed into and confined in the

chamber TC under a pressure slightly in excess of the pressure at the well head so that well fluids which may be laden with solid particles will be excluded from the chamber TC and damage to the working parts of the drive mechanism will be prevented. Such lubricant could be supplied through a supply line SL-10 leading from the source of hydraulic fluid pressure CFP-1 to an inlet fitting IF-1 on the drive mechanism D communicating with the chamber TC therein. A valve V-10 may be provided in the supply line SL-10 for controlling the flow of the such fluid to the chamber under desired conditions of pressure. If desired or necessary, a high pressure pump HPP may be interposed between the source of control fluid pressure CFP-1 and the valve V-10 for delivering the fluid under higher pressure to the chamber of the drive mechanism.

A return line RL-10 from the pump to the tank FT-2 permits excess fluid from the pump to flow back into the tank for reuse as desired. An adjustable pump valve DV may be connected in the return line RL-10 and adjusted to provide the desired pressure for the supply line SL-10 and the chamber TC of the drive mechanism with excess fluid being dumped into the tank FT-2.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A method of injecting soft flexible conduit into a well against the well pressure confined in the well including: forming a closed chamber communicating at one end with the bore of the well in fluid pressure communication therewith; closing the other end of the chamber around a string of soft flexible conduit to be installed in the well; filling the conduit with fluid; drawing the soft flexible conduit with the fluid therein through the seal into the chamber by force applied to the conduit in the chamber between the seal and the well bore; and directing the soft flexible conduit from the chamber into the bore of the well.

2. A method of injecting soft flexible conduit into a well against the well pressure confined in the well including: forming a closed chamber communicating at one end with the bore of the well in fluid pressure communication therewith; sealing around the string of soft flexible conduit to be installed in the well at the closed end of the chamber; drawing the soft flexible conduit through the seal into the chamber; directing the soft flexible conduit from the chamber into the bore of the well; circulating fluids through said flexible conduit into the well casing; and utilizing said circulating fluid to draw said flexible conduit downwardly in said well.

3. A method of the character set forth in claim 2 including: the additional step of stopping circulating of said fluids into said well to draw said flexible conduit into the well and directing a jet of circulating fluids forwardly from the end of said conduit to remove bridges or obstructions in the well preventing entry of the conduit into the well therpast.

4. A method of the character set forth in claim 3 including: the additional steps of stopping flow of the jet of fluids forwardly of the conduit and again directing the circulation of fluids rearwardly from the end of said flexible conduit to draw the end of said conduit further into the well.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,920,076 Dated November 18, 1975

Inventor(s) Tibor Laký

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

On Title Page, at [62]: Change "Division of Ser.
No. 300,831, Oct. 25, 1972, abandoned." to read
-- Division of Ser. No. 300,831, Oct. 25, 1972,
now Pat. 3,866,679. --

Signed and Sealed this

First Day of February 1977

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks