July 22, 1952 I. A. MILLER 2,604,169

WELL TREATING AND FLOW CONTROLLING DEVICE

Filed Feb. 7, 1948

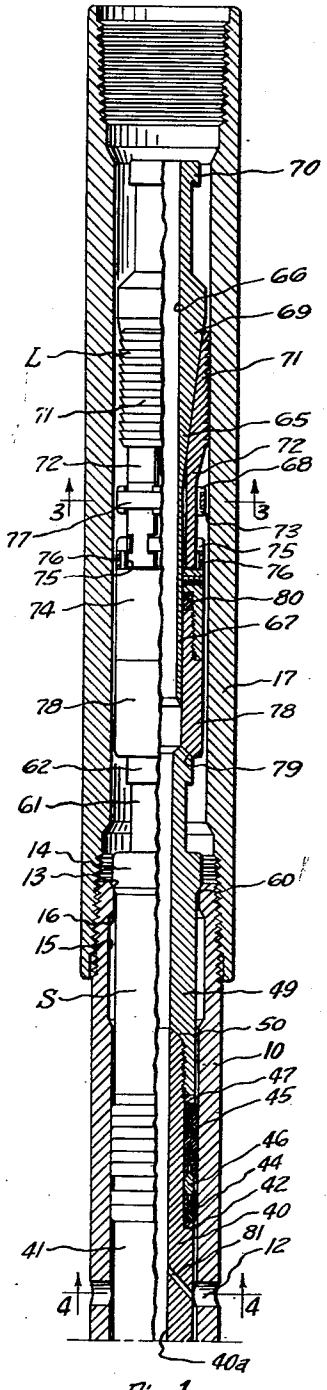



Fig. 1

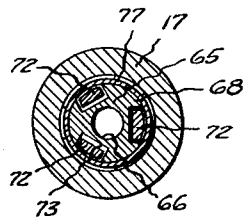



Fig. 3

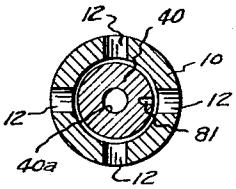



Fig. 4

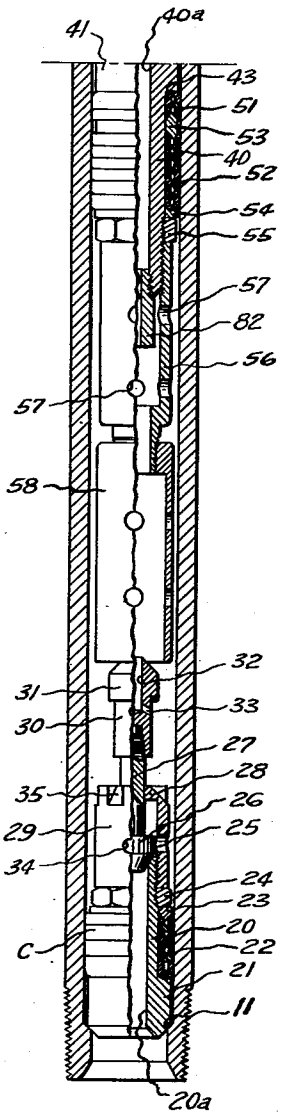



Fig. 2

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Patented July 22, 1952 2,604,169

# UNITED STATES PATENT OFFICE

2,604,169

## WELL TREATING AND FLOW CONTROLLING DEVICE

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Application February 7, 1948, Serial No. 6,936

8 Claims. (Cl. 166—2)

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This invention relates to new and useful improvements in well treating and flow controlling devices.

It is becoming more frequently customary, in modern oil and gas well production practice, to install packers between the well flow conductor or tubing and the bore of the well or the well casing. The packers are installed for the purpose of sealing off the high pressures of the producing formations of such wells to prevent the high fluid pressures from acting against the well surface connections in the annular space between the flow conductor and the well casing, and to prevent such high pressures from being impressed upon the long string of well casing to reduce the danger of leaks through such casing. It is also becoming a more common practice to provide loading fluids, such as columns of water, or "mud" or the like, in the annular space between the well tubing and casing and above the packers to counterbalance or exceed the upward force exerted against such packers by the high producing formation fluid pressures.

