United States Patent [19]

Laky

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[45] **Feb. 18, 1975**

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

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[73] Assignee: **Otis Engineering Corporation,** Dallas, Tex.

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[21] Appl. No.: **300,831**

[52] **U.S. Cl.** ..... **166/77,** 134/167 C, 166/82, 166/222, 226/171, 226/183, 285/256, 285/369

[51] **Int. Cl.** **E21b 17/00,** E21b 33/03

[58] **Field of Search** ..... 166/77, 82, 222, 315; 175/317, 422; 285/174, 175, 256, 369; 403/43, 44; 254/175.5, 175.7, 190, 191; 226/171 X, 183 X; 277/73, 74; 239/DIG. 13; 134/167 C, 167 P

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Primary Examiner—Werner H. Schroeder

[57] **ABSTRACT**

An apparatus and 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. The capstan drive provides for a positive movement of the pipe with a minimum of heavy equipment and without heavy hoisting equipment, and provides means for moving the flexible pipe or hose without imposing an excessive longitudinal stress on the hose as it is moved, since the pipe is supported on the capstan and is maintained in frictional contact therewith by a chain guide roller system which is adjustable to control the friction with which the hose engages the capstan. The stuffing boxes are also automatically fluid pressure adjusted to provide a positive seal with a minimum of squeeze and friction under the conditions of use to which they are exposed. The method also encompasses the washing out of sand bridges or debris plugs or the like in the well by use of the jet nozzle which automatically changes from the crawling or pulling condition to a washing condition upon engagement of a bridge or plug in the well.

44 Claims, 22 Drawing Figures

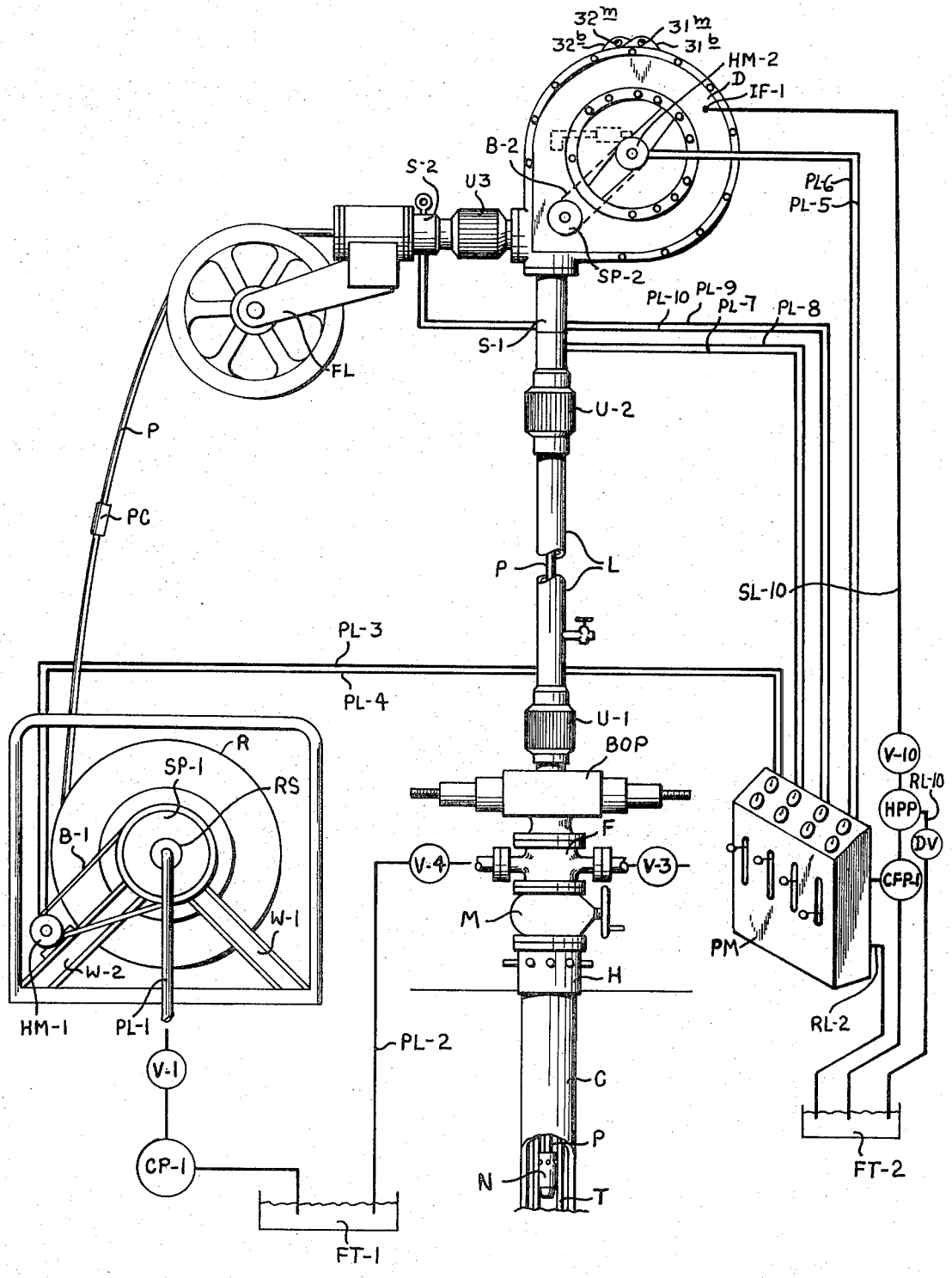

32m
31m
32b
31b
HM-2
D
IF-1
B-2
S-2
U3
PL-6
PL-5
SP-2
PL-10
PL-9
PL-7
PL-8
S-1
FL
U-2
P
PC
P
L
SL-10
PL-3
PL-4
U-1
BOP
R
SP-1
RS
B-1
F
V-4
V-3
M
W-1
W-2
H
HM-1
PL-1
PL-2
V-1
C
P
CP-1
N
T
FT-1
PM
RL-2
FT-2
V-10
RL-10
HPP
DV
CFP-1

FIG. 1

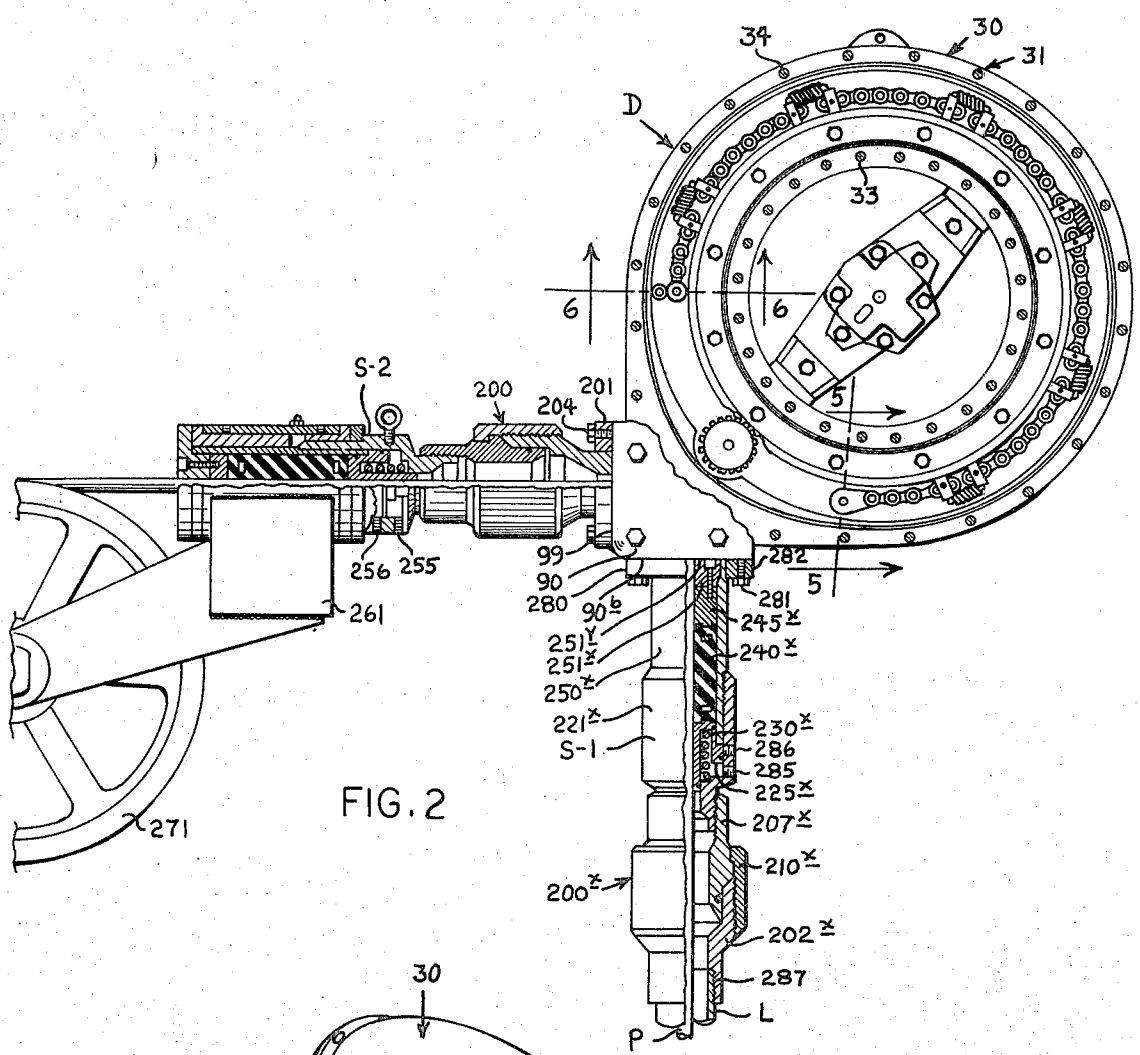

34
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D
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6
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S-2
200
201
204
99
90
280
90b
251Y
251X
250X
221X
S-1
256
255
261
271
282
281
245X
240X
230X
286
285
225X
207X
210X
200X
202X
287
L
P

FIG. 2

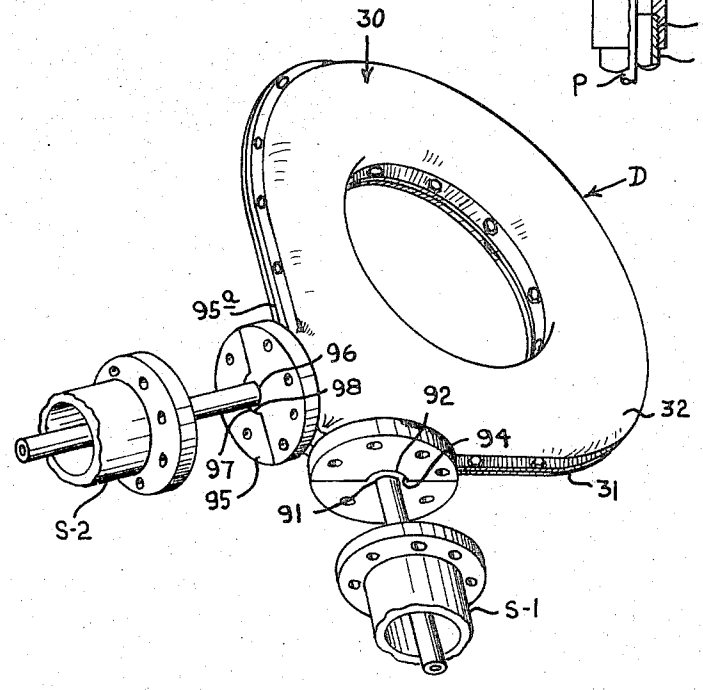

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D
95a
96
98
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S-2
S-1

FIG. 3

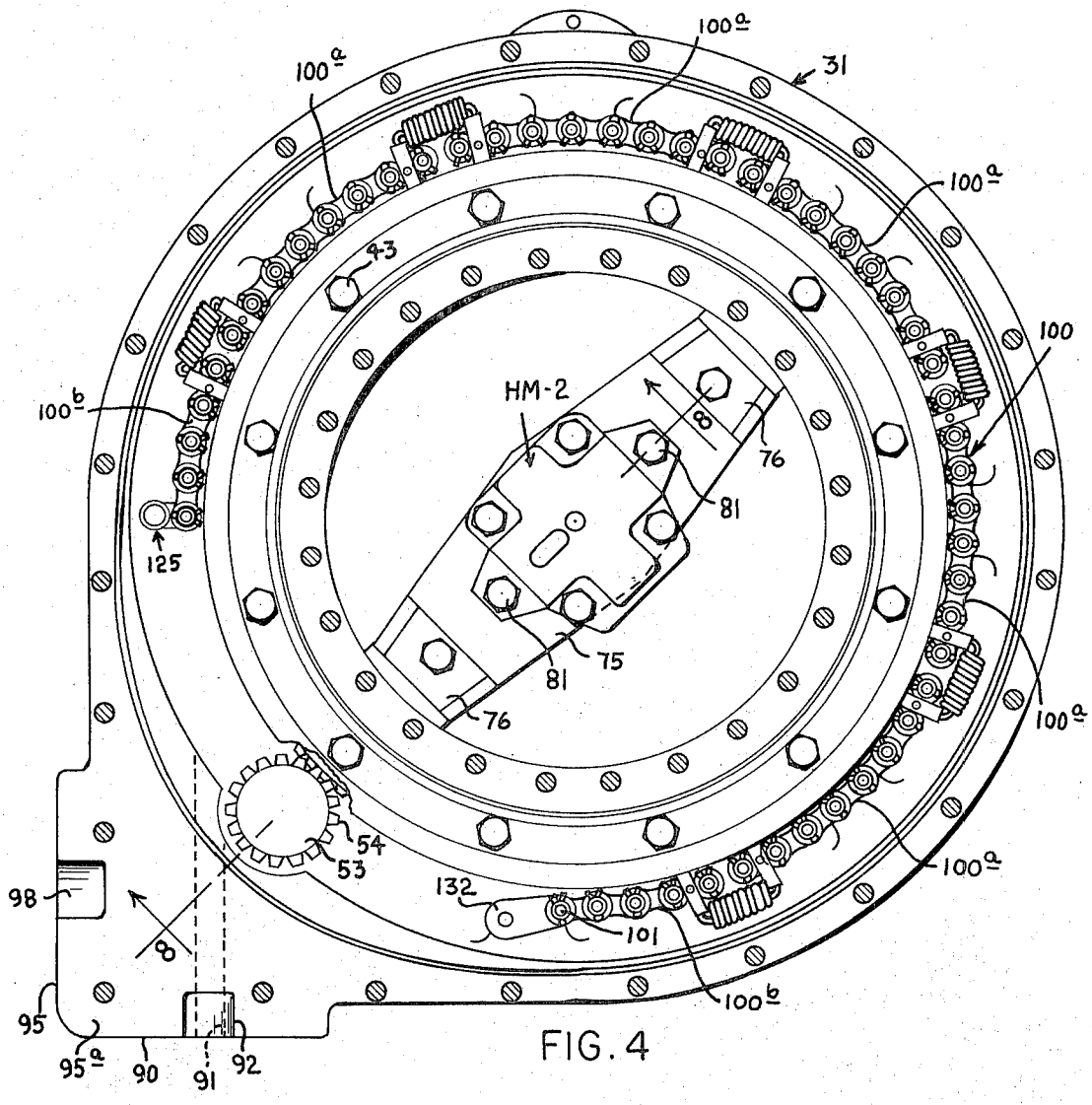

100a
100a
31
100a
100
100b
HM-2
8
76
81
125
75
81
76
100a
54
53
132
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100a
98
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100b
95
95a
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91
92

FIG. 4

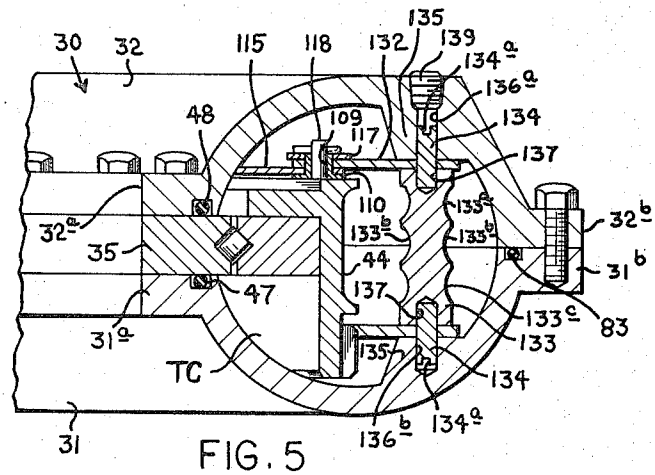

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134a
136a
48
109
117
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137
110
133a
133b
32a
35
44
32b
31b
47
137
133c
83
31a
133
TC
135
134
31
136b
134a

FIG. 5

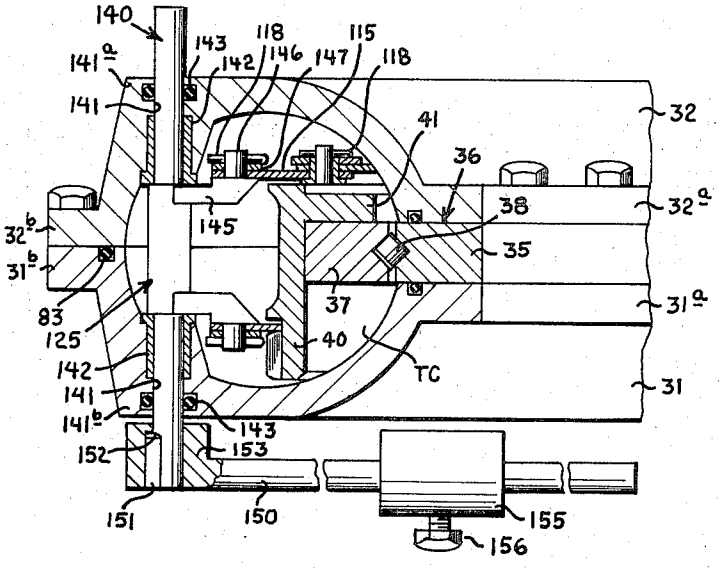


FIG. 6

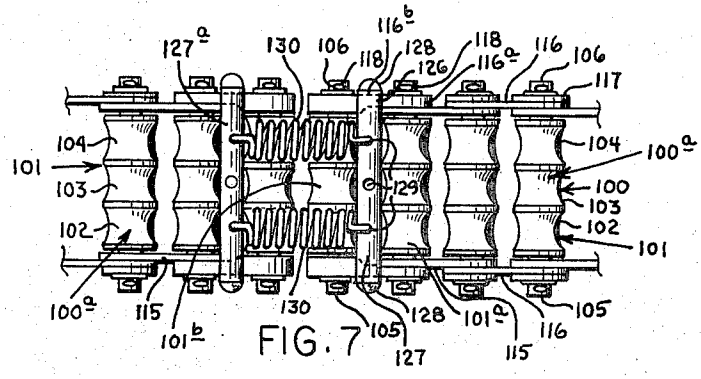


FIG. 7

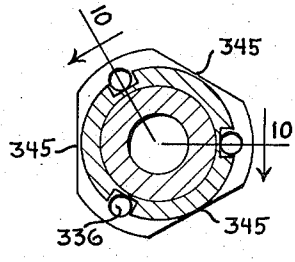


FIG. 12

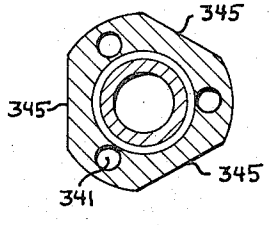


FIG. 13

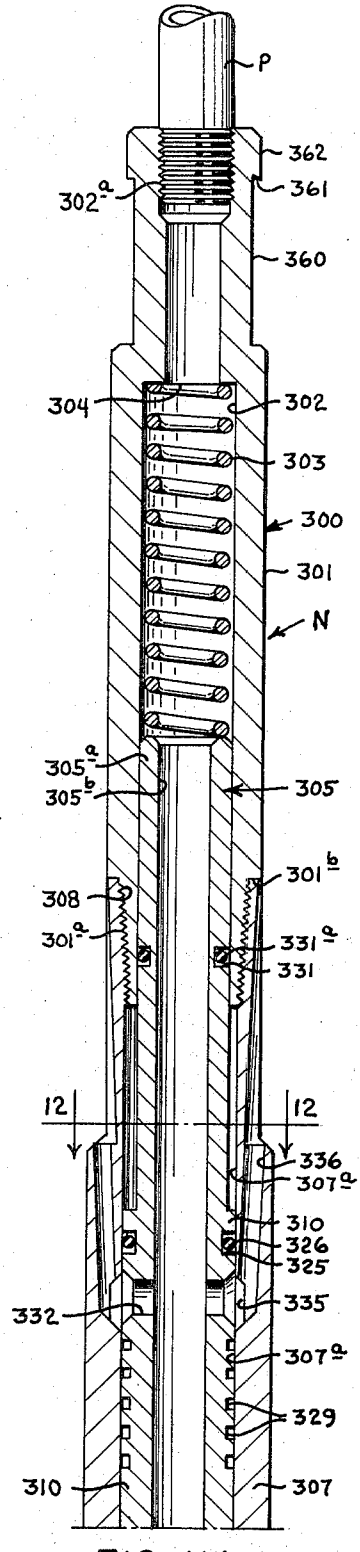


FIG. 11A

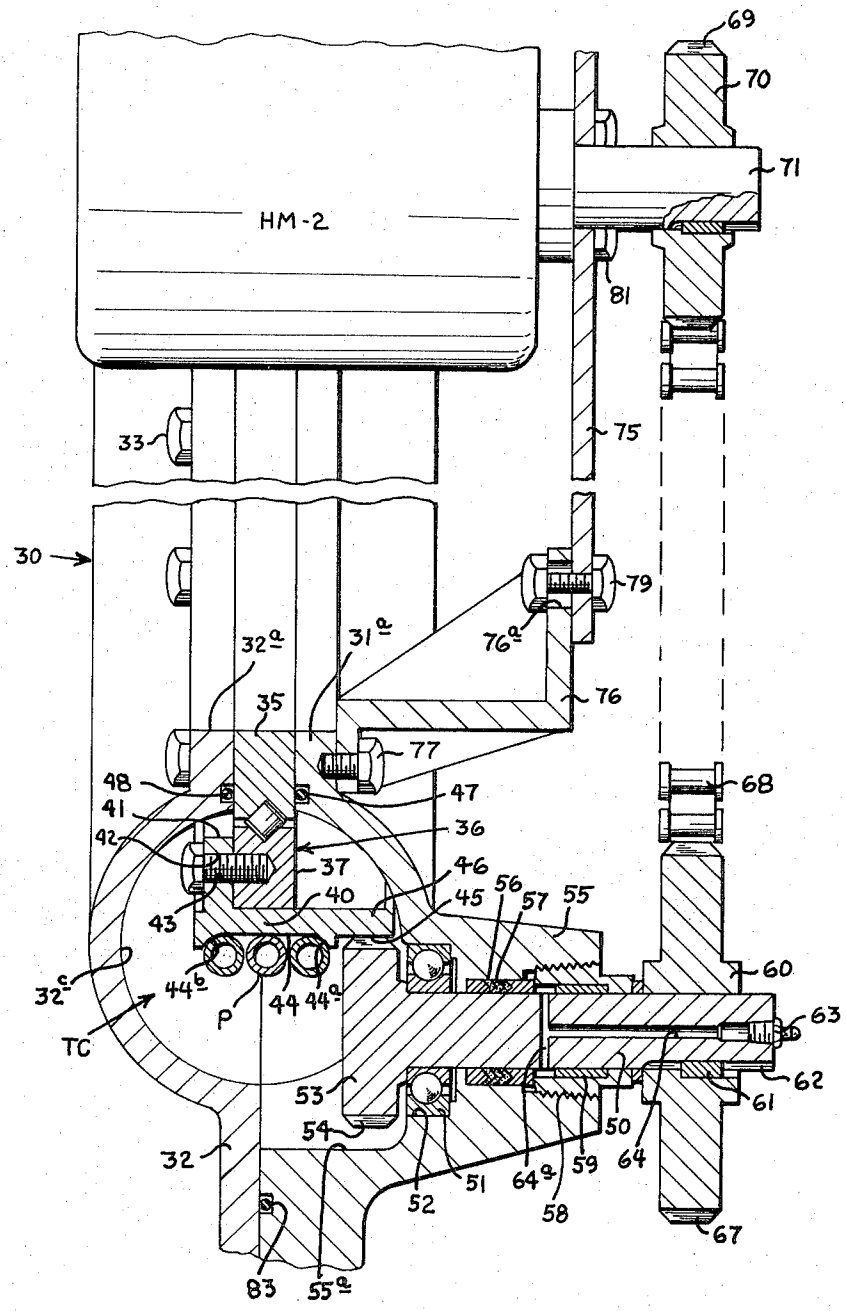

HM-2
69
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76a
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32a
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36
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46
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43
60
63
62
61
