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ZONE SELECTOR FOR DUAL COMPLETION WELLS

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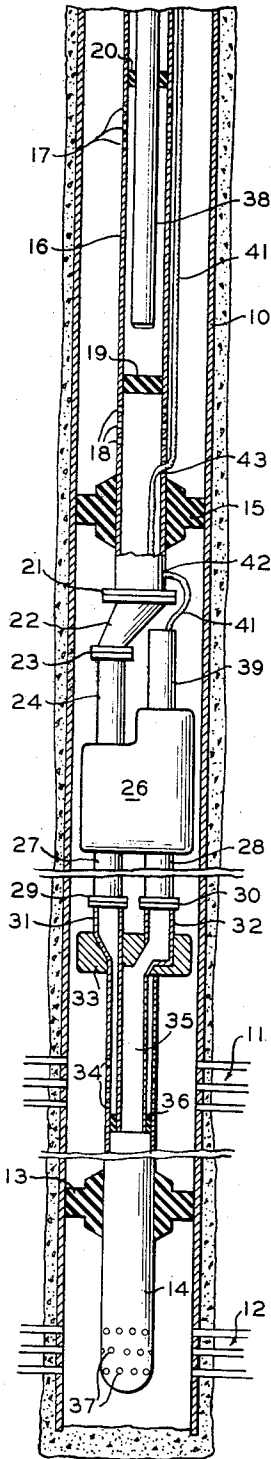


FIG. 1

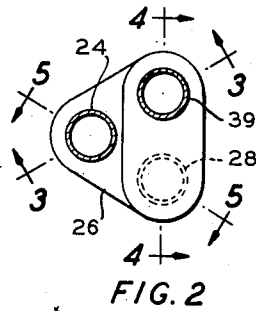


FIG. 2

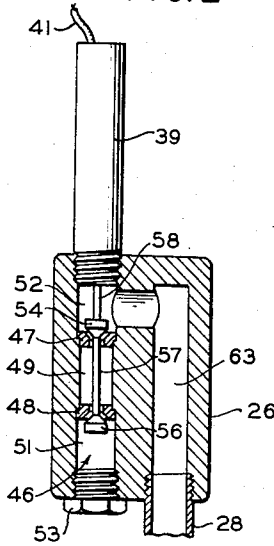


FIG. 3

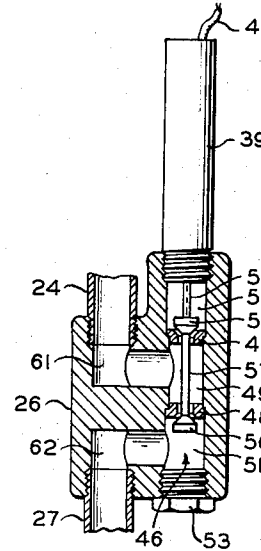


FIG. 4

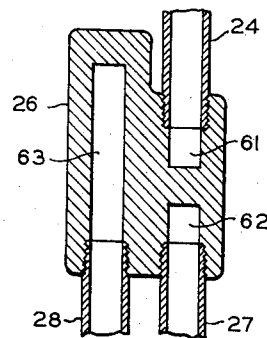


FIG. 5

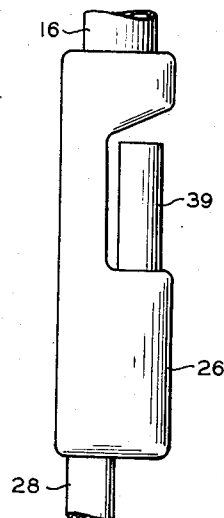


FIG. 6

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ZONE SELECTOR FOR DUAL COMPLETION WELLS

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This invention relates to apparatus for producing and controlling the flow of dual completion wells. A specific aspect of the invention pertains to a three-way valve for use in transferring fluid flow from one to the other of a pair of conduits and alternately connecting them to a third conduit, such as the production string in a well.

