Nov. 20, 1956 O. C. SLOAN ET AL 2,771,142

TUBING DRAINS

Filed March 18, 1953

2 Sheets-Sheet 1

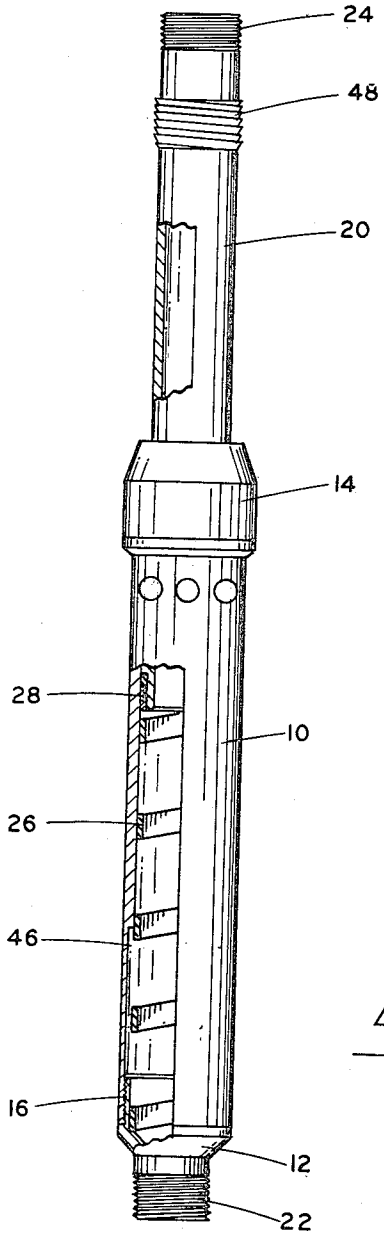

Fig 1

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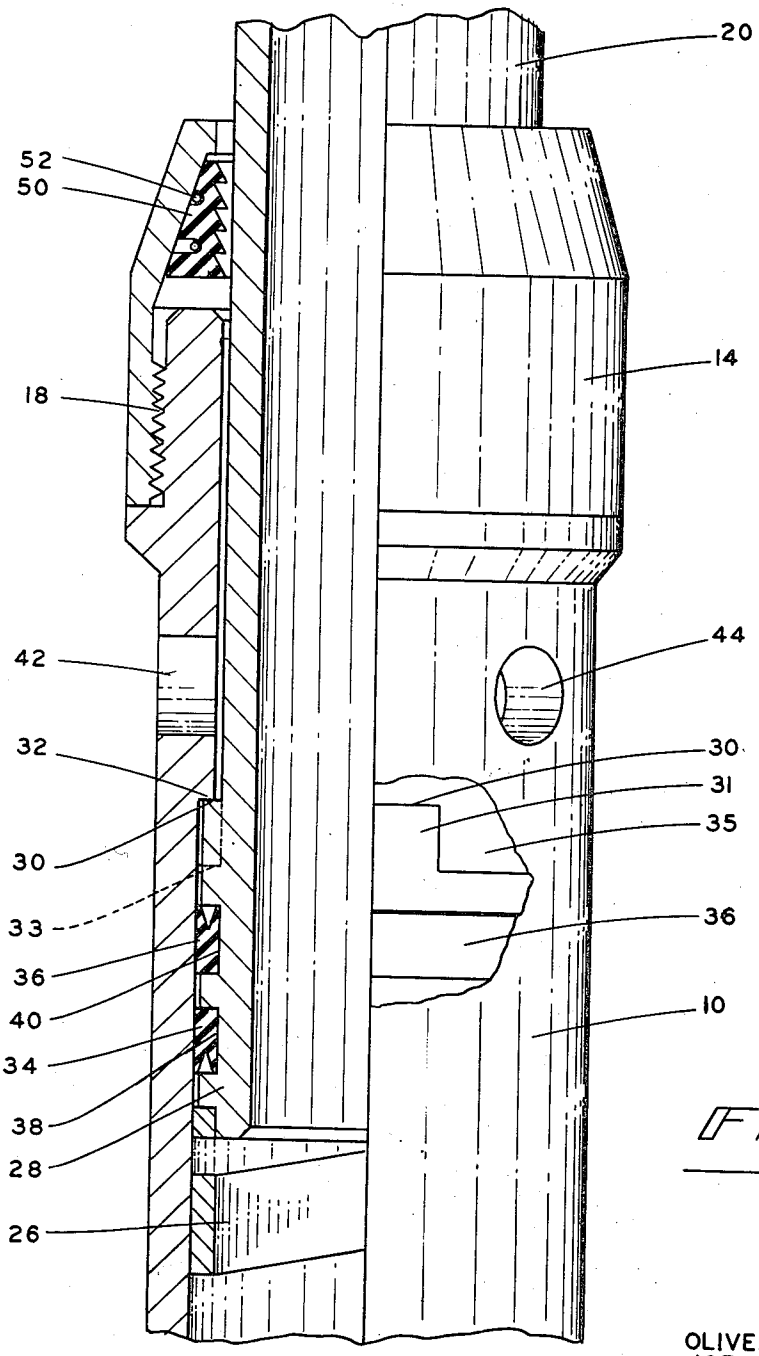

