

W. D. MYERS

MULTIPLE ZONE SELECTIVE CROSS-OVER APPARATUS

Filed Dec. 27, 1962

4 Sheets-Sheet 1

FIG. 1.

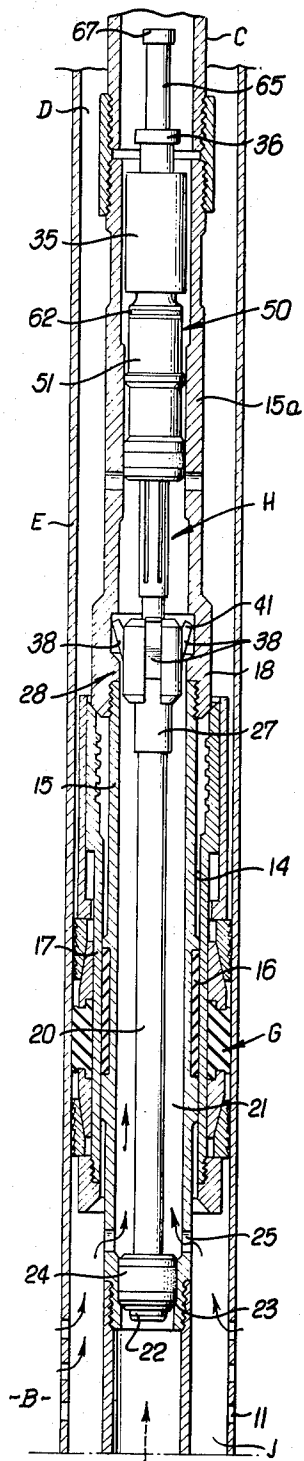


FIG. 1a.

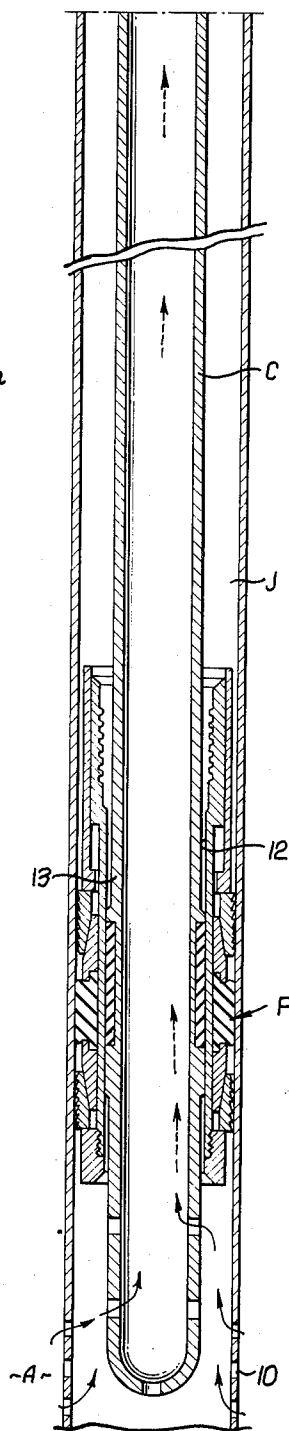


FIG. 5.

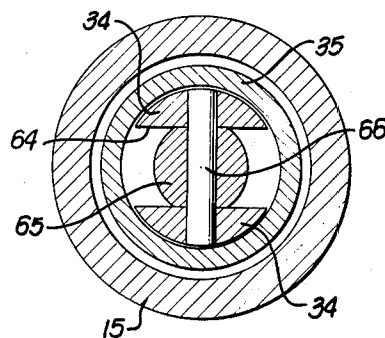
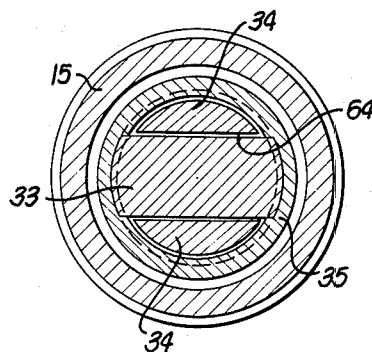


FIG. 6.



INVENTOR.
WILLIAM D. MYERS
BY
Mellin and Hanscom
ATTORNEYS.

Aug. 3, 1965

W. D. MYERS

3,198,257

MULTIPLE ZONE SELECTIVE CROSS-OVER APPARATUS

Filed Dec. 27, 1962

4 Sheets-Sheet 2

FIG. 2.