In the production of dual completion wells by artificial lift, bottom hole pumps provide a very effective lifting means. However, it is very difficult to provide two down-hole pumps in a single well, thus making it difficult to produce wells in which both zones require artificial lift. It has been suggested previously that a single pump can be used to produce both zones if suitable connections and valves are provided. In these prior suggestions, the operation of the downhole valves has been by mechanical means, such as rotating or raising and lowering the production tubing or sucker rods. To obviate the necessity for these mechanical manipulations of the well equipment, my invention provides an electrically operated three-way valve to switch production from one zone to the other.

The principal object of the invention is to provide an improved apparatus for controlling flow from dual production zones in a well. Another object is to provide an improved three-way valve for alternately connecting a single conduit on one side of the valve with one and the other of a pair of conduits on the other side of the valve for fluid flow either to or from the pair of conduits. Another object of the invention is to provide an improved apparatus for producing dual well completions. It is also an object of the invention to provide apparatus which simplifies the selection of upper and lower producing zones in a well which are pumped alternately with a single pump. Other objects of the invention will become apparent from a consideration of the accompanying disclosure.

The invention provides a simple three-way valve which can be readily operated with an electric motor operated valve operating mechanism or any suitable conventional reciprocating means. The valve connects the tubing or producing string of a well alternately with the conduit leading to the upper production zone and the conduit leading to the lower production zone so that the mere operation of a switch at the surface of the well shifts the production from one producing zone to the other as desired.

A more complete understanding of the invention may be had from a consideration of the drawing of which Figure 1 is a schematic cross-section of a well having the apparatus of the invention installed therein. Figure 2 is a plan view of the valve mechanism, while Figures 3, 4, and 5 are vertical cross-sections of the valve mechanism taken along the lines 3—3, 4—4, and 5—5, respectively. Figure 6 is an elevation of another embodiment of the valve mechanism.

Referring to Figure 1, the well equipment comprises a well casing 10 provided with perforations 11, opposite an upper producing formation, and perforations 12, opposite a lower producing formation. A lower packer 13 is attached to the wall of the casing and provides a seal with

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lower tubing 14, in order to separate the upper and lower producing zones. An upper packer 15 is an ordinary hook well packer attached to the tubing string 16 and providing a seal with the wall of casing 10. Tubing string 16 is provided with perforations 17 and 18, a plug 19, intermediate the perforated sections in said tubing string, and a pump seating nipple or hold-down 20. Tubing 16 is provided with a flanged union 21 which provides a means of attachment to an adapter 22 which in turn connects by means of flanged coupling 23 to a conduit 24 connecting directly with valve casing or housing 26 by means of screw threads or other suitable attaching means. Adapter 22 provides for offset from tubing 16 to the valve case opening for pipe 24. Tubing nipples 27 and 28 are attached to the valve housing 26 by means of screw threads or other suitable connecting means and are provided with flanged unions 29 and 30 for attachment to tubing nipples 31 and 32 which are threaded into a change-over device 33. Lower tubing 14 is provided with perforations 34 positioned intermediate packers 13 and 15 and is attached to the lower portion of change-over 33. Inner tubing 35 is attached to change-over 33 and is provided with a seal 36 with tubing 14 at a point intermediate perforations 34 and perforations 37 in the lower end of tubing 14. It should be noticed that the upper end of tubing nipples 27 and 28 will be slightly offset from the lower ends since their openings in the lower portion of valve housing 26 are not in the center of the well bore. Generally, however, these tubing nipples are long enough to allow this much misalignment. If an installation is made in which cross-over 33 and valve assembly 26 must be close together, it may be desirable to provide special offset fittings. A pump 38 is provided in the tubing 16 just above plug 19 and is utilized to lift a fluid through tubing 16 to the surface of the well. Electrically operated valve operating mechanism 39 screws into the valve housing and connects with the valve stem of the valve as shown in Figures 3 and 4. An insulated cable 41 connects with the electric motor of device 39 and passes to an electric power source at the surface of the well. This cable passes into conduit 16 through a sealed opening 42 and out again through opening 43 above packer 15 and continues to the surface of the well in the annular space surrounding tubing 16. Grounding of the other contact of the electric motor with the well tubing provides a complete circuit for the electric motor of the valve operating mechanism.

