United States Patent

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[54] **VALVE DEVICE**
15 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **137/608,** 137/614.11; 251/282
[51] **Int. Cl.** **F16d 1/00**
[50] **Field of Search** 137/608, 609, 614.13, 614.14, 614.21, 614.11; 251/282

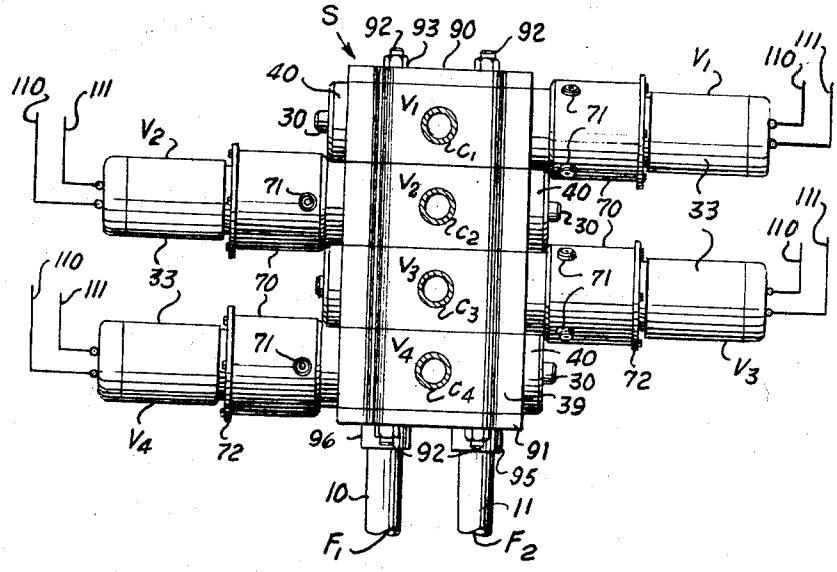
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ABSTRACT: A valve device having pressure-balanced spaced annular valve members movably mounted on an operator rod and movable relative to spaced valve seats in a valve body bore communicating with a central flow passage between the seats and a pair of flow passages spaced outwardly of the seats. The rod shifts each valve member individually relative to its seat for selectively communicating the central flow passage with either of the outwardly spaced flow passages, depending upon the direction of longitudinal movement of the rod. The valve is used singly or is assembled in stacked relationship with a plurality of identical valves with the outwardly spaced flow passages aligned and in communication with each other defining a pair of separate common flow passages extending the length of the stack. Each valve in the stack is individually operable to communicate its central flow passage with either of the common flow passages of the stack. The valve stack is especially useful for selectively communicating separate conduit lines leading to each of the individual valves with either of two conduit lines connected into the common flow passages of the stack.



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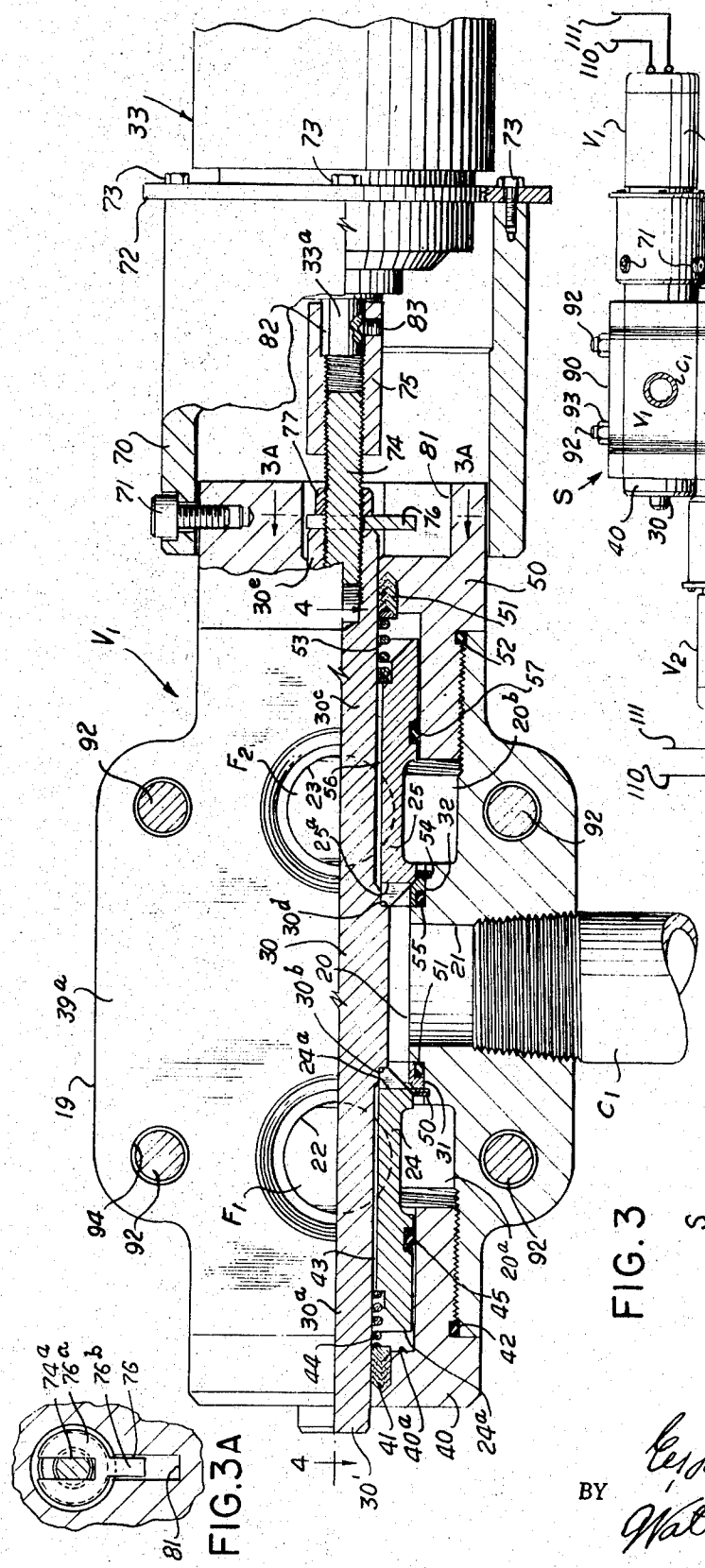


FIG. 3A

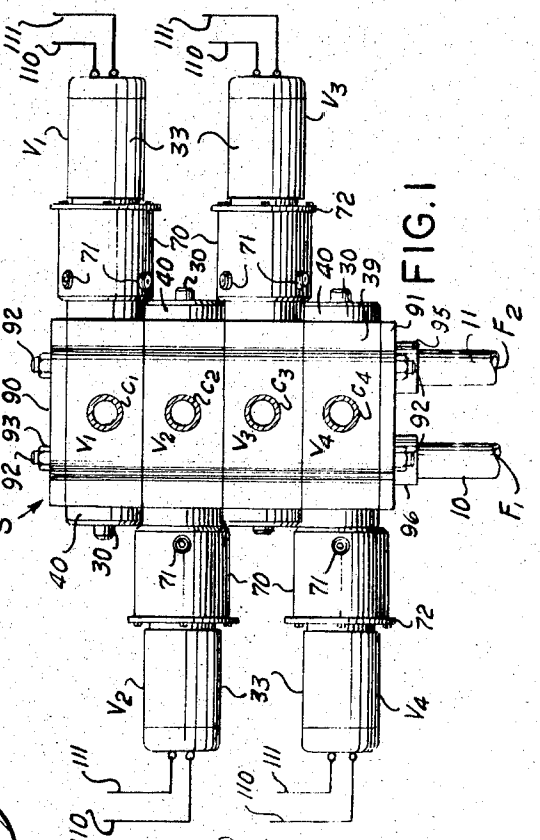


FIG. 1

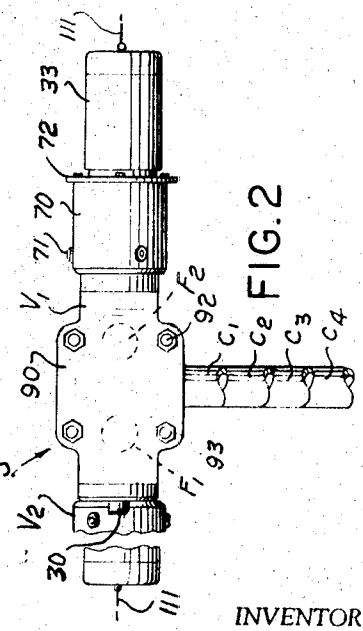


FIG. 2

FIG. 3

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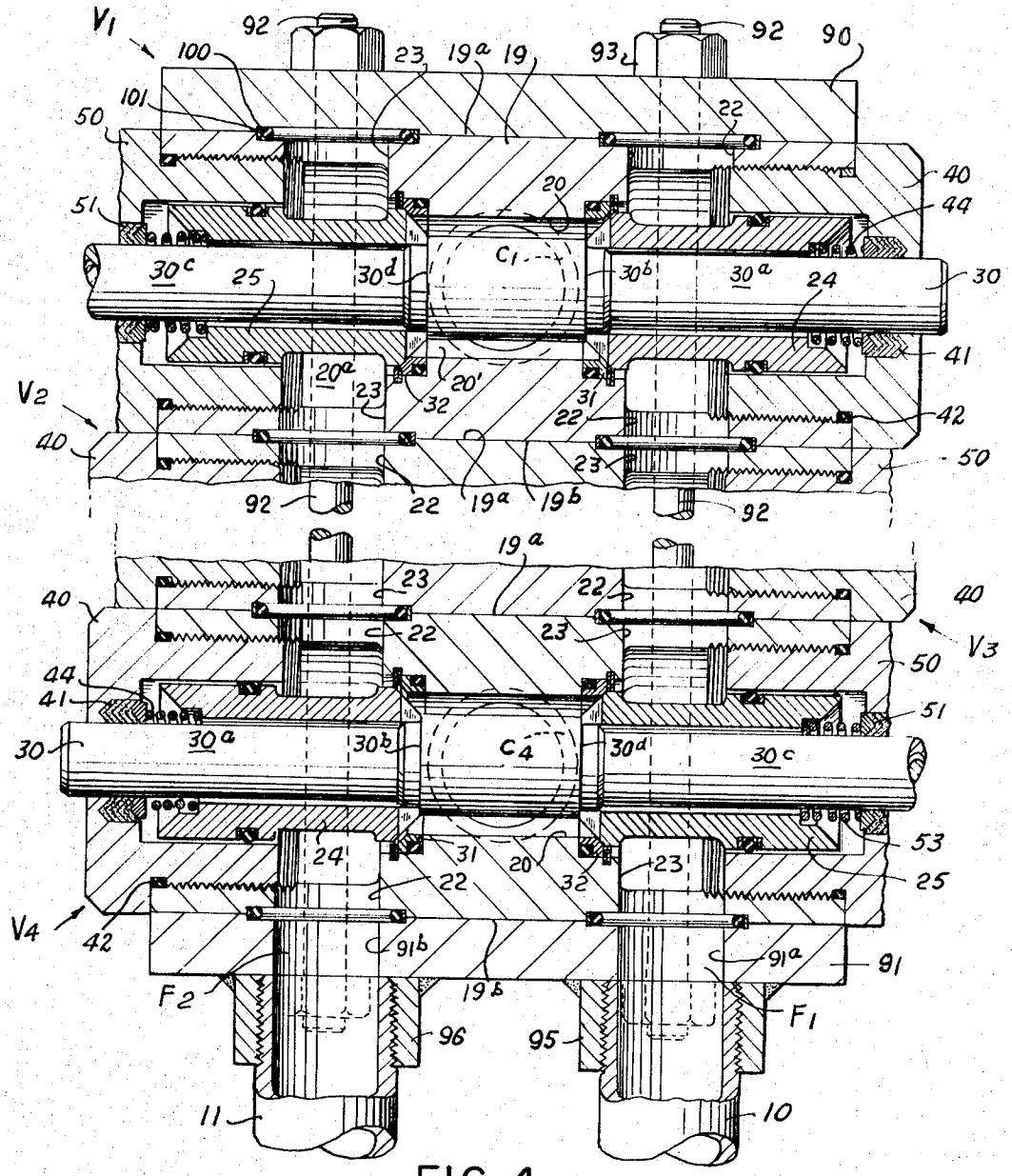


