Aug. 25, 1953 C. C. BROWN 2,649,916

WELL PACKER

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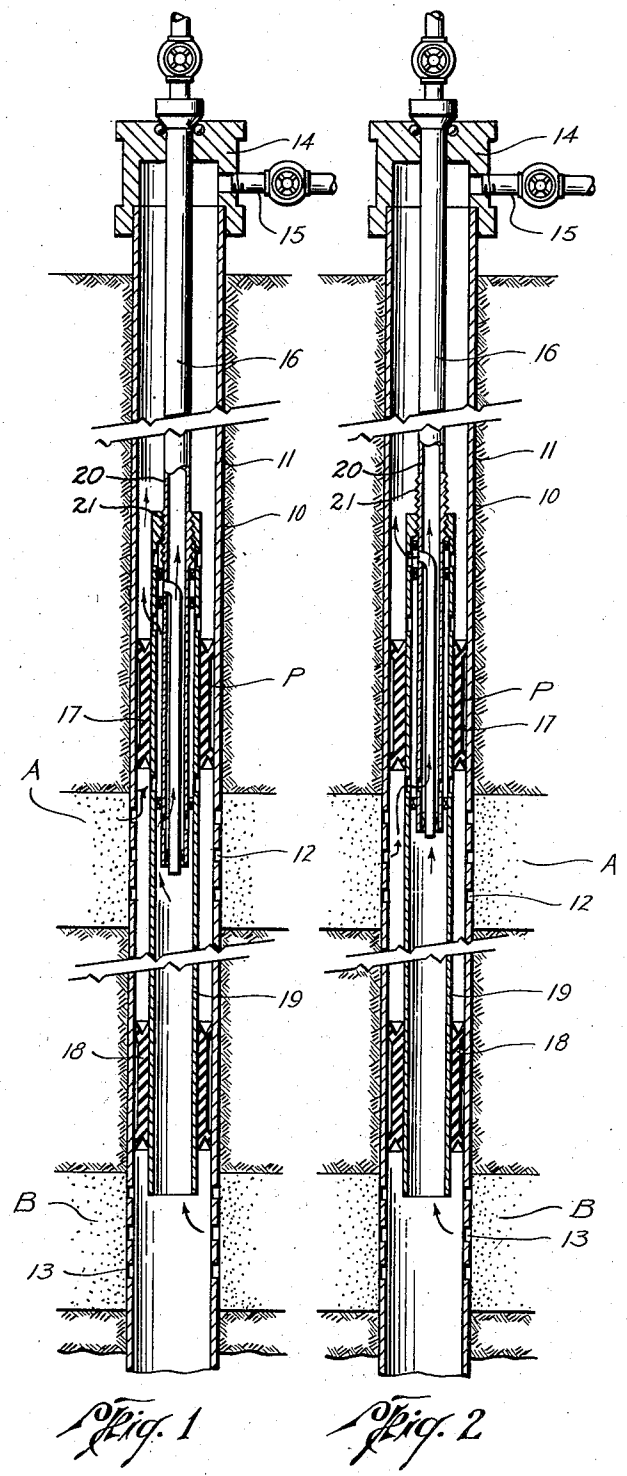


Fig. 1

Fig. 2

Fig. 5

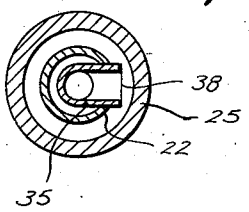
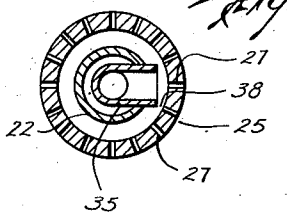


Fig. 6



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Filed Sept. 24, 1951 4 Sheets-Sheet 2