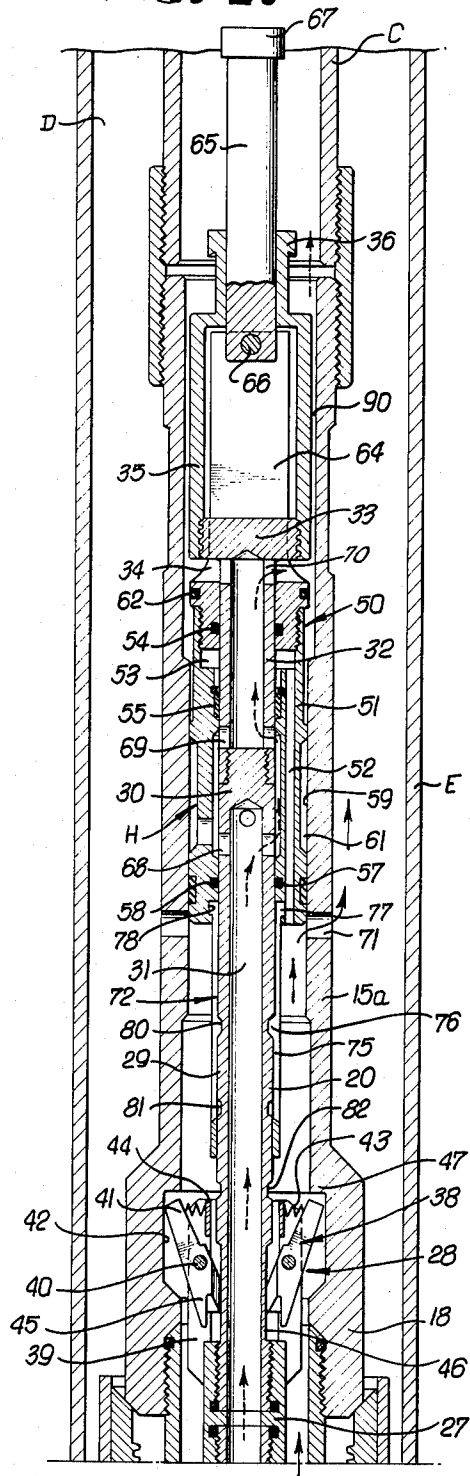
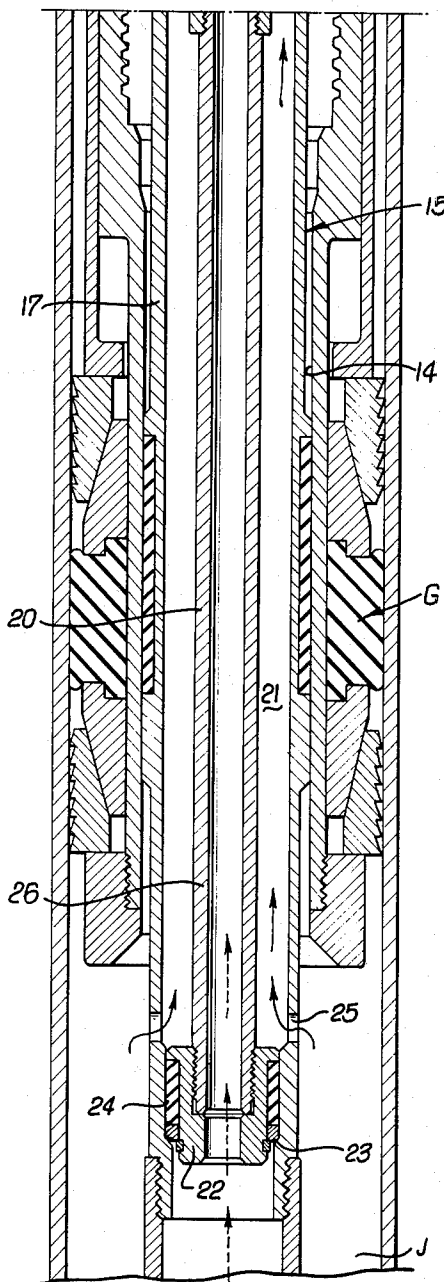


FIG. 2a.



INVENTOR.
WILLIAM D. MYERS
 BY
Mellin and Hanscom
 ATTORNEYS.

Aug. 3, 1965

W. D. MYERS

3,198,257

MULTIPLE ZONE SELECTIVE CROSS-OVER APPARATUS

Filed Dec. 27, 1962

4 Sheets-Sheet 3

FIG. 3.

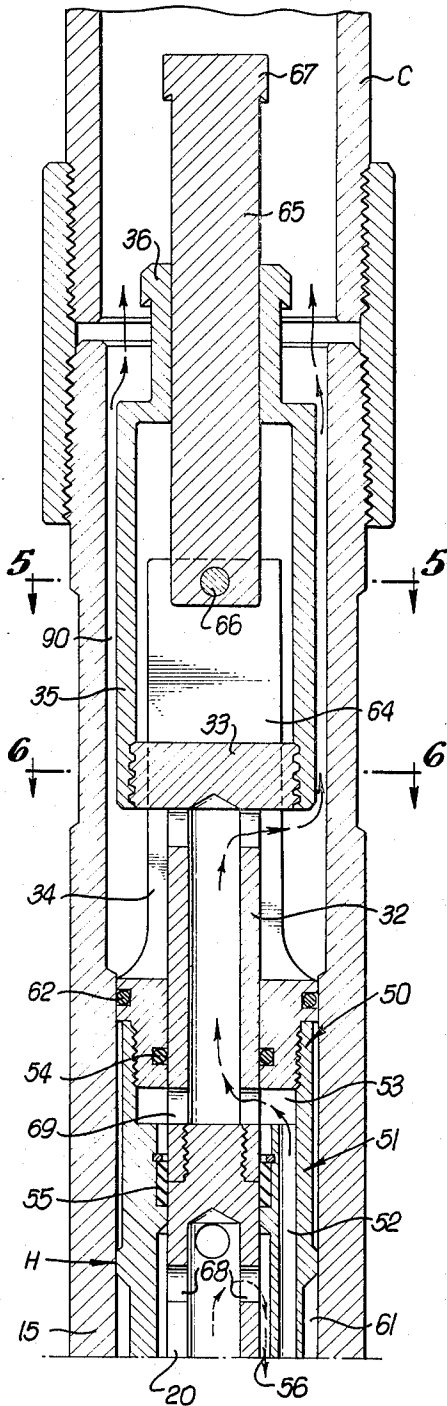
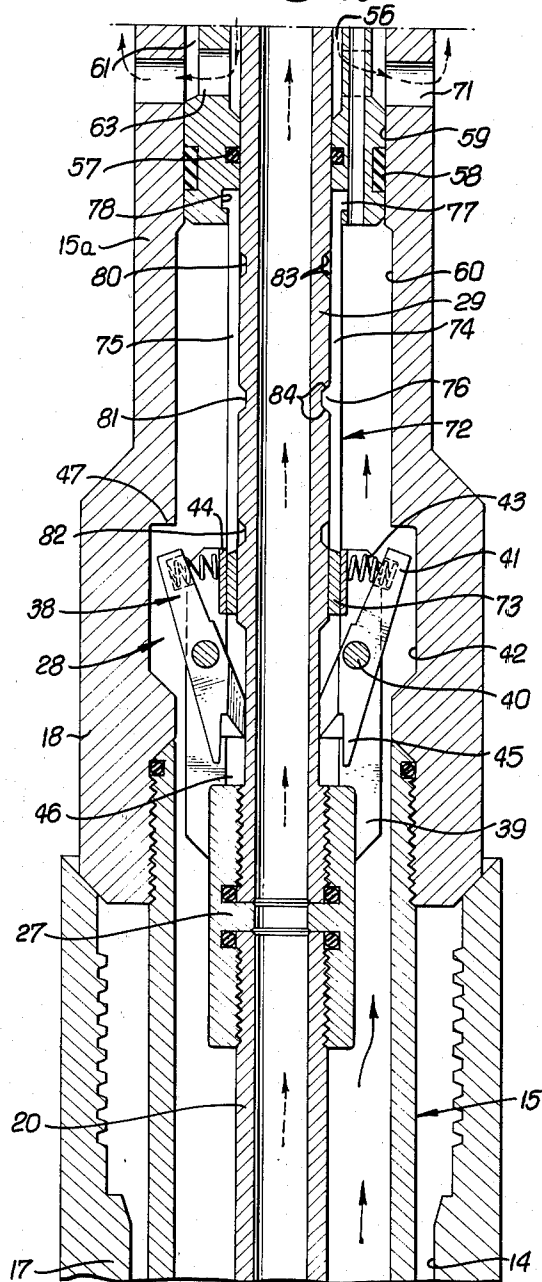