FIG. 4

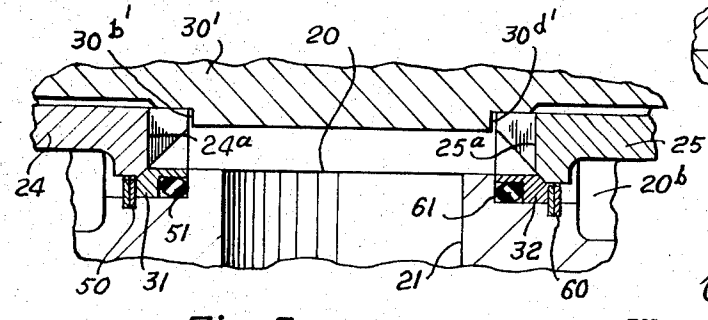


Fig. 5

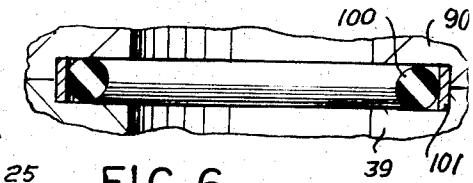


FIG. 6

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VALVE DEVICE

This invention relates to valves and more particularly to valves having pressure-balanced valve members for selectively communicating a plurality of flow passages for use either singly or in assembled stacked relationship.

It is one object of the invention to provide a new and improved valve.

It is a particularly important object of the invention to provide a valve having pressure-balanced valve means for selectively communicating a plurality of flow passages in the valve.

In accordance with a further object of the invention, one form of the valve includes spaced pressure-balanced valve members disposed in a bore of a body for movement by a valve operator rod between positions selectively communicating a first flow passage intersecting the bore with either of two additional flow passages spaced from the first flow passage.

It is a still further object of the invention to provide a valve having annular valve members each including flow passage means continuously communicating pressure to opposite end portions of each valve member so that it functions under balanced pressure conditions.

It is another object of the invention to provide in a valve of the character described an operator rod disposed in spaced relation through an annular valve member defining a flow passage along the rod through the valve member for communicating pressure to end positions of the valve member whereby the forces on the valve member resulting from fluid pressure are balanced.

It is another object of the invention to provide a valve of the character described wherein the operator rod is movable in one direction for opening one of the valve members and in the other direction for opening the other of the valve members and the valve members are each spring biased toward a closed position.

It is still a further object of the invention to provide a valve of the character described wherein the second and third flow passages do not communicate with each other and are not communicatable simultaneously with the first flow passage.

It is another object of the invention to provide a valve of the character described which has planar substantially parallel opposite body surfaces and a flow passage arrangement whereby the valve is usable alone or in multiples in juxtaposed stacked relation to provide a valve stack having a plurality of flow passages communicated through the valves in selected combination.

It is another object of the invention to provide a valve stack formed of valves of the character described for selectively controlling flow between individual conduit lines leading to each of the valves and flow passages common to all of the valves and extending through the stack.

It is a still further object of the invention to provide a valve stack comprising a plurality of individually operable valves of the character described for controlling flow between selected combinations of conduit lines connected into the stack.

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

FIG. 1 is a side view in elevation of a valve stack assembly embodying the invention;

FIG. 2 is a top plan view of the valve stack shown in FIG. 1;

FIG. 3 is an enlarged horizontal view partly in elevation and partly in section of the upper valve of the valve stack of FIG. 1;

FIG. 3A is a fragmentary sectional view along the line 3A–3A of FIG. 3;

FIG. 4 is a fragmentary vertical sectional view along the line 4–4 of FIG. 3 showing the top and bottom valves and portions of the intermediate valves in the valve stack of FIG. 1;

FIG. 5 is a further enlarged fragmentary sectional view of the lower central portion of a modified form of one of the valves showing inward adjacent end portions of the valve members and a central fragmentary portion of the operator rod; and

FIG. 6 is an enlarged fragmentary view in section of one of the ring seal arrangements between the valve bodies and with the end plates of the valve stack assembly.

Referring to the drawings, in accordance with one aspect of the invention, a plurality of substantially identical valves V1, V2, V3, and V4 are assembled in juxtaposed stacked relation to provide a valve stack S which is connected with a pair of conduit lines 10 and 11. The conduit lines 10 and 11 communicate respectively with common flow passages F-1 and F-2 which extend in parallel laterally spaced relation throughout the length of the valve stack so that each of the individual valves in the stack communicates through the common flow passages with the conduits 10 and 11. The individual valves V1—V4 are provided with individual conduit lines C1, C2, C3, and C4, respectively. Each of the valves is separately operable to selectively communicate its conduit line with either of the flow passages F1 and F2 through the valve stack. Thus, all of the lines C1—C4 are communicated with the line 10 or the line 11, or a portion of the lines C1—C4 are communicated with the line 10 and a portion with the line 11, as desired.

Each of the identical valves V1, V2, V3, and V4, embodying the invention, FIGS. 1 and 4, has a body 19 provided with a longitudinal horizontal bore 20 intersected by a central lateral horizontal bore 21, and laterally spaced vertical bores 22 and 23. In the stacked relationship of the valves, the aligned communicating bores 22 and 23 define the vertical common flow passages F1 and F2 through the entire valve stack. The conduit lines C1—C4 are each connected, respectively, into a lateral bore 21 of the valves V1—V4.