Fig. 3

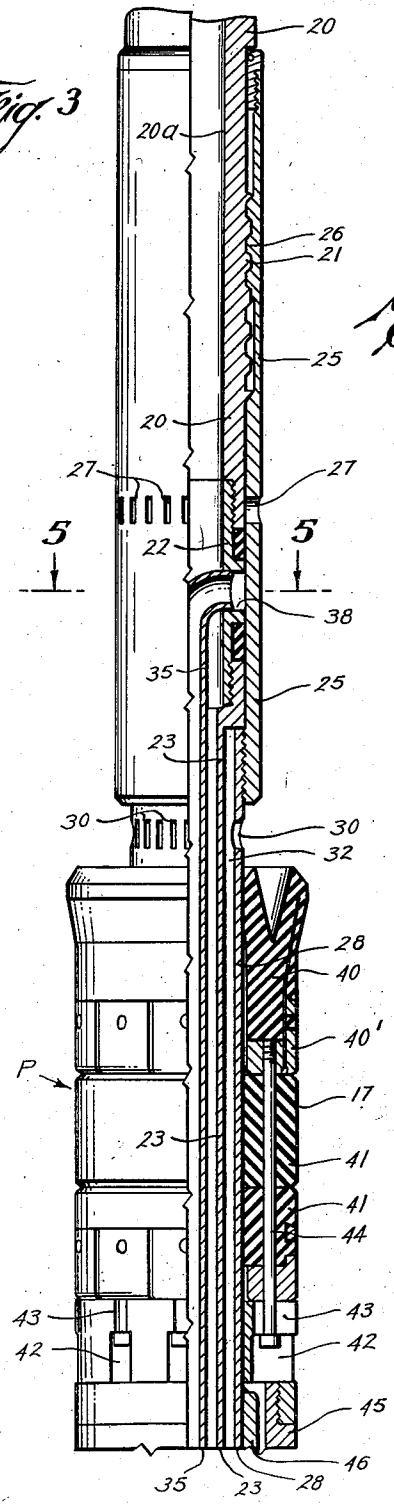
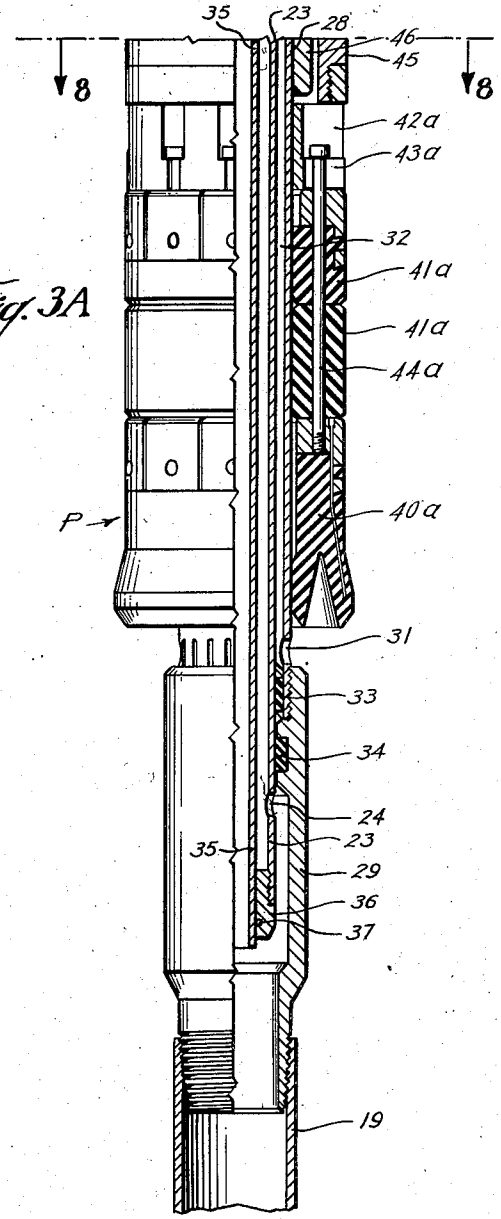


Fig. 3A



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Filed Sept. 24, 1951 4 Sheets-Sheet 3

Fig. 4

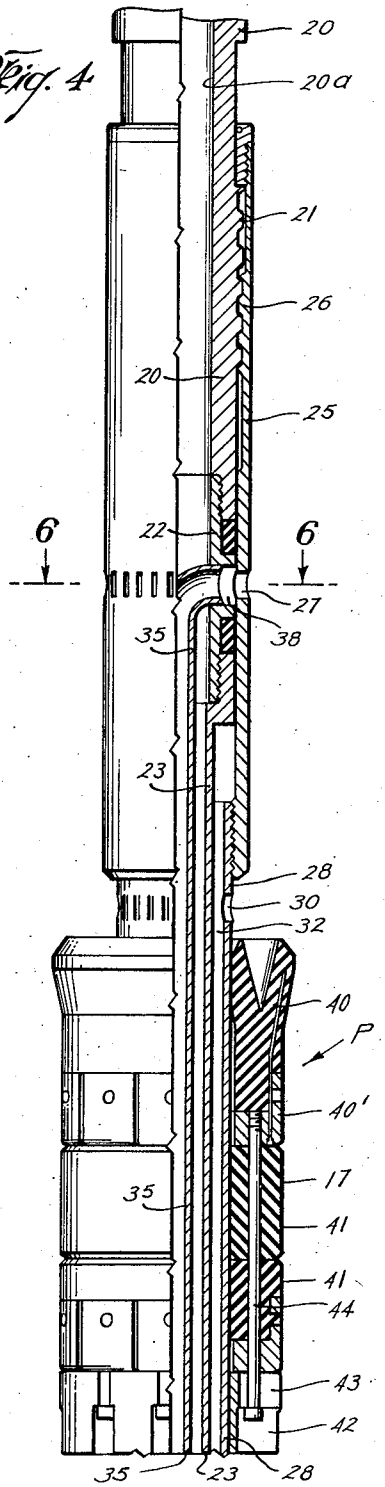
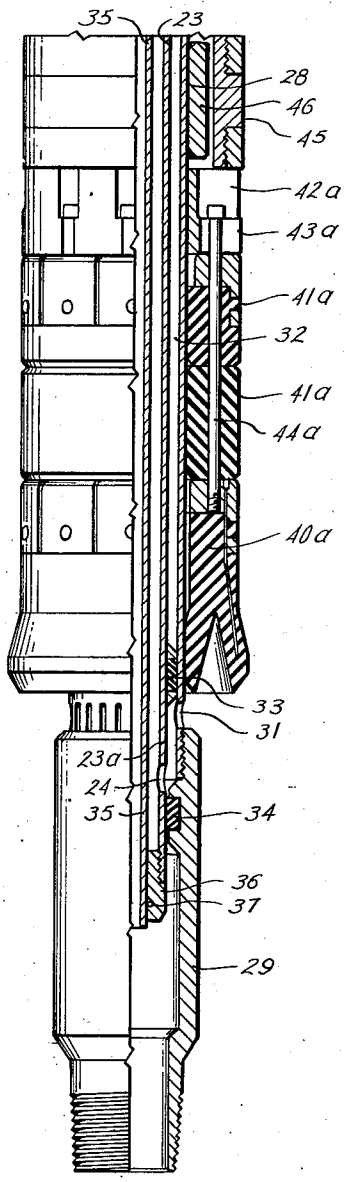


Fig. 4A



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Filed Sept. 24, 1951 4 Sheets-Sheet 4

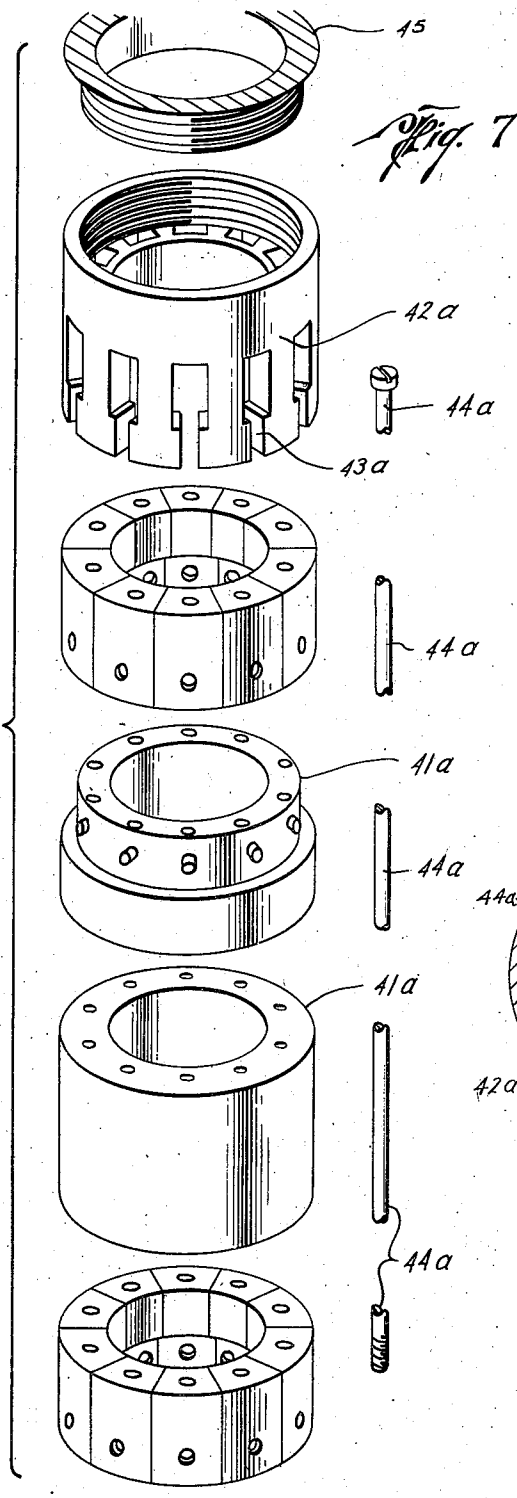

Fig. 7

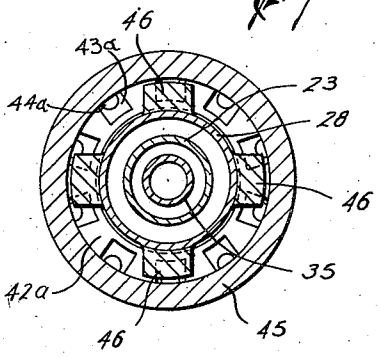

Fig. 8

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Patented Aug. 25, 1953

2,649,916

UNITED STATES PATENT OFFICE

2,649,916

WELL PACKER

Cicero C. Brown, Houston, Tex.

Application September 24, 1951, Serial No. 248,071

14 Claims. (Cl. 166—11)

1

This invention relates to new and useful improvements in well packers.

One object of the invention is to provide an improved well packer which is particularly adapted for use in dual production wells and which is constructed so that production from two different producing zones may be conducted to the surface simultaneously through the usual well casing and well tubing.

Another object is to provide an improved dual production packer which is so arranged that production from either zone may be selectively directed either through the well casing or the well tubing, whereby the tubing may be utilized as the flow conductor for either zone as conditions may require.

Another object is to provide a well packer of the character described wherein communication between the well tubing may be selectively established with either of the producing zones whereby one zone may be acidized and brought in through the tubing, after which flow from that zone may be directed to the casing so that the tubing may be thereafter utilized to acidize and bring in the second zone.

A further object is to provide a well packer of the cross-over type which may be actuated at any time to produce either zone through the tubing or through the casing as desired or as dictated by well conditions.

A still further object is to provide a well packer of the cross-over type which is actuated by rotation of the tubing string, with the actuation of the device shifting the positions of various flow ports to direct flow from the producing zones in a desired manner.

The construction designed to carry out the invention will be hereinafter described together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is a vertical sectional view of a well packer constructed in accordance with the invention and illustrating the same disposed within a well bore with the device in a position directing flow from the upper zone through the well casing and flow from the lower zone through the well tubing,

Figure 2 is a view similar to Figure 1 with the well packer actuated to direct flow from the upper zone through the tubing and to direct flow from the lower zone through the well casing,

2

Figure 3 is an enlarged view partly in section and partly in elevation of the upper portion of the well packer with its parts in the position of Figure 1,

Figure 3A is a continuation of Figure 3 showing the lower portion of the packer,

Figure 4 is a view similar to Figure 3 but showing the parts of the well packer shifted as illustrated in Figure 2,

Figure 4A is a continuation of Figure 4 showing the lower portion of the device,

Figure 5 is a horizontal cross-sectional view taken on the line 5—5 of Figure 3, and

Figure 6 is a horizontal cross-sectional view taken on the line 6—6 of Figure 4.

Figure 7 is an exploded view illustrating the particular construction of substantially the lower half of the packer assembly.

Figure 8 is a horizontal sectional view taken on line 8—8 of Figure 3A.

In the drawings the numeral 10 designates a well bore which traverses an upper producing formation A and a lower producing formation B. The usual well casing 11 extends through the well bore and has perforations or inlets 12 opposite the formation A with similar provisions or inlets 13 opposite the formation B. A casing head 14 is mounted on the upper end of the casing and has a valved flow line outlet 15 extending therefrom.

The usual well tubing 16 extends axially within the casing 11 and has its upper end projecting through the casing head. As schematically shown, the tubing 16 is mounted for rotation within the casing head 14 and the particular swivel mounting may be of any desired construction. The improved well packer apparatus generally indicated at P is mounted on the tubing string 16, as will be explained and is adapted to be set within the well casing 11. The well packer apparatus includes a packing assembly 17 which is located above the upper producing formation A so as to seal off the annulus between the tubing and casing at a point above said formation. A well packer 18 of any desired construction is adapted to be set within the well casing 11 at a point between the producing formations A and B and is arranged to segregate the well fluids produced from said formations. The packer 18 is of a type which will permit a central pipe or conductor to slide therethrough.

With the packing assembly 17 and the packer 18 set within the well casing in the manner illustrated in Figures 1 and 2, the well fluids from the upper formation A may flow through the inlets 12 into the space between the packers. Flow

from the lower formation B is through the inlets 13 and into the lower end of a tail pipe or conductor 19 which extends axially through the lower packer 18 and which is secured to the apparatus P as will be hereinafter described. By means of the apparatus P the flow from the space between packers 17 and 18 may be directed through the apparatus and then upwardly through the well casing to the surface; at such time the flow of fluids from the lower formation will pass upwardly through the apparatus P and upwardly through the tubing. Upon actuation of the apparatus P flow from the upper formation A may be upwardly through the tubing with flow from the lower formation B being upwardly through the casing.