32c
44b
P
44
44a
TC
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54
50
64
59
64a
58
32
51
52
67
83
55a

FIG. 8

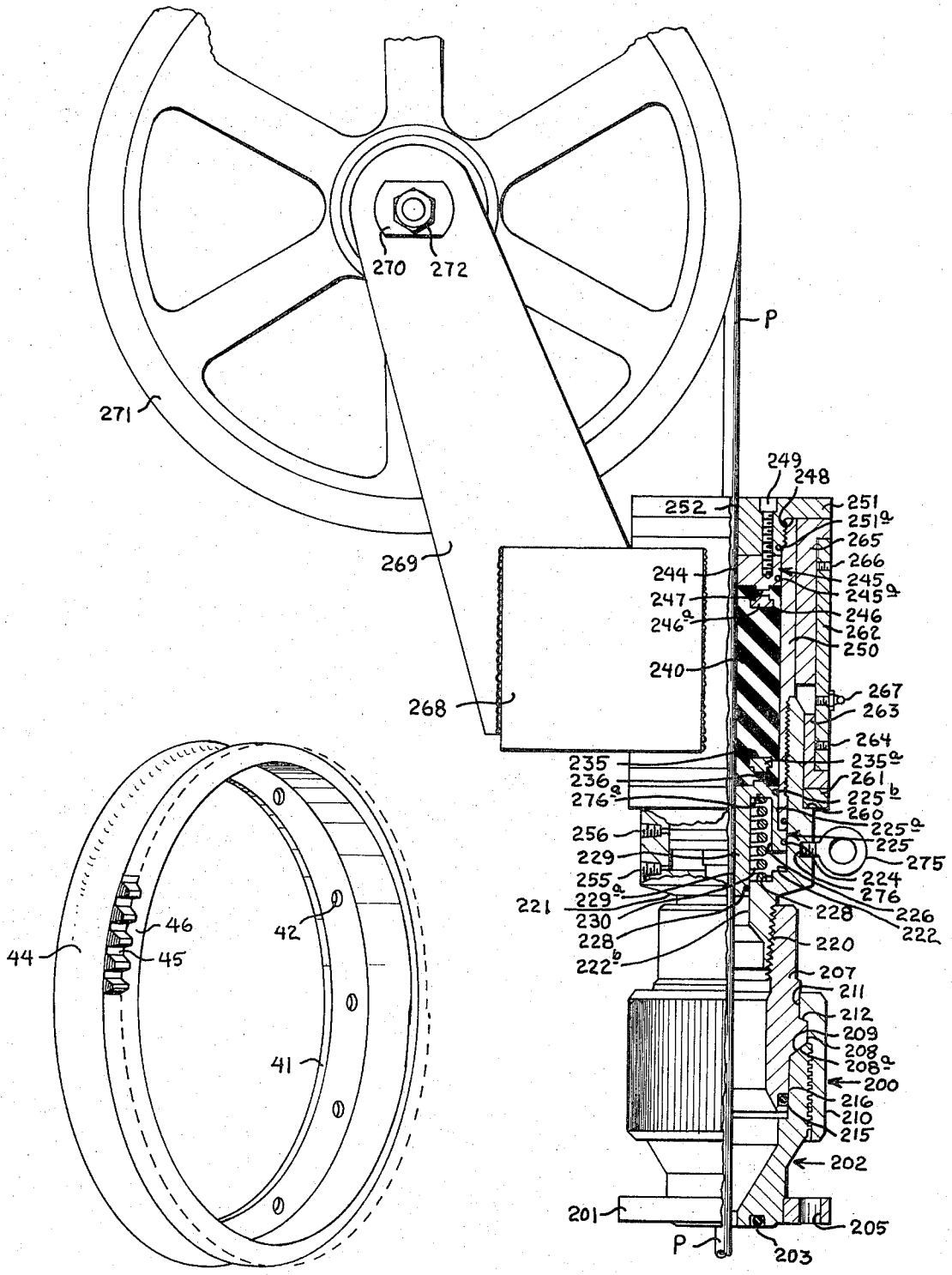

270
272
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268
P
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251a
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240
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263
264
235a
235
236a
276a
261
225b
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225a
225
256
229
275
255a
224
229a
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221
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228
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228b
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222b
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207
211
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FIG. 9