Referring to Figure 2, the relative positions of conduits 24, 27, and 28 and valve operating mechanism 39 can be seen. (Corresponding elements of all of the figures are correspondingly numbered.) These conduits and the valve operating mechanism are shown in generally triangular arrangement with respect to each other. This arrangement is desirable in order to obtain compactness in the unit which renders the device adaptable to the relatively narrow space in a well tubing, however, these conduits and this device may be arranged in another pattern and even in a straight line where space permits. It is essential that conduit 28 lies outside of conduits 24 and 27, and the latter conduits may be coaxial but this is not essential.

Figure 3, which is a cross-section of the valve mechanism taken on the line 3—3 of Figure 2, shows the detail of the schematic arrangement of the parts of the valve. The valve housing 26 is traversed by a vertical valve chamber 46 having positioned therein valve seats 47 and 48 in suitable spaced apart relation which divide the valve chamber into an intermediate section 49, a lower section 51, and an upper section 52. The lower end of the valve chamber is closed by a screw plug 53. Valve heads 54 and 56 are connected by a valve stem 57 which is of greater length than the distance between the valve

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seats so that as one valve head is seated the other valve head is in the open position. Of course, it should be understood that both valve seats may be reversed so that the valve heads 54 and 56 are positioned intermediate the valve seats; and valve stem 57 will then be shorter than the distance between the valve seats so that the seating of either valve leaves the other valve in the open position. Valve stem 57 is connected by a connecting rod 58 to the reciprocating member of valve operating device 39.

Intermediate valve chamber 49 is connected by means of L-shaped conduit or passageway 61 with pipe 24. The lower valve chamber 51 is connected by L-shaped conduit or passageway 62 to pipe 27. Conduits 61 and 62 provide a passageway through the valve chamber when valve head 56 is off the seat, thereby allowing passage of fluid between conduits 27 and 24.

In Figure 4, which shows a cross-section of the valve assembly taken on the line 4—4 of Figure 2, an L-shaped conduit 63 through the valve housing connects conduit 28 with upper valve chamber 52. When valve stem 57 is in the uppermost position valve head 54 is off seat 47 and fluid is free to pass from conduit 28 to intermediate valve chamber 49 and thence to conduit 24. Each of the aforesaid L-shaped conduits has a vertical leg section and a horizontal foot section.

Figure 5 provides a cross-sectional view of the valve assembly 26 taken on line 5—5 of Figure 2 and is self-explanatory.

Figure 6 is an elevation of another embodiment of valve assembly 26 shown in relation to conduit 16 and 28. The structure of this valve assembly is similar to that shown in Figures 1-5, inclusive, the principal distinction being in the extension of the valve housing upwardly to tubing 16. The upper section of the housing provides a curved conduit or passageway (not shown) which serves the purpose of connecting L-shaped conduit or passageway 61 of Figure 3 with tubing 16. An advantage in this structure lies in the fact that tubing 16 screws directly into the upper end of the valve housing and eliminates adapter 22 and the short connecting tubing or pipe 24; and also the valve operating mechanism 39 is in a more protected position.

In the embodiments of the valve assembly shown in the drawing, the valve housing encloses conduits 61, 62, and 63 connecting with the various sections of the valve chamber. While this structure is preferred, it is also feasible to utilize a generally cylindrical valve housing enclosing the valve chambers, seats and heads and to utilize separate L-shaped conduits or tubing screwed into the generally cylindrical valve housing to connect with the three different valve chambers and provide passageways from conduits 27 and 28 through the valve to conduit 24. When the valve of the invention is utilized within an oil well casing it is particularly desirable to construct the valve with as short a distance as possible between the axis of the valves proper, conduits 24 and 27, and conduit 28 in order to conserve space in the casing.