FIG. 3a.



INVENTOR.

WILLIAM D. MYERS

BY

Mellin and Hanscom
ATTORNEYS.

Aug. 3, 1965

W. D. MYERS

3,198,257

MULTIPLE ZONE SELECTIVE CROSS-OVER APPARATUS

Filed Dec. 27, 1962

4 Sheets-Sheet 4

FIG. 4.

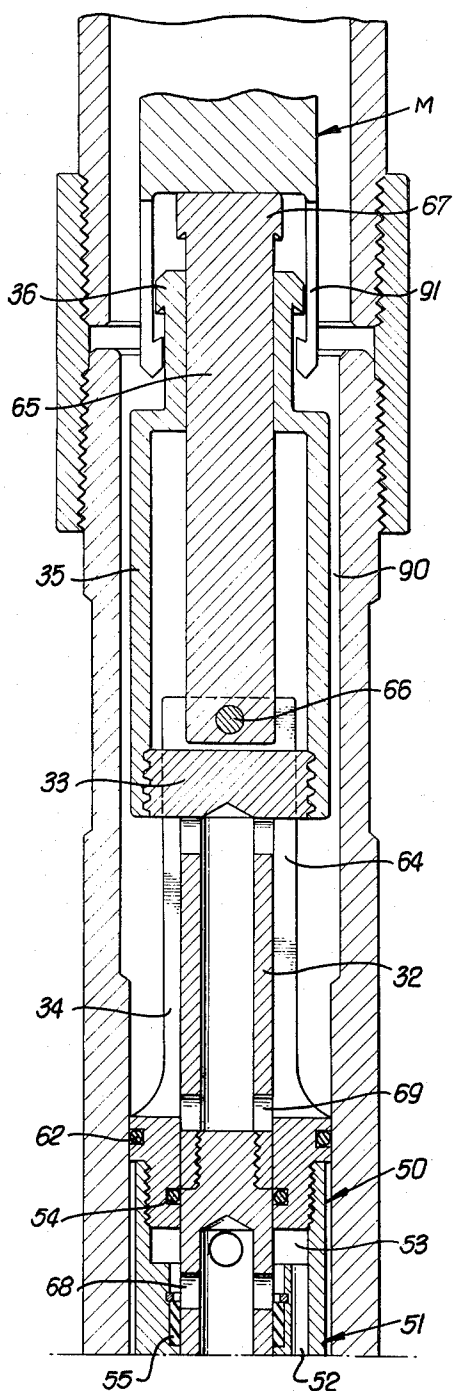
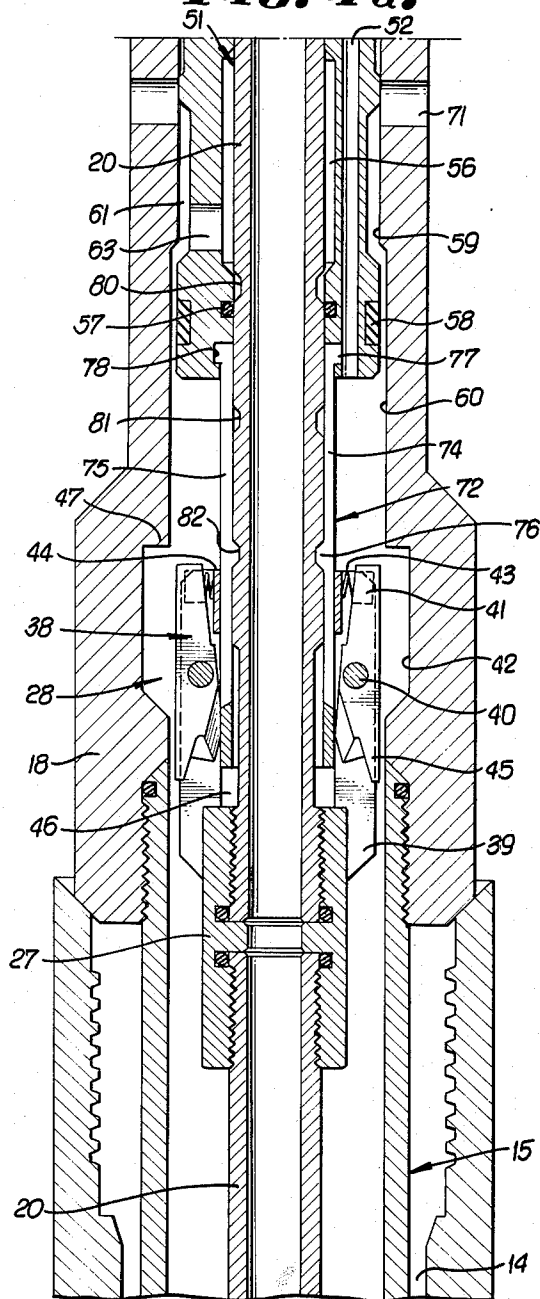


FIG. 4a.



