

April 28, 1953

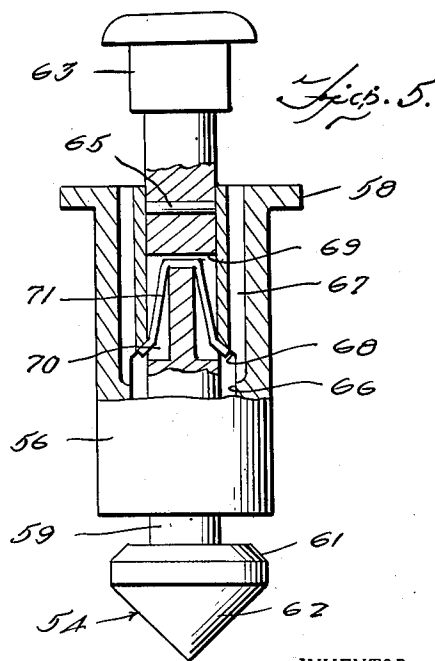
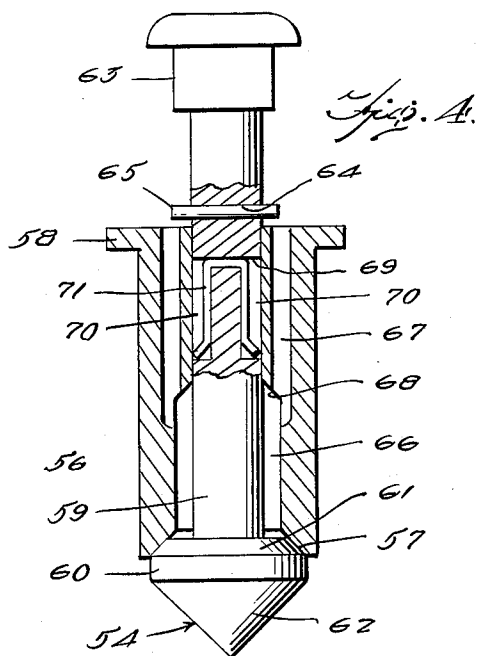
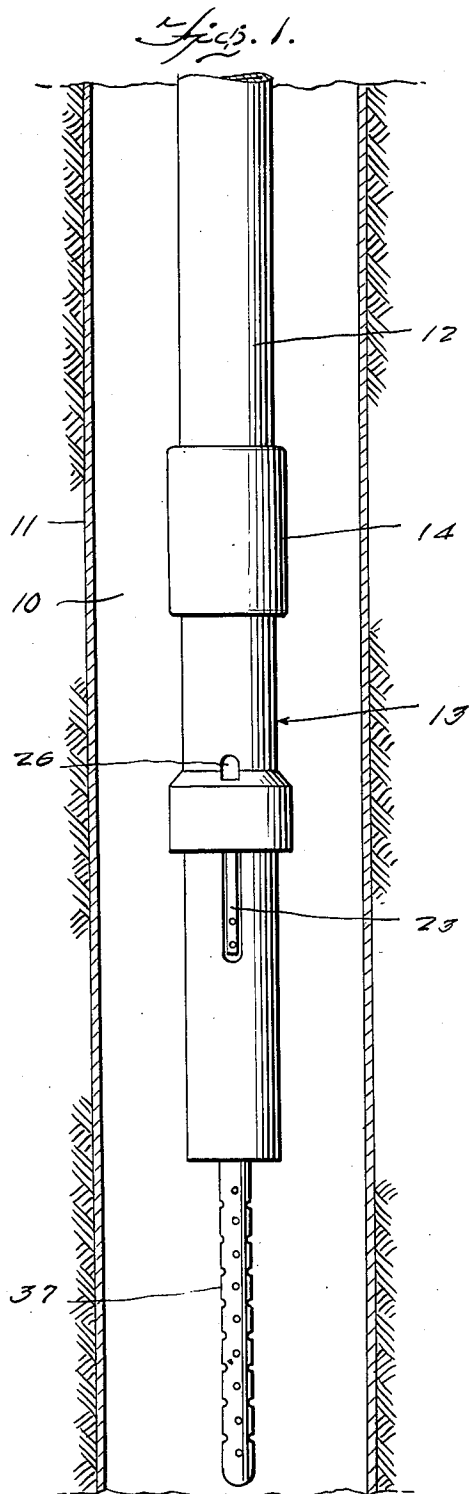
D. O. ROLLINS