It sometimes becomes necessary or desirable, after the packer has been installed and the loading fluid inserted in the annular space thereabove, to establish circulation of fluids between the annular space and the bore of the well tubing for the purpose of removing the loading fluids, or for the purpose of permitting removal of the packer, or when it is desired to "kill" the well. Attempts have heretofore been made to utilize valve means, such as control head packers and the like, for establishing circulation of fluid between the annular space and the bore of the well tubing, but such valve means have very frequently proven unsatisfactory for many reasons, including the fact that the valves do not always positively close off and thus leak, the fact that the valves frequently cannot be reopened, the fact that the usual control head packer requires the use of heavy, expensive auxiliary hoisting equipment for manipulation or movement of the tubing to open the valve, the fact that some devices require such high pump pressure for operation as to create danger of rupturing the casing or collapsing the tubing, and for many other reasons. In such cases, well operators have resorted to perforating the tubing or flow conductor to establish circulation between the bore of the well conductor and the annular space between such conductor and the well casing. However, it is difficult in many instances to accurately locate the perforations, and it is often extremely difficult if not impossible to perforate

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the flow conductor, and in some wells it is difficult to perforate the flow conductor without perforating the casing and creating a dangerous condition.

It is, therefore, an important object of this invention to provide a novel well treating and flow controlling device which may be installed in a well flow conductor above a packer, and which is initially closed but which may be opened without manipulation of the tubing to establish circulation between the annular space exteriorly of the flow conductor above the packer and the bore of the flow conductor.

Another object of the invention is to provide a device of the character described including a housing adapted to be connected in a well flow conductor and having a lateral opening establishing communication between the interior and exterior of the housing, in combination with a removable closure for said lateral opening and means for releasably locking said closure in position in the housing, whereby flow from the annular space exteriorly of the housing into the bore of the housing through such lateral opening is completely prevented while the closure is in position in the housing, said closure being removable to establish communication between the bore of the housing and the annular space exteriorly thereof.

A further object of the invention is to provide, in a device of the character described, means for preventing fluids entering the housing through the lateral opening from flowing downwardly through the conductor to the producing formation therebelow, said means permitting upward flow of fluids from the producing formation through said housing.

Still another object of the invention is to provide a device of the character described wherein the closure means and the locking means are each removable from the housing upon an upward nonrotative movement, whereby said closure and locking means may be removed from the housing by means of a flexible line retrieving mechanism.

A particular object of the invention is to provide a well treating and flow controlling device of the character described wherein the upward force exerted upon the closure member by the pressure of the well fluid from the producing formation is transferred from the closure member to the locking means in such a manner that the locking action of said locking means is increased to positively prevent upward displace-

ment of said closure member and locking means from the housing.

A still further object of the invention is to provide a device of the character described which is so constructed and arranged that it may be utilized for controlling the flow of well fluids from the producing formations upwardly through the well flow conductor, or for controlling the admission of fluids from the annular space exteriorly of the housing through the lateral opening into the bore of the housing to provide for auxiliary lifting of fluids from the producing formation, or both.

Additional objects and advantages of the invention will readily be apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

Figure 1 is a view, partly in elevation and partly in section, of the upper portion of a device constructed in accordance with the invention,

Figure 2 is a similar view of the lower portion of the device,

Figures 3 and 4 are horizontal cross-sectional views taken on the line 3—3 and 4—4 of Figure 1.

In the drawings, the numeral 10 designates an elongate tubular housing or nipple having external screw threads at each end. At its lower end, the nipple is provided with an internal annular beveled seat 11 for receiving and supporting the beveled lower end of a check valve assembly C. The structure of the check valve will hereinafter be more fully explained.