FIG. 10

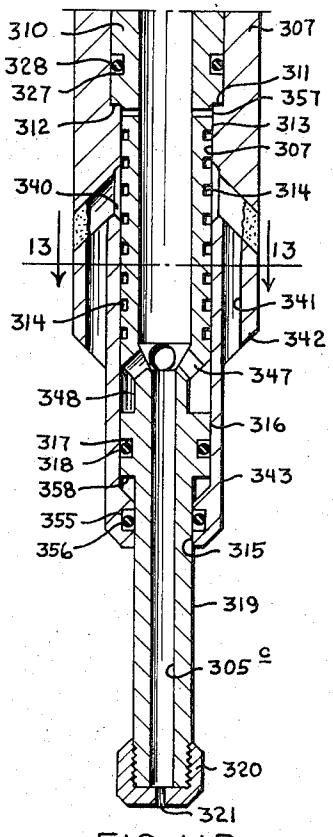


FIG. 11B

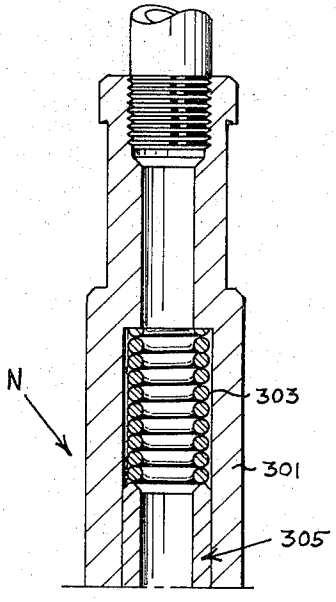


FIG. 14A

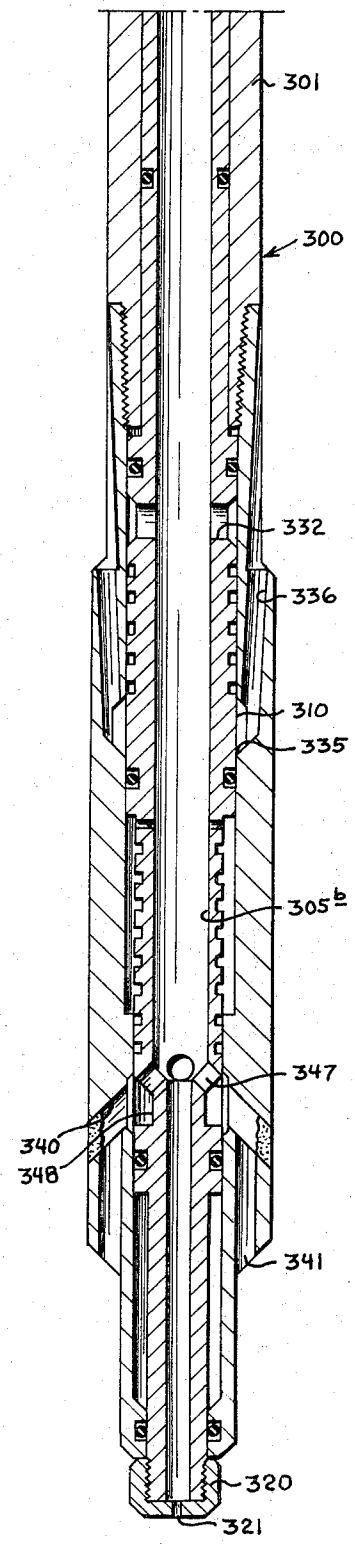


FIG. 14B

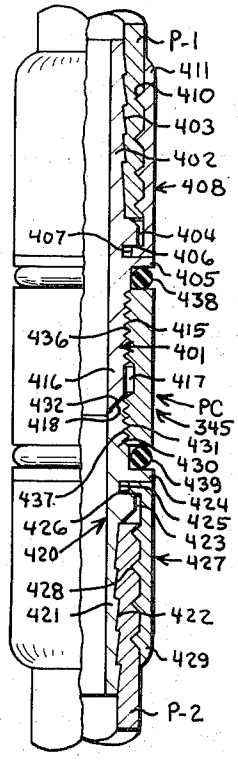

P-1
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402
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407
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438
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432
PC
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P-2

FIG. 15

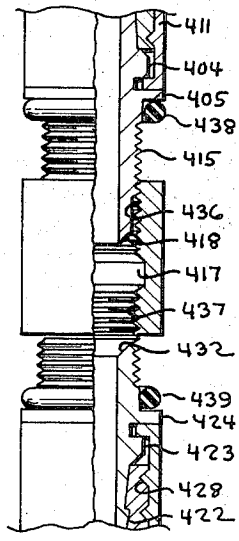

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FIG. 16

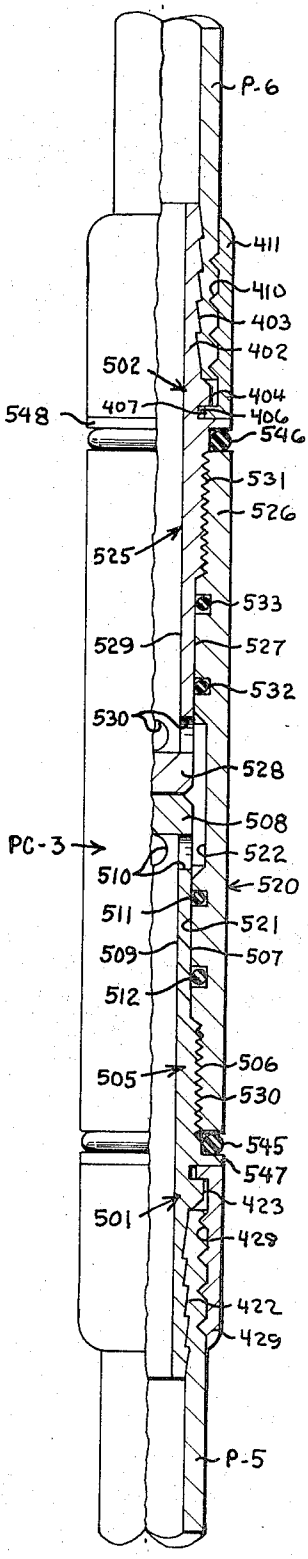


FIG. 19

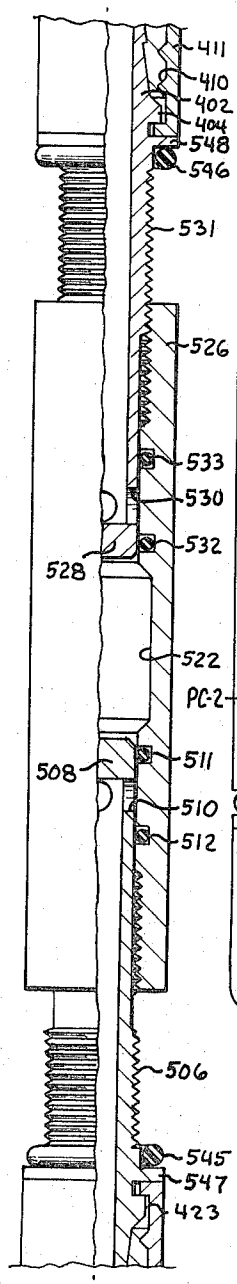


FIG. 20

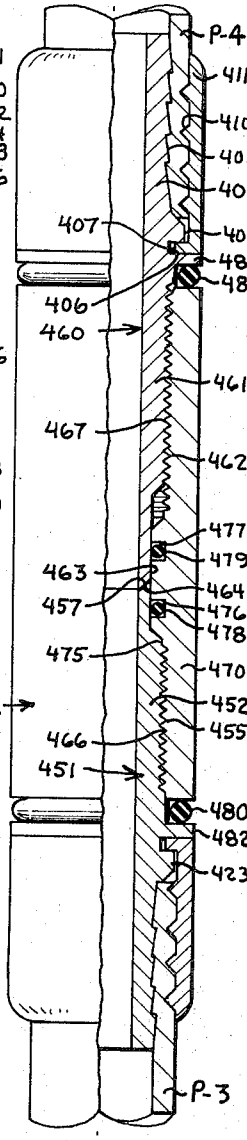


FIG. 17

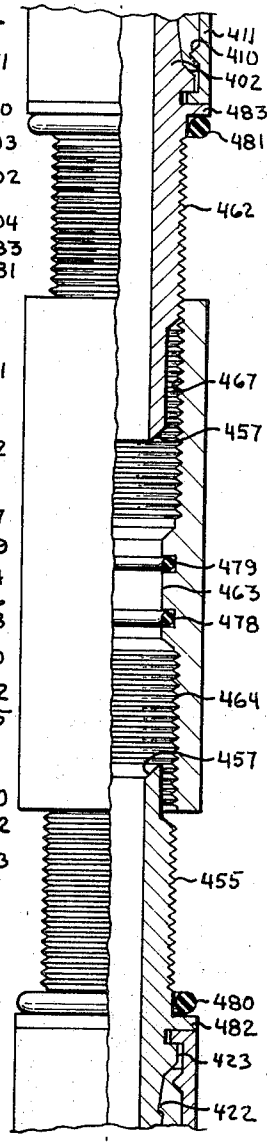


FIG. 18

APPARATUS FOR INSERTING FLEXIBLE PIPE INTO WELLS

This invention relates to new and useful methods and apparatus 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 further object of the invention is to provide an apparatus for use in injecting a soft flexible pipe, hose or conductor into a well under pressure.