In accordance with one important feature of the invention, a pair of spaced annular pressure-balanced valve members 24 and 25 are disposed on a longitudinal operator rod 30 in the horizontal bore 20 for movement relative to valve seats 31 and 32, respectively, secured in the bore around the operator rod on opposite sides of the central bore 21 for selectively controlling communication between the bore 21 and either of the laterally outwardly spaced vertical bores 22 and 23. An actuator motor 33 connected with the operator rod moves the rod in opposite longitudinal directions to individually shift the valve members 24 and 25 relative to the seats 31 and 32 between open and closed positions. When one of the valve members is moved to open position by the operator rod, the other of the valve members is returned to closed position, so that the bore 21 is communicated with only one of the bores 22 and 23 at a time. Thus, each of the valves V1—V4 is individually operable for selectively communicating the conduit lines C1—C4, respectively, with either of the vertical flow passages F1 and F2 through the valve stack into the conduit lines 10 and 11.

The valve stack has a particularly important application, for example, in the production of wells where the conduit lines C1—C4 extend, respectively, to separate producing wells, not shown, while the conduit lines 10 and 11 function as a test line and a common flow line, respectively. When all of the wells are producing the operator rod of each of the valves V1—V4 may be positioned to communicate lines C1—C4 with the flow passage F2 through the valve stack so that the production fluids flow into the common flow line 11. When testing of one of the wells is desired, the valve for that particular well is shifted by means of its operator rod to communicate its flow with the test line 10. For example, the operator rod of the valve V1 maybe shifted in the opposite direction toward the valve member 24 to communicate its conduit line C1 with the flow passage F1 so that the production fluids flowing into the valve V1 through the conduit line C1 are directed into the test line 10, while the production fluids entering remaining valves V2, V3, and V4 flow through the passage F2 of the valve stack into the flow line 11. Thus, by manipulation of the several valves in the stack, any one or more of the valves may direct fluids into the test line 10 while the remaining valves direct fluids to the flow line 11; and, since the valves are independently operable any combination of valve positions can be effected.

In each of the identical valves V1—V4, the bore **20** of the body **19** is enlarged along opposite end portions **20***a* and **20***b* adjacent to and communicating with the laterally spaced vertical bores **22** and **23**, respectively.

The enlarged end portion of the bore **20***a* is sealed by a closure cap **40** threaded into the body **19** in slidable relationship over a reduced end portion **30***a* of the operator rod **30**. A seal assembly **41** supported by the closure cap **40** seals between the cap and the operator rod. A ring seal **42** is disposed around the closure cap within the body for sealing therebetween.

A The annular valve member **24** is disposed within the enlarged bore portion **20***a* and the cap **40** and surrounds the reduced operator rod end portion **30***a* for movement relative to the seat **31**. The bore of the valve member is larger than the diameter of the operator rod portion **30***a*, providing an annular space **43** within the valve member around the operator rod which communicates with the central portion of the bore **20** through circumferentially spaced end slots **24***a* of the valve member so that pressure from the central portion **20'** of the bore **20** is transmitted to the outward end portion of the valve member to provide for balancing of the member with respect to pressure, as further explained hereinafter. A spring **44** confined between the outward end of the valve member and the seal assembly **41** biases the valve member toward the seat **31** while the inward end of the valve member is engageable with an annular shoulder **30***b* on the operator rod for moving the valve member outwardly from the seat to an open position.

A ring seal **45** around the valve member within the closure cap **40** outward of the bore **22** seals around the valve member within the closure cap along a line of the same diameter as the line of sealing between the valve member and the seat **31**. The valve member is thus pressure balanced with respect to the fluid pressure around the member within the bore portion **20***a* between the seal **45** and the seal between the valve member and the seat **31**. The pressure in the central portion **20'** of the bore **20** acts on end portions of the valve member inward of the seat **31** and is communicated through the valve member in the annular space **43** to the end portions of the valve member outward of the seal **45** so that the valve member is balanced with respect to pressure.

The seat **31** is secured by a lock ring **50** in the body **19** between the central portion of the bore **20** and the enlarged portion **20***a* of the bore. A ring seal **51** seals between the body and the seat.

The operator rod **30** is moved toward its outward free end **30'** to shift the valve member **24** to an open position spaced from the seat **31**, FIG. **3**, to communicate the central portion of the bore **20** past the valve member **24** into the enlarged bore portion **20***a* for flow between the bore **21** connected with the conduit line **C1** and the laterally spaced vertical bore **22** of the valve.

At the opposite end of the valve, a closure member **50** is threaded into the body **19** in the enlarged bore end portion **20***b* for sealing around the operator rod and valve member **25** and connecting the actuator motor **33** with the valve. A seal assembly **51** disposed in the closure member around the operator rod seals between the closure member and the rod. A ring seal **52** seals between the body **19** and the closure member **50**.

The valve member **25** is disposed on the reduced end portion **30***c* of the operator rod within the enlarged valve body bore portion **20***b*, and is slidable slidably supported at one end in the bore of the closure member **50**. A spring **53** confined between the outward end of the valve member and the seal assembly **51** biases the valve member toward the seat **32** which is secured by a lock ring **54** in the body between the central portion and the enlarged portion **20***b* of the bore **20**. A ring seal **55** seals between the seat **32** and the body **19**.

The bore of the valve member **25** is larger than the reduced portion **30***c* of the operator rod providing an annular space **56** through the valve member along the rod which communicates through circumferentially spaced end slots **25***a* in the valve member with the central portion **20'** of the bore **20**. The inward end of the valve member is engageable with an annular shoulder **30***d* on the operator rod so that the valve member is moved by the rod outwardly to an open position spaced from the valve seat **32** when the rod is moved toward the actuator motor. The valve member is returned to a closed position against the seat by the spring **53** when the rod is moved in the opposite direction.

A ring seal **57** seals between the valve member and the closure member **50**. The line of sealing between the seal **57** and the closure member is the same diameter as the line of sealing between the valve member and the seat **32** so that the valve member is pressure balanced with respect to the pressure within the enlarged end bore portion of the bore **20** through the annular space **56** to the outward end portion of the valve member in the same manner as the valve member **24**.

When the valve member **25** is moved by the operator rod from the closed position shown in FIG. **3** to an open position spaced from the seat **32**, communication is established from the central portion **20'** of the bore **20** into the enlarged bore end portion **20***b* permitting fluid flow between the bore **21** and the laterally spaced vertical bore **23** of the valve.