2,636,563

OIL WELL FINISHING TOOL

Filed March 12, 1948

3 Sheets-Sheet 1



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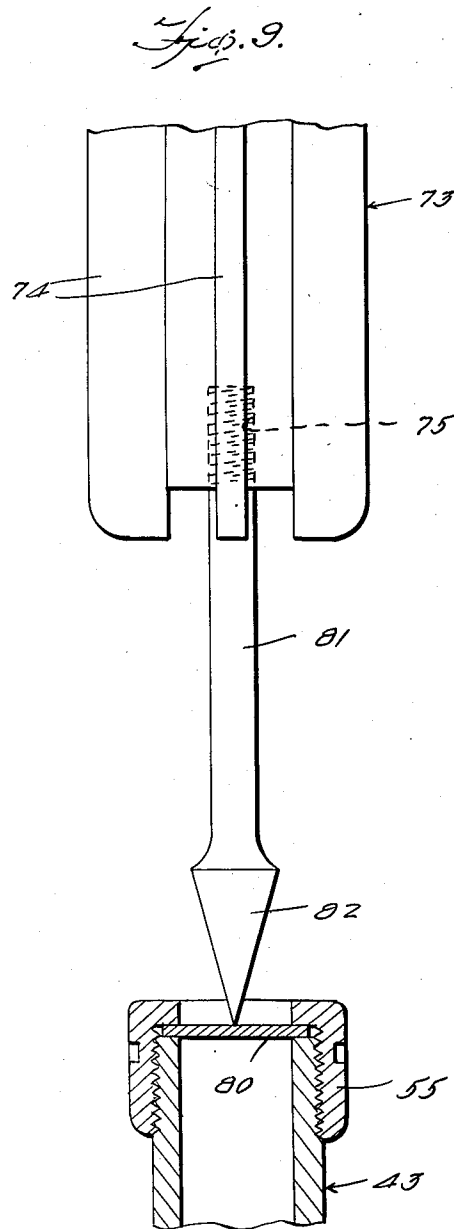
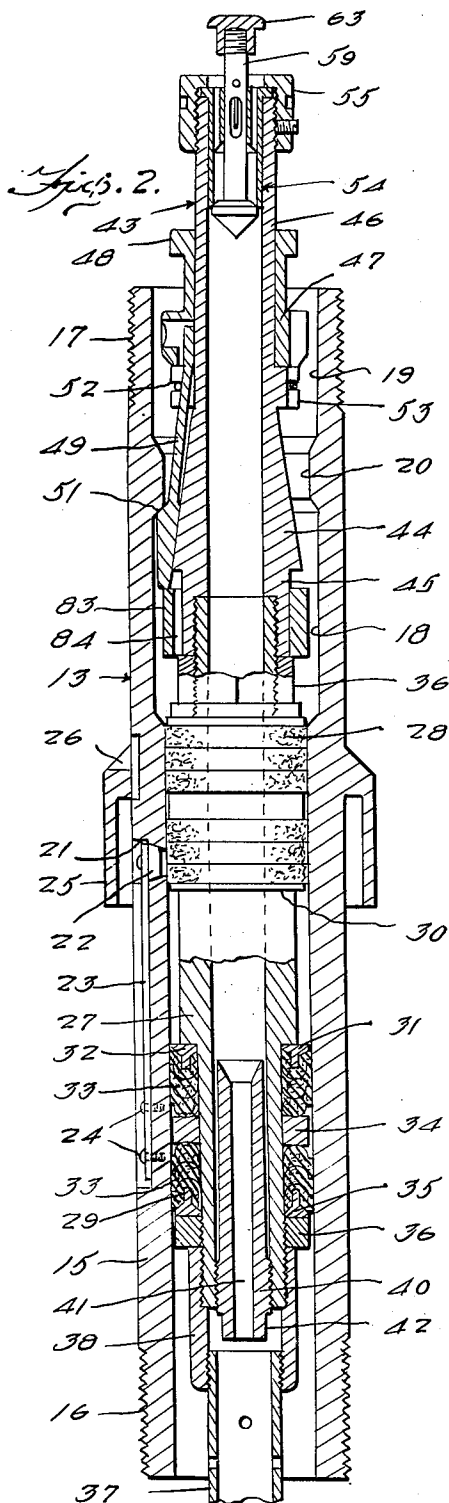
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3 Sheets-Sheet 2