It is also feasible to position valve stem 57 together with its two valve heads and seats in a horizontal position and operate the valve stem by means of a suitable connection with a vertical operating mechanism, such as device 39. This may be done with a system of gears or levers. However, the arrangement shown in the drawing is more practical and is preferred.

In operation of the apparatus, when it is desired to pump the lower zone, valve operating device 39 is actuated by operation of a switch at the surface to bring valve head 56 onto seat 48 and move valve head 54 off seat 47 by upward movement of valve stem 57. This provides a passageway from conduit 28 to conduit 24 via L-shaped conduit 63, valve chambers 52 and 49, and L-shaped conduit 61 so as to permit flow of fluid through perforations 37 up lower tubing 14, conduit 35, crossover 33,

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and tubing nipple 32 to conduit 28. The flow is continued through valve 47 and into tubing 16. Fluid then passes through perforations 18 into the annulus between tubing 16 and casing 10 from which it passes back into tubing 16 through perforations 17 above packer 19. Pump 38 then moves the fluid from tubing 16 to the surface.

Similarly, when it is desired to pump the upper zone, the action of operating device 39 is reversed and valve stem 57 is reversed so as to seat head 54 and unseat head 56, thereby opening flow through the lower valve from conduit 27 to conduit 24 and thence to tubing 16. This permits flow of fluid from the upper production zone through perforations 11 and 34 into the annulus between lower tubing 14 and inner tubing 35 from which the flow is through crossover 33, pipe nipple 31, and conduit 27 to valve 26.

While the valve assembly of the invention is particularly adapted to dual production wells, it is also useful in other applications where alternate flow from or to a pair of conduits to or from a single conduit is desired. The operation of valve 26 may be effected to advantage by the electric motor-operated valve operating mechanism but the invention is not limited to operation of this valve by this means, since it may be operated by any suitable reciprocating actuator which can be utilized to periodically reverse the valve positions.

Certain modifications of the invention will become apparent to those skilled in the art and the illustrative details disclosed are not to be construed as imposing unnecessary limitations on the invention.

I claim:

1. In combination with a well having an upper and a lower producing zone; a casing and a tubing in said well; a first packer between said casing and said tubing above the upper producing zone; an L-shaped conduit connected to said tubing below said packer and having a generally horizontal foot section; a pair of reciprocating valves in ports in opposite walls of said foot section, the valve heads of said valves being connected by a common valve stem of such a length that when either valve is closed the other is in the open position to provide alternate fluid flow therethru; means for operating said valves; a dual production change-over device having an axial conduit communicating thru one of said valves with said L-shaped conduit and a concentric outer conduit communicating thru the other of said valves with said L-shaped conduit, said axial and concentric conduits being in communication with the producing zones so as to provide alternate flow from said zones into said tubing through said valves as said valve stem is reciprocated.

2. The apparatus of claim 1 including a packer between said tubing and casing intermediate said producing zones and below said L-section; means for passing fluid from said upper production zone into said outer conduit intermediate said packers; and means for passing fluid from said lower production zone into said axial conduit.

3. The apparatus of claim 1 wherein said means for operating said valves comprises an electric motor-driven valve-operating mechanism connected with said valve stem.

4. The apparatus of claim 1 including a pump in said tubing above said packer; a plug in said tubing intermediate said pump and said packer; perforations in said tubing intermediate said packer and said plug; a seal between said pump and said tubing above said last-named perforations; and perforations in said tubing intermediate said plug and said seal.

5. Apparatus comprising in combination in a well a well tubing; a pair of vertical conduits directly below said tubing; and a valved conduit separately connecting the upper end of each conduit of said pair of conduits with the lower end of said tubing, the valves of said conduit being reciprocating valves having a common valve stem of such a length that when one valve is open the other is closed

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so as to provide for alternate flow of fluid from said pair of conduits to said tubing.

