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CABLE INJECTING DEVICE

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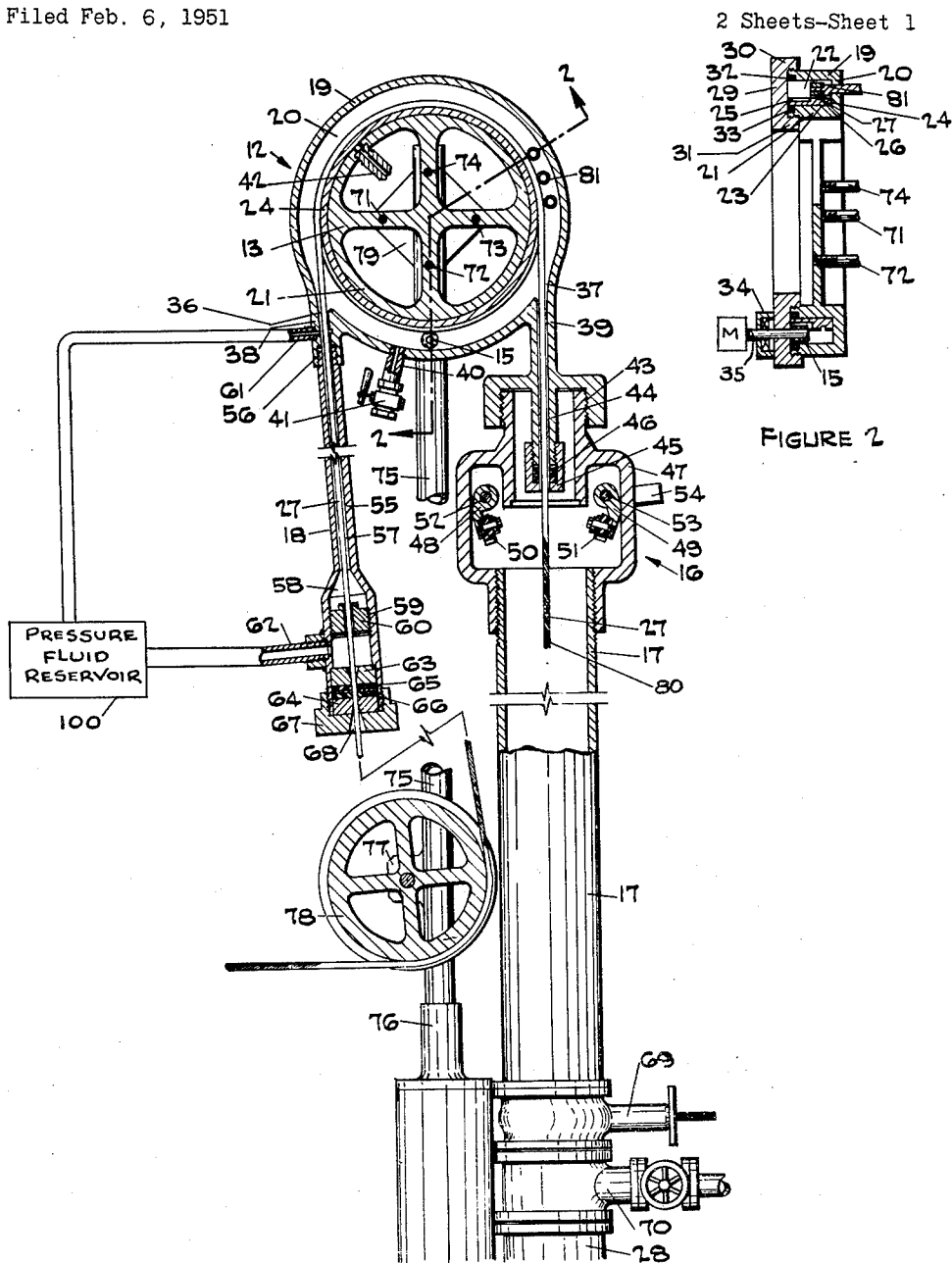


FIGURE 1

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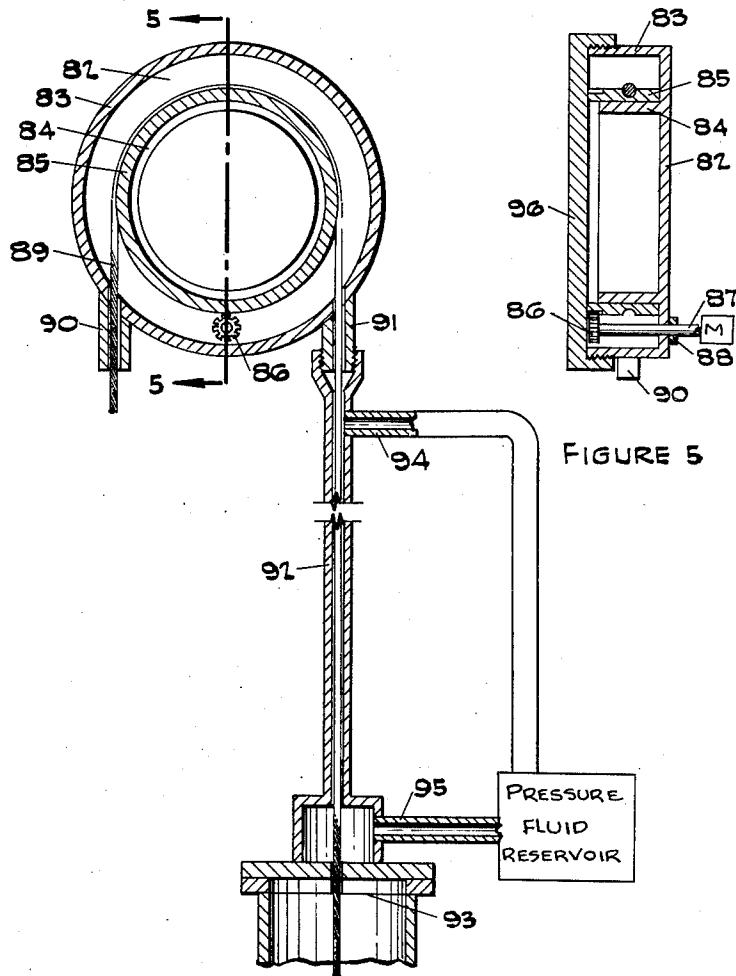
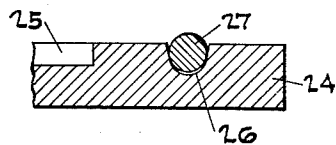
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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CABLE INJECTING DEVICE

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7 Claims. (Cl. 166—14)

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This invention relates to oil well equipment and pertains more particularly to an apparatus for inserting strings of flexible elongated cylindrical elements, such as cables, wire lines, etc., through a pressure seal into a high-pressure vessel.

Since the present invention is especially well suited for inserting strings of flexible cable into high pressure wells, it will be described herein in its application to this particular type of operation, the closed well casing or tubing being considered as a pressure vessel. It is, however, understood that the invention is in no way limited thereto, but may also be used for inserting temperature and pressure bulbs, or similar instruments, and leads and connections appertaining thereto, into pressure vessels such, for example, as towers in oil refineries, etc.

It is often desirable during the operation of a high pressure well to introduce thereinto on a cable various well tools or instruments such as pressure or temperature recorders, flow indicators, etc. Insertion of these devices into the well casing or tubing is generally accomplished by first installing a "lubricator," which consists of a length of pipe placed above the master valve on the christmas tree, or on the well head, said pipe having a sealing element, stuffing box, or other suitable closure means at the top thereof. With the master valve closed, the desired well tool is introduced into the lubricator, the sealing element or stuffing box is closed about the cable secured to the tool, the master valve is opened, and the tool lowered into the well.

In order to overcome the force exerted by the well pressure, acting on the cross-sectional area of the cable which sometimes reaches very high values and tends to force the cable out of the well, it is generally necessary to attach weights or sinkers to the lower end of the cable either below or above the tool. When a very small-diameter wire line or cable is used, tools can be successfully introduced into a well by this means. However, when it is necessary or desirable to use a relatively large-diameter cable, for example, an insulated conductor cable having an armor sheath made of wire strands, it is not practical in most cases to use a sufficient amount of sinkers to overcome the well pressure and the friction of the sealing element or stuffing box on the cable.

For example, in a well with a pressure of 3000 pounds per sq. in., a one-half inch cable having a cross-sectional area of about one-fifth of a square inch would have an extrusion force against it of 600 pounds. Added to this would be the friction of the sealing element or stuffing box against the cable which may be as great as 300 pounds for a 3000-pound per sq. in. pressure in a well. Thus, to insert a tool or apparatus on a one-half inch cable into a well with a 3000-pound per sq. in. pressure, enough sinkers would have to be

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attached to the cable to make the total weight of the tool and sinkers greater than 600 pounds. In addition to the apparatus and sinkers being very heavy, they would also be very cumbersome since they would necessarily have to be from 10 to 30 feet or more in length, depending on the diameter of the apparatus and sinkers, said diameter being governed by the diameter of the casing into which they are being inserted.

It may be seen that if 30 feet of apparatus and weights are to be inserted in a well casing, a lubricator at least 30 feet in height must be employed above the christmas tree. Additionally, if a lubricator device, such as disclosed in Patent application Serial No. 182,970, filed September 2, 1950, now Patent No. 2,670,225, issued February 28, 1954, is employed, the seal on said lubricator may add another several feet to the overall length of the assembly.

It is, therefore, a primary object of the present invention to provide an apparatus for inserting a cable through a sealing element into a high-pressure well without the necessity of using weights or sinkers.

It is also an object of this invention to provide a device of the above type comprising a housing of toroidal or annular shape, said shape enabling said housing to withstand high internal pressures without undue increase of the thickness of its walls.

A further object of this invention is to provide a cable-gripping mechanism adapted to grip a substantial length of a cable while inserting it through a high-pressure seal into a well casing or tubing.

Other objects and advantages will be apparent from the following description taken in reference to the drawings, wherein:

Figure 1 is a front elevation, partly in cross section, of one embodiment of the present cable-inserting mechanism mounted for operation at a well head.

Figure 2 is a cross-sectional view of the cable-gripping element of the present apparatus taken along the line 2—2 of Figure 1.

Figure 3 is an enlarged cross-sectional view of a cable positioned in the cable groove of the present cable-gripping element.

Figure 4 is a cross-sectional view of another embodiment of the present cable-inserting mechanism mounted for operation at a wellhead.

Figure 5 is a cross-sectional view taken along line 5—5 of Figure 4.

Referring to Figure 1, the novel cable-gripping device of the present invention comprises a housing 12 having a webbed wheel-shaped support member, or shaft 13 formed or affixed to the central portion thereof, with a large-diameter ring gear 24 rotatably mounted on said shaft 13 and

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adapted to be rotated on the shaft 13 by a relatively small-diameter pinion 15.

In order to reduce the overall height of the present cable-inserting apparatus, the cable-gripping device is preferably positioned between a wire line valve 16 at the top of a lubricator pipe section 17 at the top of the well and the sealing element 18 through which the cable is supplied over a sheave 78 from a cable supply reel, not shown. When located in this position, the housing 12 of the cable-gripping device must necessarily be of rigid fluid-tight construction adapted to withstand and contain whatever pressure exists in the well casing or tubing.