INVENTOR.

WILLIAM D. MYERS

BY

Meelin and Hanson
ATTORNEYS.

1

3,198,257

MULTIPLE ZONE SELECTIVE CROSS-OVER APPARATUS

William D. Myers, Houston, Tex., assignor to Baker Oil Tools, Inc., Los Angeles, Calif., a corporation of California

Filed Dec. 27, 1962, Ser. No. 247,579

19 Claims. (Cl. 166—136)

This invention relates to subsurface well bore apparatus, and more particularly to apparatus for conducting fluids from a plurality of formation zones in a well bore through separate paths to the top of the well bore.

In a well bore having a plurality of producing zones, it is desirable to conduct the fluid from each zone along a separate flow path to the top of the well bore. Production from a first zone may be conducted through a tubing string to the top of the well bore, and production from a second zone through a region externally of the tubing string to the top of the well bore, as, for example, through the annulus around the tubing string. The flow pattern may require change at times to cause production from the second zone to flow through the tubing string to the top of the well bore and production from the first zone to flow through the region externally of the tubing string to the top of the well bore.

An object of the invention is to provide improved apparatus for conducting fluids from different well formations through separate flow paths to the top of the well bore, the flow paths being selectively interchangeable.

Another object of the invention is to provide apparatus for conducting fluids from different well formations through separate paths to the top of the well bore, the flow paths being selectively interchangeable without removing the apparatus from the well bore.

A further object of the invention is to provide apparatus for conducting fluids in a conventional manner from a lower zone in the well bore through tubing extending to the top of the well bore, and from an upper zone through the annulus around the tubing string, or for producing fluids in a cross-over manner from the lower zone through the annulus and the upper zone through the tubing, a selective control portion of the apparatus remaining in the well bore and being shiftable therein to change the mode of production between conventional and cross-over. More specifically, shifting can occur by manipulating a suitable device within the tubing string.

An additional object of the invention is to provide control apparatus for conducting fluids from different formation zones through separate paths in a tubing string and around the tubing string, the flow paths being selectively interchangeable without withdrawing the control apparatus from the well bore, the apparatus being releasably secured in the well bore and being adapted to be lowered through the tubing string to its operative position and also elevated through the tubing string when its removal is desired.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURES 1 and 1a together constitute a longitudinal section through multiple zone well apparatus, with the parts arranged for conducting production from the zone

2

to the top of the well bore in a conventional manner, FIG. 1a being a lower continuation of FIG. 1;

FIGS. 2 and 2a are longitudinal sections, on an enlarged scale, of the apparatus disclosed in FIG. 1, FIG. 2a being a lower continuation of FIG. 2;

FIGS. 3 and 3a are views corresponding to FIG. 2 on a further enlarged scale, with the parts shifted to conduct fluid in a cross-over manner to the top of the well bore, FIG. 3a being a lower continuation of FIG. 3;

FIGS. 4 and 4a are views corresponding to FIGS. 3 and 3a, with the parts shifted to still another relative position, FIG. 4a being a lower continuation of FIG. 4; and

FIGS. 5 and 6 are horizontal sectional views taken along the lines 5—5 and 6—6, respectively, of FIG. 3.

The apparatus illustrated in the drawings is capable of conducting fluids from a lower formation A to the top of the well bore along a separate path from the flow path pursued by well production emanating from an upper formation B in the well bore. Fluid from one formation may be produced through a tubing string C extending to the top of the well bore and fluid from the other formation through the tubing-casing annulus D surrounding the tubing string, or such flow paths may be interchanged.

As shown in the drawings, a casing string E is disposed in the well bore, the casing being appropriately sealed off with respect to the wall of the well bore between the lower and upper formation zones A, B. Fluid from the lower zone A can flow into the casing E through lower casing perforations 10, and fluid from the upper zone B can flow into the casing through upper perforations 11. A suitable well packer F is anchored in packed-off condition in the well casing between the upper and lower sets of perforations 11, 10 and an upper well packer G can be set in the well casing above the upper perforations 11. The upper and lower well packers G, F may have been previously installed in the well casing, or either or both of the well packers can be run therein and set in the well casing on the tubing string C, all in a known manner.

In the specific embodiment of the invention illustrated in the drawings, the lower and upper packers F, G may have been previously anchored in packed-off condition in the well casing. The lower packer F has a passage 12 therethrough adapted to receive the lower portion 13 of the tubular string C in leak-proof relation, the tubular string extending to the top of the well bore. This tubular string also extends through the central passage 14 through the upper packer G. As specifically illustrated, the portion of the tubular string extending through the upper packer G may be constituted as an outer tubular body 15 formed of a single or a plurality of sections threadedly or otherwise suitably secured together, these sections carrying a suitable side seal 16 adapted to sealingly engage the wall of the upper packer body 17 to prevent leakage therebetween. Appropriate location of the side seal 16 in the upper packer results from engagement of a stop or head 18 on the outer tubular body 15 against the upper end of the packer body 17. When such engagement occurs, the lower portion 13 of the tubular string C is appropriately disposed within the passage 12 through the lower packer in leak-proof relation thereto. The upper portion 15a of the outer tubular body 15 is suitably connected to the remainder of the tubing string C thereabove, which extends to the top of the well bore, there being suitable surface connections (not shown) at the top of the well bore with the tubular string C, as well as with the tubing-casing annulus D.