6. A three-way valve comprising a valve body of generally triangular horizontal cross-section; a vertical valve chamber adjacent a first apex of said body; a pair of spaced-apart valve seats in said valve chamber providing an upper chamber above the upper valve seat, a lower chamber below the lower valve seat, and an intermediate chamber between said valve seats; a first L-shaped chamber in said body extending from said intermediate chamber to a second apex of said body and upwardly through the top thereof; a second L-shaped chamber in said body extending from said lower chamber to said second apex of said body and downwardly through the bottom thereof, said first and second L-shaped chambers providing separate and distinct passageways; a third L-shaped chamber in said body extending from said upper chamber to a third apex of said body and downwardly through the bottom thereof; a pair of valve heads spaced apart on a valve stem extending between said valve seats, said stem being of such a length that when one valve head is seated the other is open and vice versa; and means for reciprocating said valve stem.

7. A three-way valve comprising a valve body; a vertical valve chamber in said body having an upper and a lower valve seat therein dividing said chamber into an upper chamber, an intermediate chamber, and a lower chamber; a pair of valve heads spaced apart on a valve stem extending between said valve seats, said stem being of such a length that when one valve head is seated the other is open; a first L-shaped conduit extending laterally and upwardly from said intermediate chamber, being adapted to connect with a conduit extending downwardly thereto; a second L-shaped conduit extending laterally and downwardly from said lower chamber, being adapted to connect with a conduit extending upwardly thereto, and a third L-shaped conduit extending laterally and downwardly from said upper chamber, being adapted to connect with a separate conduit extending upwardly thereto.

8. In combination, the valve of claim 7; a well tubing connected with said first conduit; conduit means connecting said second conduit with a first producing zone in a well; another conduit means connecting said third conduit with a second producing zone in said well.

9. In combination with a well having an upper and a lower producing zone, a casing and a tubing in said well; a first packer between said casing and said tubing above the upper producing zone; an L-shaped conduit connected to said tubing below said packer having a generally horizontal foot section; a pair of reciprocating valves in parts in opposite walls of said foot section, the valve heads of said valves being connected by a common valve stem of such a length that when either valve is closed the other is in the open position; means for operating said valves; a dual production change-over device having a first conduit connected thru one of said valves with said L-shaped conduit and a second conduit connected thru the other of said valves with said L-shaped conduit, said first and second conduits being in separate communication with the producing zones so as to provide alternate flow

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from said zones into said tubing through said valves as said valve stem is reciprocated.

10. In combination with a well having an upper and a lower producing zone; a casing and a tubing in said well; a first packer between said casing and said tubing above the upper producing zone; an L-shaped conduit connected to said tubing below said packer having a generally horizontal foot section; a pair of reciprocating valves in ports in opposite walls of said foot section, the valve heads of said valves being connected by a common valve stem of such a length that when either valve is closed the other is in the open position; means for operating said valves; a dual production change-over device having a first conduit communicating thru one of said valves with said tubing and a second conduit communicating thru the other of said valves with said tubing, said first conduit being in communication with one of the producing zones and said second conduit being in communication with the other producing zone so as to provide alternate flow from said zones into said tubing through said valves as said valve stem is reciprocated.

11. Apparatus comprising a valve body having an upright L-shaped conduit therein communicating at its upper end with a well tubing, its other end communicating thru a first port with a first conduit leading to a port in the lower side of said body and thru a second port with a second conduit leading to a separate port in the lower side of said body; a first valve head in said first port and a second valve head in said second port connected by a common valve stem of such a length that when one of said valve heads is in closed position the other is in open position, being adapted to provide alternate flow first from one of the ports in the lower side of said body, then from the other, to said well tubing; and means for operating said valve stem.

12. The apparatus of claim 11 including a subjacent pair of conduits connecting with the ports in the lower side of said body.

13. The apparatus of claim 11 wherein said means comprises an electric motor-driven valve-operating mechanism.

14. The apparatus of claim 11 including a dual production changeover device having an axial conduit connected with one of the ports in the lower side of said body and a concentric outer conduit connected with the other port in the lower side of said body.

15. The apparatus of claim 14 wherein said first and second ports are in the upper and lower walls, respectively, of the foot portion of said L-shaped conduit so as to position said valve stem vertically, and said axial conduit connects with the upper valve.

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