

[72] Inventor **Roy E. Thompson**
18 Colony Road, Gretna, La. 70053
 [21] Appl. No. **799,702**
 [22] Filed **Feb. 17, 1969**
 [45] Patented **Jan. 5, 1971**

3,381,753 5/1968 Fredd..... 166/224X
 3,441,084 4/1969 Fredd..... 166/224X
 3,448,803 6/1969 Sizer..... 166/224X

Primary Examiner—Ian A. Calvert
 Attorney—Pravel, Wilson and Matthews

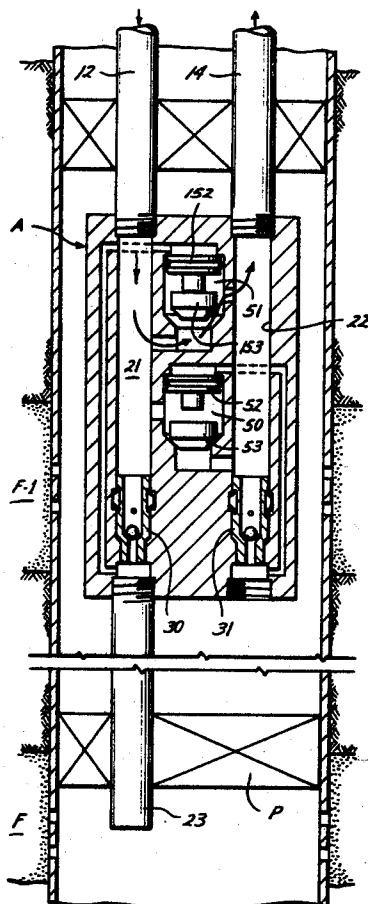
[54] **COMMUNICATING VALVE ASSEMBLY FOR
 MULTIPLE WELL FORMATIONS**
8 Claims, 8 Drawing Figs.

[52] U.S. Cl..... 166/224,
 166/313
 [51] Int. Cl..... E21b 33/122
 [50] Field of Search..... 166/313,
 146, 189, 224, 153—156

[56] **References Cited**
UNITED STATES PATENTS

3,115,187 12/1963 Brown..... 166/313X
 3,302,721 2/1967 Yetman..... 166/313

ABSTRACT: A communicating valve assembly for multiple well formation production and for controlled circulation of fluid between pipe strings connected thereto wherein two control valves are disposed between the two pipe strings in conjunction with a check valve for each pipe string, and wherein the control valves are constructed so that upon increasing the pressure in either of the strings above the well formation pressure in communication with such string, one of the control valves opens to direct fluid from one pipe string to the other, whereby tools may be pumped upwardly and out of either pipe string or the well may be "killed" by increasing the pressure in only one of the strings.



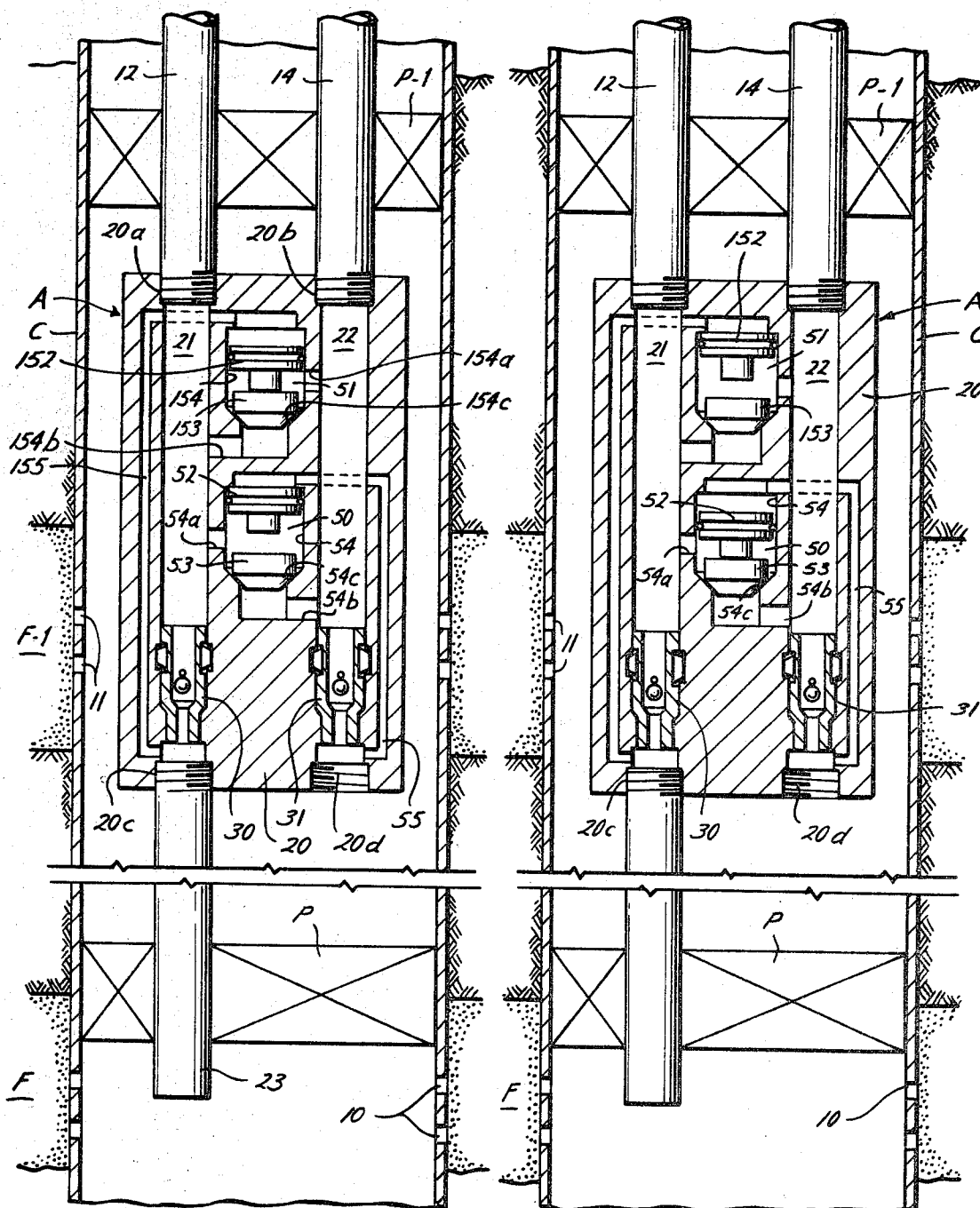


Fig. 1

Fig. 2

INVENTOR
 Roy E. Thompson
 BY
 Hayden Pravel Wilson & Matthews
 ATTORNEYS

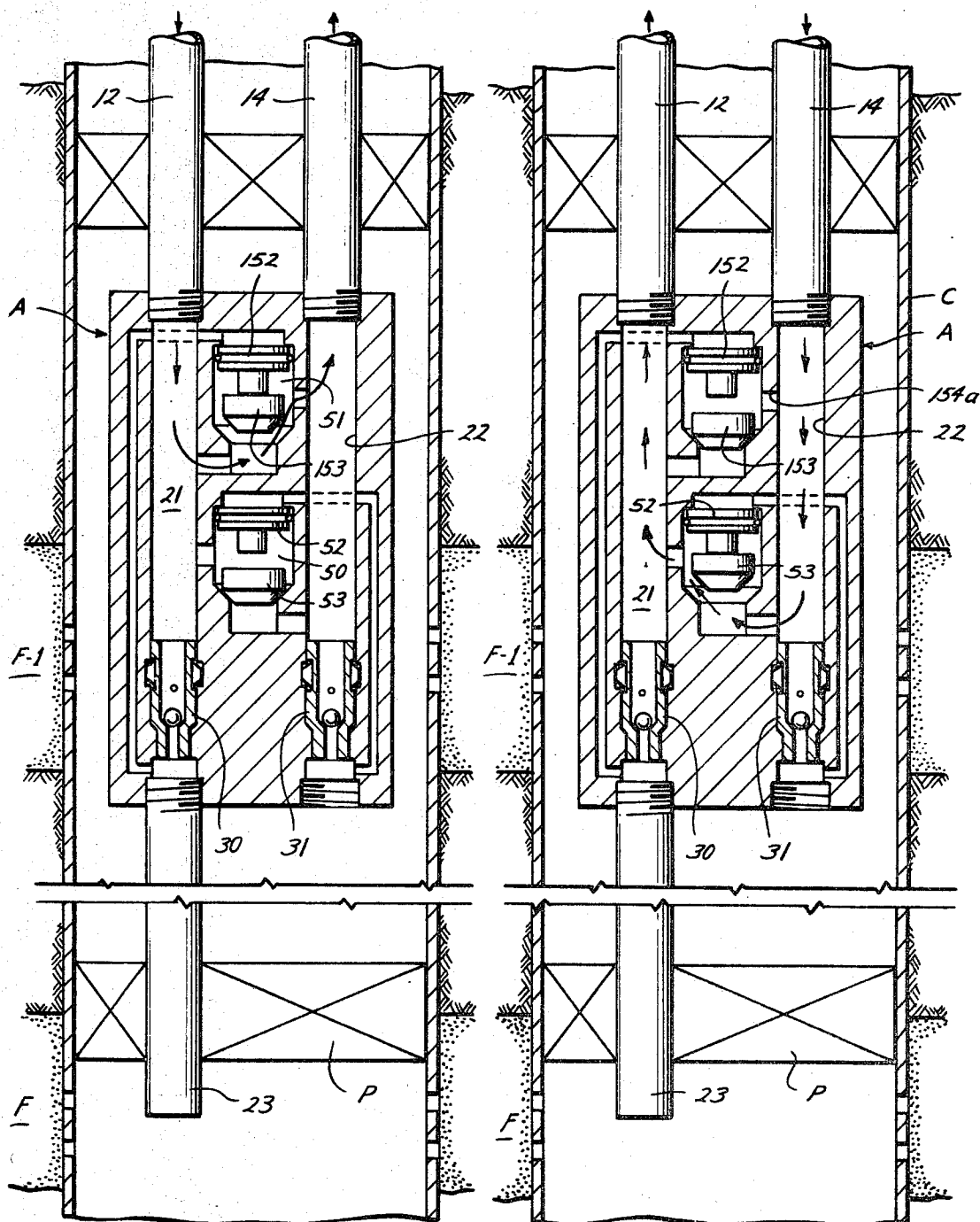


Fig. 3

Fig. 4

INVENTOR
Roy E. Thompson
BY

Hayden Pravel Wilson & Matthews
ATTORNEYS

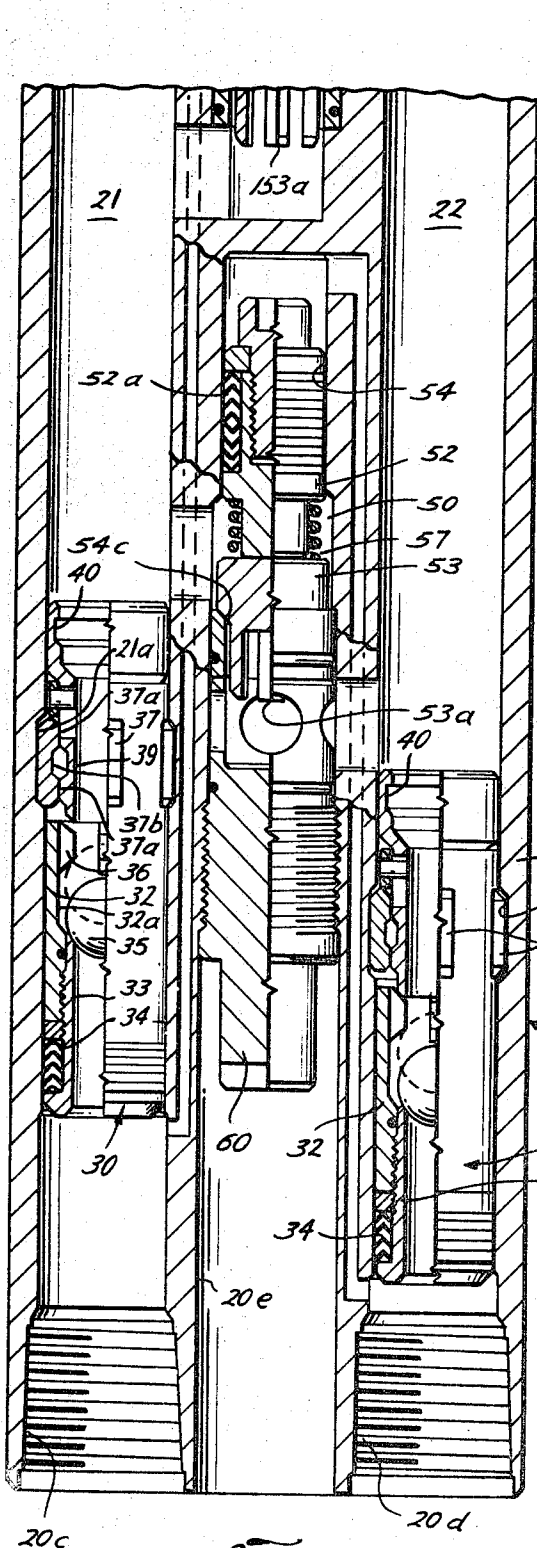


Fig. 5B

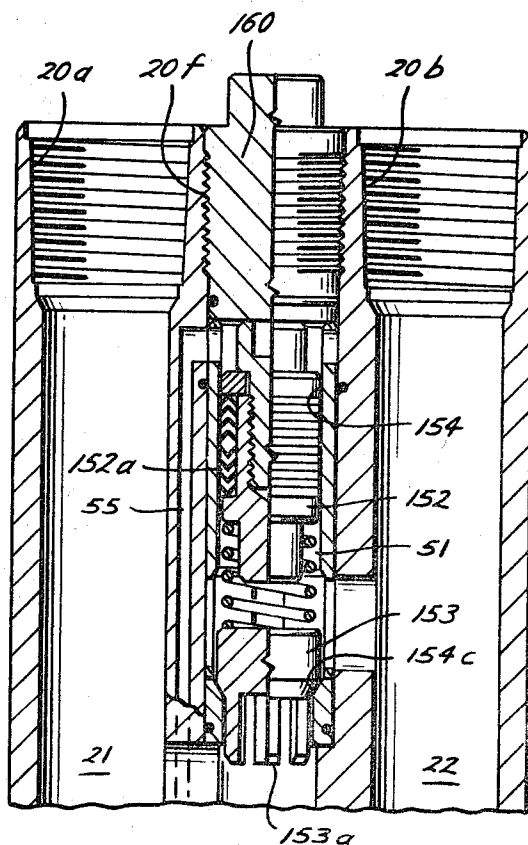
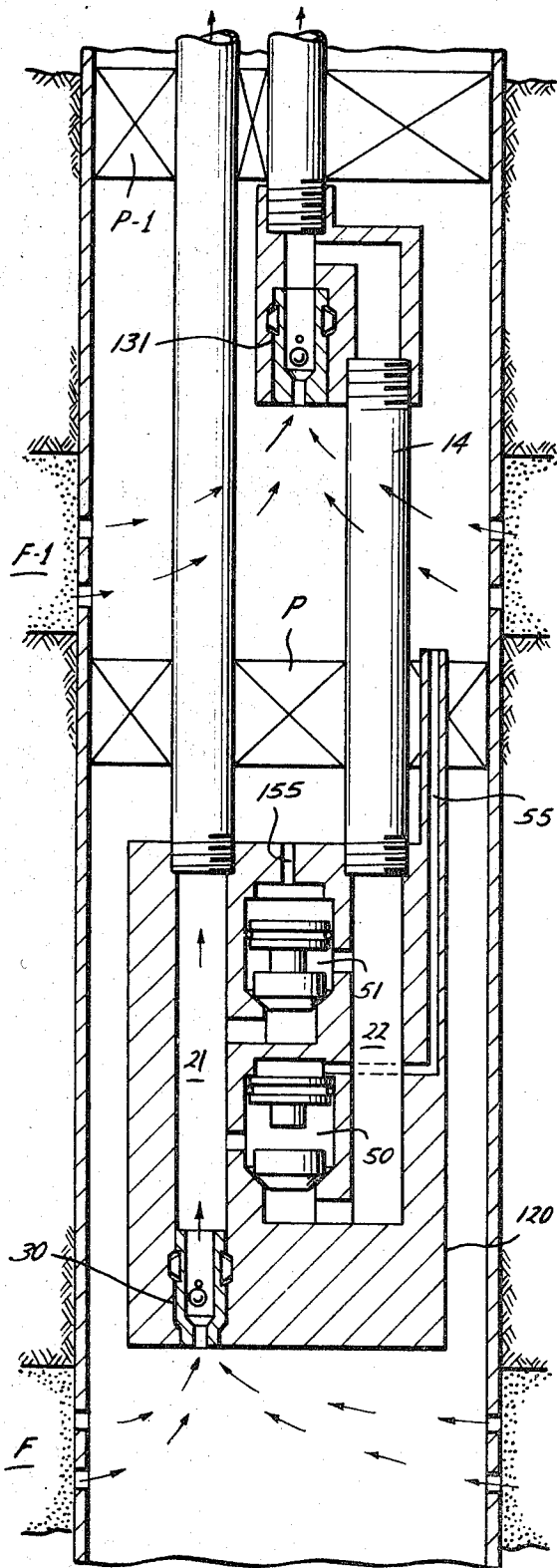
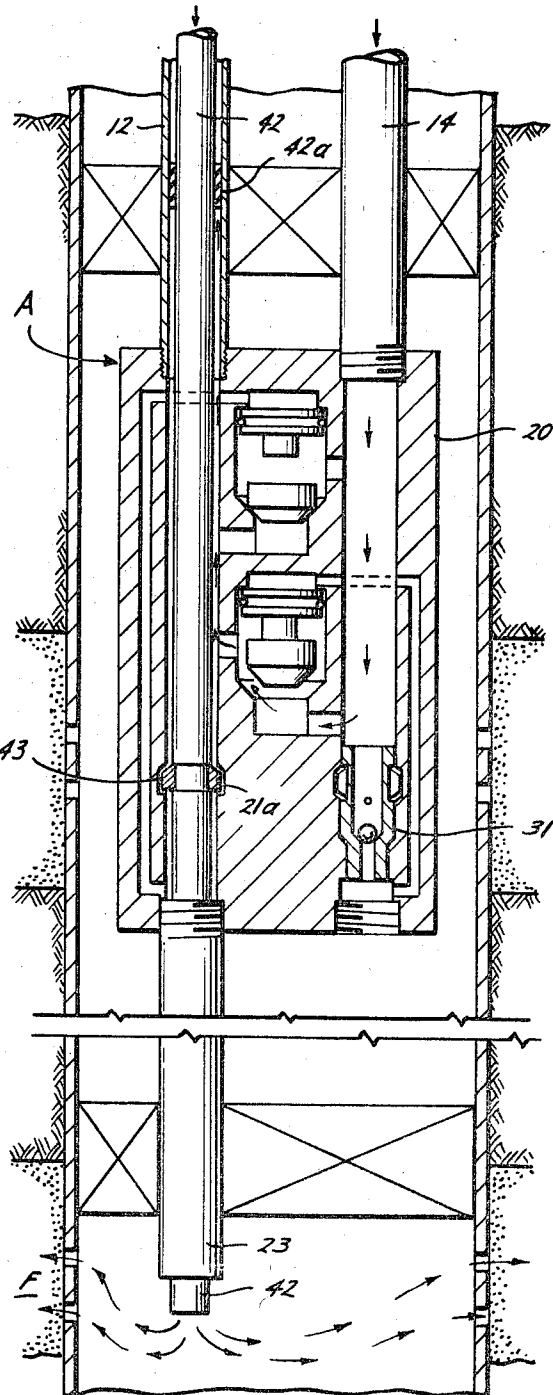


Fig. 5A

Roy E. Thompson
INVENTOR

BY
Hayden Pravel Wilson & Matthews
ATTORNEYS



INVENTOR
Roy E Thompson

BY

Hayden Pravel Wilson & Matthews
ATTORNEYS

COMMUNICATING VALVE ASSEMBLY FOR MULTIPLE WELL FORMATIONS

BACKGROUND OF THE INVENTION

The field of this invention is valves for multiple well formation operations.

It is quite common for two or more formations in a well to be produced simultaneously using multiple well completion and production apparatus. The completion and production apparatus heretofore used has generally required a pipe string for each well formation plus an additional pipe string for pumping fluid downwardly and into the other pipe strings so as to pump tools upwardly out of such other pipe strings. Where the additional pipe string was not used, the two or more producing strings had to be pressured up above the well formation pressure to obtain fluid circulation for pumping tools upwardly out of the strings.

Furthermore, heretofore there has been no way to circulate between two or more production strings after the packers are set in the well, without first swabbing out mud or heavy fluid, or without first running a tool on a wireline to operate sliding sleeve valves or the like, both of which are time consuming and potentially dangerous because of the risk of producing a blowout through the lubricator.

SUMMARY OF THE INVENTION

With the present invention, completion, production and other operations in multiple well formations may be performed with only the single pipe string for each well formation. The valve of the present invention permits the pumping of fluid downwardly in one pipe string and upwardly in the other pipe string. By reason of such fluid flow, tools may be pumped upwardly and out of either pipe string by increasing the fluid pressure in only one of the strings to cause the fluid pressure to move a tool in the other pipe string upwardly. Also, the swabbing of heavy mud of fluid prior to circulating fluid from one pipe string to the other is not necessary; instead, the fluid circulation may be used for replacing heavy mud or fluid with light fluid to permit the well to flow. Conversely, the well may be readily "killed" or prevented from flowing by circulating heavier mud into the pipe strings.

Other advantages and features of the present invention will be apparent from the following description and the drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic view, partly in section and partly in elevation, illustrating the communicating valve assembly of the present invention in position in a well pipe or casing for production of well fluids through two pipe strings from two different well formations in the same well wherein the fluid pressure through the left pipe string is greater than through the right pipe string;

FIG. 2 is a view similar to FIG. 1 but showing the condition wherein the fluid pressure through the right pipe string is greater than the fluid pressure in the left pipe string;

FIG. 3 is a view similar to FIG. 1 and 2, but illustrating the positions of the control valves and the check valves for the circulation of fluid from the left pipe string to the right pipe string;

FIG. 4 is a view similar to FIG. 3 but illustrating the reverse circulation from the right pipe string to the left pipe string;

FIGS. 5A and 5B are vertical sectional views, partly in elevation, of the details of the preferred form of the communicating valve assembly of this invention, with FIG. 5A illustrating the upper portion thereof and FIG. 5B illustrating the lower portion thereof;

FIG. 6 is a view similar to FIG. 4, but illustrating the mounting of a well tool or pipe within the left pipe strings in place of a removable check valve; and

FIG. 7 is a schematic view similar to FIG. 1, but illustrating a modification thereof wherein the check valve for the right pipe string is disposed in the pipe string at a point remote from the body of the communicating valve assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the drawings, the letter A designates generally the communicating valve assembly of this invention which is adapted to be disposed in a well pipe or casing C in proximity to two or more well formations F and F1. The casing C is suitably perforated at 10 and 11 for communicating the interior thereof with each of such well formation F and F1, respectively, as will be well understood. The formations F and F1, and the area in the casing C thereof, are separated by well packers P and P1, the construction of which is conventional and well understood. As will be explained in detail hereinafter, the communicating valve assembly A is connected to two pipe strings 12 and 14 which extend to the surface so that oil or other well fluid may be produced through such strings 12 and 14 from the well formations F and F1, respectively. Although the invention is described herein for dual well formation completion, production and other operations, it will be understood that multiple well formations may be handled in the same manner with additional provision for the additional well formation or formations.

Considering the invention more in detail, the communicating valve assembly A includes a valve body 20 which has box threads 20a and 20b for making threaded connections with the tubing or pipe strings 12 and 14, respectively.

Such box threads 20a and 20b are formed at the upper ends of a first longitudinal bore 21 and a second longitudinal bore 22, respectively, each of which terminates at its lower end in a threaded box 20c and 20d, respectively. The threads 20c are preferably utilized for connection with a tail pipe 23 which extends downwardly through the lower packer P for communicating with the lower well formation F. The threads 20d are not utilized in the preferred form of the invention, although the tail pipe 23 may be threaded into such box threads 20d instead of the threads 20c to change the flow pattern through the communicating valve A with respect to the two well formations F and F-1 as will be evident to those skilled in the art.

In the preferred form of the invention, illustrated in particular in FIGS. 1-5B, check valves 30 and 31 are disposed in the longitudinal bores 21 and 22, respectively, for permitting fluid flow upwardly therethrough and through the bores 21 and 22, while preventing fluid flow downwardly below such check valves 30 and 31. Although the particular construction of the check valves 30 and 31 may be varied and various conventional check valves may be utilized in the invention, it is preferable to provide removable check valves such as illustrated in detail in FIG. 5B. Since the check valves 30 and 31 as illustrated in FIG. 5B are duplicates, the same numerals and letter references are used with respect to both of such check valves 30 and 31 and specific reference is made to both of such check valves 30 and 31 and specific reference is made to the details of check valve 30 only. Thus, check valve 30 has a body 32, to which is threaded a retaining sleeve 33 which confines a packing 34 for maintaining a seal with the internal surface of the longitudinal bore 21. The body 32 has a recess 32a into which a ball 35 is positioned for movement from the solid line position to the dotted line position illustrated in FIG. 5B. When the ball valve 35 is in the solid line position, it engages the lower portion of the body 32 for closing fluid flow through the central passage of the check valve 30, whereas when the valve 35 is in the dotted line position, the fluids may flow upwardly around the ball valve 35. This is because the ball valve 35 engages only radially spaced lugs 36 when it is in the dotted line position so that fluid may flow around the ball valve 35 and upwardly through its open upper end.

A plurality of retractable dogs 37 are circumferentially spaced and are supported by the body 32 above the ball valve 35. Such dogs 37 have mating internal surfaces 37a and a recess 37b for coaction with corresponding surfaces on an internal expander sleeve 39. Thus, the dogs 37 may radially retract to a diameter which is at least as small as the internal diameter of the bore 21 when the surfaces 37a and the recess 37b interfit with the corresponding external surface of the expander ring 39. However, when the sleeve 39 is positioned

downwardly with respect to the dogs 37 as illustrated in FIG. 5B then the dogs 37 are held outwardly in their expanded position. In the form of the invention illustrated in FIG. 5B, the dogs 37 enter an annular recess 21a which is formed in the wall of the longitudinal bore 21 insofar as the check valve 30 is concerned. The dogs 37 on the check valve 31 are adapted to enter an annular recess 22a in the longitudinal bore 22 when such lugs or dogs 37 are in the expanded position illustrated in FIG. 5B. It can be seen that when the check valves 30 and 31 are moved upwardly from the position shown in FIG. 5B, the body 32 moves upwardly and it carries the sleeve 39 therewith while the dogs 37 remain held in their position by engaging the upper surfaces of the annular recesses 21a and 22a. However, when the expander sleeve 39 becomes aligned with the dogs 37, the upward force acting on the dogs 37 forces them inwardly to mate or interfit the corresponding recesses and raised surfaces of the expanded sleeve 39 so that they can be retracted to a diameter small enough to pass upwardly in the bore 21 and bore 22. The check valves 30 and 31 may be retracted by the use of any conventional tools, normally of the type which are adapted to fit into and engage with a fishing groove or neck 40 at the upper end of each of the check valves 30 and 31, as will be well understood.

In some instances, it may be desirable to replace the check valves 30 and 31, or either of them, with a well tool. Thus, by way of example, the check valve 30 has been replaced as illustrated in FIG. 6 by a section of pipe or tubing 42 which has retractable dogs 43 of any conventional design which are adapted to fit into the annular recess 21a and which are adapted to be retrieved therefrom upon an upward movement of the tubing 42. Also, the tubing 42 preferably has an annular piston 42a therewith above the valve body 20 so that the tubing 42 can be pumped upwardly and released from the recess 21a to remove same from the pipe string 12 with fluid pressure circulated from the other tubing string 14, as will be more evident hereinafter. Such tubing 42 may be used for the purpose of injecting cement, acidizing or for performing other operations in connection with the lower well formation F, as indicated by the arrows in FIG. 6. In place of the tubing 42, any other well tools such as a perforation gun may be lowered for performing well operations.

In addition to the check valves 30 and 31 or the well tools which may be utilized in place thereof, the communicating valve A has a first control valve 50 and a second control valve 51. The control valve 50 has an upper valve element 52 and a lower valve element 53 which are disposed in a valve chamber 54 in the valve body 20 for controlling fluid flow between the longitudinal bores 21 and 22. The valve elements 52 and 53 are longitudinally movable relative to each other, although they may move together depending upon the direction of fluid pressure acting thereon. The chamber 54 is in fluid communication with the longitudinal bore 21 by means of a passage 54a. Such passage 54a introduces fluid pressure to the area between the upper valve element 52 and the lower valve 53 to cause them to move away from each other to the position illustrated in FIG. 1 when the pressure is above and below the valve elements 52 and 53 is less than the pressure therebetween from the bore 21, as will be more evident hereinafter. The area below the valve element 53 in the chamber 50 is in communication with the longitudinal bore 22 by means of a longitudinal passage 54b. The lower portion 54c of the chamber 54 forms a valve seat for engagement by the lower valve elements 53 to thereby close communication through the chamber 54 from the passage or port 54b.

The upper end of the chamber 54 is in communication with the fluid in the upper well formation F-1 by means of a fluid passage 55 disposed in the valve assembly body 20 and extending from the passage area below the check valve 31 to the area above the upper valve element 52 in the chamber 54. The upper portion of the chamber 54 is formed with an annular valve seat 54d against which the upper portion of the upper valve element 52 engages for closing fluid flow from the passage 55 into the chamber 54, or vice versa. It is to be noted

that the cross-sectional area of the valve element 52 is greater than the cross-sectional area of the valve element 53 so that when the pressure acting above the valve element 52 and below the valve element 53 is the same, the valve element 52 moves downwardly and forces the lower valve element 53 downwardly to the closed position shown in FIG. 2, assuming the pressure in between the elements 52 and 53 is less than the pressure above and below such valve elements 52 and 53.

The upper control valve 51 is preferably a duplicate of the lower control valve 50 and therefore like parts of the valve 51 has the same reference letters and numerals as the valve 50 except that they are preceded by the numeral "1". The passage or port 154a of the valve 51 corresponds with the port 54a of the valve 50 in that it establishes communications from the longitudinal bore 22 to the area between the upper valve element 152 and the lower valve element 153. The port or passage 154b corresponds with the port or passage 54b in that it establishes communication from the longitudinal bore 21 to the area below the lower valve element 153. The upper valve element 152 of the control valve 51 is exposed to fluid pressure through the passage 155 in the body 20 which is in communication with the lower well formation F. It is to be noted that the lower control valve 50 is shown in detail in FIG. 5B whereas the upper control valve 51 is shown in detail in FIG. 5A. As illustrated therein, the valve element 52 has an annular resilient packing or seal 52a which is in constant sealing engagement with the inside surface of the chamber 54 so that fluid does not pass around the valve element 52. Similarly, the valve element 152 has an annular seal or packing element 152a which maintains a seal with the wall of the bore or chamber 154 at all times.

Preferably, a light spring 57 is disposed between the elements 52 and 53 as illustrated in FIG. 5B and likewise a spring 157 is disposed between the elements 152 and 153. Such spring is not essential to the operation of the present invention but it does prevent frictional forces from interfering with the proper functioning of the valve elements, and particularly it keeps the valve elements 52 and 53 in the valve 50 and the valve elements 152 and 153 in the valve 51 separated from each other when the fluid pressures are at equilibrium with respect to the areas exposed to such pressure.

For the purposes of guiding the lower valve element 53 as it moves longitudinally relative to the valve seat 54c, the valve element 53 preferably has a plurality of guide fingers 53a which are circumferentially spaced from each other as illustrated in FIG. 5B. The valve element 153 is similarly constructed with guide fingers 153a corresponding to the fingers 53a.

For the purposes of assembly and disassembly, the control valve 50 is removably mounted in the body 20 and is removably held in place by a removable plug 60 which is threaded into a bore 20e in the body 20. The same arrangement is provided at the other end of the body 24 removably retaining the control valve 51, and such structure includes a removable plug 160 which is mounted in a threaded upper bore 20f of the body 20 as seen in FIG. 5A.

In the operation or use of the form of the invention illustrated in FIG. 1-6, various operations are possible as illustrated by the schematic illustrations of the operation of the invention in FIG. 1-4 and 6. It is to be noted that the apparatus of FIGS. 5A and 5B is shown in the position corresponding with the operation illustrated in FIG. 2. FIGS. 1 and 2 illustrate the condition of the various parts of the communicating valve assembly A of this invention during the flow of the oil or other well fluid upwardly from the well formations F and F-1. FIG. 1 illustrates the condition wherein the pressure of the well fluid flowing upwardly in the tail pipe 23, longitudinal bore 21 and tubing or pipe string 12 is greater than the fluid pressure in the longitudinal bore 22 and the tubing or pipe string 14. It is to be noted that in such situation, both of the control valves 50 and 51 are in the closed position with the flow between the bores 21 and 22 closed from each so that there is no cross flow or circulation between the pipe strings

12 and 14. This occurs because the greater pressure in the bore 21 acts between the valve element 52 and 53 to cause the valve element 53 to seat on the valve seat 54c to close fluid flow through the chamber 54. The valve elements 152 and 153 are moved to their lower position so that the valve element 153 seats on the valve seat 154c to close flow through the chamber 154 due to the fact that the formation pressure acts on the upper valve element 152 through the passage 155. Since the cross-sectional area of the valve element 152 is greater than the cross-sectional area of the valve element 153, a downward force is exerted on the valve elements 152 and 153 even though the fluid pressure thereabove and therebelow is the same.

When the pressure of the fluid in the longitudinal bore 22 and the pipe string 14 is greater than the fluid pressure in the pipe string 12 and the bore 21, the valves 50 and 51 are shifted to the relative positions shown in FIGS. 2, 5A and 5B. It is to be noted that under such circumstances, the flow between the pipe strings 12 and 14 is still maintained closed from each other automatically since both of the lower valve elements 53 and 153 are in the seated or closed positions. However, the valve element 52 of the lower control valve 50 is in the lowermost position because the pressures acting above and below the valve 50 are greater than the pressure therebetween. Conversely, the valve elements 152 and 153 are separated from each other because the pressure between them is greater than the pressure above and below. It is to be noted that the check valves 30 and 31 are open in both the condition of FIG. 1 and the condition of FIG. 2.

When it is desired to circulate fluid from one tubing string to another using the communicating valve assembly A of this invention, the fluid pressure in one of the pipe strings 12 or 14 is increased to an amount sufficient to overcome the pressure from the well fluid in the string being pressured. For example, as illustrated in FIG. 3, fluid circulation may be provided from the pipe string 12 through the pipe string 14 by increasing the pressure in the pipe string 12 above that in the well formation F so as to close the check valve 30 and shift the upper control valve 51 to the open position illustrated in FIG. 3. Such shift in the upper control valve 51 occurs because the lower valve element 153 is exposed to the greater pressure in the bore 21 as compared to the pressure in the line 155 above the upper valve element 152. Since the cross-sectional area of the valve element 152 is larger than the cross-sectional area of the valve element 153, the upward fluid force multiplied by the cross-sectional area of the valve element 153 must exceed the pressure in the line 155 multiplied by the cross-sectional area of the valve element 152 for the valve elements to move upwardly to the position shown in FIG. 3. The valve element 52 of the lower control valve 50 remains in the closed position because of the greater pressure below the valve element 52 than the pressure thereabove. The pressure above the valve element 53 is greater than the pressure therebelow since the pressure in the string 12 is initially greater than in the string 14. However, after communication from the string 12 to the string 14 is established by the opening of the valve 51, then the pressure above and below the element 53 is essentially the same so that it stays seated by its own weight. Even if the valve 53 opens at that time, it is immaterial since such opening would merely add to the flow of the liquid from the string 12 to the string 14.

To provide for reverse circulation from the pipe string 14 to the pipe string 12, the pressure in the pipe string 14 is increased so it will be greater than the pressure in the well formation F-1 and therefore the check valve 31 is moved to the closed position as illustrated in FIG. 4. The control valve 50 is opened because of the greater pressure or fluid force acting on the valve element 53 than the pressure acting on the valve element 52 through the fluid passage or flow line 55. The upper control valve 51 is in the closed position because of the greater fluid pressure between the valve elements at 152 and 153 than the fluid pressure thereabove and therebelow.

It is desirable to circulate down one tubing string and back up through the other tubing string without communicating with the producing well formations or zones under the following circumstances, by way of example:

1. When it is desired to replace heavy mud or fluid in the tubing strings 12 and 14 for thus permitting the well formations to flow upwardly through the tubing strings 12 and 14, a light fluid may be circulated from one of the tubing strings to the other in the manner depicted in FIG. 3 or FIG. 4.

2. When it is desired to "kill" a pipe string, the other pipe string may serve as a means to introduce relatively heavy mud or fluid into the other string. Thus, assuming it is desirable to "kill" the flow of production or fluid upwardly in the pipe string 14, relatively heavy mud can be introduced through the pipe string 12 and create the condition illustrated in FIG. 3. The reverse could be obtained by the procedure illustrated in FIG. 4 so that the well formation F could be "killed" using heavy mud introduced into the string 12 through the pipe string 14.

3. When it is desired to pump fluid operated tools into and out of the flow lines, this can be accomplished in a manner heretofore described in connection with FIG. 6. Thus, fluid under pressure introduced through line 14 can act to pump the tubing 42 upwardly due to the location of the piston 42a above the communicating valve A.

4. When it is desired to pump tools such as paraffin cleaning tools into and out of the tubing string, the circulation of fluid from one of the pipe strings 12 and 14 through the other is preferably utilized.

5. When it is desired to introduce clean fluid into a tubing string to replace zone produced fluid such as those which may contain sand and/or paraffin and other contaminants, the circulation from one string to another can be effected with the present invention.

Other examples of uses for the present invention may occur to others, but the foregoing are sufficient to illustrate the utility and advantages of the present invention.

An alternate form of the invention is illustrated in FIG. 7, wherein the valve body 120 is the same as the valve body 20 except that the lower end of the longitudinal bore 22 is closed instead of having the valve 31 therein. The check valve 31 is replaced by a check valve 131 which is disposed at an intermediate position in the pipe string 14, but between packers P and P-1. The fluid from the formation F-1 still flows inwardly through the check valve 131 and the fluid from the well formation F still flows inwardly through the check valve 30, but the relative positions of such check valves are different as illustrated in FIG. 7 as compared to FIGS. 1-6. The control valves 50 and 51 in FIG. 7 are identical to those described in connection with FIGS. 1-6 in the preferred form of the invention, the only difference being that the flow tubes 55 and 155 are rearranged as illustrated for communicating with the well formations. However, the flow passage 55 still communicates with the upper formation F-1 and the passage 155 still communicates with the lower formation F and therefore the operation of the control valves 50 and 51, as well as the check valves 30 and 131 is the same as described heretofore in connection with FIGS. 1-6.

I claim:

1. A communicating valve assembly for use with multiple pipe strings in a well having multiple well formations separated from each other by a well packer comprising:

- a valve body;
- said body having first longitudinal bore adapted to be connected to a first pipe string for establishing fluid flow between a first well formation in a well and the surface;
- said body having a second longitudinal bore adapted to be connected to a second pipe string for establishing fluid flow between a second well formation disposed longitudinally below the first well formation; said body having first and second passage means each interconnecting said first and second longitudinal bores;

- d. a first control valve in said first passage means and a second control valve in said second passage means disposed for controlling fluid flow between said first longitudinal bore and said second longitudinal bore;
 - e. a first check valve operably connected to said first longitudinal bore for permitting the flow of fluid from the first well formation into the first longitudinal bore and adapted to be closed by fluid pressure in the first longitudinal bore in excess of the pressure of the fluid from the first well formation;
 - f. a second check valve operably connected to the second longitudinal bore for permitting the flow of fluid from the second well formation into the second longitudinal bore and adapted to be closed by fluid pressure in the second longitudinal bore in excess of the pressure of the fluid from the second well formation;
 - g. said first control valve having valve means therewith for movement to an open position when said fluid pressure in said first longitudinal bore is in excess of the fluid pressure in said first well formation and has closed said first check valve; and
 - h. said second control valve having valve means therewith for movement to an open position when said fluid pressure in said second longitudinal bore is in excess of the fluid pressure in said second well formation and has closed said second check valve.
2. The structure set forth in claim 1, wherein:
- a. said first check valve is disposed in the lower end of the first longitudinal bore; and
 - b. means are provided for releasably mounting said check valve in said first bore to permit retrieval of the check valve from the bore.
3. The structure set forth in claim 1, wherein:
- a. said valve means for each of said control valves includes a pair of valve elements adapted to move relative to each other;
 - b. means are provided for introducing fluid pressure from the first longitudinal bore to the area between the valve elements of the first control valve;
 - c. means are provided for introducing fluid pressure from said second longitudinal bore to the area below the valve elements of the first control valve;
 - d. means are provided for introducing fluid pressure from a first well formation to the area above the valve elements of the first control valve;
 - e. means are provided for introducing fluid pressure from the second longitudinal bore to the area between the valve elements of the second control valve;
 - f. means are provided for introducing fluid pressure from said first longitudinal bore to the area below the valve elements of the second control valve; and
 - g. means are provided for introducing fluid pressure from a second well formation to the area above the valve elements of the second control valve.
4. The structure set forth in claim 1, wherein each of said control valves includes:
- a. a valve chamber;
 - b. an upper valve element disposed in said valve chamber for longitudinal reciprocation;
 - c. a lower valve element disposed in said valve chamber for longitudinal reciprocation relative to and with said upper valve element;
 - d. the valve chamber for said first control valve having upper and lower passages connecting to said first longitudinal bore above and below said upper valve element and said lower valve element of said first control valve, respectively, and an intermediate passage connecting to said second longitudinal bore between said upper and lower valve elements of said first control valve; and
 - e. the valve chamber for said second control valve having upper and lower passages connecting to said second longitudinal bore above and below said upper valve element and said lower valve element of said second control valve,

respectively, and an intermediate passage connecting to said first longitudinal bore between said upper and lower elements of said second control valve.

5. The structure set forth in claim 4, wherein: in each of said control valves, said upper valve element has a larger surface area exposed to fluid pressure than said lower valve element whereby the upper valve element moves downwardly with the lower valve element to close flow through said chamber when the pressure above said upper valve element and below said lower valve element is the same and is greater than the pressure between said valve elements.

6. A communicating valve assembly for use with multiple pipe strings in a well having multiple well formations separated from each other by a well packer comprising:

- a. a valve body;
- b. said body having first longitudinal bore adapted to be connected to a first pipe string for establishing fluid flow between a first well formation in a well and the surface;
- c. said body having a second longitudinal bore adapted to be connected to a second pipe string for establishing fluid flow between a second well formation disposed longitudinally below the first well formation;
- d. a first control valve and a second control valve disposed for controlling fluid flow between said first longitudinal bore and said second longitudinal bore;
- e. each of said control valves having a pair of valve elements adapted to move relative to each other;
- f. means for introducing fluid pressure from the first longitudinal bore to the area between the valve elements of the first control valve while exposing the area thereabove and therebelow to the fluid pressure in the second longitudinal bore; and
- g. means for introducing fluid pressure from the second longitudinal bore to the area between the valve elements of the second control valve while exposing the area thereabove and therebelow to the fluid pressure in the first longitudinal bore.

7. The structure set forth in claim 6, wherein: one of the valve elements in each pair has a larger area than the other of the valve elements whereby an equal fluid pressure thereabove and therebelow forces them to a closed position to close off flow between the first and second bores when the pressure between the elements is less than that above or below same.

8. A communicating valve assembly for use with multiple pipe strings in a well having multiple well formations separated from each other by a well packer comprising:

- a. a valve body;
- b. said body having first longitudinal bore adapted to be connected to a first pipe string for establishing fluid flow between a first well formation in a well and the surface;
- c. said body having a second longitudinal bore adapted to be connected to a second pipe string for establishing fluid flow between a second well formation disposed longitudinally below the first well formation;
- d. a first control valve and a second control valve disposed for controlling fluid flow between said first longitudinal bore and said second longitudinal bore;
- e. each of said control valves having a pair of valve elements adapted to move relative to each other;
- f. means for introducing fluid pressure from the first longitudinal bore to the area between the valve elements of the first control valve;
- g. means for introducing fluid pressure from a source other than the first longitudinal bore to the areas above and below the valve elements of the first control valve;
- h. means for introducing fluid pressure from the second longitudinal bore to the area between the valve elements of the second control valve; and
- i. means for introducing fluid pressure from a source other than the second longitudinal bore to the areas above and below the valve elements of the second control valve.