A preferred embodiment of the housing 12 is circular in shape, having a flange 19 (Figure 2) affixed to the base plate 20 of said housing to form the outer wall thereof. A second flange 21 of identical height, but of slightly smaller diameter is also secured to the base plate 20 concentrically with flange 19 to form an annular passageway 22 (Figure 2) between said flanges 19 and 21. Slidably mounted for rotation on the periphery 23 of said inner flange or bearing 21 is a gear wheel or ring gear 24 having a gear track 25 cut in one-half its outer surface and a circumferential groove 26 cut in the other half of its outer surface.

The circumferential groove 26 is adapted to receive and substantially contain therein a length of a cable 27 insertable through the lubricator 17 into the well casing or tubing 28. The size of the grooved wheel and the size of the groove therein are necessarily dependent upon the flexibility of the cable 27 and the size thereof, respectively. As shown in Figure 3, the groove 26 is preferably of depth equal to about three-fourths of the diameter of the cable 27 contained therein. When the cross-sectional diameter of the groove 26 is equal to the diameter of the cable 27, equal frictional forces will be applied between the surface of said groove and the lower half of said cable 27 when the gear ring 24 is rotated.

In certain cases, it is often desirable to provide a suitable groove 26 which will exert a gripping action on a cable contained therein. Excellent results have been obtained by employing a ring gear 24 (Figure 3) having a groove slightly smaller in diameter than the normal cable diameter. In order to get the cable 27 in the smaller groove 26 it is necessary to open up the top of the groove by beveling the walls thereof at an angle depending on the difference in the diameters of the cable and groove. A groove 26 of the above-described design exerts a gripping on the cable 27 whereby greater frictional forces may be applied between the groove and the cable than when a groove and cable of equal diameter are used.

The diameter of the grooved ring gear 24 depends upon the flexibility of the cable 27 being inserted in the well, said flexibility being in turn dependent on the size and material of which the cable is made. Normally, the diameter of the ring gear 24 is from about 20 to 50 times or more than the diameter of the cable 27. If an armored and insulated cable is employed, having an outer armor sheath of a plurality of wires twisted around said cable, the diameter of a ring gear to be used with this cable should be about 200 times or more the diameter of the wires in the outer armor.

The annular housing 12 containing the ring gear 24 may be closed in any suitable fluidtight manner, as by an annular cover 29 having internally threaded flanges 30 and 31 adapted to

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fit the threaded cooperating surfaces of flanges 19 and 21, as shown in Figure 2. To assure a fluidtight seal, packing rings 32 and 33 may be used if desired. Since the ability of the walls of a pressure vessel to withstand internal pressures is a function of the greatest unsupported length or dimension of said walls, it will be seen that the annular shape of the pressure space within the present housing has the advantage of permitting relatively high pressures to be used in said space without the walls having to have their thickness increased to an excessive value. It may be readily shown that if said pressure space were given a cylindrical instead of an annular shape, the thickness of the walls thereof would have to be increased by a considerable factor in order to be able to withstand the same pressures.

A suitable stuffing box 34 is also provided around the shaft 35 of the pinion 15 to form a fluidtight seal therearound. The shaft 35 of the pinion 15 is operatively connected to and rotated by a suitable prime mover means (not shown) such, for example, as a hydraulic, pneumatic or electric motor.

The housing 12 of the cable-gripping device is provided with cable entrance and outlet ports 36 and 37, respectively, through the outer wall or flange 19 thereof. Preferably, bosses or nipples 38 and 39 are formed or welded to the outer surfaces of said flange 19 to serve as guides for the cable entering and leaving the housing 12. The axes of the ports 36 and 37 through the bosses 38 and 39 and the flange 19 are tangential to the groove in the grooved ring gear 24 and may be substantially parallel to each other. Besides cable ports 36 and 37 the housing 12 may also be provided with a pressure relief port 40 normally closed by a valve 41 and injection port 42 for introducing lubricating material between flange 21 and ring gear 24.