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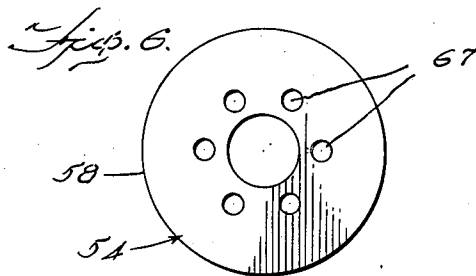
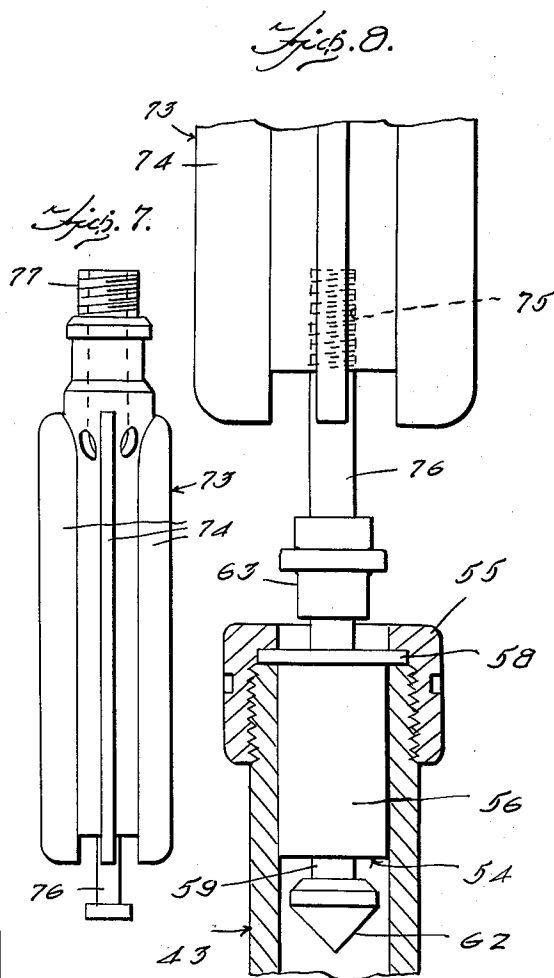
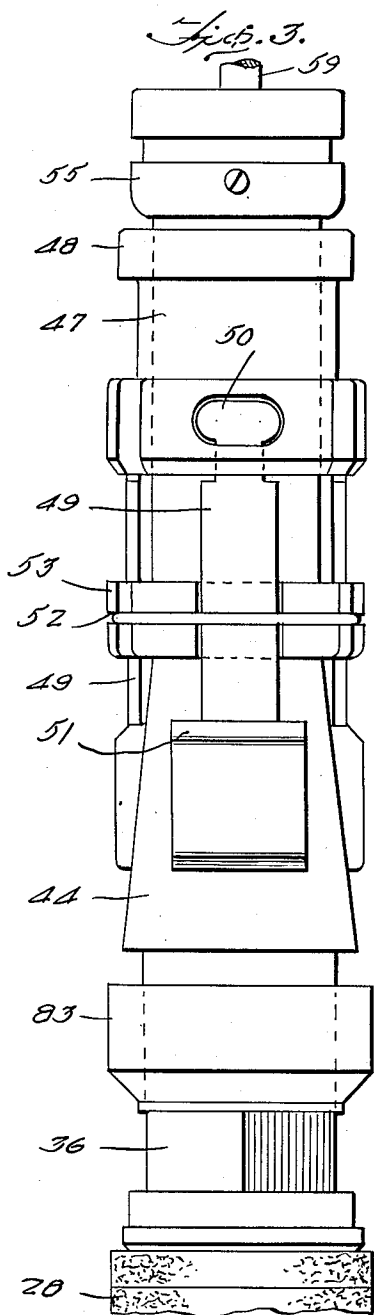
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UNITED STATES PATENT OFFICE

2,636,563

OIL WELL FINISHING TOOL

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Application March 12, 1948, Serial No. 14,422

4 Claims. (Cl. 166—2)

1

This invention relates to improvements in oil well finishing tools and more particularly to a choke and valve assembly adapted to be attached to the bottom end of a tubing string extended downwardly through a well to flow oil, sulphur, brine or other fluid mineral substance to the top of the well.