A flow control apparatus H is adapted to be lowered through the tubular string C into the outer tubular body 15, and this apparatus can be selectively manipulated to cause production from the lower zone A to be con-

ducted through the tubing string C to the top of the well bore and from the upper zone B through the tubing-casing annulus D to the top of the well bore, or vice versa. The flow control apparatus is adapted to be releasably secured in the outer tubular body 15 and can be released therefrom whenever desired and elevated through the tubing string C to the top of the well bore. The change in the flow pattern can occur without removing the flow control apparatus from the outer tubular body 15. Its release from the latter, for withdrawal to the top of the well bore, can also be accomplished in a comparatively simple manner.

The flow control apparatus H to be disposed within the outer tubular body 15 includes an inner tubular body or mandrel 20 of substantially smaller external diameter than the inside diameter of the outer tubular body 15, providing an annular passage 21 therebetween when the inner tubular body is located within the outer tubular body. Downward movement of the flow control apparatus is limited by engagement of a lower head 22 on the inner tubular body 20 with a stop shoulder 23 formed on the outer tubular body 15. A suitable side seal 24 is mounted on the lower head to seal against the wall of the outer tubular body adjacent to its stop shoulder 23 when the head engages the shoulder. When the head 22 engages the stop shoulder 23, the seal 24 is disposed below a plurality of inlet ports 25 in the outer tubular body, communicating with the annular space J around the tubing string between the upper and lower packers G, F, into which annular space the upper casing perforations 11 open.

The inner tubular body 20 may be made conveniently of several sections, including a lower section 26 threaded into the body 27 of a releasable holding or latching device 28, which body, in turn, is threadedly secured to an adjacent body section 29 having an upper end wall 30 closing its central passage 31, the end wall portion being threadedly secured to still another tubular body section 32 having an upper end wall 33 provided with outwardly projecting wings 34 threaded into the lower portion of a running-in and retrieving device 35 having a suitable upper head 36 adapted to be coupled to a conventional wire line operated setting tool or retrieving tool M (see FIG. 4).

The inner body structure 20 can be releasably locked or latched into the outer tubular body 15, when the lower head 22 engages the stop shoulder 23, by a plurality of latches or dogs 38 mounted in circumferentially spaced, longitudinal slots 39 in the latch body 27 on pivot pins 40 secured to the body and extending across the slots. When the inner body head 22 engages the stop shoulder 23, the upper holding portions 41 of the locking dogs 38 are urged outwardly into a companion circumferential lock groove 42 within the outer body member 15 by springs 43 engaging the lock portions 41 of the dogs and also webs or inner portions 44 of the lock body, which constitute seats for the springs. When the upper lock portions 41 of the latches are disposed in the lock groove 42, lower retracting nose portions 45 of the latches or dogs are disposed within a circumferential groove 46 in the inner tubular body section 29. With the lock portions 41 disposed in the locking groove 42 of the outer body 15, upward movement of the inner tubular body or mandrel 20 to any significant extent is prevented by engagement of the upper ends of the dogs with the upper side wall 47 of the internal locking groove.

With the lower head 22 engaging the stop shoulder 23, fluid from the lower zone A will pass into the lower portion 13 of the tubing string C and through the lower packer, flowing upwardly into the inner tubular body 20. Fluid from the upper zone B will flow into the casing around the tubing string C between the upper and lower packers G, F and then through the inlet ports 25 into the annulus 21 between the inner and outer tubular bodies 20, 15. By suitably locating a valve device 50 forming

part of the flow control apparatus H, the fluid from the lower zone can be caused to flow from the inner tubular body 20 into the tubing string C above the flow control apparatus, and fluid from the annulus 21 into the tubing-casing annulus D above the upper packer G, or the two flow paths just referred to may be interchanged.

The valve device 50 includes an annular piston valve member 51 disposed between and slidable along the inner and outer tubular bodies 20, 15. As shown, the annular piston valve member or head 51 has a plurality of circumferentially spaced, longitudinal passages 52 opening through the lower end of the piston valve and communicating with a circumferential groove 53 in the piston valve member thereabove. Above this groove, the piston member carries an internal side seal 54 adapted to slidably seal against the periphery of the inner tubular body 20. Below the circumferential groove 53, the piston valve carries another suitable side seal 55 adapted to slidably seal against the periphery of the inner body 20. This side seal 55 is disposed above an internal circumferential groove or passage 56, of extended length, formed in the piston valve, there being a lower internal side seal 57 on the piston valve below the annular passage 56 adapted to slidably seal against the periphery of the inner body 20.

The annular piston valve member 51 also carries a lower external side seal 58 adapted to sealingly engage against the inner wall 59 of the outer tubular body 15, which has an internal diameter substantially less than the internal diameter of the internal body portion 60 therebelow. This lower external seal 58 is below an external annular passage or groove 61, of extended length, in the piston valve member 51, there being an upper external side seal 62 on the piston valve member adapted to sealingly engage against the wall 59 of smaller internal diameter of the outer tubular member.

The piston valve 51 also has a plurality of side ports 63 extending between its internal and external annular passages 56, 61 and alternating with the longitudinal passages 52 through the piston valve. The upper portion of the piston valve has a wide longitudinal slot 64 receiving the inner tubular body member 32, the wings 34 extending laterally of this slot and being threaded to the running-in and retrieving portion 35 of the apparatus. The piston valve 51 is connected to a shifting stem 65 extending into the slot by a pin 66, the stem projecting upwardly above the running-in and retrieving portion 36 of the member 35 and having a suitable enlarged head 67 for engagement by conventional wire line operated tools (not shown) which can effect shifting of the piston valve 51 along the inner and outer body members 20, 15 to different positions.