The construction of the well packer apparatus P is clearly illustrated in Figures 3 and 3A and referring to Figure 3, the well tubing 16 (Figure 1) is connected to or formed integral with a tubular actuator 20, which actuator is formed with coarse external threads 21 on its outer surface. The bore 20a of the actuator is in direct communication with the bore of the tubing. The lower end of the tubular actuator 20 is connected to a coupling 22, which coupling has its lower end connected with an inner pipe 23. This inner pipe extends axially through the entire apparatus P and has an inlet port 24 formed in its lower portion (Figure 3A). An actuating sleeve 25 surrounds the actuator 20 and has coarse internal threads 26 which engage the threads 21 of the actuator. It is preferable that the threads 21 and 26 be left hand threads. As will be explained, when the actuator is rotated with respect to the sleeve 25, the coaction between threads 21 and 26 will cause longitudinal movement of the sleeve relative to the actuator and to the tubing as well as with respect to the inner pipe 23.

The actuating sleeve 25 is provided with a plurality of cross-over slots or openings 27 which are disposed at a point intermediate the ends of the sleeve and below the threads 26. The lower end of the sleeve 25 is coupled to an elongate tubular mandrel 28 which surrounds the inner pipe 23 and which provides a support for the packing assembly 17. The mandrel 28 has its lower end terminating short of the lower end of the inner pipe 23 and has a coupling 29 threaded onto this lower end. This coupling has its lower end secured to the tail pipe 19 which extends downwardly through the lower packer 18 which is mounted within the well casing 11. The mandrel 28 has a plurality of by-pass openings or slots 30 in its upper end just below its connection with the sleeve 25 and has similar by-pass openings or slots 31 in its lower portion adjacent the coupling 29. It will be evident that flow entering the openings 31 may pass upwardly through the annular space 32 formed between the mandrel 28 and the pipe 23 and may then flow outwardly through the openings 30 at the upper end of the mandrel, thereby by-passing the packing assembly 17.

Communication between the openings 31 and the annular space 32 is adapted to be shut off by means of an annular packing 33 which is mounted on the exterior of the inner pipe 23 (Figures 3A and 4A) when the mandrel is moved downwardly relative to the pipe. When the packing 33 is above the openings 31 flow cannot pass from the openings 31 into the annular space 32 between the mandrel and pipe. Instead, the port 24 in the lower end of the inner pipe 23 is

moved into a position above an annular packing 34 mounted in the coupling 29 so that communication is established between the openings 31 and the ports 24, whereby flow may enter the bore 23a of the inner pipe 23. Since this inner pipe is connected through the coupling 22 with the actuator 20, which actuator is, in turn, connected directly to the tubing 16, the flow through ports 31 is thus directed upwardly through the tubing. It will thus be seen that when the apparatus is in the position of Figure 3A flow from the upper producing zone A is through ports 31, upwardly through the annular passage 32, ports 30 and into the casing above the packing assembly 17.

At this time flow from the formation B is upwardly through the tail pipe 19 into the coupling and then through ports 24 into the inner pipe from where it passes upwardly through the tubing. Upon a shifting of the mandrel downwardly with respect to the inner pipe, the parts move to the position of Figure 4A, whereby flow through the ports 31, which is from the upper formation A, is to the ports 24 and upwardly through the tubing. At this time since the ports 24 in the inner pipe have moved above the packing 34, the flow from the lower producing formation which is passing upwardly through the tail pipe cannot enter the inner pipe 23.

For the purpose of crossing over the flow from the lower formation B through the packing apparatus and into the well casing above the packing assembly, an axial tube or conductor 35 is disposed within the inner pipe. This tube has an open lower end and extends through a collar 36 which is threaded into the lower end of the inner pipe 23; a suitable O-ring packing 37 seals off between the tube or conductor and the collar. The upper end of the tube or conductor 35 is curved radially outwardly and is connected in a radial opening 38 which is formed in the coupling 22 which couples the actuator 20 to the inner pipe 23. When the mandrel 28 has been shifted downwardly with respect to the inner pipe to establish communication between the openings 31 in the mandrel and the ports 24 in the pipe, as heretofore explained and as shown in Figure 4A, the radial opening 38 in which the upper end of the tube 35 is connected is aligned with the cross-over ports 27 which are formed in the actuating sleeve 25 (Figure 4). Thus, the flow from formation B is upwardly through the conductor or tube 35 and then outwardly through the cross-over ports 27 into the well casing above the packing assembly 17. It is, of course, obvious that when the mandrel 28 is in the position with respect to the inner pipe 23 as shown in Figure 3A, the radial opening 38 in which the conductor or tube 35 is connected, is below or misaligned with the cross-over ports 27 (Figure 3), whereby upward flow through the cross-over tube or conductor 35 cannot occur.