In the modern practice of drilling deep wells, such as oil and sulphur wells, the well bore or hole is maintained full of a fluid mud of very high specific gravity which replaces the material removed from the well bore and holds any soft formation against collapsing into the well bore and also maintains sufficient pressure on any gas, oil or other fluid mineral encountered to prevent such mineral from being forced to the surface, blowing out the well. Such deep wells are drilled by a rotary bit attached to the bottom end of a string of tubing sections collectively referred to as the drill stem and frequent tests are made by means of this string of hollow tubing to determine the nature of the formation encountered at different depths. Thus the depth below the surface of strata of oil bearing sands or other mineral deposits is accurately known. As the well is drilled a casing or liner is continuously positioned in the bore and this casing is lowered and the drilling operation carried on through the column of fluid mud in the well bore.

After the well has been drilled to the level of the major oil bearing sands or deposit of other fluid mineral the next step is to flow the well, that is allow the oil or other mineral to rise to the surface. In the past it has been necessary to swab the well, that is, remove the column of fluid mud from the well to permit the fluid mineral to rise. The present method of flowing does not necessarily require removal of all of the mud and involves lowering a string of open, flow tubing, usually with a restricted opening or choke in the bottom end, through the mud column to the level of the oil bearing sands or other mineral deposit and then pumping or "swabbing" the flow tubing to remove the mud therefrom and bring the petroleum or other mineral to the surface. This removal of the mud from the flow tubing is a laborious and time consuming operation and introduces a serious danger of the well blowing out as a portion of the mud column is removed.

It is among the objects of the present invention to provide an improved method of flowing wells which involves maintaining the bottom end of the string of flow tubing closed as the string is lowered through the mud column in the well bore, thus maintaining the flow tubing empty and

2

free of mud until it has been lowered to operative position at the producing level, and then opening the bottom end of the string to permit the immediate flow of mineral from the producing level, and to provide suitable apparatus for carrying out such method including a combined choke and valve assembly so arranged that the valve will remain closed while the tubing string is being lowered to operative position, and can be opened at any depth by a valve opener lowered from the surface, in which the valve and choke assembly is effective to prevent leakage of mud or other fluid into the tubing string before the valve is opened, can be arranged to provide for washing or acidifying the well by fluid forced into the flow tubing at the surface level, is bodily retrievable from the bottom of the flow tubing string when desired, provides for the use of chokes of different volumetric capacity and is simple, durable and economical in construction and easy to apply and operate.

Other objects and advantages will become apparent from a consideration of the following description and appended claims in conjunction with the accompanying drawings wherein:

Figure 1 is a diagrammatic elevation showing a choke and valve assembly, illustrative of the invention, in operative position on the bottom end of a string of flow tubing in a well bore;

Figure 2 is a longitudinal cross section of the choke and valve assembly;

Figure 3 is a longitudinal elevation of a fragmentary upper portion of the assembly showing a releasable assembly lock in a different operative position from that shown in Figure 2;

Figure 4 is a longitudinal cross section through the valve unit per se, showing the valve closed;

Figure 5 is a view similar to Figure 4 showing the valve open;

Figure 6 is a top plan view of the valve unit; Figure 7 is a longitudinal elevation of valve opener;

Figure 8 is a view illustrating the manner in which the valve opener opens the valves; and

Figure 9 is a view similar to Figure 8 showing a modified valve opener for opening a modified form of valve.

With continued reference to the drawings, there is illustrated in Figure 1 a well bore 10 having a casing or liner 11 and in which a column of fluid mud extends from the bottom substantially to the top of the bore. The bottom section of a string of flow tubing is fragmentally illustrated, as indicated at 12, and to the bottom end of the bottom section 12 of the flow tubing string there

3

is attached a choke and valve assembly illustrative of the invention and generally indicated at 13. The assembly 13 is conveniently attached to the bottom end of the tubing section 12 by a coupling sleeve 14 threaded onto external screw threads provided on the tubing section and the valve and choke unit adjacent their adjoining ends.

The choke and valve assembly is illustrated in detail in Figures 2 and 3 and comprises an elongated cylindrical casing 15 having external screw threads 16 and 17 at the lower and upper ends thereof, spaced apart internal cylindrical recesses 18 and 19 providing between them an annular internal shoulder 20, and three lateral ports 21 intermediate the length thereof. The cylindrical internal recess 19 opens to the upper end of the casing and the ports 21 are closed by respective valve plugs 22 mounted on the ends of respective leaf springs 23 positioned in longitudinal grooves provided in the outer surface of the casing and secured at their opposite ends to the casing by suitable fasteners such as the screws or rivets 24. An annular deflector 25 surrounds the ported portion of the casing circumspacially thereof and is secured at its upper end to the casing by suitable means such as welding, as indicated at 26.

An elongated tubular mandrel 27 is positioned in the casing 15 and is provided on the outer surface thereof with two spaced apart packing assemblies the upper of which is indicated at 28 and the lower at 29. The end portions of the mandrel are reduced to provide spaced apart annular shoulders 30 and 31 providing abutments for the lower end of the upper packing and the upper end of the lower packing respectively. Each packing comprises a ring 32 bearing against the corresponding shoulder, packing rings 33 of suitable flexible material, such as leather or rubber, separated by an annular separator 34 an end ring 35 corresponding to the ring 31 and opposed thereto, and a packing nut 36 threaded onto the corresponding screw threaded end portion of the mandrel. The packings 28 and 29 may be adjustably expanded by tightening the packing nuts 36 and provide a fluid tight seal between the mandrel 27 and the internal bore of the casing 15. An elongated, perforated nipple 37 is secured to the lower ends of the mandrel by a cylindrical coupling 38 threaded onto the externally screw-threaded upper end of the nipple and onto the externally screw threaded lower end of the mandrel upon which the packing nut 36 is also threaded. The lower end of the mandrel is also internally screw threaded and receives a choke tube or bean 40 which has an externally screw threaded portion threaded into the mandrel and a restricted bore 41 therethrough for limiting the flow of fluid mineral, such as petroleum, through the choke and valve assembly. The bottom end of the choke tube is bored or made otherwise non-circular to provide a wrench head 42 for threading the tube into and out of the mandrel. The choke tube is thus rendered interchangeable and a tube having a bore of any desired volumetric capacity within the operative limits of the apparatus can be used.

A tubular, locking slip mandrel, generally indicated at 43, is provided in its lower end with internal screw threads and is threaded onto the externally screw threaded upper end of the packing mandrel 27. This locking slip mandrel has, intermediate its length, an upwardly tapering conical portion 44, a cylindrical portion 45 at the

4

lower end of the conical portion and an elongated cylindrical portion 46 of a smaller outside diameter than the portion 45 above the conical portion 44. A locking slip carrier 47 in the form of an annular ring or sleeve is slidably mounted on the upper cylindrical portion 46 of the slip mandrel. This carrier has at its upper end an annular extension 48 providing a shoulder which may be engaged by a suitable fishing tool for extracting the mandrels from the casing 15 in case it is desired to retrieve the mandrels with the choke and valve from the bottom of the string of flow tubing in the well. At its lower end the carrier 47 is provided with another annular enlargement in the inner side of which are provided angularly spaced openings which receive the upper ends of locking slips 49. The locking slips 49 are pivotally secured in the carrier by knobs 50 on the upper ends of the locking slips seated in the openings in the carrier and the lower ends of the locking slips are enlarged and somewhat spade shaped and provided at their upper ends with inclined shoulders 51 which engage under the internal shoulder 20 of casing 15 to releasably lock the mandrels in operative position in the casing. A wire 52 extending around the locking slips and seated in notches provided in angularly spaced radial extensions 53 on the locking slip mandrel holds the locking slips in operative position on the slip mandrel.

In the arrangement illustrated, there are three locking slips having their center lines spaced at substantially equal angular intervals around the slip mandrel. When the assembled mandrels are in the position in the casing, illustrated in Figure 2, the locking slips are forced outwardly by the conical portion 44 of the slip mandrel to engage under the shoulder 20, but, when the mandrels are positioned further toward the bottom end of the casing and the carrier 47 is raised on the slip mandrel the lower ends of the slips are moved inwardly, as illustrated in Figure 3, out of engagement with the shoulder 20 so that the mandrels can be withdrawn from the casing.

In the form of the invention illustrated in Figures 2 and 3 a valve unit, generally indicated at 54, is secured in the upper ends of the locking slip mandrel 43 by an internally flanged nut 55 screw threaded onto the upper ends of the slip mandrels. This nut may be locked in position on the slip mandrel by a set screw extending through the wall of the nut.

The valve unit 54, as illustrated in detail in Figures 4 and 5, comprises a cylindrical valve body 56 having a bore of circular cross section therethrough, a bevelled valve seat 57 in its lower end and an outwardly extending annular flange 58 around its upper end which flange is engaged by the internal flange of nut 55 to secure the valve unit 54 in the slip mandrel, and a valve plunger 59 slidable in the bore of the housing. The plunger 59 has on its lower end a gate or piston 60 having a bevelled upper surface 61 adapted to engage the valve seat 57 and a conical lower end 62 for reducing the frictional resistance of fluid flow past the valve gate. At its upper end the plunger 57 is provided with a knob 63 and intermediate its length is a transverse aperture 64 adapted to receive a shear pin 65 which serves to maintain the valve in closed position, as illustrated in Figure 4. The lower end of the valve body bore is provided with a counter-bore 66 and annularly spaced fluid passages 67 lead from the upper end of this counterbore to the upper end surface of the valve body. The

5

counter bore provides at its upper end an annular shoulder 68 internally of the valve body and the stem 59 is provided below the transverse aperture 64 with a second transverse aperture 69 the ends of which open into downwardly extending diametrically opposed slots 70 in the valve stem. A U-shaped spring 71 having outwardly turned lower end portions is mounted in the stem 59 so that its bight portion is seated in the transverse apertures 69 and its legs are disposed in the longitudinal slots 70. When the valve stem is moved to valve opening position, as illustrated in Figure 5, the outwardly turned lower end portions of spring 71 engage under internal annular shoulder 68 to retain the valve in open position.

In using the improved choke and valve assembly, the assembly is attached to the bottom end of the first section of the flow tubing string at the upper end of the well by the coupling 14. The tubing section is then lowered into the well and additional sections consecutively added thereto until the choke and valve assembly is brought to the production level in the well, the valve unit 54 remaining closed while the flow tubing string is being lowered through the mud column in the well to exclude mud from the interior of the flow tubing. When the choke and valve assembly has been brought to the production level of the well and it is desired to open the valves a valve opener, generally indicated at 73, is lowered through the string of flow tubing to strike the knob 63 on the valve plunger forcing the plunger down and shearing the shear pin 65 to move the plunger from the valve closing position illustrated in Figure 4 to the open valve position illustrated in Figure 5.

This valve opener 73 is a body of metal having three angularly spaced, longitudinally extending blades or fins 74 joined at their inner edges to a central core. The lower end of this core is provided with a screw threaded well 75 into which is threaded the upper end of a valve operating pin 76 having a cylindrical shank and a cylindrical head on the bottom thereof somewhat larger than the shank. The upper end of the valve opener 73 is provided with a hollow, externally screw threaded cylindrical extension 77 engageable by a suitable wire supported tool to retrieve the valve opener from the flow tubing string when desired. It is not necessary for operativeness of the device however to retrieve the opener since the amount of fluid flowing through the choke tube 40 will easily flow through the spaces between the blades or fins 74 of the valve opener, and through ports between the blades lead into the hollow extension 77.

As illustrated in the modified form of the invention shown in Figure 9, the valve unit 54 may be substituted by a frangible disc 83 secured on the upper end of the locking slip mandrel 43 by the internally flanged nut 55. In this case the valve opening pin 73 is substituted by an elongated pin 81 having a substantially conical, pointed lower end 82 for rupturing the disc 80.

Any necessary amount of weight may be added to the valve opener to open the valve or rupture the frangible disc and as soon as the valve is opened or the disc broken the fluid mineral, such as petroleum, will flow into the perforated nipple 37, through the choke tube 49, the packing mandrel 47, and the locking slip mandrel 43 into the lower end of the bottom section of the string of flow tubing.

Under certain conditions it is desirable to force

6

fluid downwardly and through the flow tubing and into the space between the casing and the bottom end of the flow tubing to wash out or acidify the well, to dissolve precipitated matter, or force some or all of the material between the casing and the flow tubing string to the surface. This is accomplished with the device of the present invention by withdrawing the mandrel choke and valve assembly from the casing and upwardly through the flow tubing to the surface, removing the upper packing 28 and placing sleeve 83 in the location of the removed packing and then forcing the assembly back down through the flow tubing string to a position in which it is again locked in the casing 15. The sleeve 83, under these conditions, serves to center the mandrels in the casing 15 and is provided in its inner face with angularly spaced openings 84 which permit fluid such as water, acid or solvent to flow between this sleeve and the packing mandrel and into the space between this mandrel and the surface of the casing bore from which it flows through the ports 21 opening the spring closed valves 22. As the fluid flows through the ports 21 the annular deflector 25 directs the fluid downwardly to prevent damage to the well casing at this location.

Thus, with the device of the invention, the well may not only be flowed without removing the column of fluid mud from the well and without having to remove any mud from the interior of the flow tubing, but fluid, such as water, acid or solvent, may be forced to the production level of the well also without interference by the mud column in the well.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A valve and choke assembly for flowing wells comprising a cylindrical casing adapted to be connected at one end to the bottom end of a string of well flow tubing and having an annular internal shoulder adjacent said one end, a tubular packing mandrel slidably mounted in said casing and extending longitudinally thereof, a perforated nipple having a closed end and an open end secured at its open end to the end of said mandrel remote from said one end of the casing, a choke tube having a restricted bore therethrough threaded into the end of said mandrel to which said nipple is connected, a packing on said mandrel sealing the latter to the interior of said casing, a slip mandrel threaded at one end to the other end of said packing mandrel and having a conical surface intermediate its length tapering in a direction away from said packing mandrel, a slip carrier slidable on said slip mandrel, locking slips pivotally secured to said carrier and engageable with the shoulder in said casing by said conical surface to releasably lock said mandrels in said casing, a valve unit secured in the other end of said slip mandrel, and a flanged nut threaded onto the other end of said slip mandrel operatively securing said valve unit to said mandrel, said valve unit being adapted to be opened by a valve open-

7

er lowered through a string of flow tubing to which said assembly is attached and striking the upper end of said valve unit.

2. A valve assembly for flowing wells comprising a hollow casing attachable at one end to the bottom end of a string of well flow tubing, a tubular mandrel assembly slidable in said casing, and a valve unit carried by said mandrel assembly adjacent said one end of the casing and comprising a cylindrical housing received in said mandrel assembly at said one end thereof and having an internal fluid passage extending therethrough and a valve seat at the end thereof disposed inwardly of said mandrel assembly, a plunger slidable in said housing and extending longitudinally therethrough, said plunger having a valve gate on one end engageable with said valve seat to close said valve, a shear pin extending through said plunger and engageable with said valve housing to hold said valve plunger in valve closing position, said plunger being movable to valve opening position by a valve opener lowered through the flow tubing string to impinge the top end of said valve plunger, and means carried by said plunger and engageable with said housing to lock said plunger in valve opening position relative to said housing.

3. A valve and choke assembly for flowing wells comprising a tubular casing attachable at one end to the lower end of a string of well flow tubing, a tubular mandrel assembly slidably mounted in said casing, means releasably locking said mandrel assembly in operative position in said casing with one end of said assembly adjacent said one end of the casing and the other end of the mandrel assembly adjacent the other end of said casing, packing means between said mandrel assembly and said casing preventing the flow of fluid therebetween, a tubular choke secured in said mandrel assembly at said other end of the latter and having a restricted bore therethrough, a tubular valve housing secured in said mandrel assembly at said one end of the latter and having one end disposed inwardly of said mandrel assembly and provided with an annular valve seat, a valve plunger slidably mounted in said valve housing and extending longitudinally therethrough with one end extending outwardly of said one end of said mandrel assembly and

8

having on its other end a valve head engaging said annular valve seat to close the valve, means connected to said plunger and releasably engaging said housing and holding said valve in closed condition, said valve being opened by impingement of a valve opening weight on said one end of said valve plunger, and lock means connected to said valve plunger and engaging said valve housing when said valve is opened to maintain said valve in opened condition.

4. In combination with a tubular casing attachable at one end to the bottom end of a string of well flow tubing and a tubular mandrel assembly mounted in said casing and having one end adjacent said one end of said casing, a flow controlling valve comprising a tubular valve housing mounted in said mandrel assembly at said one end of the latter with one end disposed inwardly of said mandrel assembly and provided with an annular valve seat, a valve plunger extending slidably through said valve housing longitudinally thereof with one end extending beyond the other end of the latter for impingement by a valve opening weight and having on its other end a valve head engaging said valve seat to close the valve, means connected to said valve plunger and releasably engaging said housing and holding said valve in closed condition, and lock means carried by said plunger and engaging said housing when said valve is opened to retain said valve in open condition.

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