The inner tubular member 20 has outlet ports 68 below its end wall 30 and upper inlet ports 69 above such end wall. It also has outlet ports 70 below its upper end wall 33 communicating with the slot 64 of the piston valve. The outer tubular body member 15 has a plurality of outlet ports 71 communicating with the tubing-casing annulus D above the upper packer G, which extend through the portion of the outer tubular body member having the restricted internal diameter portion 59.

The piston valve 51 is shiftable to determine the flow paths of the fluids from the lower and upper zones A, B through the tubing and the tubing-casing annulus, and can be releasably latched in such position. As shown, a latch sleeve 72 is secured to the lower portion of the piston valve 51. This latch sleeve includes a circumferentially continuous lower portion 73, and has circumferentially spaced, longitudinal slots 74 providing spring-like latch arms 75, the intermediate portions of which have inwardly directed latch fingers or cams 76. Lugs 77 are provided on the upper ends of the arms 75, extending outwardly into a circumferential groove 78 in the piston valve member 51. When the piston valve member 51 is mounted on the inner body member 20, the lugs 77 are held in the internal groove 78.

5

The latch fingers or cams 76 are adapted to be releasably received selectively in each of three circumferential latch or lock grooves 80, 81, 82 provided in the exterior of the inner body member 20. Each groove has tapered or outwardly diverging side walls 83 into which the latch fingers or cams 76 can shift inherently under the spring force of the latch arms 75, the upper and lower sides 84 of the cams being tapered to conform to the inclination of the side walls 83 of the lock grooves. The exertion of sufficient longitudinal force on the piston valve 51 will cause the fingers 76 to be cammed out of a lock groove 80, 81, or 82, and when such cams or fingers are disposed opposite another groove, they will be snapped thereinto by the very substantial spring force exerted by the latch arms 75.

As disclosed in FIGS. 1, 1a, 2, 2a, the piston valve member 51 is in a position for conventional flow of fluids from the lower and upper formation zones A, B through the tubing string C and through the tubing-casing annulus D to the top of the well bore. When the piston valve is in such position, the latch fingers 76 are in the uppermost lock groove 80. The lower external seal 58 is sealing against the inner wall 59 of the outer body member 15 above the outlet ports 71, the lowermost inner seal 57 being disposed below the outlet ports 63, and the intermediate internal seal 55 being disposed above the inlet ports 69 on the opposite side of the end wall 30, the inner annular passage 56 extending between the outlet and inlet ports 68, 69 on opposite sides of the end wall 30. With the parts in this position, fluid from the lower zone A will pass through the lower packer F and tubing string C into the inner body member 20, flowing outwardly through the outlet ports 68 into the internal annular passage 56, and then through the inlet ports 69 on the other side of the end wall into the body section 32, then passing outwardly through the upper ports 70 and through the slot 64 into the outer body member 15 to flow through the annular space 90 around the running-in and retrieving member 35 of the flow control apparatus into the tubing string C thereabove for continued passage through the latter to the top of the well bore. The fluid from the upper zone B passes through the inlet ports 25 into the annulus 21 between the inner and outer tubular bodies 20, 15, and then out through the outlet ports 71 into the tubing-casing annulus D for upward passage through the latter to the top of the well bore.

If the flow pattern is to be changed, a suitable tool is lowered on a wire line through the tubing string C into engagement with the valve actuating stem 65, a downward force being imposed on this stem, such as a jarring action, which will be transmitted through the annular piston valve 51 to the latch mechanism 72, camming the fingers 76 out of the upper groove 80, the piston valve 51 then moving downwardly along the inner and outer tubular bodies 20, 15 until the fingers 76 snap into the intermediate groove 81. The wire line mechanism can now be released from the stem 65 and withdrawn from the tubing string C.

With the latches 72 in their intermediate holding position, as shown in FIGS. 3, 3a, the upper and lower external seals 62, 58 are disposed in sealing engagement with the wall 59 of the outer body member on opposite sides of the outlet ports 71. The lowermost internal seal 57 sealingly engages against the periphery of the inner body member 20 below its outlet ports 63, the intermediate seal 55 sealingly engaging against the periphery of the body between the outlet and inlet ports 68, 69 on opposite sides of the end wall 30, and the uppermost internal seal 54 sealingly engaging the periphery of the inner body 20 above the inlet ports 69. Fluid from the lower zone A passing through the lower packer F and tubing string C into the inner body 20 will now pass outwardly through the outlet ports 68 into the internal annular passage 56, proceeding through the side ports 63 through the piston valve into the external annular passage 61, and through

6

the outlet ports 71 into the tubing-casing annulus D, flowing therethrough to the top of the well bore. On the other hand, fluid from the upper zone B will pass through the inlet ports 25 into the annulus 21 between the inner and outer tubular bodies 20, 15, flowing upwardly through the longitudinal valve passages 52 into the circumferential groove 53 thereabove, then flowing inwardly through the inlet ports 69 to the interior of the inner body member 32, and then outwardly through its outlet ports 70 and through the slot 64 into the annular passage 90 between the running-in and retrieving portion 35 of the device and the body 15, then continuing upwardly through the tubing string C to the top of the well bore.

With the flow control apparatus H latched in place, a suitable shifting tool can be lowered on a wire line through the tubing string C and become connected to the valve stem 65 for the purpose of shifting the valve piston 51 between a position in which fluid flow from the upper and lower zones A, B is conducted through the tubing C and the tubing-casing annulus D in the conventional manner, as disclosed in FIGS. 1, 1a, 2, 2a, or in the crossed-over manner, as disclosed in FIGS. 3, 3a. Such shifting can occur as often as desired without removing any of the flow control mechanism H from the tubing string C.

As explained above, the flow control apparatus H can be installed in place by lowering it through the tubing string C on a suitable wire line, the inner mandrel 20 of the apparatus entering the outer body portion 15 and coming to rest upon the stop shoulder 23, with its lower seal 24 sealing against the companion surface of the outer body member 15 below the inlet ports 25, the latch dogs 38 snapping outwardly into the locking groove 42. During downward movement of the apparatus H through the tubing string C, the latches 38 will merely freely ratchet over coupling spaces, and the like, in the tubing string, shifting inwardly from such coupling spaces against the expansion force of the springs 43. Once disposed opposite the locking groove 42, however, the latches 38 are shifted outwardly thereinto by the springs 43 and will prevent upward movement of the inner body member 20 relative to the outer body member 15, downward movement of the former being prevented by engagement of the lower head 22 with the stop shoulder 23. Accordingly, the piston valve 51 can be shifted between its different operative positions, since the latches 38 and the lower shoulder 23 prevent any significant longitudinal movement of the inner body member 20 within the outer body member 15.

The flow control mechanism H can be retrieved readily from the tubing string C whenever desired. A suitable and known pulling device M is connected to a wire line and lowered through the tubing string C, this pulling device engaging the valve stem 65, and also having suitable latching devices 91 adapted to extend over the running-in and retrieving head 36 to be coupled thereto. The downward force imposed on the stem 65 by the pulling tool M, as by jarring downwardly therein, will shift the latch device 72 downwardly, its fingers 76 being cammed out of a particular groove 80 or 81 in which it has been disposed, the piston valve 51 being shifted downwardly until the lower portion 73 of the latch sleeve engages the inwardly directed retracting noses 45 of the latch dogs 38, to shift such noses outwardly and the upper coupling portions 41 of the latch dogs inwardly completely out of the locking groove 42 of the outer body member 15 and fully within the confines of the body slots 39. The sleeve 72 will be latched in this position by snapping of the cams 76 into the lowermost groove 82, resulting in the holding of the latches 38 in their fully retracted position (FIGS. 4, 4a). The retrieving tool M can now be elevated on the wire line to pull the inner mandrel member 20 upwardly out of the outer body member 15 and through the tubing string C to the top of the well bore.

At any time thereafter, the latch device 72 can be disposed in either the conventional or cross-over valve holding position on the inner body member 20, which will allow the springs 43 to expand the latch members 38 outwardly, the tool H being relowered through the tubing string C and into position within the outer body member 15, the latches 38 again shifting outwardly into the locking groove 42 upon engagement of the head 22 with the shoulder 23.

From the foregoing description, it is apparent that the flow paths can be selectively interchanged whenever desired without removing the apparatus H from the well bore. A suitable shifting tool is merely lowered on a wire line, or the like, through the tubing string C to shift the flow control device to the desired flow controlling condition, the flow control device being releasably held in such position. The apparatus H can be released and retrieved through the tubing string C whenever desired without the need for the running of any special tools. Through use of known retrieving apparatus, the latch sleeve 72 is shiftable downwardly to release the latches 38, the retrieving device M being coupled to the retrieving portion 35 of the apparatus so that elevation of the wire line, or the like, in the tubing string C will withdraw the apparatus H from the outer tubular member 15 and through the tubing string C to the top of the hole.

I claim:

1. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means secured within said body means against substantial longitudinal movement with respect thereto and providing therewith separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; and valve means shiftable mounted in said tubular body means to control flow of fluids through said passages, said valve means being positionable in said body means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string.

2. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means secured within said body means against substantial longitudinal movement with respect thereto and providing therewith separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; valve means shiftable mounted in said tubular body means to control flow of fluids through said passages, said valve means being positionable in said body means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; and means releasably retaining said valve means within said body means in said locations.

3. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means in said body

means and providing therewith separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; and valve means shiftable along said body means and mandrel means to control flow of fluids through said passages, said valve means being positionable in said body means and along said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means and along said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string.

4. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means within and secured to said body means and providing therewith separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; and valve means shiftable along said body means and mandrel means to control flow of fluids through said passages, said valve means being positionable in said body means and along said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means and along said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string.

5. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means in said body means and providing therewith separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; means releasably securing said mandrel means to said body means against substantial longitudinal movement therein; valve means shiftable mounted in said tubular body means with said mandrel means secured in said body means to control flow of fluids through said passages, said valve means being positionable in said body means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; and means for releasing said securing means to release said mandrel means from said body means.

6. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means in said body means and providing therewith separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; means releasably securing said mandrel means to said body means against substantial longitudinal movement therein; valve means shiftable mounted in said tubular body means with said mandrel means secured in said body means to control flow of fluids through said passages, said valve means being positionable in said body means in one location for

conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; means for releasing said securing means to release said mandrel means from said body means; and means releasably retaining said valve means within said body means in said locations.

7. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means in said body means and providing therewith separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; means releasably securing said mandrel means to said body means; valve means shiftable along said body means and mandrel means to control flow of fluids through said passages, said valve means being positionable in said body means and along said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means and along said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; means releasably retaining said valve means within said body means in said locations; and means for releasing said securing means to release said mandrel means from said body means.

8. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means in said body means and providing therewith separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; means releasably securing said mandrel means to said body means against substantial longitudinal movement therein; valve means shiftable mounted in said tubular body means with said mandrel means secured in said body means to control flow of fluids through said passages, said valve means being positionable in said body means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; and means operatively connected to said valve means and shiftable thereby to release said securing means and thereby release said mandrel means from said body means.

9. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means adapted to be moved down through the tubular string into a predetermined location in said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; and valve means shiftable mounted in said tubular body means and movable downwardly through the tubular string with said mandrel means and adapted to control flow of fluids through said

passages, said valve means being positionable in said body means in one location with said mandrel means in said predetermined location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means in another location with said mandrel means in said predetermined location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string.

10. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means adapted to be moved down through the tubular string into said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; lock means on said mandrel means for releasably securing said mandrel means to said body means when disposed therein against substantial longitudinal movement therein; valve means on said mandrel means movable through the tubular string therewith into said tubular body means and shiftable mounted in said tubular body means with said mandrel means secured in said body means to control flow of fluids through said passages, said valve means being positionable in said body means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; and means for releasing said lock means to release said mandrel means from said body means.

11. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means adapted to be moved down through the tubular string into said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; lock means on said mandrel means for releasably securing said mandrel means to said body means when disposed therein; valve means carried by said mandrel means and movable downwardly therewith through the tubular string into said tubular body means and shiftable along said body means and mandrel means to control flow of fluids through said passages, said valve means being positionable in said body means and on said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means and on said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; and means for releasing said lock means to release said mandrel means from said body means.

12. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means adapted to be moved down through the tubular string into said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above

11

said body means and to the region externally of the tubular string; lock means on said mandrel means for releasably securing said mandrel means to said body means when disposed therein; valve means carried by said mandrel means and movable downwardly therewith through the tubular string into said tubular body means and shiftable along said body means and mandrel means to control flow of fluids through said passages, said valve means being positionable in said body means and on said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means and on said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; and means operatively connected to said valve means and shiftable thereby to release said lock means and release said mandrel means from said body means.

13. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means adapted to be moved down through the tubular string into said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; lock means on said mandrel means for releasably securing said mandrel means to said body means when disposed therein against substantial longitudinal movement therein; valve means on said mandrel means movable through the tubular string therewith into said tubular body means and shiftable mounted in said tubular body means with said mandrel means secured in said body means to control flow of fluids through said passages, said valve means being positionable in said body means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; and means operatively connected to said valve means and shiftable thereby to release said lock means and release said mandrel means from said body means.

14. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means adapted to be moved down through the tubular string into said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; lock means on said mandrel means for releasably securing said mandrel means to said body means when disposed therein; valve means carried by said mandrel means and movable downwardly therewith through the tubular string into said tubular body means and shiftable along said body means and mandrel means to control flow of fluids through said passages, said valve means being positionable in said body means and on said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means and on said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; means for releasing said lock means to release said mandrel means from said

12

body means; and means releasably retaining said valve means within said body means in said locations.

15. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string, mandrel means adapted to be moved down through the tubular string into said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; lock means on said mandrel means for releasably securing said mandrel means to said body means when disposed therein against substantial longitudinal movement therein; valve means on said mandrel means movable through the tubular string therewith into said tubular body means and shiftable mounted in said tubular body means with said mandrel means secured in said body means to control flow of fluids through said passages, said valve means being positionable in said body means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; means operatively connected to said valve means and shiftable thereby to release said lock means and release said mandrel means from said body means; and means releasably retaining said valve means within said body means in said locations.

16. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means in said body means and providing therewith separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; and annular valve means slidable along the exterior of said mandrel means and along the inner wall of said body means to control flow of fluids through said passages, said annular valve means being positionable in said body means and on said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means and on said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string.

17. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string: tubular body means adapted to form part of the tubular string; mandrel means adapted to be moved down through the tubular string into said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; annular valve means carried by said mandrel means and movable downwardly therewith through the tubular string into said body means and slidable along the exterior of said mandrel means and along the inner wall of said body means to control flow of fluids through said passages, said valve means being positionable in said body means and on said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable

13

in said body means and on said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; lock means on said mandrel means for securing said mandrel means to said body means when disposed therein; and means for releasing said lock means to release said mandrel means from said body means.

18. In apparatus to be disposed in a well bore having upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string; tubular body means adapted to form part of the tubular string; mandrel means adapted to be moved down through the tubular string into said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; annular valve means carried by said mandrel means and movable downwardly therewith through the tubular string into said body means and slidable along the exterior of said mandrel means and along the inner wall of said body means to control flow of fluids through said passages, said valve means being positionable in said body means and on said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means and on said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; lock means on said mandrel means for securing said mandrel means to said body means when disposed therein; means for releasing said lock means to release said mandrel means from said body means; and means releasably retaining said valve means within said body means in said locations.

19. In apparatus to be disposed in a well bore having

14

upper and lower producing zones and in which one zone is to be produced through a tubular string disposed in the well bore and the other zone through a region externally of the tubular string; tubular body means adapted to form part of the tubular string; mandrel means adapted to be moved down through the tubular string into said body means and providing with said body means separate passages adapted to conduct fluids from the upper and lower zones to the interior of the tubular string above said body means and to the region externally of the tubular string; annular valve means carried by said mandrel means and movable downwardly therewith through the tubular string into said body means and slidable along the exterior of said mandrel means and along the inner wall of said body means to control flow of fluids through said passages, said valve means being positionable in said body means and on said mandrel means in one location for conducting fluids separately from the lower zone to said interior of the tubular string and from the upper zone to said region and positionable in said body means and on said mandrel means in another location for conducting fluids separately from the lower zone to said region and from the upper zone to said interior of the tubular string; lock means on said mandrel means for securing said mandrel means to said body means when disposed therein; means for releasing said lock means to release said mandrel means from said body means; means releasably retaining said valve means within said body means in said location; and means retaining said latch releasing means in its latch releasing position.

References Cited by the Examiner

UNITED STATES PATENTS

2,649,916	8/53	Brown	166—150 X
2,766,831	10/56	Otis	166—116
2,936,832	5/60	Brown et al.	166—127 X

BENJAMIN HERSH, *Primary Examiner*.