The packing assembly 17 is subject to variation and as shown includes an upper packing cup 40 which surrounds the mandrel 28. A pair of annular packing elements 41 are disposed below the packing cup 40 and are supported upon a retaining ring 42. The retaining ring is provided with radial slots 43 and headed bolts 44 pass through the slots and have their upper ends secured into the segmental base members 40' of the upper packing cup. The retaining ring 42 is connected through a coupling collar 45 with the retaining ring 42a of a lower packing unit. This lower unit is constructed in an identical manner to the upper

unit, including annular packing elements 41*a* and a packing cup 40*a* having its sealing lips downwardly directed. Bolts 44*a* extend between the retaining ring 42*a* and the lower sealing cup 40*a* being movable within slots 43*a* in the retaining ring.

The packing assembly 17 is confined against displacement from the tubular mandrel 28 by a plurality of ribs 46 which are disposed within the bore of the connecting collar 45 and which are adapted to abut the ends of the retaining rings 42 and 42*a* of the upper and lower packing units of the assembly. The packing units are so constructed that the pressure differential across the assembly is depended upon to set the packer and manipulation of the mandrel to effect setting is not necessary. It is evident that the pressure from above acting upon the upper packing cup 40 will urge the same downwardly, while pressure from below acting against the lower packing cup 40*a* will urge the latter upwardly. The pressures thus acting upon the cups 40 and 40*a* will result in axial force being applied to the annular packing elements 41 and 41*a* to distort the same outwardly into sealing position with the well casing.

In the operation the apparatus is assembled as illustrated in Figure 3, and is lowered into the well casing and located therein as shown in Figure 1. The fluid pressures acting upon the cups 40 and 40*a* of the packing assembly 17 will set or radically expand same to seal off the annulus between the tubing and the casing. The tail pipe 19 which is connected to the lower end of the apparatus extends through the lower packer 18 which is constructed and operates in the same manner as packer 17.

For purposes of illustration it will be assumed that neither of the zones have been acidized to bring in the production and thus, with the parts in the position shown in Figures 1, 3 and 3A, the lower zone B is in communication with the well tubing 16, such communication being established through the inner pipe 23 and the ports 24 thereof. An acidizing operation may be carried out through the well tubing, through the inner pipe 23, and through the tail pipe 19 to the lower zone, whereby this zone of production may be brought in. When flow of well fluids from zone B begins, the tubing 16 may be rotated with respect to the actuating sleeve 25, the latter being held against rotation because it is connected to the mandrel 28 on which the packing assembly is mounted. The frictional engagement of the sealing cups 40 and 40*a* with the casing 10 and the mandrel 28 prevent rotation of the mandrel 28 and sleeve 25 during rotation of the tubing 16, actuator 20, and inner pipe 23. As the tubing is rotated the coaction between the threads 21 of the actuator 20 and the threads 26 of the sleeve 25 result in said sleeve being moved downwardly with respect to the tubing. Since the sleeve is connected to the mandrel 28 while the actuator 20 is connected to the inner pipe 23, the mandrel will move downwardly with respect to the inner pipe so that the parts assume the position shown in Figures 4 and 4A. In such position the cross-over tube 35 is placed in communication with the cross-over ports 27 in the sleeve 25, and thus the flow from the lower producing zone B may be upwardly through the cross-over tube, cross-over ports 27 and into the annular space between the well casing 11 and the well tubing 16. The lower zone may thus be produced through the well casing.

At the same time that the cross-over of flow from the lower zone is effected, the shifting of the mandrel 28 with respect to the inner pipe establishes communication between the openings 31 of the mandrel 28 and the ports 24 of the inner pipe 23 whereby communication between the tubing 16 and the upper zone A is set up. An acidizing operation may then be carried out through the tubing to acidize the upper formation A and bring the production in from this formation. Upon the flow of well fluids from the formation A, said fluids enter openings 31, then pass through ports 24 of the inner pipe 23 from where these fluids flow upwardly through the tubing string.

After well fluids are flowing from both formations, the production from either zone may be directed either through the tubing or the casing. If it is desired to produce the upper zone through the well casing, the tubing 16 is again rotated to return the parts to the position shown in Figures 3 and 3A. In such event flow from the upper zone A is through openings 31, annular space 32 and openings 30 into the well casing. Flow from the lower zone is through ports 24, inner pipe 23 and flow tubing.

From the foregoing, it will be seen that a relatively simple apparatus which is controlled in its operation by rotation of the tubing is provided. The apparatus permits selectively directing the flow from either zone through either the tubing or the casing. As has been described, each zone may be independently completed by setting up communication between that zone and the tubing, after which the flow may be in any desired manner, as conditions require. It might be noted that certain well conditions dictate that production be through the tubing, as for example, where corrosive fluids are being produced; thus, if either zone is producing fluids which are more efficiently produced through the tubing, the present apparatus permits such production. In some instances it might be desirable to change the flow after production has been had for a period of time. In other words, if the upper zone is producing through the tubing and the lower zone is producing through the casing, it might be desirable to reverse the arrangement so that the lower zone produces through the tubing. The present apparatus permits such shifting at any time, while the apparatus is within the well casing.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made, within the scope of the appended claims, without departing from the spirit of the invention.

Having described the invention, I claim:

1. A well packer including, a well fluid conductor, an inner pipe attached to the well conductor and extending downwardly therefrom, an outer tubular mandrel surrounding said inner pipe with a flow passage formed therebetween, a connection between the upper end of the mandrel and the well fluid conductor for imparting longitudinal movement to the mandrel relative to the inner pipe upon a rotation of the conductor with respect to the mandrel, a packing assembly mounted on the mandrel, said mandrel having flow ports which direct flow from exteriorly of the mandrel below the packing assembly through said flow passage to the area exteriorly of the mandrel above the packing assembly, said inner pipe having a port and passage for directing flow

from below the inner pipe to the well conductor, said inner pipe having another port and another passage communicating with a flow port in the mandrel above said packing assembly, said ports and passages in the pipe and said ports in the mandrel being opened and closed in accordance with the relative position of the mandrel longitudinally of the inner pipe.

2. A well packer including, a well tubing, an inner pipe suspended from and communicating with the tubing, an outer tubular mandrel surrounding the inner pipe and connected with the tubing, said mandrel being movable longitudinally of the inner pipe, means for moving said mandrel to two positions relative to said inner pipe, a packing assembly mounted on the mandrel, means establishing communication between the area exteriorly of the mandrel below the packing assembly and the area exteriorly of the mandrel above said assembly when the mandrel is in its first position relative to the inner pipe, and means establishing communication between the area below the inner pipe and the well tubing also when the mandrel is in its first position, movement of the mandrel to its second position relative to the inner pipe changing the communication establishing means to set up communication between the area exteriorly of the mandrel below the packing assembly and the tubing and at the same time set up communication between the area below the inner pipe and the area exteriorly of the mandrel above the tubing.

3. A well packer as set forth in claim 2, wherein the means for moving the mandrel relative to the inner pipe is a coarse thread connection between the tubing and the mandrel, whereby rotation of the tubing imparts longitudinal movement to the mandrel.

4. A well packer as set forth in claim 2, wherein the means for moving the mandrel relative to the inner pipe is a coarse thread connection between the tubing and the mandrel, whereby rotation of the tubing imparts longitudinal movement to the mandrel, and also wherein the packer assembly includes upwardly and downwardly directed packing cups which are moved into sealing engagement by the pressures acting thereagainst.

5. A well packer including, a tubular mandrel, a packing assembly mounted on the exterior of said mandrel, an inner pipe extending axially through said mandrel and having a connection therewith permitting relative movement therebetween, a cross-over tube extending axially through and secured to the inner pipe with an annular space formed between said tube and said pipe, said tube having its upper end terminating adjacent the wall of the mandrel, closure means closing off the lower end of said annular space, means for moving the mandrel and inner pipe relative to each other, said mandrel having a cross-over port adapted to communicate with the cross-over tube when the mandrel is in one position relative to the inner pipe, and means establishing communication between the area exteriorly of the mandrel below the packing assembly and said annular space above said closure means when the mandrel is in a position establishing communication between the cross-over tube and the cross-over port.