Fig 2

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TUBING DRAINS

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6 Claims. (Cl. 166—226)

This invention relates to a tubing drain. In preferred aspects it provides apparatus for equalizing pressure between the inside and outside of the tubing in a well, especially of the type employed in drilling and/or producing oil and gas wells.

The elements of conventional rotary drilling apparatus, and methods for using same, are well known. Wells of appreciable depth are usually drilled with a rotary rig. The drilling bit is attached to the lower end of a drill string or tubing, which is rotated by mechanism at the earth's surface. During the actual drilling operation drilling mud is forced down through the annular space between tubing and well wall. The tubing itself is made up by simply screwing together long sections of pipe specially made for this service.

After the well has been drilled into the earth the required depth, the tubing can be secured within the well, and the oil or gas, or other fluid, is then often produced by flow through the tubing to the surface. It is also found necessary during the drilling of a well to use a packer to seal off the annular space between tubing and casing or well wall. In these and other circumstances, pressure differences are apt to develop between inside and outside of the tubing. It is desirable to relieve such pressure differences, and this is particularly important when the tubing string is to be pulled from the hole.

An object of this invention is to provide a pressure equalizer tool. Another object of this invention is to provide an improved tubing drain. A further object is to provide apparatus by which pressure within and without a tubing string in an oil or gas well can be equalized. Yet another object is to make possible the draining of liquid from or into a tubing string in a well thereby equalizing pressure on the inside and outside of the tubing, with subsequent withdrawal of the tubing from the well while maintaining a condition of equalized pressure with respect to the tubing. A still further object is to provide apparatus of the nature described which is operable solely by motion of the tubing string. Yet another object is to provide means for opening and closing a drain port in a tubing string in a well by simple manipulation of the tubing applied at the surface. A further object of the invention is to provide a rugged, simple pressure equalizing sub which is comparatively inexpensive to manufacture. Other objects and advantages of the invention will be apparent, to those skilled in the art, from the accompanying disclosure and discussion.

Referring to the drawings, wherein Figure 1 is a partially cut away elevation view of a preferred form of our tubing drain and Figure 2 is a detailed partially cut away elevation view of the central portion of same in a preferred embodiment, reference numeral 10 denotes the tubular body of the device, having a bottom sub 12 and a top sub 14 attached thereto as by screw thread engagement at 16 and 18 respectively. Slidably inserted within the upper part of the body and extending through the top sub 14 is mandrel tube 20. The entire device can be

made up at any desired point in the string of tubing, usually very near the bottom of the string. For this purpose male threads 22 and 24 are provided, respectively, at the end of the bottom sub member 12 and at the opposite end of mandrel 20. Mandrel 20 is adapted to slide axially within body 10. Helical compression spring 26 lies within and concentric with body 10, and urges mandrel 20 towards its outermost position. The enlarged inner end 28 of mandrel 20 is provided at the top with outer circular shoulder 30, which bears against corresponding inner circular shoulder 32 within body 10, thus limiting outward motion of mandrel 20.

The lower inner end 28 of mandrel 20 is provided with at least one and preferably a plurality of packing rings making a fluid-tight pressure resistant seal by contact with the inner surface of body tube 10. In the embodiment illustrated, these take the form of lip packoff rings 34 and 36 lying partially within circular grooves 38 and 40, respectively. These are made of suitable tough resilient material, for example an oil resistant synthetic rubber such as neoprene or butadiene-acrylonitrile copolymer.

The upper end of body 10, beyond shoulder 32, is provided with one or more drain ports, 42, 44. Within the opposite or lower end of body 10 is annular recess 46 of substantially greater length than inner end 28 of mandrel 20.

The outer end of mandrel 20 is provided, near the male threads 24 on the end thereof, with a second group of male threads 48 of greater diameter than threads 24. A mating flexible nut 50 is secured within the open end of top sub member 14. Nut 50 is constructed of tough resilient material, for example polyethylene, "Teflon," or an oil resistant synthetic rubber material of the nature mentioned above, and is adapted to effect engagement with threads 48 by longitudinal non-rotational motion when mandrel 20 is forced sufficiently far down into the body 10. The male threads 48 and corresponding female threads of nut 50 are slanted toward each other for easy insertion, but the opposite sides of the threads are helices normal to the axis of the device to prevent longitudinal disengagement on application of force tending to pull mandrel 20 out of body 10. Thus threads 48 are easily disengaged from nut 50 only by unscrewing. Flexible nut 50 is preferably reinforced by internal annular rings or springs 52.

In a preferred embodiment, as shown in Fig. 2, shoulders 30 and 32 are provided with clutch jaws 31 and 33 respectively, which engage with each other on longitudinal motion of shoulders 30 and 32 into engagement with each other and yet prevent rotational movement between mandrel 20 and body 10. This construction is employed when the particular method to be used for setting tubing anchor, tubing hold-down, or packer is accomplished by rotation of the tubing string. The clutch jaws, preferably a plurality for each shoulder, can be of any suitable construction effecting the function stated, yet permitting free engagement and disengagement of shoulders 30 and 32 on moving same into and out of contact with each other by longitudinal motion. Part of body 10 has been cut away in Figure 2, exposing a portion of the upper part of inner end 28 in elevation view, where there can be seen an upwardly extending tooth 31 of the clutch jaws. The top surface of 31 constitutes part of shoulder 30. The space 35 to the right of tooth or jaw 31 provides room for a downwardly extending tooth of the corresponding jaws 33 on the inner surface of body 10 that has been cut away.

In use, the tool is made up in the tubing string, preferably just above a tubing anchor, tubing hold-down, or packer, whichever is being used and run into the well. The tool of this invention can be run with either end

down; the terms "top" and "bottom" are used herein for convenience but the positions can be reversed in practice. After reaching the desired setting depth the prescribed method of setting the tubing anchor, hold-down, or packer is accomplished. If rotation of the tubing is required to accomplish this, the embodiment of this invention is used which has clutch jaws on the mating shoulders whereby rotation of the tubing string applied at the surface is transmitted through the tool (rotational motion between mandrel and body being prevented by the clutch jaws) to the device lower down in the string.

After the well has been flowing or if for some other reason there is a pressure differential between the inside and outside of the tubing and it is desired to equalize the two pressures, lowering of the tubing enough to collapse the spring and allow the packoff rings to enter the recess in the body permits the fluid to flow through the drain ports and equalize the pressure. If the flexible nut is not used, ports need not be drilled because flow from within the tool through the recess into the annular space between the mandrel and body gives access to the outside of the tool. However, the flexible nut and corresponding threads on the mandrel are almost indispensible for a tool that can be used under all conditions.

If it is desired to remove the tubing from the well the tubing should be lowered enough so the exposed male thread on the mandrel will engage the flexible nut which retains the tool in the open port position while coming out of the hole.

After the tool has been placed in the open port position and it is desired to close them rather than pull the tubing out, the tubing is rotated to disengage the mandrel thread from the flexible nut and then picked up to close the port passage.

Many variations from the specific details given herein can be devised by those skilled in the art, once having had the benefit of the present disclosure, without departing from the invention in its broadest aspects.

We claim:

1. A pressure equalizing tool adapted for placing in a string of tubing for use in a well, which comprises a tubular body, a bottom sub attached to one end thereof and having thread connections for attachment of the tool into a tubing string, a top sub attached to the other end of said body, a tubular mandrel slidably extending into said body through said top sub and having thread connections at the free end thereof for attachment of the tool into a tubing string, said mandrel being of sufficiently smaller external diameter than the smallest internal diameter of said body through which it moves axially as to allow clearance for fluid flow between mandrel and body, an enlarged bottom end of said mandrel within said body having an upper circular shoulder, said body having within its upper end a corresponding circular internal shoulder adapted for engagement with said shoulder on said enlarged end of said mandrel to limit outward motion of said mandrel, a helical compression spring within said body secured at its bottom by said bottom sub and pressing against the bottom of said enlarged bottom end of mandrel biasing said mandrel towards its outermost position, at least one drain port in said body between said internal shoulder and said top sub, at least one packing ring around said enlarged bottom end of said mandrel making a seal by contact with the inner circumference of said body below the aforesaid shoulders, and a cylindrical recess within the bottom portion of said body longer than the enlarged bottom end of said mandrel and of greater diameter than said packing ring, whereby when said mandrel is in its outer position said packing ring prevents fluid flow between the interior and exterior of said tool and when said mandrel is forced against said spring into its inner position with said packing-ring-bearing enlarged lower end within said recess fluid flow can occur from within said tool through the clearance between ring and recess and along the annular space between mandrel and body to and through said ports.

2. A tool according to claim 1 including male threads on said mandrel adjacent to said thread connections on its free end, and a flexible nut within said top sub adapted to engage the aforesaid male threads when said mandrel is forced by longitudinal motion into its inner position whereby withdrawal of mandrel from its inner position is resisted by cooperation of flexible nut and threads but permitted by unscrewing said threads from said nut.

3. A pressure equalizing tool adapted for placing in a string of tubing for use in a well, which comprises a tubular body, a tubular mandrel slidably extending into said body and of sufficiently smaller external diameter than the smallest internal diameter of said body through which it moves axially as to allow annular clearance for fluid flow between mandrel and body to the exterior of said tool, means for biasing said mandrel toward an outermost position, means for limiting outward motion of said mandrel, at least one packing ring around the inner end of said mandrel maintaining a seal by sliding contact with the inner circumference of said body along a considerable length thereof, and a recess within the bottom portion of said body of greater longitudinal dimension than said packing ring whereby when said mandrel is forced into said body until said packing ring is opposite said recess fluid flow can occur from the inside of said mandrel and body through said recess and into the annular space between mandrel and body and thereby to the exterior of said tool.

4. A pressure equalizing tool adapted for placing in a string of tubing for use in a well, which comprises a tubular body, a tubular mandrel slidably extending into said body with annular clearance for fluid flow between mandrel and body to the exterior of said tool, an enlarged inner end of said mandrel having an outer circular shoulder, said body having an internal circular shoulder corresponding to and engaging with said mandrel shoulder to limit outward motion of said mandrel, clutch jaws associated with said shoulders permitting longitudinal engagement and disengagement thereof but preventing rotational movement between mandrel and body, means for biasing said mandrel toward an outermost position, sealing means forming a fluid tight seal between the inner end of said mandrel and the inner circumference of said body when said mandrel is in its outermost position, and a recess within the bottom portion of said body whereby when said mandrel is forced into said body said sealing means is inoperative permitting fluid flow from within said mandrel and body through said recess and into the annular space between the mandrel and body and thereby to the exterior of said tool.

5. A tool according to claim 4 including male threads on said mandrel near its free end, at least one drain port in said body between its internal shoulder and its end into which said mandrel extends, and a flexible nut within said body between said drain port and the last-mentioned end of said body adapted to engage the aforesaid male threads when said mandrel is forced by longitudinal motion into its inner position whereby withdrawal of mandrel from its inner position is resisted by cooperation of flexible nut and threads but permitted by unscrewing said threads from said nut.

6. A tool according to claim 1 including clutch jaws associated with said shoulders permitting longitudinal engagement and disengagement thereof but preventing rotational movement between mandrel and body.

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