This invention relates to oil well tools, and particularly to an improvement in a formation testing tool of the character disclosed in the copending application of Jack A. Moosman entitled "Hydraulic Valve Device," filed February 3, 1953, and bearing Serial No. 354,889, both this application and said copending application being assigned to the same assignee.

The above identified copending application includes a packer adapted to be set in a well bore to separate the formation zone from the well fluid thereafter, valves for controlling upward flow of the connate fluid in the tool, and an equalizing valve to allow well fluid to bypass the packer and equalize the pressure above and below the packer before unseating the same. It has been found that in some instances the packer becomes stuck in the well bore and great difficulty is encountered in trying to remove the tool from the well bore, even after pressures have been equalized.

It is, therefore, the principal object of this invention to provide a formation testing tool of the type set forth above wherein an inwardly opening check valve is provided in the equalizing ports above the packer whereby fluid may be pumped down the tool and underneath the packer to aid in freeing the packer.

Various other objects of the instant invention will be apparent from the following description taken in connection with the accompanying drawings, wherein:

Figs. 1, 2 and 3 are longitudinal views partly in section of the upper, middle and lower portions, respectively, of a tool embodying the concepts of the present invention, showing the same in its running-in or coming-out condition.

Fig. 4 is a horizontal sectional view taken along line 4-4 of Fig. 2.

Referring to the accompanying drawings, wherein similar reference characters designate similar parts throughout, there is disclosed a tool embodying the concepts of the present invention including a composite tubular mandrel, generally indicated at 10, slidably received within a composite tubular housing, generally indicated at 11, said housing being connected at its lower end to a tool section 12 carrying a packer 13 and a perforated section 14 through which connate fluid may enter the tool. At its upper end the mandrel 10 has a sub 15 for attachment to the lower end of a string of pipe 16, by which the tool may be run into a well bore.

The housing 11 includes four tubular sections 17, 18, 19 and 20, reading from top to bottom, said sections being threadedly connected in end-to-end relation as shown, the lower section 20 having depending therefrom a sub 21 for attachment to the tool section 12. The mandrel 10 comprises three sections 22, 23 and 24 threadedly connected in end-to-end relation, the upper section being connected to the sub 15, previously mentioned. The top housing section 17 slideably receives the upper mandrel section 22 at its upper end and is non-rotatably connected to said mandrel section 22 by keyways 25 provided on said housing section slidably receiving keys 26 provided on the mandrel section 22.

A piston 27 is formed on the lower end of the mandrel section 22 and is slidably received within a liquid-filled cylinder 28 provided in the housing section 17. Appropriate sealing means 29 and 30 are provided on the piston 27 and are disposed in engaging engagement with the walls of the cylinder 28 and the exterior of the mandrel section 23, respectively. The liquid in the cylinder 28 is provided to be forced therefrom through a metering orifice arrangement 31 into a reservoir 32 provided in the housing section 18 upon downward movement of the mandrel 10 relative to the housing 11. The upper end of the housing section 18 slideably engages the mandrel section 23, and an O-ring seal 33 carried by the housing section 18 prevents leakage from the cylinder 28 into the reservoir 32 other than through the orifice arrangement 31. A floating piston 34 is slidably disposed within the reservoir 32 and sealingly engages the walls of the reservoir 32 by means of an O-ring seal 35 and the exterior of mandrel section 23 by means of an O-ring seal 36. The reservoir 32 communicates with the exterior of the housing 11 by means of ports 37 formed in the walls of the housing section 18.

It is apparent that the metering orifice arrangement 31 functions to retard downward telescopc movement of the mandrel 10 within the housing 11. An upwardly opening check valve arrangement 38 is provided in the upper end of the housing section 18 and communicates on its lower side with the reservoir 32 through a relatively large diameter passageway 38a and on its upper side with the cylinder 28 to allow ready upward movement of the mandrel 10 relative to the housing 11.

The lower end of the mandrel section 23 is slidably received in the upper end of the housing section 19 and there being an O-ring seal 39 on the housing section sealingly engaging said mandrel section 23. Connate fluid ports 40 are formed in the walls of the mandrel section 23, and are initially closed and covered by the opposing walls of the housing section 19. The housing section 19 carries a packing 41 which sealingly engages the mandrel section 24. A packing gland 42 threadedly received by the housing section 19 functions to retain the packing 41 in place. The packing gland 42 is centered and provided to receive a recess 43 within which the connate fluid ports 40 can be projecte and exposed. Longitudinal passages 45 are formed in the housing section 20 and communicate with the recess 43 at their upper ends and at their lower ends with the interior of the sub 21.

Equalizing ports 46 are formed in the walls of the mandrel section 24, and an annular recess 47 is formed in the housing section 20 initially surrounding said ports. The annular recess 47 communicates with the exterior of the housing 11 by means of passages or ports 48, see Fig. 4. Each of the ports 48 has an inwardly opening check valve assembly 49 mounted therein. The check valve assembly 49 comprises a spider 50 having an external flange 51 therein slidably received in a centered portion 52 of the port 48, and held therein by an annular nut 53 threaded into the outer end of said centered portion 52 and abutting the outer surface of the flange 51. The spider 50 has a plurality of passages 54 formed therein to permit fluid to pass therethrough. The inner end of the spider 50 is formed with an annular beveled seat 55 which is adapted to receive a complementary surface on the head 56 of a poppet type valve 57. The stem 58 of the valve 57 is slidably received in a central bore 59 in the spider 50. When fluid is passing inwardly through the valve assembly, the valve 57 is prevented from coming out of the spider 50 by the head 56 thereof abutting the outer surface of the mandrel section 24.

Sealing means 60 and 61 carried by the housing section 18.
2,760,582

3. 20 sealingly engage the mandrel section 23 above and below the equalizing ports 46, the latter sealing means 61 assuming the form of packing and being retained in place by a packing gland 62. It is apparent that the distance of downward movement of the mandrel 10 between the conneate fluid ports 40 and the mandrel equalizing ports 46. A spring 64 normally urges said valve upwardly toward its closed position.

The operation of the tool is as follows: With the elements of the tool in the positions shown in Figs. 1, 2 and 3, the tool is run into the well by being suspended from a string of pipe 16 and the packer 13 is set. As the weight of the string of pipe is partially imposed on the mandrel 10, the piston 27 is forced slowly downwardly, forcing the hydraulic fluid within the cylinder 28 through the metering orifice arrangement 31 into the reservoir 32. This action forces the piston 34 downwardly and the well fluid within the reservoir out through the ports 37.

As the mandrel 10 is moved downwardly, the equalizing ports 46 will first be closed, and thereafter, after considerable movement of the mandrel, the conneate fluid ports 40 will be brought into registry with and exposed within the recess 43. Consequently, conneate fluid may flow up through the perforated section 14, through the passages 45, into the recess 43, through the ports 40 and upwardly into the string of pipe 16.

After the sample has been taken, the string of pipe 16 may be pulled upwardly. This action draws the piston 27 upwardly, releasing the mandrel being readily permitted because the hydraulic fluid disposed in the reservoir 32 is allowed to freely pass upwardly through the large diametere passageway 38a and the check valve arrangement 38. Well fluid enters behind the piston 34 so that movement of said piston is not retarded. This upward movement functions first to cover the conneate fluid ports 40 and thereafter expose the equalizing ports 46 within the annular recess 47 to permit the fluid in the well bore to flow past the check valve assemblies 49 and pass downwardly through the tool to equalize the pressure above and below the packer 13. Fluid is then pumped downwardly through the well string 16 and the check valve 63. Since the fluid cannot pass outwardly through the ports 38 because of the check valve assemblies 49, the fluid flows outwardly through the perforated section 14 and applies pressure to the bottom of the packer 13 to aid in unseating the same. When the packer is unseated, upward movement of the tool is readily permitted because the well fluid above the packer can readily pass inwardly through the ports 48, the equalizing ports 46, and downwardly through the tool and out through the perforated section 14 to thereby bypass packer 13.

The present invention, a novel formation tool, has been provided whereby pressure may be pumped down through the well string to aid in unseating the packer.

While I have shown the preferred form of my invention, it is to be understood that various changes may be made in its construction by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a formation tester adapted to be lowered into a well bore on a string of well tubing, a housing, a packer on said housing adapted to be seated in the well bore, a plurality of lateral bypass ports in said housing above said packer, a mandrel slidably mounted in said housing in sealing engagement therewith above and below said bypass ports, a longitudinal passageway in said mandrel connected at its upper end with the interior of said well string and at its lower end with the interior of said housing below said packer, a plurality of bypass ports in said mandrel connecting said longitudinal passageway with the exterior of said mandrel, said mandrel bypass ports being adapted to be brought into register with said housing bypass ports by longitudinal movement of said mandrel relative to said housing, and an inwardly opening check valve in each of said housing bypass ports, whereby fluid is permitted to pass inwardly through said housing bypass ports and out the bottom of the tool to equalize the pressure above and below said packer, and whereby fluid may be pumped down through said string of well tubing and out of the bottom of said tool to apply pressure to the bottom of said packer to aid in unseating the same without passing outwardly through said housing bypass ports.

2. In a formation tester adapted to be lowered into a well bore on a string of well tubing, a housing, a packer on said housing adapted to be seated in the well bore, a plurality of lateral bypass ports in said housing above said packer, a mandrel slidably mounted in said housing in sealing engagement therewith above and below said bypass ports, a longitudinal passageway in said mandrel connected at its upper end with the interior of said well string and at its lower end with the interior of said housing below said packer, a plurality of bypass ports in said mandrel connecting said longitudinal passageway with the exterior of said mandrel, said mandrel bypass ports being adapted to be brought into register with said housing bypass ports by longitudinal movement of said mandrel relative to said housing, and an inwardly opening poppet type check valve in each of said housing bypass ports, whereby fluid is permitted to pass inwardly through said housing bypass ports and out the bottom of the tool to equalize the pressure above and below said packer, and whereby fluid may be pumped down through said string of well tubing and out of the bottom of said tool to apply pressure to the bottom of said packer to aid in unseating the same without passing outwardly through said housing bypass ports.

References Cited in the file of this patent

UNITED STATES PATENTS

1,905,208 1,980,219 2,073,107
Badgett .......... Apr. 25, 1933
Morris ............ Nov. 13, 1934
Johnston .......... Mar. 9, 1937