An actuator mounting sleeve **70** is connected on the closure member **50** by a plurality of circumferentially spaced cap screws **71**. The actuator motor **33** is connected by a mounting plate **72** secured to the outward end of the sleeve **70** by cap screws **73**.

The operator rod **30** is moved longitudinally in opposite directions for manipulating the valve members **24** and **25** by a threaded drive rod **74** connected between the operator rod and the motor drive shaft **33***a* by an internally threaded coupling sleeve **75**. The drive rod is threaded along one end portion into an internally threaded counterbore in the end portion **30***e* of the operator rod **30** and along the other end portion into the sleeve **75**. A lug or guide member **76** is secured on the drive rod **74** against the end of the operator rod **30** by a nut **77** for holding the operator rod against rotation while permitting it to move longitudinally within the bore **20** of the valve body. The lug, FIG. **3A**, is bifurcated along an end portion **76***a* which spans the rod **74** along flats **74***a* formed externally of the drive rod holding the drive rod against rotation relative to the lug. The other end portion **76***b* of the lug slidably engages in a slot **81** in the closure member **50** holding the lug against rotation while allowing it to move longitudinally with the rods **30** and **74**. A longitudinal key **82** is disposed in aligned longitudinal slots on the motor shaft **33***a* and in the sleeve **75** so that the sleeve is rotated by the shaft. The sleeve is held on the shaft by a set screw **83**. When the sleeve **75** is rotated by the mt motor shaft relative to the operator rod **30** and drive rod **74**, which are held against rotation by the lug **76** engaged in the slot **81**, the drive rod **74** is moved toward or away from the motor shaft and sleeve due to the threaded engagement of the sleeve on the rod, the direction depending upon the direction of rotation of the motor. The drive rod **74** moves the rod operator **30** for shifting the valve members **24** and **25** between closed and open position. When the operator rod **30** is moved outwardly toward its free end the shoulder **30***b* on the rod forces the valve member **24** outwardly against the spring **44**, moving the valve member away from the seat **31** to open position. The shoulder **30***d* on the rod **30** moves away from the inward end of the valve member **25**, allowing the spring **53** to bias the valve member against the seat **32** to closed position. Rotation of the sleeve **75** in the opposite direction pulls the operator rod toward the sleeve, moving the valve member **25** to an open position, while the spring **44** forces the valve member **24** back to seated engagement with the seat **31**.

While in FIG. **3** the valve member **24** is only slightly open it will be recognized that each of the valve members is movable away from its seat to a position at which the outward end of the valve member engages the closure member in which the valve member is slidable. For example, the valve member **24** is movable to a full open position at which its outward end **24***a* engages the inner shoulder surface **40***a* of the closure member **40**.

In the form of the valve shown in FIG. 3, the shoulders 30*b* and 30*d* on the operator rod 30 are spaced to hold one of the valve members open at all times. Thus, as one valve member is closed, the other valve member is always opened. One of the valve members is held open at all times to minimize pressure build up in the line C1 by allowing pressure to constantly "-bleed-off" into either of the conduits connected with the bores 22 and 23 of the valve. Such constant pressure reduction is desirable where the conduit line C1 leads from a well and safety considerations preclude complete closure of the valve V1, which might permit the pressure in the conduit line C1 to increase to and remain at an unsafe level.

Each of the valves V1—V4 is provided with upper and lower substantially parallel finished planar body surfaces 19*a* and 19*b* permitting use of the valve singly and also allowing the valve bodies to be stacked in juxtaposed relation to form the valve stack S, FIGS. 1 and 4. The valves are clamped together between top and bottom closure plates 90 and 91 which are secured by bolts 92 extending through aligned bolt holes 94 in the bodies through the entire stack of valves, the end closure plates, and nuts 93. The lower closure plate 91 is provided with a pair of ports 91*a* and 91*b* which communicate the valve stack flow passages F1 and F2, respectively, with the conduit lines 10 and 11. Internally threaded nipples 95 and 96 may be secured, as by welding, to the bottom of the closure plate 91 for connection of the conduit lines 10 and 11, respectively, into the stack.

Ring seals 100 and backup rings 101 provide seals around each of the vertical bores 22 and 23 of the valve bodies between adjacent engaged body surfaces 19*a* and 19*b*, between the upper surface of the upper valve V1 and the top closure plate 90, and between the lower surface of the lower valve V4 and the bottom closure plate 91. Each set of ring seal and backup ring is disposed in aligned recesses in adjacent members around the bores being sealed. Each backup ring is disposed around a ring seal to prevent extrusion of the ring seal between the surfaces of the adjacent members. Pressure within the flow passages F1 and F2 of the valve stack biases the ring seals outwardly causing each to seal along the top and bottom edges of the backup ring at the surfaces of the members between which the seals are disposed.

The symmetry of the valve bodies and flow passage structure of the valves V1—V4 allows the valves to be aligned in opposite directions or in the same directions, and to be inverted with respect to each other without affecting the functioning of the valves individually or of the valve stack, so long as the laterally spaced vertical bores of the valve bodies are aligned to define two separate flow passages through the stack.

In the particular stack arrangement shown in FIG. 1, adjacent valves are oriented in opposite directions and inverted with respect to each other so that the operator motors are more accessible for servicing. Specifically, the valves V2 and V4 are oriented in opposite directions and inverted relative to the valves V1 and V3. The laterally spaced vertical bores 22 of the valves V2 V1 and V3 are aligned and communicate with the laterally spaced vertical bores 23 of the valves V2 and V4 defining the laterally spaced vertical flow passage F1 of the stack. Similarly, the laterally spaced vertical bores 23 of the valves V1 and V3 are aligned in communication with the laterally spaced vertical bores 22 of the valves V2 and V4 defining the laterally spaced vertical flow passage F2 of the stack.

Each of the valve actuator motors is connected to a source of electrical current by conductors 110 and 111, each set of conductors having switching means (not shown) to permit individual operation of the actuator motors so that the valves are each independently operable.

At the particular settings of the valves V1 and V4 in the stack S illustrated in FIG. 4, the top valve V1 communicates the flow conduit C1 with the flow conduit 10 through the vertical flow passage F1 of the valve stack. The operator rod 30 of the valve V1 is positioned toward the right, holding the valve member 24 spaced from the seat 31 communicating the central portion 20' of the bore 20 with the laterally spaced vertical bore 22 of the valve, permitting flow between the flow conduit C1 and the flow conduit 10 through the stack flow passage F1. The valve member 25 of the valve V1 is engaged with the valve seat 32 so that there is no fluid communication from the conduit C1 into the upper end portion of the other vertical flow passage F2 of the valve stack. The valve V4 is communicating the conduit line C4 with the valve stack flow passage F2. The valve rod 30 of the valve V4 is at a left position holding the valve member 24 at an open position spaced from the valve seat 31 so that fluid flowing into the stack through the conduit line C4 flows past the valve member 24 within the seat 31 into the laterally spaced vertical bore 22 o f the valve defining a lower end portion of the vertical flow passage F2 of the valve stack communicating with the flow conduit 11. The valve member 25 is held against the seat 32 by the spring 53 so that there is no fluid communication between the conduit C4 and the flow passage F1. The valve members of the valves V2 and V3 are not shown though it will be understood that they may be adjusted to communicate the conduit lines C2 and C3 with either of the lines 10 or 11, as desired.

A particularly important feature of the valve stack is the flexibility of adjustment of the individually operable valves V1—V4 to provide any desired combination of communication patterns between the conduit C1—C4 leading to the individual valves and the conduits 10 and 11 connected into the flow passages F1 and F2 of the valve stack. The valves may be set to communicate all of the conduits C1—C4 into the passage F1, into the passage F2, or one portion of the conduits into the passage F1 and the other portion into the passage F2.

While the valve stack S is shown to include four identical valves embodying the invention, the valves are usable either singly or in stacked relationship comprising any desired number of valves assembled as shown and already described. Irrespective of the number of valves included in the stack, the stack is closed at its opposite ends by the plates 90 and 91, so that the flow passages F1 and F2 defined through the stack by the communicating laterally spaced or offset vertical bores of the individual valves are closed at one end and at the other end communicate with conduit lines such as the lines 10 and 11. The conduits such as C1—C4 leading to each valve may all extend from one side of the stack or, due to the symmetry of the valve bodies, some of the valves in a stack may be aligned opposite to the other so that the conduits leading to the valves in the stack extend from opposite sides of the stack, as desired. Where a single valve is employed, the closure plates 90 and 91 are secured with the top and bottom faces 19*a* and 19*b*, respectively, of the single valve body 39. The vertical orientation of the stack has been given only by way of illustration. The assemblage of juxtaposed valves is equally adaptable to horizontal and other positions of orientation.

FIG. 5 illustrates a slightly modified form 30' of operator rod 30 usable in the valve to permit both valve members 24 and 25 to be at seated closed positions simultaneously when the operator rod is centrally positioned. The operator shoulders 30*b*' and 30*d*' which engage the inward ends of the valve members 24 and 25, respectively, are slightly closer together than the shoulders 30*b* and 30*d* on the operator rod 30 so that with the modified rod 30' the valve members are fully engaged with seats 31 and 32, respectively, at a central position of the operator rod, thus precluding flow between the bore 21 and both of the bores 22 and 23. All components used with the modified operator rod 30' are identical to the components already described and are thus denoted by the same reference numerals used in FIGS. 3 and 4.

While the operator motor 33 has been illustrated and described as a preferred means for moving the operator rod 30 longitudinally, it will be obvious that numerous other forms of apparatus may be employed for actuating the operator rod, such, for example, as solenoids, various forms of mechanical linkages, diaphragms, fluid motors, hydraulic pistons, and the like.

It will now be seen that a new and improved valve has been described and illustrated and that the valve includes pressure-balanced valve members movable between open and closed positions by an operator rod for selectively communicating one flow passage with one of a plurality of other flow passages.

It will also be seen that the valve member is provided with passage means for communicating opposite end portions of the valve member with fluid pressure resulting from fluid pressures in the valve.

It will also be seen that the valve operator rod has a reduced portion disposed in spaced relation through the valve member providing flow passage means through the valve member around the valve rod to provide a pressure-balanced valve member.

It will also be seen that the valve includes a body having a longitudinal bore intersected by a first central lateral bore and spaced second and third laterally offset or spaced bores on opposite sides of the first central bore, spaced annular valve members movably disposed within the longitudinal bore for movement relative to seat means supported within the body on opposite sides of the central bore for selectively controlling fluid flow between the central bore and either of the second and third laterally spaced or offset bores, and an operator rod disposed through the valve members for moving the valve members individually in the longitudinal bore relative to the valve seats.

It will be seen that the valve includes a body having planar, substantially parallel, opposite faces, and seal means thereon whereby a plurality of such valves may be assembled together to form a valve stack having common flow passages selectively communicated with flow passages of each individual valve in the stack.

It will also be seen that when the valve is to be assembled in multiple juxtaposed relation flow control is provided between conduits connected with each valve and conduits connected with flow passages common to all of the valves.

It will be seen that a new and improved valve stack has been described and illustrated for controlling flow between a plurality of conduit lines.

It will be further seen that the valve stack may include any desired number of independently operable valves and that corresponding flow passages of the valves are aligned with and in common communication with each other defining a plurality of flow passages extending through the entire valve stack, and that each valve selectively controls flow communication to said flow passages from a separate conduit line leading to such valve.

It will be further seen that a valve embodying the invention is usable singly for selectively communicating one conduit connected with the valve with any one of a plurality of other conduits connected with the valve.

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

We claim:

1. A valve device comprising: body means provided with bores defining first, and spaced second, third and fourth flow passages intersecting and communicating with said first flow passage; first means providing a first valve seat in said first flow passage between the intersection therewith of said second and third of said flow passages; first valve means slidable in said first flow passage relative to said first valve seat for controlling flow communication between said second and said first and between said first and said third flow passages; second means providing a second valve seat in said first flow passage between the intersection therewith of said second and said fourth of said flow passages; second valve means slidable in said first flow passage relative to said second valve seat for controlling flow communication between said second and said first and between said first and said fourth flow passages; operator means movable longitudinally in said first passage and extending slidably longitudinally through both said valve means, said operator means having means thereon between said first valve means and said second valve means selectively engageable with each of said valve means upon opposite longitudinal movement of said operator means for moving each said valve means relative to said valve seat associated therewith for controlling communication between said second flow passage through said first flow passage with said third flow passage, and between said second flow passage through said first flow passage with said fourth flow passage; means closing said first flow passage at the opposite ends thereof outwardly beyond said valve means slidable therein for confining fluid pressure within said first flow passage; said first valve means and said second valve means being each provided with passage means for communicating fluid pressure from said second flow passage to opposite end surface portions of said valve means for pressure balancing said valve means; first biasing means in said adjacent closed outer end portion of said first flow passage engaging said first valve means opposite said engagement of said first valve means with said first valve seat and biasing said first valve means toward said first seat; second biasing means in said adjacent closed outer end portion of said first passage engaging said second valve means opposite e said engagement of said second valve means with said second seat and biasing said second valve means toward said second seat; and actuator means operably connected with said operator means for moving said operator means to move said valve means relative to said seats.

2. A device as defined in claim 1, wherein said first valve means is an annular member and said second valve means is an annular member and said operator means extends longitudinally through both said first and second annular valve means and is means and is spaced therefrom to provide a fluid passage through each said valve means for pressure balancing both said valve means; said means on said operator means engageable with said first and second valve means comprising a pair of opposed shoulders on said operator means each movable to engage one of said first and second valve means upon longitudinal movement of said operator means to selectively move said one valve means relative to the valve seat with which it is associated to open said valve seat to flow therethrough, said biasing means biasing the other of said first and second valve means into engagement with its associated seat when said shoulder engageable with said other valve means is moved away from said other valve means.

3. A valve device of the character defined in claim 1, wherein: said actuator means operably connected with said operator means for moving each of said first and second valve means relative to said seat with which it is associated comprises: a rotatable power unit and a threaded member rotatably connected with said operator means.

4. A valve device as defined in claim 3 wherein said body means has parallel opposite side surfaces extending perpendicular to said third and fourth flow passages for stacking a plurality of said valve devices with said third and fourth flow passages in respective separate aligned flow communication to provide an assembly having a pair of spaced separate common flow passages selectively communicable by each valve device with said second flow passage in each valve device.

5. A valve device comprising: body means provided with a longitudinal bore closed at its opposite ends; said body means having a first central lateral bore defining a first flow passage communicating with the central portion of said longitudinal bore; said body means being provided with second and third laterally offset bores intersecting said longitudinal bore and spaced on opposite sides of said first central lateral bore and providing second and third flow passages communicating with said longitudinal bore; a pair of valve seat means within said body means around said longitudinal bore, one between said first lateral bore and each of said second and third laterally offset bores; a pair of valve means disposed in said longitudinal bore each movable longitudinally therein into and out of engagement with one of said valve seat means for selectively controlling communication between said first central lateral

bore and each of said second and third offset bores through said longitudinal bore; resilient means in said longitudinal bore biasing each of said valve means toward engagement with the one of said valve seat means with which it is engageable; and an elongate operator rod longitudinally movable within said longitudinal bore and slidably extending through each of said valve means and having opposed shoulders thereon operatively engageable with each of said valve means for selectively moving each of said valve means relative to the seat means with which said valve means is engageable for selectively controlling communication between said first central lateral bore and said second and third laterally offset bores, said operator rod and said valve means providing a longitudinal annular bypass flow passage therebetween for conducting fluid pressure to the opposite ends of said valve means and said operator rod for pressure balancing said valve means and said rod.

6. A valve device as defined in claim 5 wherein said body means has seal means along opposite side faces for assembly of said valve device in juxtaposed relation with a plurality of identical valves devices in juxtaposed relation.

7. A valve stack comprising a plurality of valve devices of the character defined in claim 5 secured in juxtaposed relation, said second and third laterally offset bores of said valve devices being aligned and connected in sealed flow communication to define a pair of spaced laterally offset continuous flow passages through said stack, said valve means of each valve device providing means for communicating each of said offset flow passages selectively with said first central lateral bore of each of said valve devices in said stack by manipulation of said valve men means by said operator rod in each of said valve devices.

8. A valve stack comprising: a plurality of valves secured in juxtaposed relation and having aligned communicating laterally offset flow passages defining a plurality of separate continuous offset outlet flow passages through said stack each selectively communicable with a separate central inlet flow passage into each of said valves; each of said valves including pressure-balanced valve means and operator means, said operator means engaging said valve means for moving said valve means between positions selectively communicating said separate central inlet flow passage of each valve with a selected one of said offset outlet flow passages through said stack.

9. A valve stack as defined in claim 8 wherein said valve means in each of said valves comprises a pair of spaced annular valve members disposed between said separate central inlet flow passage into said valve and said spaced offset outlet flow passages of said stack, and said operator means comprises a rod disposed through said valve members and having means thereon engageable with said valve members to move one of said valve members to open position responsive to longitudinal movement of said rod in one direction and the other of said valve members to open position responsive to longitudinal movement of said rod in the other direction.

10. A valve device comprising: a body having a longitudinal bore, a first lateral bore intersecting a central portion of said longitudinal bore, and second and third laterally spaced offset bores intersecting said longitudinal bore; at points spaced on opposite sides of said first lateral bore; a first annular valve seat secured in said body within said longitudinal bore between said first lateral bore and said second laterally spaced offset bore; a first annular valve member movably disposed in said longitudinal bore and engageable at an inward end with said first valve seat for controlling flow communication between said first lateral bore and said central portion of said longitudinal bore and said second laterally spaced offset bore; means for sealing between said body and said first valve member outward of said second laterally spaced offset bore; resilient means operatively associated with said first valve member for biasing said valve member toward said first valve seat; first closure means on said valve body closing said longitudinal bore outward of said first valve member; a second annular valve seat secured in said body within said longitudinal bore between said first lateral bore and said third laterally spaced offset bore; a second annular valve member movably disposed in said longitudinal bore and engageable at an inward end with said second valve seat for controlling flow communication between said first lateral bore and said central portion of said longitudinal bore and said third laterally spaced offset bore; means sealing between said body and said second valve member outward of said third laterally spaced offset bore; resilient means operatively associated with said second valve member for biasing said valve member toward said second seat; second closure means on said valve body closing said longitudinal bore outward of said second valve member; an elongate operator rod movably disposed longitudinally in said longitudinal bore and extending through said first and second valve members and said first and second closure means and having opposed shoulder means thereon between said valve members engageable with one of said valve members upon movement of said operator rod in opposite directions for selectively moving said one of valve members outwardly relative to the one of said valve seats engageable by said valve member; bypass passage means between said valve members and said operator and providing continuous flow communication between the opposite ends of said valve members for pressure balancing said valve members; and actuator means connected with one end of said operator rod outwardly of the adjacent closure means for moving said rod in said opposite longitudinal directions in said longitudinal bore for moving said valve members selectively between closed and open positions.

11. A valve stack comprising a plurality of valves of the character defined in claim 10 secured together in juxtaposed relation, said second and third laterally spaced offset bores of said valves being connected in aligned flow communication to define two separate laterally spaced offset flow passages through said stack, each of said valves being independently operable to selectively communicate each first lateral bore of each of said valves with either of said laterally spaced offset flow passages through said valve stack.

12. A valve device comprising: a body having substantially planar side surfaces aligned substantially parallel with each other and a longitudinal bore spaced between and extending along an axis substantially parallel with said side surfaces; said body having a first central lateral bore formed therein spaced between said parallel side surfaces intersecting and defining a flow passage communicating with the midportion said longitudinal bore and extending in substantially the same direction as said planar side surfaces of said body; said body being further provided with a pair of laterally spaced second and third offset bores extending substantially perpendicular to said planar side surfaces and opening at opposite ends through said planar side surfaces, said second and third bores being spaced on opposite sides of said first central lateral bore and intersecting said longitudinal bore whereby said first central lateral bore communicates with said second and third laterally offset bores through said longitudinal bore; a first valve seat secured in said body around said longitudinal bore between said first central lateral bore and said second laterally offset bore; a first annular valve member movably disposed within said longitudinal bore between said first central bore and said second laterally offset bore for movement relative to said first valve seat to engage said first valve seat for controlling flow communication between said first central lateral bore and said second laterally offset bore through a portion of said longitudinal bore; seal means on said first valve member sealing between said body and said first valve member outward of said second laterally offset bore; said first valve member having bypass flow passage means therethrough continuously communicating said central portion of said longitudinal bore inward of said first valve seat with said longitudinal bore outward of said seal means on said first valve member for pressure balancing said first valve member; resilient biasing means operatively connected with said first valve member for biasing said valve

member toward said first valve seat; closure means on said body closing said longitudinal bore outward of said first valve member; a second valve seat secured in said body around said longitudinal bore between said first central lateral bore and said third laterally offset bore; a second annular valve member movably disposed within said longitudinal bore between said first central bore and said third laterally offset bore for movement relative to said second valve seat to engagement therewith for controlling flow communication between said first central bore and said third laterally offset bore through said longitudinal bore; seal means on said second valve member sealing between said body and said valve member outward of said third laterally offset bore; said second valve member having bypass flow passage means therethrough continuously communicating said central portion of said longitudinal bore inward of said second valve seat with said longitudinal bore outward of said seal means on said second valve member for pressure balancing said second valve member; resilient biasing means operatively connected with said second valve member for biasing said valve member toward said second valve seat; closure means on said body outward of said second valve member for closing the outward end of said longitudinal bore; an operator rod slidably disposed longitudinally in said longitudinal bore and slidably extending through both said valve members and having opposed shoulder means thereon intermediate said valve members and engageable with said valve members for actuating said valve members to selectively move said valve members away from the valve seats with which they are engageable to communicate said first central lateral bore with either of said second and third laterally offset bores; and means connected with said operator rod for moving said rod in opposite longitudinal directions for selectively actuating said valve members.

13. A valve device as defined in claim 12 wherein said operator rod is disposed in spaced relation through each of said first and second valve members defining annular bypass flow passages through said members for pressure balancing said members.

14. A valve device as defined in claim 13 wherein said longitudinal bore of said valve body is enlarged along opposite end portions outward of said valve seats, said enlarged bore portion outward of said first valve seat communicating with said second laterally offset bore and said enlarged bore portion outward of said second valve seat communicating with said third laterally offset bore.

15. A valve stack comprising a plurality of valves of the character defined in claim 12 secured in juxtaposed relation, said side planar surfaces of said valve bodies of adjacent valves being engaged with each other with said second and third laterally offset bores of said valves disposed in aligned flow communication to define a pair of laterally spaced separate continuous flow passages through said stack; seal means supported between said valve bodies around said communicating laterally offset bores of said bodies for sealing around said bores between engaging adjacent body planar side surfaces; a first closure plate secured along the outside planar side face of the valve at one end of said valve stack; seal means supported between said first closure plate and said first end valve body side face around the second and third laterally offset flow passages of said body closed by said first closure plate; a second closure plate secured along the outside side planar face of the valve at the other end of said valve stack; and means on said second closure plate providing fluid communication therethrough with said spaced flow passages through said valve stack; seal means around said second and third laterally offset flow passages of said second end valve body between said body and said second closure plate; and means providing separate fluid communication to said first central lateral bore of each of said valves in the said stack; each of said valves being independently operable to selectively communicate said first central lateral bore of each of said valves with either of said laterally offset flow passages through said valve stack.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,556,147 Dated January 19, 1971

Inventor(s) Phillip S. Sizer and Thomas L. Elliston

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 11, omit "A"

Column 3, line 63, omit "slidable"

Column 4, line 49, omit "mt"

Column 8, line 33, omit "and is means"

Column 9, line 21, for "valves" read --valve--

Column 9, line 31, omit "men"

Column 9, line 61, omit the semicolon (;)

Signed and sealed this 18th day of May 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER,
Commissioner of Pate