A particular object of the invention is to provide a method and apparatus 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 an apparatus and 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 an apparatus and 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.

A further important object of the invention is to provide an improved drive means for injecting soft flexible pipe, hose or conductors into well bores under pressure with a minimum of damage or deformation of the pipe or conductor.

A particular object of the invention is to provide a capstan drive mechanism in which the drive elements of the mechanism are sealed within a closed chamber for moving the soft flexible pipe under pressure from the exterior of the well through a stuffing box into the bore of the well against the well pressure present therein.

Still another object of the invention is to provide in a soft flexible conductor or hose of the character described a coupling for connecting lengths of the conductor together in longitudinal flow communication with each other and wherein the couplings are readily movable through the stuffing boxes and drive mechanism into the well bore under pressure.

A further object is to provide a coupling of the character described which is readily connectable and disconnectable from adjacent lengths of the conductor or hose without the necessity of rotating either portion of the conductor or hose about its longitudinal axis, and which is provided with means for positively sealing the joint connecting the two adjacent sections of conductor.

Still another object of the invention is to provide a coupling of the character described which permits repair of damaged sections of the flexible conductor or hose by cutting out the damaged portion and inserting a coupling in its place for connecting the two ends of the section from which the damaged portion was removed.

Still another object of the invention is to provide 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 installed, 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 ditritus, 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 flow 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.

Another object is to provide in a jet nozzle of the character described means for changing the direction of flow of the jets ejected from the nozzle by means of the fluid circulated through the soft flexible conductor into the well and in response to the engagement of the nozzle with obstructions in the well bore and the removal of obstructions from the well bore.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed 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 integral 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;

FIGS. 11A and 11B are a longitudinal sectional view 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. 12 is a horizontal cross sectional view taken on the line 12—12 of FIG. 11;

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

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

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 fairlead 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 of 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 movement of the motor HM–1. Similarly, 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 an 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 a 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 con-

trol 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 of 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 side 31 and a cover side 32, respectively.

Each of the housing halves has a concave annular recess 31*c* and 32*c*, 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 tow halves of housing are bolted together by bolts 33 and bolts 34 extending through openings in the internal and external flanges 32*c* and 32*b* of the cover side 32 of the housing, and threaded into threaded apertures in the internal and external flanges 31*a* and 31*b*, respectively, of the drive half of the housing. The inner flanges 31*a* and 32*a* of the housing halves are spaced apart to receive the inner race 35 of an X-bearing 36 having an inner race 35 and outer race 37 confining a plurality of alternately oppositely disposed roller bearing members 38 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 annular 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 44*a* and 44*b*, respectively, to provide side guides for the friction surface 44 thereon. The inner flange 44*a* 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 31*a* and 32*a* of the drive half and cover half of the housing and O-ring seal members disposed 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 31*b* of the cover half receives an O-ring seal member which seals between the outer flanges 31*b* and 32*b* 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 55*a* 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 **64***a* extending to the exterior of the shaft between the bearing **59** in the bushing **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 **31***a* of the motor half of the housing by bolts **77** extending through apertures in the bracket and the flanges **31***a* and **32***a* 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 **76***a* in the bracket **76** being elongated to permit adjustment of the position of 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 **90***a* and **95***a*, 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 **44***b* 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 **44***a* thereon. The width of the capstan surface **44** is preferably equal to approximately 3 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 **44***b* to be wound on the surface approximately 3 times and then to exit from the friction surface **44** through the exit opening **91** at a tangential position adjacent the flange **44***a* of the capstan friction surface. Thus, the hose enters through the openings into the chamber TC and is directed 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 **100***a*, and short end sections **100***b* at its ends for connecting the same to the housing **30** and to a tensioning crank mechanism **125.** THe sections **100***a* 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 **116***a* of each inner section **100***a* of the chain are thicker than the links **115** and **116,** as clearly shown in FIG. **7.** The portion of the outer link **116***a* connected to the roller **101***a* just inwardly from the end roller **101***b* 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 **116***a* 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 **101***a* and **101***b*, the outer surface of each link **116***a* is provided with a transverse groove **116***b* which receives a downwardly extending arm **126** of a U-shaped connector member **127** secured to each of the side links **116***a* on opposite sides of the rollers by suitable bolts **128.** Each of the connector members **127** is provided in its base **127***a* with a plurality of holes **129,** substantially overlying the concave guide surfaces **102, 103** an **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 **100**a 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 casptan 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 **100**b 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 **100***b*, 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 **135***a* and **135***b* in the concave bores **31***c* and **32***c* of the housing members **31** and **32,** respectively, and axially aligned openings **136***a* and **136***b* are provided in the bosses **135***a* and **135***b* 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 hold the soft flexible pipe in frictional contact with the friction surface **44** of the capstan member **40** in the chamber. The opening **136**a 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 **136***a* and for holding the pins in place in the bores **136***a* and **136***b* 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 **134**a 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 **136***a* and **136***b* 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 **100***b* of the pressure member **100** is identical to the shorter section **100***b* 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 **141***a* and **141***b* 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** of 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 **100***b* 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 wieght 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 pressuremember **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 **133***a*, **133***b* and **133***c* 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** form 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 enlared 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 **226***a* of the counter bore and a shoulder **222***a* at the inner end of the enlarged bore **222** of the housing. A protuding cylindrical nose **229** of the piston **225** engages in the reduced bore **222***b* 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 **235***a* 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 sleeve **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 **251***a* 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 **229***a* 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 **225***a* 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 **225***a* 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 connected lengths of the pipe P for guiding the same around the sheave and into the suffing 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 **31***m* and **32***m* are provided on the external flanges **31***b* and **32***b*, respectively, of the drive housing **30** of the toroid drive mechanism D. Therefore, suitable hoisting equipment may be connected to the hous-

ing 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 **31**m 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 **32***m* on the cover member **32** permits lifting the same while the drive half member **31** is supported by means of the eye-member **31***m* 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 **250***x*, 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 **90***b* 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 **90***b* of the boss **90** for securing the stuffing box to the toroid drive mechanism. Within the bore of the packing cylinder sleeve **250***x* the gland member **251***x* 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 **250***x* for holding the retaining member **244** having the packing sleeve **240***x* secured thereto in place in the bore of the packing cylinder sleeve. The gland member **251***x* has an annular groove **251***y* formed in its end surface for receiving an O-ring seal for sealing between the gland member **251***x* and the face **90***b* 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 **221***x* also 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 **221***x* above and below the seal member **224***x* on the piston **225***x* in the housing for moving the piston in either direction in the housing to compress or elongate the packing sleeve **240***x* in the stuffing box. A spring **230***x* 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 **207***x* is identical to that of the stuffing box S–2, as are the female union half **202***x* and the threaded collar sleeve **210***x* for connecting the sections of the union **220***x*. The female half **202***x* 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 to 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 out 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 **302***a* 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 **307***a* in the upper portion thereof internally threaded at **308** to thread onto the reduced lower end **301***a* of the upper section **301** to abut against the shoulder **301***b* 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 **307***a* of the lower section **307** of the housing. The lower portion **307***b* 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 **307***b* 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 **307***b* 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 **307***b* of the lower housing section and seal between the bore **307***b* 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 **307***a* 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 prevent scarifying of the bore. The reduced neck end **305**a of the piston sleeve member **305** also has an external annular groove **331** formed therein and an O-ring seal member **331***a* is disposed in the groove to seal between the neck **305***a* and the bore wall of the bore **302** of the upper housing member **301.**

Substantially medially of the bore **307***a* 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 **301**a of the housing and the bore **305***b* 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 **336** also creates a forward or downward thrust on nozzle assisting to draw the hose downwardly in the well bore.