6. A well packer including, a tubular mandrel, a packing assembly mounted on the exterior of said mandrel, an inner pipe extending axially through said mandrel and having a connection therewith permitting relative movement therebetween, a cross-over tube extending axially through and secured to the inner pipe with an annular space formed between said tube and said pipe, said tube having its upper end terminating adjacent the wall of the mandrel, closure means closing off the lower end of said annular space, means for moving the mandrel and inner pipe relative to each other, said mandrel having a cross-over port adapted to communicate with the cross-over tube when the mandrel is in one position relative to the inner pipe, means establishing communication between the area exteriorly of the mandrel below the packing assembly and said annular space above said closure means when the mandrel is in a position establishing communication between the cross-over tube and the cross-over port, and sealing means between said mandrel and said inner pipe for closing off communication between the area exteriorly of the mandrel below the packing assembly and said annular space and for setting up a communication between the area exteriorly of the mandrel below the packing assembly upon longitudinal movement of said mandrel relative to said inner pipe and the area exteriorly of the mandrel above said assembly.

7. A well packer as set forth in claim 5, together with a well tubing connected directly to the inner pipe, and wherein said means for moving the mandrel and inner pipe relative to each other is a coarse thread connection between the well tubing and the mandrel, whereby rotation of the well tubing imparts movement to the mandrel longitudinally with respect to the tubing and inner pipe.

8. A well packer as set forth in claim 6, together with a well tubing connected directly to the inner pipe, and wherein said means for moving the mandrel and inner pipe relative to each other is a coarse thread connection between the well tubing and the mandrel, whereby rotation of the well tubing imparts movement to the mandrel longitudinally with respect to the tubing and inner pipe.

9. A well packer including, a tubular mandrel, a packing assembly mounted on the exterior of said mandrel, an inner pipe extending axially through said mandrel and having a connection therewith permitting relative movement therebetween, a cross-over tube extending axially through and secured to the inner pipe with an annular space formed between said tube and said pipe, said tube having its upper end terminating adjacent the wall of the mandrel and its lower end open for admitting fluid from therebelow, closure means closing off the lower end of said annular space, means for moving the mandrel and inner pipe relative to each other, said mandrel having a cross-over port adapted to be aligned or misaligned with the upper end of the cross-over tube in accordance with the position of the mandrel with respect to the inner pipe, said inner pipe having an inlet port in its lower portion above said closure means and having an outlet at its upper end for communicating with the surface of the well, an internal packing carried by the mandrel for packing off between the exterior of the inner pipe and the bore of the mandrel, the relative movement of the mandrel with respect to the inner pipe positioning said packing either above or below the inlet port in the pipe, said mandrel having an inlet opening in its lower portion above the packing and having an outlet opening in its upper portion above the packing assembly, and an an-

nular packing means secured to the inner pipe for packing off between the inner pipe and mandrel and being adapted to be disposed either above below the inlet port of the mandrel in accordance with the position of the mandrel with respect to the inner pipe.

10. A well packer as set forth in claim 9, together with a well tubing connected directly to the upper end of the inner pipe, and wherein said means for moving the mandrel and inner pipe relative to each other is a coarse left hand connection between the well pipe and the upper end of the mandrel, whereby rotation of the well tubing imparts a movement to the mandrel longitudinally with respect to the tubing and inner pipe.

11. A well packer as set forth in claim 9, together with a well tubing connected directly to the upper end of the inner pipe, and wherein said means for moving the mandrel and inner pipe relative to each other is a coarse left hand connection between the well pipe and the upper end of the mandrel, whereby rotation of the well tubing imparts a movement to the mandrel longitudinally with respect to the tubing and inner pipe, the packing assembly which is mounted on the mandrel comprising an upper packing cup having upwardly directed sealing lips, a lower packing cup having downwardly directed sealing lips, and annular packing elements disposed between the packing cups whereby pressures above and below said packing assembly move the same into packing position.

12. A well packer as set forth in claim 9, wherein the packing assembly comprises an upper packing cup having upwardly directed sealing lips, a lower packing cup having downwardly directed sealing lips, and annular packing elements disposed between the packing cups whereby pressures above and below said packing assembly move the same into packing position.

13. A dual production well packer for use in a well having an upper producing zone and a lower producing zone, said packer including, a mandrel having a packing assembly thereon for packing off between the well tubing and well casing of said well, an inner pipe within the mandrel connected directly to the well tubing, means for moving the mandrel and inner pipe relative to each other, means for establishing communication between the upper producing zone and the well casing, additional means for establishing communication between the upper zone and the well tubing, means for establishing communication between the lower zone and the well casing, additional means for establishing communication between the lower zone and the well tubing and means controlling the various communication-establishing means in accordance with the relative position of the mandrel with respect to the inner pipe, whereby flow from either zone may be directed to either the well casing or tubing as desired.

14. A well packer as set forth in claim 13, wherein said means for moving the mandrel and inner pipe relative to each other is a connection between the well tubing and the mandrel to move the mandrel longitudinally with respect to the tubing and inner pipe upon a rotation of the tubing with respect to said mandrel.

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