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VALVE FOR WELL PIPE

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FIG. 1.

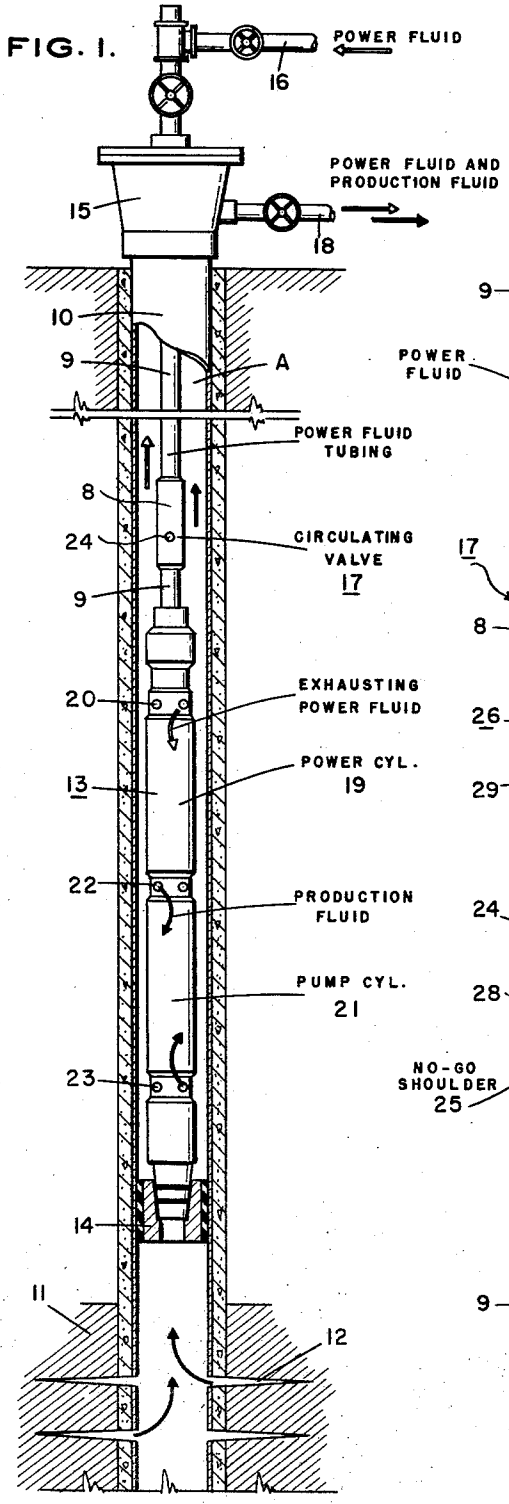


FIG. 2.

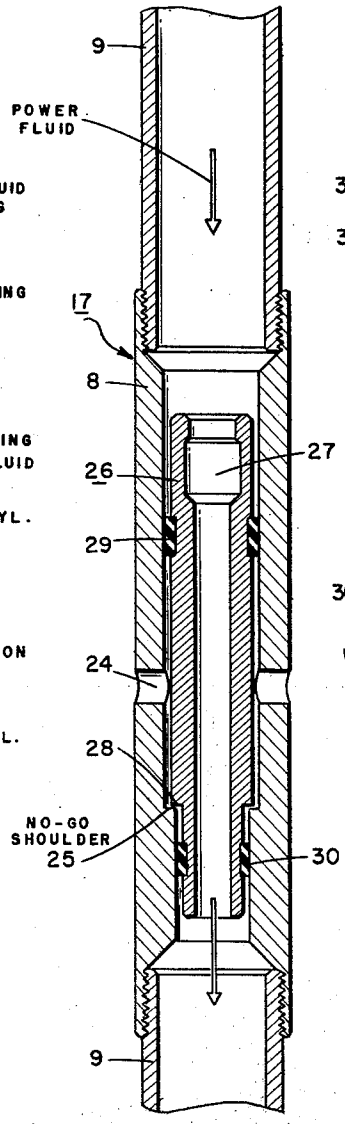
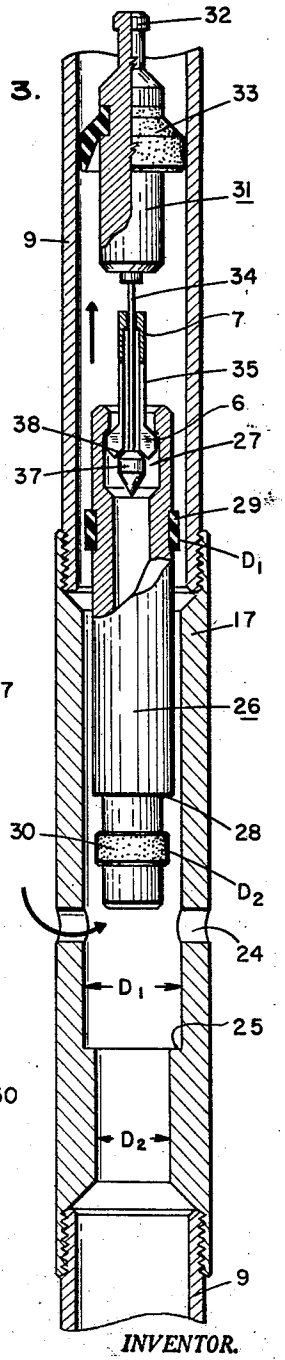


FIG. 3.



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VALVE FOR WELL PIPE

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The present invention concerns a hydraulically operable circulating and tubing drain valve and its method of use.

Conventional insert subsurface hydraulic pumps used in wells are run in the wells on tubing strings which are used to conduct power or operating fluid to the engine or power parts of the pump assemblies. A disadvantageous feature of this operation is that thread dope, scale, and other materials capable of fouling the engine parts remain in the power tubing string after the pump assembly has been landed and is otherwise ready to begin operation. Therefore, it is desirable to remove these unwanted materials from the power tubing string prior to initiation of pumping operations, and the present invention is directed to this end.

Briefly, the apparatus of the invention includes a nipple provided with fluid circulation ports and connected in the power tubing string adjacent to the subsurface hydraulic pump assembly. The nipple also is provided with an inner shoulder below the ports, which forms a smaller nipple inner diameter below the shoulder and which serves as a stop for a mandrel which is lowerable into and removable from the nipple. The mandrel is provided with a shoulder which forms a smaller mandrel outside diameter below the shoulder and which engages the nipple shoulder. Upper and lower sealing means arranged on the outer surfaces of the mandrel above and below the mandrel shoulder, respectively, seal off the spaces between the mandrel and nipple above and below the nipple ports, respectively. Thus, the upper sealing means exposes a greater area to fluid pressure within and outside of the power tubing string than does the lower sealing means. The mandrel also has a fishing neck at the upper end thereof designed to engage a retrieving tool used to remove the mandrel from the tubing string.

Briefly, the method of the invention includes the steps of running on a tubing string and landing in a well pipe an insert-type subsurface pump assembly, the tubing string being used to conduct power fluid to the pump assembly during pumping operations; circulating fluid down the annulus between the tubing string and the well pipe, through circulating ports located in the tubing string above and adjacent to the pump assembly and up the tubing string to flush out and remove unwanted materials remaining in the tubing string following landing of the pump assembly in the well pipe; and then pumping or otherwise moving a hydraulically removable valve device downwardly through the tubing string and seating it adjacent the circulating ports to prevent fluid flow therethrough. Additionally, the method includes removing the valve device from the tubing string by pumping or otherwise moving a retrieving tool down the tubing string until it latches onto the valve device and then circulating fluid down the annulus between the well pipe and the tubing string and through the circulating ports to unseat the valve device and pump it and the fishing tool upwardly through the tubing string to the earth's surface. Once the valve device has been removed from the tubing string, the circulating ports serve as drainage ports when the tubing string and pump assembly are pulled from the well.

Thus, primary objects of the invention include providing a hydraulically operable circulating and tubing drain valve for use with insert-type subsurface hydraulic pumps

that is inexpensive to construct and operate, does not require manipulation of the tubing string to open and close it, and that can function as a tubing drainage means during pulling operations.

The above and other objects and advantages of the invention will be apparent from the following more detailed description thereof given in conjunction with the drawings wherein:

FIG. 1 is a cross-sectional view of a well bore showing a pump assembly, a power fluid tubing, and a circulating valve arranged in the power fluid tubing positioned in the well bore;

FIG. 2 is a vertical, partly-sectional view showing the circulating valve of FIG. 1 in greater detail; and

FIG. 3 is a vertical, partly-sectional view showing one element of the circulating valve being removed from the power tubing string by means of a retrieving tool.

Referring to the drawings in greater detail, in FIG. 1 is shown a well pipe 10 penetrating a subsurface oil-containing formation 11 perforated as at 12. A conventional insert-type subsurface hydraulic pump assembly 13 is shown landed in a pump seating unit 14 positioned in well pipe 10. The upper end of pump assembly 13 is connected to the lower end of a tubing string 9 used to conduct power fluid from a surface source, not shown, to the engine or power end 19 of pump assembly 13. Power tubing string 9 fluidly communicates with a conduit 16, which in turn fluidly communicates with the power fluid source through well-head 15. A surface conduit 18 used to conduct mixed production fluids and spent power or operating fluids fluidly communicates with the annulus A between tubing string 9 and pipe string 10 through wellhead 15. A circulating valve 17 is arranged in power fluid tubing string 9 adjacent pump assembly 13. Ports 20 adjacent the power end 19 of pump assembly 13 exhaust spent power fluid into annulus A. Ports 22 and 23 positioned on each end of the pump end 21 of pump assembly 13 exhaust pumped production fluids into annulus A.

In FIGS. 1 and 2 the paths of the fluids are illustrated by arrows. The light arrows designate the paths of the power fluid flow, and the dark arrows designate the paths of the production fluid flow. In FIG. 3 the dark arrows represent the path of flow of the fluid used to unseat and remove from tubing string 9 an element of valve 17. The elements of valve 17 are seen more clearly in FIG. 2. The valve includes a nipple 8 connected in tubing string 9 and provided with fluid circulation ports 24, which fluidly communicate the interior and exterior thereof. A no-go shoulder 25 is formed on the inner surface of nipple 8 below circulation ports 24. This shoulder forms on the inner surface of nipple 8 an upper portion of diameter D_1 and a lower portion of smaller diameter D_2 (see FIG. 3). A mandrel 26 seated in nipple 8 is provided with a shoulder 28 formed on the outer surface thereof. This shoulder forms upper and lower, larger and smaller, respectively, outside diameters on mandrel 26. An upper packoff 29 is arranged on the larger diameter portion of mandrel 26 to seal off the space between nipple 8 and mandrel 26 above circulating ports 24 when shoulder 28 rests on shoulder 25. A lower packoff 30 is arranged on the smaller diameter portion of mandrel 26 to seal off the space between nipple 8 and mandrel 26 below shoulder 25 when shoulder 28 rests on shoulder 25. An inside fishing neck 27 is formed on the upper end of mandrel 26. Mandrel 26 is positioned within nipple 8, as illustrated in FIG. 2, during pumping operations. Thus, power fluid designated by the light arrows is pumped down tubing string 9 and through the opening in mandrel 26 to pump assembly 13.

FIG. 3 shows mandrel 26 connected to a retrieving tool 31 and both being pumped upwardly through tubing

string 9. The retrieving tool includes a fishing neck 32 adapted to engage a wire line fishing tool; a swab cup 33 formed to prevent upward fluid flow past the retrieving tool; a mandrel 34 having an enlarged knobbed lower end 37; and a cylindrical member 7 slidably arranged on mandrel 34 and provided with fingers or collets 35 having latching dogs 6 positioned on the ends thereof for engaging the inwardly projecting lugs of fishing neck 27 and for locking retrieving tool 31 in fishing neck 27 when mandrel 34 is moved upwardly relative to cylindrical member 7, and the surfaces of knobbed end 37 and dogs 6 engage as at 38. In operation, after pump assembly 13 in run in pipe string 10 on tubing string 9 in which nipple 8 is connected and landed in seating unit 14 and the proper wellhead connections are made up, fluid is circulated through conduit 18 down annulus A through circulation ports 24 and upwardly through nipple 8 and tubing string 9 and through conduit 16 to flush out and remove materials such as sand, scale, thread dope, etc., that may have remained in tubing string 9 following running and landing of pump assembly 13. After these materials have been removed by the circulating fluids, circulation of fluids in this manner is halted, and mandrel 26 is dropped into tubing string 9 and either circulated downwardly therethrough by circulating fluids down tubing string 9 and through circulation ports 24 and up annulus A or allowed to fall into position in nipple 8. Downward movement of mandrel 26 is arrested when no-go shoulder 25 engages shoulder 28. This position of mandrel 26 is shown in FIG. 2, and it is the position of the mandrel during pumping operations. To operate pump assembly 13, power fluid is pumped through conduit 16, wellhead 15, tubing string 9, and mandrel 26 to the power end 19 of pump assembly 13. The power fluid is discharged from pump assembly 13 through ports 20 into annulus A, where it mixes with production fluids from formation 11, which enter pump end 21 of pump assembly 13 and are discharged therefrom into annulus A through ports 22 and 23. The mixed spent power fluid and production fluids are pumped up annulus A through wellhead 15 into conduit 18. In this operation, fluid pressure within tubing string 9 is greater than the fluid pressure in annulus A, and this differential pressure acts on the differential area formed by diameters D_1 and D_2 of packoffs 29 and 30, respectively, to hold mandrel 26 in place in nipple 8.

When it is desired to remove mandrel 26 from tubing string 9, retrieving tool 31 is pumped down tubing string 9 until the knobbed end 37 of mandrel 34 and dogs 6 of collets 35 are positioned inside fishing neck 27. Then, as seen in FIG. 3, an external pressure is applied in annulus A by pumping fluid through conduit 18 and wellhead 15 into annulus A, which acts on the differential

areas of seals 29 and 30 and moves mandrel 26 upwardly to open circulating ports 24. Once these ports have opened, mandrel 26 and retrieving tool 31 are reverse circulated from tubing string 9 by the fluid pressure acting on the under side of swab cup 33. Fishing neck 32 is provided in the event difficulties are encountered in removing mandrel 26 and retrieving tool 31 hydraulically, and it is found necessary to use wire line tools to effect the removal thereof. After mandrel 26 has been removed from nipple 8 and tubing string 9, pump assembly 13 may be removed from pipe string 10 by pulling up tubing string 9. In this operation, circulation ports 24 act as drainage ports for fluids contained in tubing string 9.

Having fully described the elements, objects, and operation of my invention, I claim:

Apparatus for use in pumping fluids from a well comprising:

an hydraulically operated subsurface pump arranged in said well;

a tubing string connected at its lower end to said pump and at its upper end to a source of power fluid for supplying power fluid to said pump;

a circulating nipple having circulation ports and connected in said tubing string above and adjacent said pump, said nipple also having an inner annular shoulder below said ports providing upper and lower bore portions in said nipple of, respectively, larger and smaller diameters;

a hollow tubular mandrel removably arranged within said nipple and adapted to permit power fluid to circulate therethrough, said mandrel having an outer annular shoulder thereon intermediate the length thereof providing on said mandrel upper and lower portions, of respectively, larger and smaller diameters, and adapted to seat on said nipple inner shoulders; and

upper and lower packers arranged, respectively, on the larger and smaller diameter portions of said mandrel adapted to seal off the space between said nipple and said mandrel above and below, respectively, said nipple ports when said mandrel outer shoulder is seated on said nipple inner shoulder.

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