The lower reduced portion **307***b* 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 **345***a* and **345***b* 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 **305***c* of the bore **304***b* of the tubular piston member **305** has a plurality of downwardly and outwardly inclined lateral openings **347** formed in its wall above the lower piston **316** communicating the bore **305***b* 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. **14B,** this external annular groove **348** is moved into communication with the internal annular groove or recess **340,** whereby fluids moving downwardly throug- 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. **14B,** 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 portion **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 **307**a 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 buttresslike 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** eenters 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 holdong the male and female union members is 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 dis-

connected 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 strip 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 couling 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 diminsh 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 portion. In this form of the device, as in the form first 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 midportion 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 surface **463** on the female union member for sealing between the coupling sleeve and the sealing surfaces of said union memebers 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 **457** 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 terminating 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 **509** 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 sleeve 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 couping 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 member **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 PC**03** 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 the 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 conduit, 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 dump 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 scop 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. Apparatus for injecting an elongate soft flexible conduit into a well under pressure including: drive means connected to the upper end of the well in fluid communication therewith; seal means connected with the drive means in fluid communication therewith and sealing the drive means and the well bore against the escape of well fluids from the well bore through the drive means past the seal means; means in said drive means engaging said soft flexible conduit for drawing the same through the seal means into the drive means for passage from the drive means into the well bore; and fluid pressure supply means connectable with the end of said elongate flexible conduit exteriorly of the well for maintaining fluid under pressure within said conduit to prevent said conduit from collapsing as it is moved into the well against the pressure of well fluids confined in said well.

2. An apparatus of the character set forth in claim 1 including: means for storing said elongate body of soft flexible conduit in a continuous connected condition for injecting through the seal means and drive means into the well.

3. Apparatus for injecting soft flexible conduit into a well under pressure including: a first seal means connected with the upper end of the well for confining well pressure therebelow in the well; an elongate soft flexible conduit having one end extending through said first seal means into the well; drive means connected with the first seal means for frictionally engaging said soft flexible conduit to move the same into the well; second seal means connected with the drive means for sealing around said flexible conduit between the drive means and the exterior atmosphere to enclose fluid pressure exteriorly of said flexible conduit in the drive means between the first and second seal means; and fluid pressure supply means connected with the other end of said flexible conduit exteriorly of the well for maintaining fluid under pressure within said conduit to prevent said conduit from collapsing as it is moved into the well against the pressure of well fluids confined in said well and to maintain circulation of fluid through said conduit as said conduit is moved into said well.

4. An apparatus of the character set forth in claim 3 including: means for storing a body of a plurality of connected sections of said soft flexible conduit for injection through the seal means and drive means into the well.

5. Apparatus of the character set forth in claim 1 including: hydraulically operable means for moving said seal means into and out of sealing engagement with the soft flexible conduit passing therethrough.

6. Apparatus of the character set forth in claim 5 including: remote source of hydraulic fluid pressure; means for conducting said hydraulic fluid pressure from said source to said seal means; and means for controlling the flow of hydraulic fluid from said source to said seal means to control the actuation of the seal means into and out of sealing engagement with the soft flexible conduit.

7. Apparatus of the character set forth in claim 1 including: hydraulic power means for operating said drive means.

8. An apparatus of the character set forth in claim 7 including: a source of hydraulic fluid pressure; a conductor for conducting hydraulic fluid under pressure from the source to the hydraulic power means for driving said drive means; and a control means between the source of hydraulic fluid pressure and the hydraulic power means for controlling the supply of hydraulic fluid from the source to the power means to control the operation of the power means and the operation of the drive means.

9. Apparatus of the character set forth in claim 3 including: hydraulically operable means for moving said seal means into and out of sealing engagement with the soft flexible conduit passing therethrough.

10. Apparatus of the character set forth in claim 3 including: remote source of hydraulic fluid pressure; means for conducting said hydraulic fluid pressure from said source to said seal means; and means for controlling the flow of hydraulic fluid from said source to said seal means to control the actuation of the seal means into and out of sealing engagement with the soft flexible conduit.

11. Apparatus of the character set forth in claim 3 including: hydraulic power means for said drive means.

12. An apparatus of the character set forth in claim 3 including: a source of hydraulic fluid pressure; a conductor for conducting hydraulic fluid under pressure from the source to the hydraulic power means for driving said drive means; and a control means between the source of hydraulic fluid pressure and the hydraulic power means for controlling the supply of hydraulic fluid from the source to the power means to control the operation of the power means and the operation of the drive means.

13. Apparatus of the character set forth in claim 3 including: first hydraulic operating means for actuating said first seal means; second hydraulic operating means for actuating said second seal means, said first and second hydraulic operating means being independently operable for controlling the engagement and disengagement of said first and second seal means selectively with the soft flexible conduit passing through said seal means; and third hydraulic means for driving said drive means for moving said soft flexible conduit through said seal means and said drive means.

14. Apparatus for moving an elongate string of soft flexible conduit longitudinally of said conduit into a

well against fluid pressure confined in said well, comprising: a housing connected to the well having a chamber therein with opening means opening to the well and to the exterior of the housing exteriorly of the well; a capstan member rotatably mounted in the chamber in the housing; an elongate string of soft flexible tubular conduit having one end extending into said housing chamber from the exterior of the well and around said capstan and from said chamber into the well; an annular conduit engaging surface on said capstan member for engaging the conduit to be moved; means in the housing for holding the conduit in engagement with the capstan member; means for rotating the capstan member to move the conduit longitudinally of the conduit through the housing chamber; means sealing between said conduit and said housing at said chamber opening means; and fluid pressure supply means connected with the other end of said flexible conduit exteriorly of the well for maintaining fluid under pressure within said tubular conduit at least as great as the pressure of the well fluids confined in the well exteriorly of said conduit.

15. Apparatus of the character set forth in claim **14** including: means for adjusting said seal means connected with said housing at said opening means in fluid communication with the chamber therein for controlling the sealing engagement thereof with the flexible conduit to be moved through said opening means by said capstan member.

16. Apparatus of the character set forth in claim **14** wherein said housing opening means includes an inlet opening into said chamber of said housing and an outlet opening from said chamber of said housing; and said seal means comprising first seal means connected with said housing at said inlet opening for sealing around conduit moving through said inlet opening and second sealing means connected with said housing at said outlet opening for sealing around conduit moving through said outlet opening.

17. An apparatus of the character set forth in claim **16** including: first hydraulic means for actuating said first seal means; second hydraulic means for actuating said second seal means, said first and second hydraulic means being independently operable for controlling the engagement and disengagement of said first and second seal means selectively with the soft flexible conduit passing through said seal means; and hydraulic drive means for driving said capstan member for moving said soft flexible conduit through said seal means and said housing.

18. An apparatus of the character set forth in claim **17** including: means for storing a body of a plurality of connected sections of said soft flexible conduit for injection through the seal means and housing into the well.

19. Apparatus of the character set forth in claim **17** including: reel means for storing a body of soft flexible conduit for injection through the seal means and housing into a well; and hydraulic power means for rotating said reel for winding and unwinding said soft flexible conduit on the reel.

20. Apparatus of the character set forth in claim **19** including: an elongate body of soft flexible conduit formed of a plurality of sections joined together wound on said reel for movement into and out of a well.

21. Apparatus of the character set forth in claim **20** including: coupling means for connecting said sections of said soft flexible conduit together without rotation of said sections of conduit around their longitudinal axes.