The boss 39 is threaded, as at 43, to be secured to the top of the wire line valve 16 or the lubricator 17. The boss 39 may be provided with a tubular cable guide 44 having, if desired, a cap 45 secured to its lower end containing wiping disks 46 of rubber or other suitable material. The wire line valve 16, which is actually a small blowout preventer, comprises a housing 47 in which a pair of rams 48 and 49 carrying sealing rubbers 50 and 51 are swingingly mounted on shafts 52 and 53 which may be actuated by a handle 54. In operation, the rams 48 and 49 rotate toward each other and the rubbers 50 and 51 seal against the cable 27.

The annular space about the cable 27 in cable port 36 may be closed by any suitable pressure seal or closure device secured to the housing 12 or boss 38 and adapted to fit around the cable 27. Preferably a pressure seal of the type disclosed in a copending patent application No. 182,970, filed September 2, 1950, is employed. As shown in Figure 1, the high-pressure seal 18 comprises an elongated tubular member 55 secured in any suitable manner, as by screw threads 56, to the boss 38 in coaxial relation to the cable port therethrough. The bore 57 through said tubular member 55 is of a slightly greater diameter than that of the cable 27 passing therethrough.

One portion of the bore 57 may be enlarged, as at 58, and tapped as at 59, to receive one or more outwardly threaded gas flow resistance orifice units 60. Fluid conduits 61 and 62 are in communication between the bore 57 of said tubular member 55 near the opposite ends thereof. The conduits 61 and 62 are also in communi-

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cation with a reservoir 100 containing a relatively viscous transfer liquid or sealing material such as heavy oil or grease. Waxes, asphalt or emulsions thereof, glue, sugar syrup, paraffin, water, drilling muds, or any viscous material may be used as pressure fluids.

The viscous transfer fluid is injected into the bore 57 of the tubular member 55 through conduit 61 and is withdrawn through conduit 62. The transfer fluid is supplied from a reservoir at a pressure slightly greater than the well pressure so that a high differential pressure seal is formed between the cable 27 and the walls of the bore 57. Since the clearance between the walls of the bore 57 and the cable 27 may be in the order of .001-.005 of an inch, the well pressure cannot force the transfer fluid out and an effective solid-liquid-solid seal is formed within the bore of the apparatus. The source of pressure for injecting the transfer fluid may comprise the utilization of the well casing pressure in a manner well known to the art, or the employment of a compressor such as an air-operated high-pressure power gun. A pair of holding sleeves 63 and 64 are positioned in the enlarged portion of the bore 57 near the lower end thereof for holding therebetween one or more cable wipers 65 and 66 which are preferably made of a resilient material such as rubber. The sleeves 63 and 64 and wipers 65 and 66 are held in the bore 57 by a threaded cap 67 having an axial bore 68 therethrough, said cap being secured to the lower end of the tubular element 55.

In operation, the entire above-described apparatus is affixed in a fluidtight manner to the top of the lubricator pipe section 17 which is in turn bolted to a valve 69 and T 70 at the top of a christmas tree or well casing 28 (Figure 1). Rather than have the boss 39 support the weight of the housing 12 and sealing element 18, the housing 12 is normally secured as by bolts 71, 72, 73, 74 and plate 79 to suitable support means such, for example, as a support post 75 or A-frame positioned adjacent the well casing 28. A hydraulic or screw jack 76 may serve as a base for the support post 75 to facilitate in connecting the housing 12 to the valve 16 and lubricator 17. A block 77 may be secured to the lower end of said post 75 for mounting thereon a grooved idler wheel or pulley 78 over which the cable 27 may pass before entering the sealing element 18.

Before mounting the present apparatus at a well head, valve 69 is closed. The valve 16, housing 12 and sealing element 18 are then assembled together and the cover 29 (Figure 2) of the housing is removed so that the end 80 of the cable 27 may be forced up the tubular member 55 and threaded in the groove 26 over the wheel or ring gear 24 and out the cable port 37 and guide 44. With the cable 27 extending through the valve 16, the tool or instrument to be inserted in the well is attached to the end of the cable.

The assembled apparatus is then secured to the top of the lubricator section 17 in any suitable manner as by bolts, screw threads, or the like. After replacing the cover 29 on the housing 12 transfer fluid is introduced under pressure through conduit 61 into the annular space around the cable 27 in the tube 55, and if desired into the fluidtight housing 12. Valve 69 at the top of the well is then opened and the tool and cable 27 attached thereto may be lowered into the well by rotating the pinion gear 15

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which in turn rotates the ring gear 24. When valve 69 is opened the housing 12 is subjected to the full pressure of the well.

It is to be noted that the cable 27, which rests in the groove 26 of the large-diameter wheel 24, is in frictional contact with said wheel through at least one-half the circumference thereof. The frictional forces set up between said wheel and cable are sufficient to pull the cable 27 through the pressure seal 18 and force it out cable port 37 and through valve 16 into the well. If needed, additional frictional contact between the grooved wheel 24 and cable 27 may be obtained by using a groove as previously described with regard to Figure 3. If desired, additional frictional forces may be applied to the cable by employing one or more idler wheels or roller bearings 31 rotatably and adjustably affixed to the base 29 of the housing 12. These adjustably mounted idler wheels exert a uniform and adjustable radial pressure upon the cable to increase the total frictional or gripping force of the injector. These idler wheels may also serve as guide means for keeping the cable 27 in its grooved track 26.

After the cable 27 has been inserted in the well casing 28 to the desired depth, valve 16 may be closed and thereafter the injection of viscous transfer fluid into the sealing element 18 may be stopped. When it is desired to remove the cable from the well, this is readily accomplished by reversing the prime mover (not shown) to drive pinion 15 and ring gear 24 in the opposite direction. While the present embodiment has been described with the housing 12 of the cable-inserting device positioned between the sealing element 18 and the valve 16, it is realized that in many instances, especially on low-pressure wells, the sealing element 18 may be positioned between the housing 12 and the valve 16 thus obviating the necessity of employing a housing that is fluidtight.

Thus, in the embodiment shown in Figures 4 and 5, a cylindrical housing 82 is provided with a pair of raised flanges 83 and 84, flange 83 forming the circular wall of the housing and flange 84 forming a bearing on which a combination ring gear and grooved wheel 85 is mounted for rotation. A small gear 86, mounted on a shaft 87 which extends through one side of the housing 82 and through a suitable stuffing box 88, is adapted to actuate the geared and grooved wheel 85.

A cable 89 is illustrated as entering cable inlet port 90, passing over wheel 85, out cable outlet port 91 and through a pressure seal 92 which is affixed to the top of a well head 93. The fluid type seal 92 is provided with inlet and outlet conduits 95 and 94, respectively, for passing a fluid through the tubular seal 92 in a manner previously described. Since the packing device or seal 92 in this embodiment is between the well head 93 and the housing 82, the latter may or may not, as desired, be closed by a cover 96 in any suitable manner.

I claim as my invention:

1. An apparatus for inserting a cable into pressure wells, comprising an annular pressure-tight housing having inlet and outlet cable ports through the wall thereof, said outlet cable port being in fluidtight communication with the well, sealing means connected to the inlet cable port for passing a cable into the well through said housing, a cable engaging ring rotatably supported within said annular housing concentrically therewith, said wheel having a circumferen-

tial groove in the outer surface thereof, said groove being in frictional engagement with said cable over a substantial portion of the circumference of said wheel, and driver means engaging said ring to rotate said ring whereby the cable is forced through said outlet cable port and into the well against the pressure therein, said driver means extending exteriorly of the housing in fluid-tight relationship therewith.

2. An apparatus for inserting a cable into pressure wells, comprising an annular fluid-tight housing having inlet and outlet cable ports through the wall thereof on substantially diametrically opposite sides of said housing, said cable ports extending through the wall in substantially the same direction, said outlet cable port being in fluidtight communication with the well, sealing means connected to the inlet cable port for passing a cable into the well through said housing, a ring element rotatably supported within said annular housing concentrically therewith, said ring element having a circumferential groove in the outer surface thereof, said groove having a cross-sectional diameter slightly smaller than the cable and a depth equal to at least the radius of said cable, the edges of said groove being beveled to admit the cable substantially to the bottom of said groove, said grooved ring element being in gripping frictional engagement with said cable over a substantial portion of the circumference of said wheel, and driver means engaging said ring element to rotate said ring element whereby the cable is forced through said outlet cable port and into the well against the pressure therein, said driver means extending exteriorly of the housing in fluidtight relationship therewith.

3. An apparatus for inserting an elongated flexible element into a pressure vessel, comprising a fluid-tight annular housing, first and second port means in said housing for leading said flexible element into and out of said housing, said flexible element entering and leaving said housing in substantially opposite directions, packer means adapted to form a seal about said flexible element connected to said first port means, conduit means in fluid-tight communication between said second port means and the pressure vessel, a ring rotatably supported within said housing concentrically therewith, said ring being in engagement with said flexible means throughout substantially 180 degrees of the circumference of said sheave, and driving means in engagement with said ring within said housing to rotate said ring, whereby said flexible element is frictionally forced by the rotation of said ring into said pressure vessel through said packer and conduit means, said driver means extending exteriorly of the housing in fluid-tight relationship therewith.

4. An apparatus for inserting an elongated flexible element into a pressure vessel, comprising a fluid-tight annular housing, first and second port means in said housing for leading said flexible element into and out of said housing, said flexible element entering and leaving said housing in substantially opposite directions, tubular packer means adapted to form a seal about said flexible element connected to said first port means, conduit means in fluidtight communication between said second port means and the pressure vessel, a gear ring rotatably supported within said housing, circumferential friction means on said gear ring adapted to engage said flexible means throughout substantially 180 degrees of the circumference of said gear ring, pinion means driving said gear

ring, whereby said flexible element is frictionally forced by the rotation of said gear ring into said pressure vessel through said packer and conduit means, and a shaft for said pinion means extending exteriorly of said housing in fluidtight relationship therewith.

5. An apparatus for inserting an elongated flexible element into a pressure vessel, comprising an annular housing, first and second port means in said housing for leading said flexible element into and out of said housing, said flexible element entering and leaving said housing in substantially opposite directions, tubular packer means adapted to form a seal about said flexible element connected to said first port means, conduit means in fluid-tight communication between said second port means and the pressure vessel, a ring element rotatably supported within said annular housing concentrically therewith, said ring element having gear means formed throughout one portion of its outer circumferential surface, said ring element having a groove throughout the other portion of its outer circumferential surface, the inner circumferential surface of the ring rotating on the inner wall of the annular housing as on a bearing and driver pinion means engaging said gear means, whereby said flexible element is frictionally forced by the rotation of said ring element between said two ports, said driver pinion means extending exteriorly of said housing in fluidtight relationship therewith.

6. An apparatus for inserting an elongated flexible element into a pressure zone, said apparatus comprising a fluid-tight annular housing, an annular pressure chamber within said housing, first and second port means in said housing for leading said flexible element respectively into and out of said annular pressure chamber, a ring element rotatably mounted within said pressure chamber concentrically therewith, said ring element being adapted to engage said flexible element over a substantial portion of the circumference of said ring element, and driving means in engagement with said ring element within said annular pressure chamber to rotate said ring element, said driving means extending through the walls of said housing in pressure-tight relationship therewith.

7. An apparatus for inserting a cable into a pressure vessel, comprising a pressure-tight annular housing having a first port adapted for sealed connection with the pressure vessel and a second port provided with pressure seal means adapted to close about a cable passing therethrough, a cable-engaging ring mounted within said annular chamber concentrically therewith, said ring being adapted to rotate on the inner wall of said annular housing as on a bearing, and driver means engaging said ring to rotate said ring, said driver means extending exteriorly of the housing in pressure-tight relationship therewith, the rotation of said driver-actuated ring causing the cable to move within the housing from one of said ports to the other.

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