Intermediate its ends, the housing or nipple 10 is provided with lateral openings or ports 12, which may vary in number from one to four or more. The ports extend substantially radially through the wall of the housing and provide for communication between the interior and exterior of the housing. An upwardly facing beveled annular seat or shoulder 13 is formed at the upper end of the interior bore wall of the housing, and this seat is adapted to receive and support a beveled flange 14 of a port closure or sealing means S which extends downwardly into the housing. The details of structure of the closure or sealing means S will also be hereinafter more fully explained.

An elongate internal annular locking recess 15 may be provided near the upper end of the bore of the housing, as clearly shown in Figure 1, such recess having a downwardly facing locking shoulder 16 at its upper end. The locking recess may be provided or omitted, as desired, and will permit the use of a flow control device of the character set forth in the patent to Herbert C. Otis, 2,246,811, issued June 24, 1941, whereby the flow control device may be locked in position in the housing.

An elongate thick-walled tubular housing or nipple extension 17, having internal screw threads at each end, is threaded onto the upper end of the housing 10 and forms an upward continuation thereof, as clearly shown in Figure 1. The housing extension is adapted to receive a locking mechanism L which engages the upper end of the closure or sealing member S to positively hold the same in position in the nipple 10.

The usual well tubing may be screw threaded into the internal threads at the upper end of the extension 17, and may be connected to the lower end of the housing 10 by means of the customary tubing collars, whereby the housing and extension may be connected in the well tubing string and lowered into the well bore.

The check valve C is preferably constructed or formed with a tubular body 20 having an external annular flange 21 at its lower end. The lower edge of the flange 21 is beveled to engage and seat upon the upwardly facing seat 11 at the lower end of the nipple or housing 10. A plurality of upwardly facing U-shaped sealing rings 22 are mounted on the body and abut against the upper shoulder of the flange 21, being confined on said body between said flange and an annular follower ring 23 which is held in place on the body by a packing nut 24 threaded onto the upper end of said body. The upper end of the bore 20a of the body is flared to provide a valve seat 25, and a valve head or plunger 26 is adapted to engage this seat to close the bore of the body. An upstanding stem 27 extends upwardly from the valve head 26 and is slidable through a guide collar 28 which is preferably formed integral with the upper end of a valve cage 29 which surrounds the valve head and is threaded onto the upper end of the tubular body. A retrieving head 30 is fastened to the upper projecting end of the valve stem 27 and is provided with an external annular undercut flange 31 adapted to be engaged by a suitable retrieving tool, whereby the check valve assembly may be removed from the housing. An axial opening 32 is formed in the upper end of the retrieving head and has a plurality of substantially radially extending ports 33 communicating therewith, whereby fluids may flow through the ports 33 into the opening 32 and upwardly therethrough, for a purpose which will be hereinafter explained. Flow openings 34 are provided in the side wall of the valve cage 29, whereby fluids flowing upwardly through the bore of the valve may pass outwardly through the openings into the bore of the housing 10 thereabove. Inclined flow courses 35 are formed in the upper end of the cage for permitting fluid passage under conditions which will be hereinafter further set forth.

It will be seen, therefore, that when the valve head 26 is in engagement with the seat 25 in the check valve body 20, fluid in the bore of the housing above the check valve will be prevented from flowing downwardly from the housing to the producing formation therebelow. However, well fluids from the producing formation below the housing may flow upwardly through the bore of the body 20 and lift the valve head 26 off the seat 25, whereupon such fluids will flow past the valve head and through the flow openings 34 and the cage 29 to the bore of the housing above the sealing rings 22 . Thus, the check valve assembly permits upward flow of fluids therepast, but prevents downward flow.

The closure or sealing member S includes an elongate tubular mandrel 40 having an external enlargement 41 located intermediate its ends and providing an upwardly facing shoulder 42 and a downwardly facing shoulder 43. A plurality of rings of upwardly facing U-shaped packing 44 surround the upper portion of the mandrel and abut against the undercut upwardly facing shoulder 42, and a plurality of oppositely facing U-shaped packing rings 45 similarly surround the upper end of the mandrel and are spaced above the packing rings 44 by a spacer ring 46. The packing rings are retained in position on the mandrel by a follower ring 47 which is confined against displacement from the mandrel by the lower end of a positioning head 49 which is threaded onto

the upper end of the mandrel 40 and engages the follower ring. Complementary bevels are formed on the upper end of the mandrel and in the bore of the positioning head to provide a fluid-tight sealing engagement at 50 between said mandrel and head.

A plurality of inverted U-shaped sealing rings 51 are mounted on the lower portion of the mandrel 40 and abut against the undercut downwardly facing shoulder 43 at the lower end of the enlarged central portion 41, and a plurality of upwardly facing U-shaped packing rings 52 likewise are mounted on the lower portion of the mandrel below the rings 51 and are separated therefrom by a spacer ring 53. The packing rings 51 and 52 are retained in position on the mandrel by a follower ring 54, similar to the follower ring 47, and a packing nut 55 which is threaded onto the lower end of said mandrel. A tubular cage or sleeve member 56 is also threaded onto the lower end of the mandrel and abuts against the nut 55 to lock the same in position on the mandrel. Flow openings 57 are provided in the cylindrical walls of the cage 56 for admitting fluids from exteriorly of the cage to the interior thereof.

An elongate cylindrical stop sleeve 58 is screw threaded onto the lower end of the cage 56 and extends therebelow. The extreme lower end of the stop sleeve is adapted to engage the upper end of the valve cage 29 to prevent the check valve C from flowing upwardly against the lower end of the bore 40*a* of the closure or sealing member S to plug and prevent fluid flow upwardly through the flow passage of the closure member. The length of the stop sleeve is sufficient to permit the valve head 26 to rise completely off the seat 25 of the check valve before the retrieving head 30 engages the lower end of the cage member 56. Thus, fluid may always flow upwardly through the check valve, past the valve head 26, and through the flow openings 33 and 32 in the retrieving head of the check valve assembly into the bore of the cage member 56, from whence the fluid will flow upwardly through the bore 40*a* of the tubular mandrel of the closure member.

The positioning head 49 is provided with an enlargement or external annular flange 14 near its upper end having its lower edge beveled to provide a seat 60 adapted to engage and seat upon the shoulder 13 formed at the upper end of the housing 10. A retrieving connection 61 formed on the upper end of the positioning head has an external undercut flange 62 which may be engaged by a suitable retrieving tool (not shown) of the character set forth in the patent to H. C. Otis, 1,898,261, issued February 21, 1933, whereby the closure or sealing member S may be lifted or pulled from its position within the housing 10.

When the seat 60 at the lower end of the flange 14 is in engagement with the shoulder 13 at the upper end of the housing 10, the enlarged central portion 41 of the mandrel 40 is positioned in substantial alignment with the lateral openings or ports 12 formed in the wall of the housing. Thus, the sealing rings 44 and 45 on the upper portion of the mandrel 40 are positioned above the lateral openings 12 and the sealing rings 51 and 52 on the lower portion of the mandrel are positioned below the lateral opening, and such rings seal between the exterior of the mandrel and the internal bore wall of the nipple or housing 10 to prevent fluids exteriorly of the housing from entering the housing through the openings 12 and admixing with the fluids from the producing horizon flowing upwardly through the housing and closure member. Similarly, fluids within the housing will be prevented from flowing outwardly therefrom through the openings 12 to the annular space exteriorly of the housing, whereby a complete separation of fluids exteriorly and interiorly of the housing is provided for.

The anchoring member L, provided for positively but releasably holding the closure or sealing member S in position in the nipple 10, includes an elongate tubular mandrel 65 having an axial bore 66. The lower portion 67 of the mandrel is substantially cylindrical and an external annular flange 68 is provided at the upper end of this cylindrical section. Immediately above the flange 68, the mandrel is flared outwardly and upwardly to form a slip expanding section 69. The upper portion of the mandrel is reduced in diameter and is provided at its upper end with an external annular undercut flange 70, which forms a retrieving connection adapted to be engaged by a suitable retrieving tool (not shown) whereby the anchoring mechanism L may be removed from the well tubing.

Gripping elements or slips 71, having gripping teeth or serrations on their outer surface, are slidable upon the flared or inclined portion 69 of the mandrel. Handles 72 depend from the slips and extend downwardly through slots 73 in the flange 68. The lower ends of the slip handles are substantially T-shaped and are loosely connected to a slip carrier or sleeve 74 by means of the engagement of such T-shaped lower ends of the handles in correspondingly T-shaped slots 75 provided in the upper portion of the slip carrier. The slip handles are restrained against outward displacement from the T-shaped slots in the slip carrier by a band 76 which surrounds said carrier and is secured in an annular groove formed in its outer surface. A similar band 77 prevents outward displacement of the slip handles from the slots 73 in the annular flange 68 on the mandrel.

The slip carrier is slidable on the lower cylindrical portion 67 of the mandrel and upward movement of the slips on the mandrel is limited by the engagement of the carrier with the flange 68. Downward movement of the slips is limited by engagement of the lower ends thereof with the upper surface of the flange 68.

A carrier extension or foot piece 78 is screw-threaded into the counter-bored lower end of the carrier 74 and extends downwardly below the lower end of the cylindrical portion 67 of the mandrel, whereby a beveled seat 79 formed in the lower end of the bore of the extension or foot piece may engage the beveled upper end of the flange 62 at the upper end of the closure member S, as clearly shown in Figure 1. A packing ring 80 is mounted in the counter-bore of the lower portion of the slip carrier 74 and is retained in place therein by the upper end of the extension member 78. The packing ring seals between the carrier and the exterior of the cylindrical portion of the mandrel to prevent fluid flow therebetween, whereby fluid is positively directed upwardly through the bore 66 of the mandrel.

With the foot piece 78 engaging the upper end of the closure S, in the manner shown in Figure 1, the mandrel 65 of the locking member L is forced downwardly between the slips 71 until the tapered or flared portion 69 of the mandrel positively forces the gripping teeth of the slips into tight gripping engagement with the wall of the housing extension 17. Further downward force applied to the mandrel will increase the gripping engagement of the slips with the bore wall of the

housing extension. It will be seen, therefore, that any upward force applied to the closure member S will be transmitted through the upper end thereof to the slip carrier foot piece 78, and from such foot piece through the slip carrier 74 to the slip handles 72 and the slips 71. Since the slips are in tight gripping engagement with the bore wall of the housing extension, upward displacement of the closure member will be prevented.

In order to assure that the upward pressure of fluids flowing through the housing will be applied to the closure member, rather than to the mandrel of the locking member L, the bore 40*a* of the closure member is preferably made smaller than the bore 66 of the locking member mandrel. Thus, the pressure differential resulting from restriction of flow is applied to the mandrel of the closure member, tending to force the closure member upwardly. Due to the engagement of the foot piece 78 of the slip carrier 74 of the locking member with the upper end of the closure member, the upward force applied to the closure member by the upwardly flowing well fluids will be transmitted through the slip carrier to the slips to prevent upward displacement of the closure member and locking member from their positions in the housing extensions.

Since the bore 66 of the mandrel 40 of the locking member is larger than the bore 40*a* of the closure member, there will be substantially no pressure reduction at the mandrel of the locking member. Therefore, the mandrel 65 of the locking member will remain in slip expanding position and the slips will be maintained in gripping engagement with the bore wall of the housing extension to positively prevent upward displacement of the closure member and locking member from their positions in the housing and extension, and the lateral openings 12 will remain closed to prevent fluid communication between the interior and exterior of the housing.

In many cases, the well treating and flow controlling device will be installed in the well with the check valve C, the closure member S, and the locking member L in position in the housing and extension. In such event, the parts are arranged in the manner illustrated in Figures 1 and 2 and the lower end of the housing is connected to the tubing string therebelow while the upper end of the extension is connected to the tubing string thereabove, and the tubing string with the device in place is then lowered into the well bore.

However, if desired, the housing 10 and the extension member 17 may be connected in the tubing string, in the manner already described, and lowered into the well bore prior to installation of the check valve, closure member and locking member. After the tubing has been positioned in the well, the check valve is lowered through the tubing into position in the housing engaging the seat 11 at the lower end thereof. The closure member S is next lowered through the tubing until the seat 60 engages the shoulder 13 at the upper end of the housing 10, and the locking member is then lowered through the tubing until the foot piece 78 engages the upper end of the closure member. Downward force applied to the mandrel 65 of the locking member will then spread the slips 71 into gripping engagement with the bore wall of the extension 17 to positively anchor the closure member S and locking member L in place in the housing and extension.

The most common location for the housing 10 is just above a packer (not shown) which is arranged to seal off the annular space between the tubing and casing above the producing formation. If loading fluid is present in the well bore when the tubing and packer are lowered thereinto, it is preferable that the closure member and locking mechanism be in place in the housing to close the lateral openings 12 therein and prevent intercommunication between the interior of the tubing and the exterior thereof. After the packer has been set, the loading fluid may be swabbed or flowed out of the bore of the tubing in the customary manner. Since the lateral openings 12 are closed, the loading fluid in the annular space between the tubing and casing above the packer will not be disturbed and will remain in such annular space to counter-balance the upward pressure of the fluids of the producing formation acting upwardly against the packer.

Should it subsequently become desirable or necessary to circulate the loading fluids from the annular space above the packer, to remove the packer, to kill the well, or for any other reason, a retrieving tool may be lowered through the well tubing to engage under the flange 70 at the upper end of the locking member mandrel, whereupon an upward pull applied to the mandrel will lift the same from between the slips 71 to permit retraction of said slips from gripping engagement. Upward movement of the mandrel with respect to the slips will continue until the slips engage the upper surface of the flange 68, whereupon the slips will be lifted with the mandrel and the slip carrier attached to said slips will likewise be lifted. The locking member L may then be lifted upwardly and removed from within the tubing. The retrieving tool may again be lowered through the tubing to engage under the flange 62 at the upper end of the closure member S, whereupon an upward pull applied by means of the retrieving tool will lift the closure member upwardly out of the housing 10 and extension 17, and the closure member may be removed from the tubing.

Removal of the closure member from within the housing will open the lateral ports 12 to permit flow of fluids from exteriorly of the housing into the bore thereof, or in the reverse direction, as desired. The loading fluids may then be circulated from the annular space in the customary manner by circulating fluids through the lateral ports 12.

The check valve C will prevent any downward flow of fluids therepast, whereby the fluid pressure required to circulate the loading fluids from within the annular space is not applied to the producing formation.

After the loading fluids have been circulated from the annular space, the closure member and locking member may be reinserted, if desired. Or, in some instances, it may be desired to remove the check valve from within the housing, this being accomplished by lowering a retrieving tool into the tubing to engage under the flange 31 at the upper end of the retrieving head 30 of the valve and lifting. The valve plunger 26 will thus be lifted into engagement with the collar 28 of the valve cage, whereupon continued lifting will remove the check valve from the housing.

In some instances, it may be desired to provide the closure means S with a flow restrictive orificed bean 82, which is threaded into the lower end of the bore of the mandrel 40, as shown in Figure 2. With the orificed flow restricting bean in such position in the mandrel, the volume or rate of

flow of fluids from the producing formation upwardly through the housing may be limited and controlled.

In other instances, it may be desirable to provide a small side flow opening or inlet 81 in the wall of the enlarged portion of the mandrel 40, as is shown in Figure 1. The flow inlet opening 81 would permit the introduction of extraneous fluid from exteriorly of the housing into the bore of the housing, and in the event the fluid is a lifting fluid, the flow opening would provide for controlled admission of the lifting fluid for aeration and lifting of the fluids from the producing formation, in the customary or well-known manner.

Obviously, the side opening 81 in the enlarged portion of the mandrel 40 may be used in combination with the flow restrictive bean 82, whereby the flow of fluids from the producing formation and through the lateral openings 12 may be simultaneously controlled. Manifestly, either the opening 81 or the flow restrictive bean 82, or both, may be omitted if desired.

From the foregoing, it will be seen that an improved novel well treating and flow controlling device has been provided which may be installed in a well flow conductor, and which is initially closed but which may be opened without manipulation of the tubing to establish circulation between the annular space exteriorly of the flow conductor and the bore of the flow conductor. It will also be seen that the device is particularly adapted for use in a well flow conductor above a packer for establishing communication between the annular space above the packer and the interior of the tubing to permit circulation of fluids therebetween for the purpose of equalizing pressures, circulating loading fluid from the annular space, opening the packer, removing the packer, and the like. Furthermore, it will be seen that the device provides for opening of the lateral ports in the housing without manipulation of the tubing, the closure means and locking member and check valve all being removable from the housing upon an upward non-rotative pull, whereby said check valve, closure, and locking member may be removed from the housing by means of a flexible line retrieving mechanism.

It is particularly to be noted that the device is so constructed and arranged that the pressure fluids in the tubing above the device may not flow downwardly past the check valve provided in the device. Furthermore, it is manifest that when the device is used in the well tubing above a packer, and the lateral openings are opened to establish communication between the annular space and the bore of the housing, the check valve will prevent the flow of fluids from the annular space downwardly through the housing to the formation below the packer, thus preventing contamination of the producing formation with the loading fluids, such as "mud" and the like.

It is particularly important to note that the device has been so constructed and arranged that the upward force exerted upon the closure member by the pressure of the well fluid from a producing formation is transferred from the closure member to the locking member in such a manner that the locking action of the locking member is not reduced, and may be increased, to positively prevent upward displacement of the closure member and locking member from the housing.

It will also be noted that a device has been provided which is so constructed and arranged that it may be utilized for controlling the flow of well fluids from the producing formation upwardly through the well flow conductor, or for controlling the admission of fluid from the annular space exteriorly of the housing through the lateral opening into the bore of the housing to provide for auxiliary lifting of fluids from the producing formation, or both simultaneously.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A well treating and flow controlling device including, a tubular housing adapted to be connected in a well flow conductor so as to form a part thereof and having a lateral flow port formed therein, a tubular closure member removably positioned in the housing and having stop means engageable with the housing to limit downward movement of the closure member with respect to said housing, sealing means carried externally by the closure member and engageable with the bore wall of the housing for sealing between the closure member and housing to prevent flow of fluid through the lateral flow opening in the housing, a tubular locking mandrel having expansible gripping means slidably mounted thereon and expansible into gripping position by a downwardly tapered expander section on the locking mandrel when said locking mandrel is moved downwardly with respect to said gripping means, and a foot piece connected with the gripping means and extending about and below the lower cylindrical portion of the locking mandrel and adapted to engage the upper end of the tubular closure member whereby said closure member is locked in place closing the lateral opening of the housing when the gripping means is expanded by the mandrel, said mandrel being movable upwardly to release the gripping means and permit the mandrel, gripping means, and foot piece to be removed independently of the closure member.

2. A well treating and flow controlling device including, an elongate tubular housing adapted to be connected in a well flow conductor and having a lateral flow opening formed therein, a tubular closure member removably mounted in the housing, stop means on the housing engaging the closure member for limiting downward movement of the closure member with respect to the housing, sealing means on the exterior of the closure member engageable with the bore wall of the housing for preventing passage of fluids exteriorly of the closure member from the lateral opening to the bore of the housing above and below the closure member, and a locking member comprising a tubular mandrel having a flow passage larger in cross-sectional area than the cross-sectional area of the bore of the tubular closure member, said mandrel having expansible and retractable locking means slidably mounted thereon and arranged to be expanded into gripping engagement with the bore wall of the housing by a downwardly tapered expander section on the mandrel when said mandrel is moved downwardly with respect to said locking means, and a foot piece connected with the locking means and extending below the mandrel and having a tubular lower end adapted to engage the upper end of the tubular closure member to limit downward movement of the locking means

and to permit the expander section of the mandrel to be moved downwardly with respect to the locking means to expand said locking means into gripping engagement with the bore wall of the housing, said mandrel having a lower cylindrical portion telescoping into the tubular portion of said foot piece and terminating short of the lower end thereof, the engagement of the foot piece with the closure member holding said closure member against upward displacement from the housing, said locking member being removable from the housing independently of the closure member upon an upward non-rotative pull applied to the mandrel to retract the expander section from expanding engagement with the locking means, whereby the closure member may be separately removed from the housing upon an upward non-rotative pull applied thereto.

3. A well treating and flow controlling device of the character described in claim 2 and including, valve means removably mounted in the housing below the closure member for preventing flow of fluids downwardly from the housing.

4. A well treating and flow controlling device including, a tubular housing adapted to be connected in a well flow conductor and having a lateral flow opening therein, a tubular member removably mounted within the housing, sealing means carried externally by said tubular member and sealing between said member and the bore wall of the housing for preventing flow of fluids exteriorly of said tubular member from the flow opening of the housing to the bore of the housing above and below said tubular member, stop means on the housing arranged to engage the tubular member to limit downward movement of said tubular member and position the sealing means in the housing in sealing position with respect to the lateral opening, and a locking member releasably anchored in the housing and comprising a tubular locking mandrel having a downwardly tapered expander section, expansible gripping means slidably mounted on the mandrel and expansible into gripping position by the expander section on the locking mandrel when said mandrel is moved downwardly with respect to said gripping means, and a tubular foot piece connected with the gripping means and extending about and below the lower end of the locking mandrel and having an annular engaging portion at its lower end for engaging the tubular member to prevent upward movement of the tubular member from within the housing, said locking mandrel having a flow passage larger in cross-sectional area than the cross-sectional area of the bore of the tubular member, whereby the fluid differential created by restriction of flow of fluids through the assembly is applied to said tubular member to tend to move said foot piece and locking means upwardly with respect to the locking mandrel to further expand said locking means.

5. A well treating and flow controlling device of the character set forth in claim 4 and including, flow restrictive means carried by the tubular member for restricting flow upwardly therethrough.

6. A well treating and flow controlling device of the character set forth in claim 4 and including, a flow restricting opening formed in the wall of the tubular member and establishing communication between the bore of said tubular member and the lateral flow opening of the housing, whereby fluids may flow from said lateral opening of the housing through said flow restricting opening in the tubular member to the bore of the tubular member and thence to the bore of the housing.

7. A well treating and flow controlling device of the character set forth in claim 4 wherein, the tubular member is provided with a lateral flow opening establishing communication between the bore of the tubular member and the lateral opening of the housing, and a flow restricting member is carried by said tubular member below the lateral flow opening therein for controlling flow of fluids upwardly through the bore of said tubular member.

8. A well treating and flow controlling device of the character set forth in claim 4 and including, a check valve removably mounted in the housing below the tubular member and independently of said tubular member for preventing flow of fluids downwardly from the bore of the housing.

IRA ARTHUR MILLER.

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