22. Apparatus of the character set forth in claim **21** wherein said coupling means includes: a first union body having means at one end for connecting it to a length of soft flexible conduit and a projecting connecting member on its opposite end having external threads thereon; a second union body having means at one end for connecting it to a separate section of soft flexible conduit and a projecting connecting member at its opposite end having external threads thereon; said threads of said first and second connecting members being of opposite lead or hand; and a coupling sleeve ha internal threads at its opposite ends of opposite lead or hand for engagement with the threads on the projecting connecting members of the first and second union members to secure said union members together to connect the sections of soft flexible conduit.

23. A coupling member of the character set forth in claim **22** including: means for maintaining the threads in one end of the coupling member and the threads on one of the union members in engagement until after the threads in the opposite end of the coupling member and on the other union member are disengaged.

24. A coupling member of the character set forth in claim **22** wherein the threads on said first union member are of greater extent than the threads on the second union member, and the internal threads in said coupling sleeve mating with the threads on the first union member are of greater extent than the threads therein mating with the threads on the second union member.

25. A coupling member of the character set forth in claim **22** including: seal means on each of said union members movable into coengagement to seal between said union members to provide a sealed connection between the flexible conduit sections connected to said union members.

26. A coupling member of the character set forth in claim **22** wherein said projecting connecting members of said union members are provided with sealing surfaces on their ends, and said coupling sleeve is provided with seal means engageable with said sealing surfaces of said union members to confine fluids flowing through said flexible conduit against leakage from said coupling member.

27. A coupling member of the character set forth in claim **22** wherein each union member has a longitudinal bore therethrough and the projecting connecting member of such union members includes a cylindrical sealing surface extending beyond the threads on said connecting member and having lateral ports therein and a closed end; and said coupling sleeve has sealing means disposed to engage said projecting sealing surfaces to close the lateral ports against flow therethrough when said union members are moved apart a predetermined distance; said closed ends of said projecting members being coengageable to limit movement thereof toward each other in said coupling sleeve and to position said lateral openings in each of said sealing surfaces in flow communication with each other between the seal means of said coupling sleeve.

28. A coupling member of the character set forth in claim **27** including: means maintaining the threads of the sleeve in engagement with the threads of one of the union members until after the threads of the coupling sleeve have been disengaged from the threads of the other union member to permit uncoupling the sections of soft flexible conduit to which the union members are

connected while the threads of said coupling sleeve remain engaged with the other of the union members, and said coupling sleeve and other union member are positioned with the lateral ports in the sealing surface of said other union member closed by said sealing means in said coupling sleeve.

29. Apparatus of the character set forth in claim **20** including: means for connecting one end of said elongate body of soft flexible conduit to said reel; nozzle means on the opposite end of said flexible conduit and movable with said conduit into a well bore; means for circulating fluid through said flexible conduit from the reel to the nozzle means; means on said nozzle means providing rearwardly directed jet openings from said nozzle means to the exterior thereof for directing fluids circulated through the conduit and nozzle means rearwardly of the nozzle means to apply a force to the nozzle means to move the same and the conduit connected therewith into the well bore.

30. Apparatus of the character set forth in claim **29** including: longitudinally forwardly directed jet openings on said nozzle means for directing fluid from the flexible conduit through the nozzle means to the exterior thereof forwardly ahead of said nozzle means for utilizing said forwardly ejected fluids to dislodge and to circulate foreign matter from the well bore; and valve means in said nozzle means for selectively opening and closing said rearwardly directed jet openings and said forwardly directed jet openings.

31. Apparatus of the character set forth in claim **30** including: means on said valve means projecting from the forward end of said nozzle means engageable with bridges or other foreign matter in the well bore to move said valve means from a position directing circulating fluids through said rearwardly directed jet openings to a position directing circulating fluids from said conduit through said forwardly directed jet openings.

32. An apparatus of the character set forth in claim **1** wherein the seal means comprises: a housing having a bore therethrough; an elongate tubular unitary seal member in said bore; operating means positively connected with said elongate unitary seal member for longitudinally compressing and laterally expanding said seal member to position to engage said conduit extending through said housing, and for longitudinally elongating and laterally contracting said elongate unitary seal member to a position to disengage the same from said conduit extending through said housing.

33. A device of the character set forth in claim **3** wherein each of said seal means comprises: a housing having a bore therethrough; an elongate tubular unitary seal member surrounding said bore; operating means positively connected with said elongate unitary seal member for longitudinally compressing and laterally expanding said seal member to position to engage said conduit extending through said housing, and for longitudinally elongating and laterally contracting said elongate unitary seal member to a position to disengage the same from said conduit extending through said housing.

34. An apparatus of the character set forth in claim **1** wherein said seal means includes: a housing having a bore therethrough and means for connecting the same to said drive means in flow communication with the chamber of said drive means; an elongate tubular integral resilient seal member in said housing positively connected with said elongate tubular integral resilient seal member for longitudinally compressing and laterally expanding said seal member into said bore, and for longitudinally elongating and laterally retracting said seal member from said bore.

35. An apparatus of the character set forth in claim **32** including: pressure responsive means on said operating means for actuating said operating means by fluid pressure.

36. Apparatus of the character set forth in claim **33** including: pressure responsive means on each of said operating means for actuating the same by fluid pressure.

37. Apparatus of the character set forth in claim **32** including: pressure responsive actuating means operatively connected with said operator means for actuating said operating means by fluid pressure to compress and contract said elongate tubular one-piece seal means.

38. Apparatus of the character set forth in claim **34** wherein said operating means includes: pressure responsive means exposed to fluid pressure for actuating said operating means.

39. Apparatus of the character set forth in claim **37** wherein fluid pressure conducting means is connected to said housing for conducting operation fluid to said pressure responsive means for actuating the same.

40. Apparatus of the character set forth in claim **35** wherein fluid pressure conducting means is connected to said housing for conducting operation fluid to said pressure responsive means for actuating the same.

41. Apparatus for advancing a soft flexible conduit into a well against pressure of well fluids confined therein including: a seal member connected with the upper end of the well and sealing about the flexible conduit; means for maintaining fluid under pressure in said conduit in excess of the pressure of the well fluids confined in the well exteriorly of said conduit; means for drawing the flexible conduit through the seal means into the well against the pressure in the well.

42. Apparatus for injecting a soft flexible conduit into a well against the pressure of well fluids confined therein including: a seal member connectable with the upper end of the well and sealing about the flexible conduit; means for circulating fluids through the conduit into the well through the entrant end of the conduit at a pressure in excess of the pressure of the well fluids; means for directing the circulated fluids from the conduit rearwardly thereof to draw the flexible conduit through the seal into the bore of the well.

43. Apparatus for injecting a soft flexible conduit into the well against the pressure of well fluids confined therein including seal means connectable with the upper end of the well and having means sealing about the flexible conduit; means for circulating fluids through the flexible conduit into the well at a pressure in excess of the pressure of the well fluids; and means including means utilizing the circulating fluids for drawing the flexible conduit through the seal into the bore of the well.

44. Apparatus for moving an elongate string of soft flexible conduit into a well under pressure including: seal means connected with the well and sealing about the flexible conduit to prevent escape of well fluids from the well bore; means for circulating fluid under pressure in excess of the pressure of the well fluid through said flexible conduit into the well; and drive means between the seal means and the well for drawing the soft flexible conduit through the seal means into the

well and including: a housing having a chamber therein with opening means to the exterior of the housing through the seal means; a capstan drive member rotatably mounted in the chamber in the housing; an annular conduit engaging surface on said capstan member for engaging the conduit to be moved; means in the housing for holding the conduit in engagement with the capstan member; and means for rotating the capstan member to move the conduit longitudinally of the conduit through the opening means and seal means into the well bore.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,866,679 Dated February 18, 1975

Inventor(s) Tibor Laky

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

Column 24, line 44, after "for" read --operating--

Signed and sealed this 20th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks