United States Patent [19]

Wognum

[11] **3,726,312**

[45] **Apr. 10, 1973**

[54] **VALVE**

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[22] Filed: **June 7, 1971**

[21] Appl. No.: **150,405**

[52] **U.S. Cl.**.....**137/596.2**, 137/636.1
[51] **Int. Cl.**.....**F16k 11/00**
[58] **Field of Search**.....137/596, 596.2, 636, 137/636.1

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Primary Examiner—Henry T. Klinksiek
Assistant Examiner—Robert J. Miller
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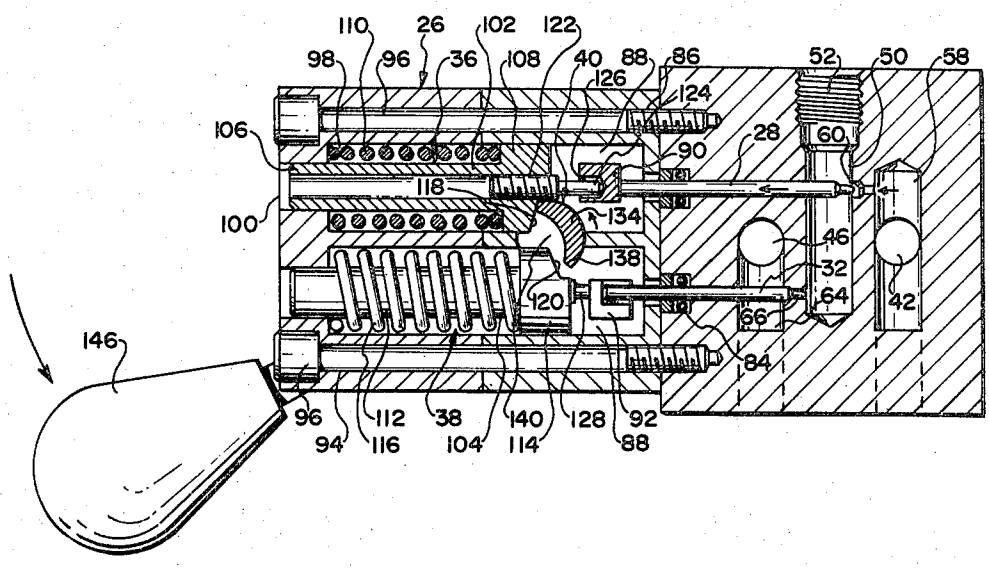
[57] **ABSTRACT**

A multi-position valve which provides throttling control. The valve includes a manifold having a first cylinder port, a second cylinder port, an exhaust port, an inlet port, a first valve port between the inlet port and the first cylinder port, a second valve port between the exhaust port and the first cylinder port, a third valve port between the inlet port and the second cylinder port, and a fourth valve port between the second cylinder port and the exhaust port. A plurality of valve rods, one of each is positionable in each of the valve ports, regulates the flow of fluid through the valve ports. Each pair of valve rods between the inlet and exhaust ports of each of the cylinder ports is connected to a yoke. A spring contacts each of the yokes to urge the respective valve rods into a closed attitude relative to the respective valve ports.

18 Claims, 16 Drawing Figures



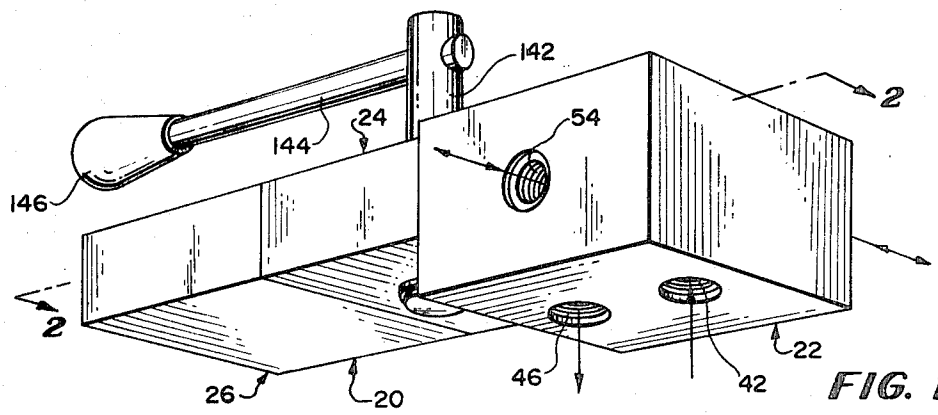


FIG. 1

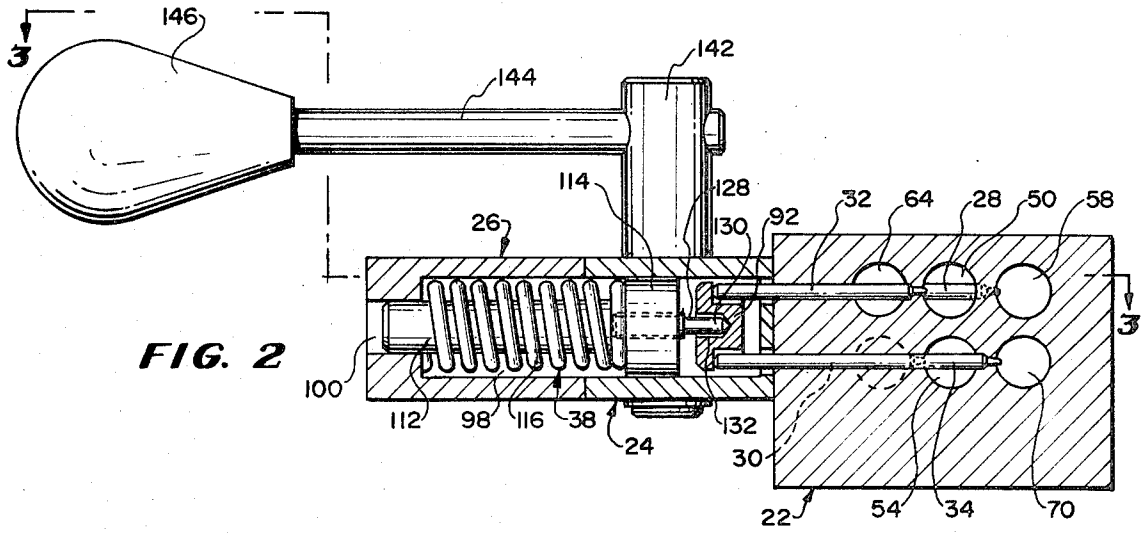


FIG. 2

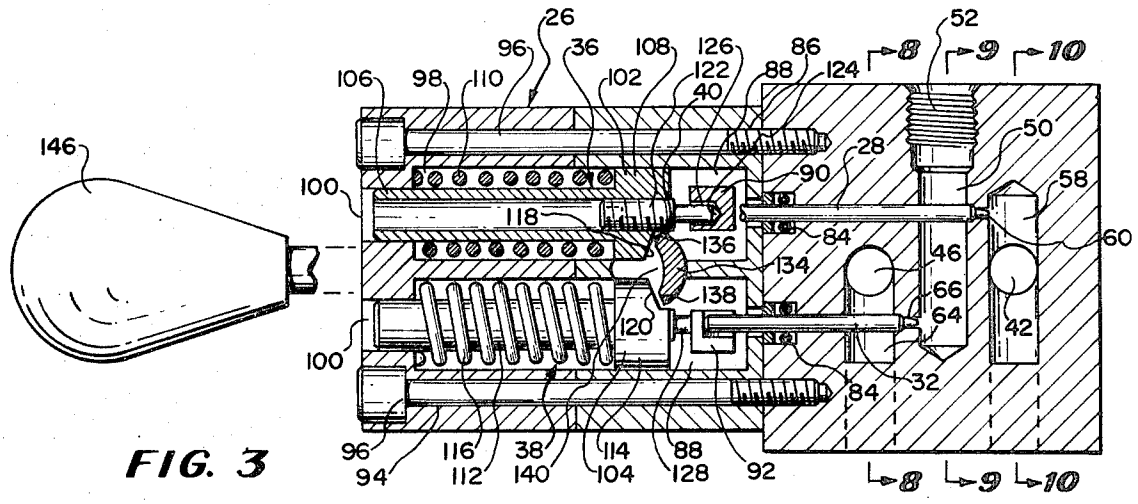


FIG. 3

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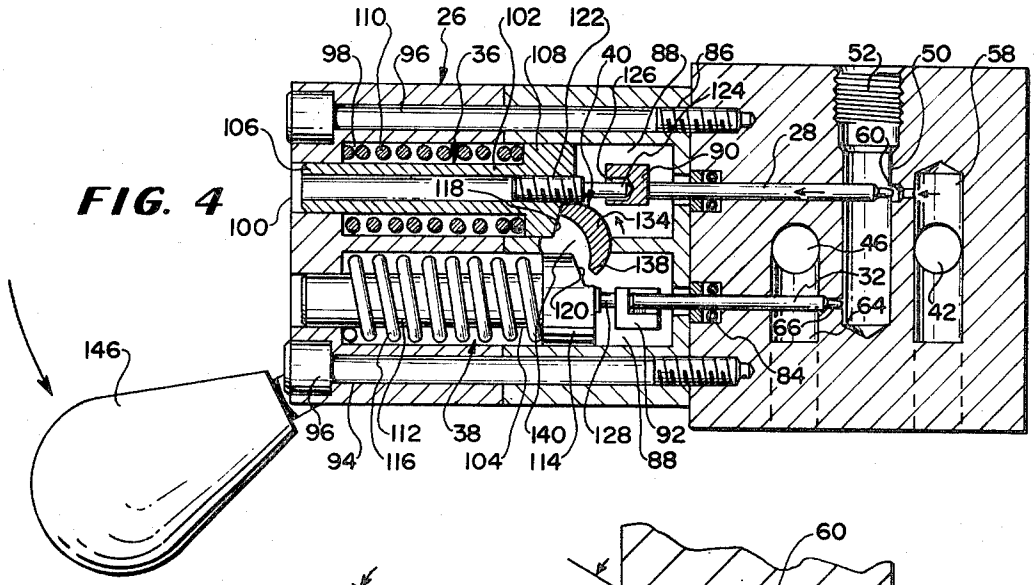

FIG. 4

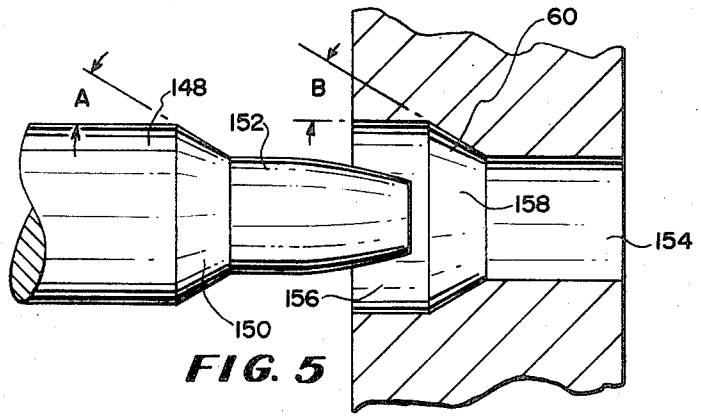

FIG. 5

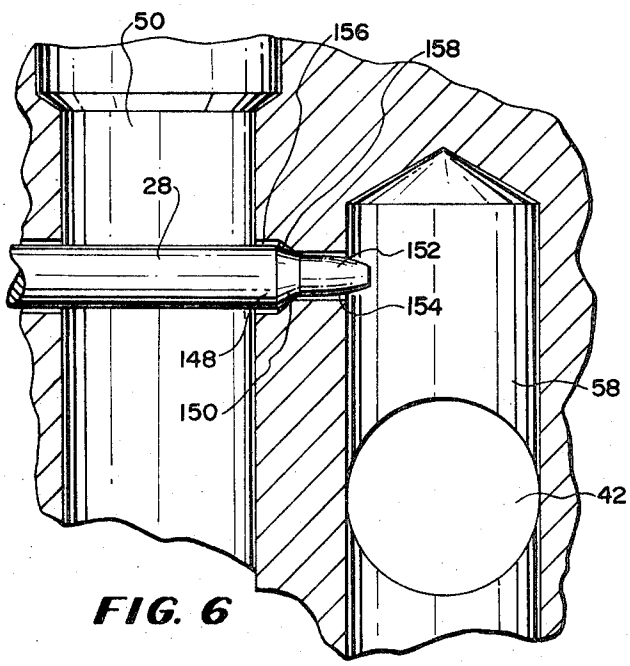

FIG. 6

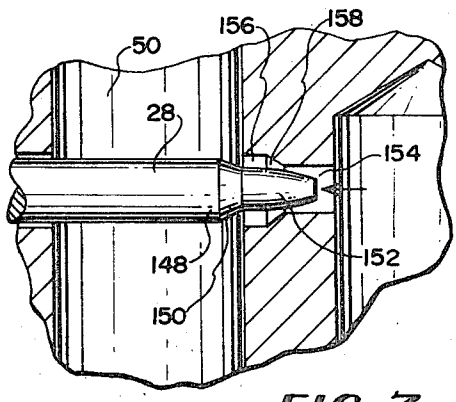

FIG. 7

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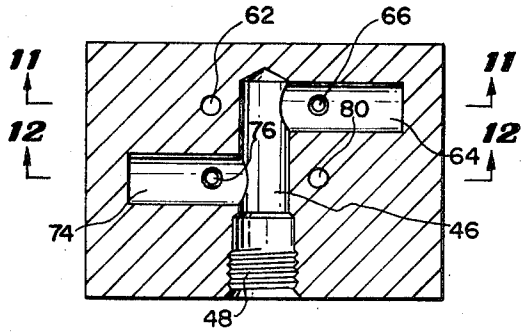

FIG. 8

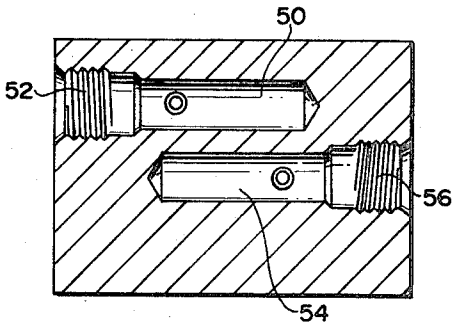

FIG. 9

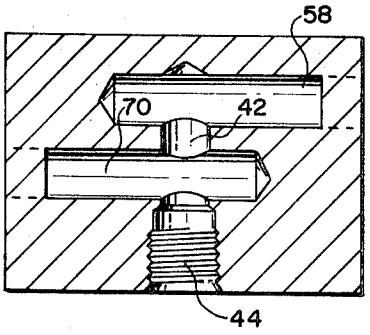

FIG. 10

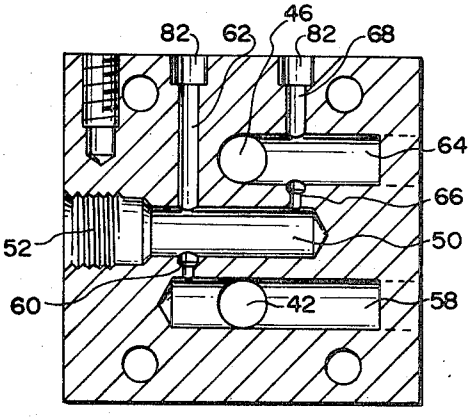

FIG. 11

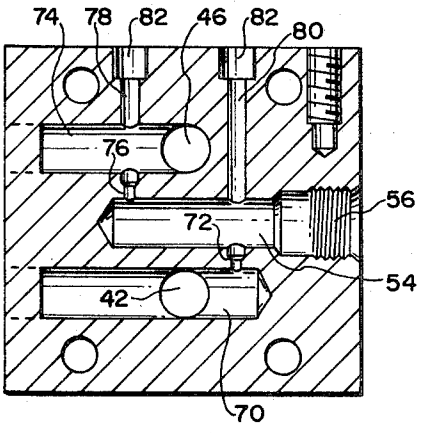

FIG. 12

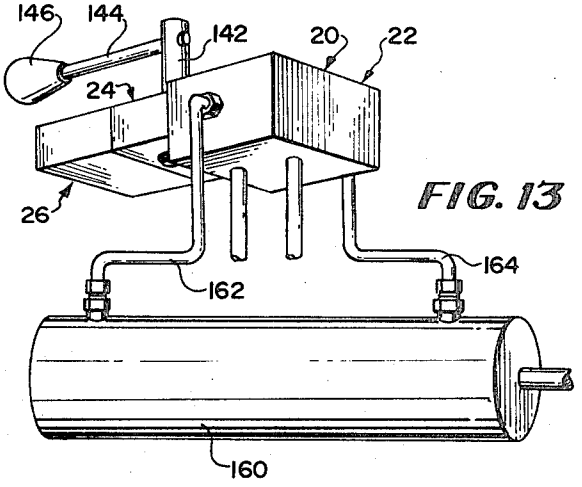

FIG. 13

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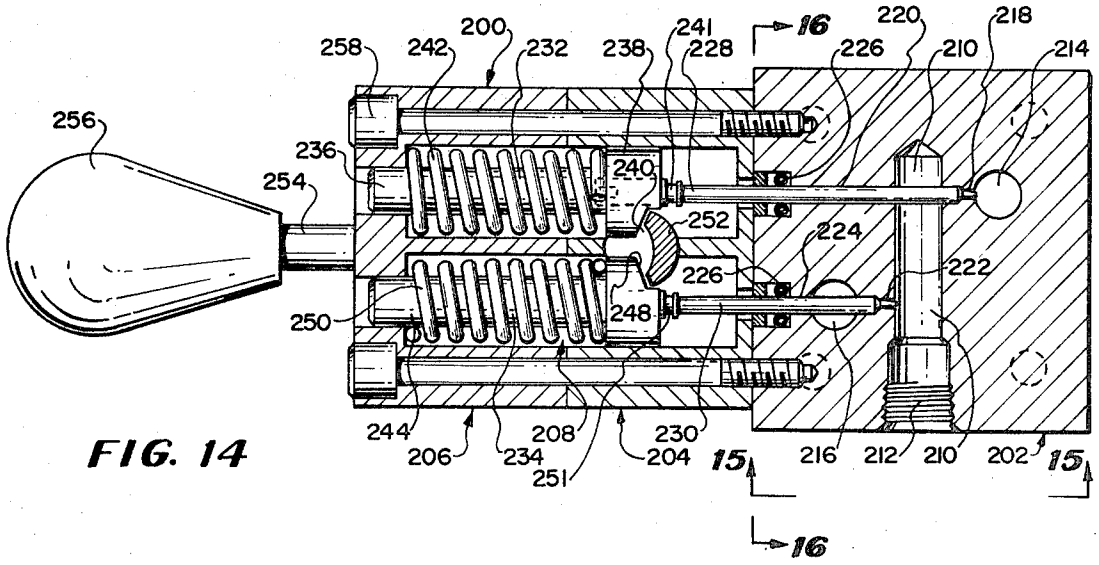

FIG. 14

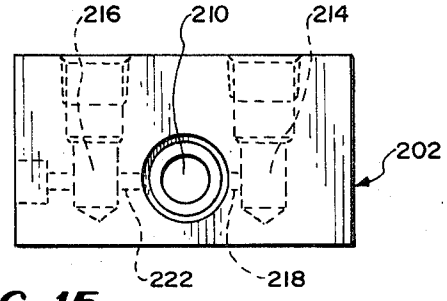

FIG. 15

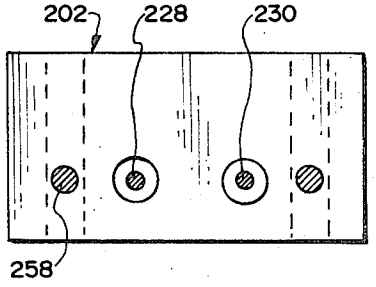

FIG. 16

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VALVE

BACKGROUND OF THE INVENTION

In many applications of fluid-powered devices, it is necessary to effect a fine control of certain devices, such as, lifts, rams, clamps and booms. The control systems for these fluid-powered devices include what is commonly known as a three-way or a four-way valve. The normal construction of a three-way or four-way valve is a spool-type valve or a disc-type valve. These valves operate quite satisfactorily in a go, no-go operation, that is, when they are either on or off. It may be appreciated that in many applications, it is required to slow down the operation of a device so that the device will move at a very slow rate. The use of spool-type or disc-type valves for a throttling operation is not satisfactory because the change in rate of fluid flow is relatively large for small increments of movement of the valve control lever. This gives a jerky flow of fluid to the operating device and thus results in a jerky motion of the controlled device. In many instances, this type of motion is not only unsatisfactory but completely disruptive to the normal operation of the device.

SUMMARY OF THE INVENTION

The valve construction disclosed herein provides a three-way or a four-way flow control valve. The valve utilizes a manifold which has an exhaust port and an inlet port. An appropriate number of cylinder ports are provided. Valve ports provide communicating paths between the inlet port and cylinder port and between the exhaust port and cylinder port. The valve ports have valve rods positioned in each of the ports to regulate the rate of flow of fluid therethrough. An important aspect of the invention is that the positioning of the valve ports and valve rods is such that the flow of liquid through each valve port is always against the respective valve rod. Springs are connected to the valve rods to urge the valve rods towards a closed position. A cam is selectively connectable with the springs for retracting selected springs, thereby allowing the force of the liquid to push back a selected valve rod to open a given valve port.

In a four-way valve construction, there are two pairs of rods and the rods of each pair are interconnected by yokes which pivotedly engage the respective rods. The rods with the yokes are urged toward a closed attitude by springs. However, the connection between the springs and the yokes is also a pivotal connection which allows the yokes to pivot and thereby have a balanced force on the yokes through positioning of the valve rods in the valve ports. It is therefore a principal object of this invention to provide an improved valve construction having a three-way or four-way valve control which allows the valve to provide a smooth throttling flow through the valve without chatter.

It is another object of the present invention to provide an improved valve construction which allows a balanced flow of liquid to flow from one side of a hydraulic cylinder to another.

It is a still further object of the herein-disclosed invention to provide an improved valve construction which may be easily manufactured and conveniently assembled.

It is still another object of the present invention to provide a valve construction which has essentially no leakage through the valve.

It is another object of the instant invention to provide a valve which is lever-controlled and is spring-centered.

It is a still further object of this invention to provide a lever-controlled valve which will remain in a selected position.

Other objects and uses of the present invention will become readily apparent to those skilled in the art upon a perusal of the following specification in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a four-way valve embodying the present invention;

FIG. 2 is a cross-sectional view taken on Line 2—2 of FIG. 1, showing a side elevation of a portion of the valve of FIG. 1;

FIG. 3 is a cross-sectional view taken on Line 3—3 of FIG. 2, showing a cross-sectional plan view of the valve shown in FIG. 1;

FIG. 4 is similar to FIG. 3, but showing a cam in an operative position to retract one of the springs of the valve;

FIG. 5 is an enlarged view of one of the ports of the valve and a portion of one of the valve rods;

FIG. 6 is an enlarged cross-sectional view, showing a valve rod in a closed attitude in one of the ports;

FIG. 7 is similar to FIG. 6, but showing the valve rod of FIG. 6 in a partially retracted position to show the throttling flow position;

FIG. 8 is a cross-sectional view taken on Line 8—8 of FIG. 3, showing an exhaust port and a pair of branches from the exhaust port;

FIG. 9 is a cross-sectional view taken on Line 9—9 of FIG. 3, showing a pair of cylinder ports;

FIG. 10 is a cross-sectional view taken on Line 10—10 of FIG. 3, showing an inlet port and a pair of branches;

FIG. 11 is a cross-sectional view taken on Line 11—11 of FIG. 8, showing a first cylinder port and the interconnection with the inlet port and the exhaust port;

FIG. 12 is a cross-sectional view taken on Line 12—12 of FIG. 8, showing the interconnection of a second cylinder port with an inlet port and an exhaust port;

FIG. 13 is a perspective view, showing the valve of FIG. 1 connected to a hydraulic cylinder;

FIG. 14 is a plan cross-sectional view of a valve embodying the herein-disclosed invention;

FIG. 15 is a side elevational view of a manifold block of FIG. 14; and

FIG. 16 is a cross-sectional view taken on Line 16—16 of FIG. 14.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and especially to FIG. 1, a four-way hydraulic valve embodying the present invention generally indicated by numeral 20 is shown therein. The valve 20 generally includes a manifold block 22, a cam block 24 connected to the manifold block, a spring block 26 connected to the cam block, four valve rods 28, 30, 32 and 34 slideably mounted in the manifold and cam blocks, a valve operator 36 urged against the valve rods 28 and 30, and a valve operator 38 urged against the valve rods 32 and 34. A cam assembly 40 is mounted in the cam block 24 for engagement with the valve operators.

The construction of the manifold 22 may be best seen in FIGS. 8 through 12. As may be seen in FIG. 10, the manifold 22 includes an inlet port 42 which is particularly adapted for connection to a source of hydraulic fluid under pressure. The port 42 has a threaded opening 44 to provide a suitable means for connecting the port to an appropriate hydraulic fitting. FIG. 8 shows an exhaust port 46 which has a threaded opening 48 for connection to a hydraulic fitting. Positioned between the inlet port and the outlet port 46 is a first cylinder port 50 having a threaded opening 52 on one side of the manifold and a second cylinder port 54 having a threaded opening 56 on the other side of the manifold. The axis of the cylinder ports 50 and 54 are parallel to each other and are positioned between the inlet and outlet ports. Looking now to FIG. 11, the first cylinder port 50 is shown with its connections to the inlet port 42 and the exhaust port 46. The inlet port 42 has a branch 58, which branch is parallel to the first cylinder port 50. A first valve port 60 is positioned between the branch 58 of the inlet port and the cylinder port 50. The valve port 60 has aligned therewith an axial rod aperture 62 which extends from the branch 58 to the side wall of the manifold. The valve rod 28 is slideably mounted in aperture 62 and is positionable in valve port 60 to regulate the flow of a hydraulic fluid therethrough. The exhaust port 46 has a branch 64 which is also parallel to the first cylinder port 50. A second valve port 66 is positioned between the branch 64 and the first cylinder port to provide communication between the first cylinder port and the exhaust port 46. A second axial rod aperture 68 is aligned with the second valve port 66 to receive the valve rod 32. The valve rod 32 regulates the flow through valve port 66.

Turning now to FIG. 12, the second cylinder port 54 is shown therein connected to the inlet port 42 and the exhaust port 46. The inlet port 42 includes a branch 70. A third valve port 72 is positioned between the branch 70 and the second cylinder port 54 to provide a communication path between the branch 70 and the second cylinder port 54. The exhaust port 46 has a branch 74 communicating therewith, which branch 74 is parallel to the second cylinder port 54 and the branch 70. A fourth valve port 76 is positioned between the branch 74 and the cylinder port 54 to provide a communicating path between the second cylinder port and the exhaust port 46. A pair of parallel axial valve rod apertures 78 and 80 is aligned with the valve ports 76 and 72, respectively, for receiving the valve rods 34 and 30, respectively. Aligned with each of the axial valve rod apertures 62, 68, 78 and 80 is an axial sealing recess 82 which receives a sealing assembly 84 for sealing the space between respective valve rod to the manifold.

The cam block 24 includes a plurality of screw apertures 86 and a pair of yoke apertures 88. A yoke 90 is positioned in one of the yoke apertures 88 in engagement with the valve rods 28 and 30. A second yoke 92 is positioned in the other yoke aperture 88 in engagement with the valve rods 32 and 34. All of the valve rods are pivotedly engageable with the respective yokes.

The spring block 26 has a plurality of screw apertures 94 which are aligned with the screw apertures 86 and have positioned therein screws 96 which secure the spring block and the cam block to the manifold. The spring block 26 has a pair of spring recesses 98 with an axial aperture 100 aligned with each recess. A spring plunger 102 is positioned in one of the spring recesses, with one end in the respective axial aperture 100. A second spring plunger 104 is positioned in the other spring recess and has the other end positioned in the respective axial aperture. The spring plunger 102 includes a hollow body 106 with an internally threaded head 108 formed integral therewith. A compression spring 110 is mounted on the body 106 in engagement with the head 108. The spring 110 constantly pushes the head 108 toward the yoke 90. The plunger 104 is identical in its construction to the plunger 102 in that it also includes a hollow body 112 with an internally threaded head 114 formed integral therewith. A compression spring 116 is mounted on the body 112 in engagement with the head 114 to urge the head 114 constantly toward the yoke 92. The head 108 has a camming surface 118 formed thereon, and the head 114 has a like camming surface 120 formed thereon.

A pivot pin 122 is threadedly mounted in the head 108 and has a pivot head 124 positioned in a pivot head recess 126 of yoke 90. A like pivot pin 128 is threadedly mounted in the head 114 and has a pivot head 130 positioned in a pivot head recess 132 of yoke 92.

The cam assembly 40 includes a cam 134, which is pivotedly mounted in the cam block 24. The cam 134 includes a camming surface 136 which is engageable with the camming surface 118 and a camming surface 138 which is engageable with the camming surface 120. The cam also includes a cam recess 140 between the camming surfaces 138 and 136, which recess allows the cam to be rotated to achieve a maximum displacement of one of the spring plungers without affecting the other. The cam is fixed to and rotates with a cam post 142 which has fixed thereto an arm 144. A handle 146 is fixed to the arm 144 to provide a convenient means for turning the cam.

Each of the valve rods 28, 30, 32 and 34 has an identical sealing end, which is best shown in FIGS. 5, 6 and 7 and will be described in detail herein. Each of the four valve ports 60, 66, 72 and 76 also has an identical construction, which is best seen in FIG. 5 and will be described in detail hereinafter. Referring now to FIG. 5, each valve rod includes a valve rod body which has on one end a tapered bevel or crown 150 extending to a tapered nose 152. It may be seen that the nose 152 has a tapered portion for reasons which will become apparent hereinafter. It should be noted that the angle between the bevel and the body, which is identified as angle A, is in this instance 29.5°. Each valve port includes a passage 154 and a rod aperture 156 with a valve seat 158 between the passage 154 and the rod aperture 156. The seat 158 is beveled, and the angle of the bevel between the axis of the opening is identified as angle B in FIG. 5 and in this instance is 30°. It should be noted that when each of the seats is formed, it is formed at an angle of 30° and the taper of the crown 150 of each of the rods is at an angle of 29.5°. When the valve is initially assembled, the difference in the angles of the two tapers causes the crown 150 to be coined into the seat 158 so that there is a perfectly snug fit between the parts, thereby providing a perfect seal

which does not allow fluid to leak past the mating surfaces of the rod and port.

Looking now to FIG. 13, which shows an application of the valve 20, it may be seen how one of the cylinder ports may be connected to a cylinder 160 through piping 162, and the other cylinder port is connected to the opposite end of the cylinder 160 by piping 164.

It may be appreciated that the manifold 22 may be simply and economically manufactured. The inlet port 42 is drilled into the block of the manifold, and the threaded opening 44 is threaded therein. The branches 58 and 70 are drilled into the manifold, and the open ends are then plugged. The outlet 46 is also drilled into the block parallel to the inlet port, and branches 64 and 74 are drilled into the manifold, intersecting the outlet. The open ends of the branches are also plugged. The cylinder ports 50 and 50 are also drilled into the block, and the threaded openings 52 and 56 are threaded into the opening. The axial rod apertures 62, 68, 78 and 80 are drilled into the port, and the appropriate valve ports are also drilled and the seats are formed. It may be appreciated that all of these drilling operations may be done simply and economically to provide an operative manifold.

It may be appreciated that the instant valve construction may be simply and economically assembled, and that the adjustment of the particular valve may be easily accomplished by moving the two pivot pins 122 and 128 axially relative to the spring plungers 102 and 104 to apply the spring force to the yokes 90 and 92 and the valve rods which are in respective engagement with the yokes.

When it is required to move the rod of the cylinder 160 inward, the handle 146 is moved in the direction shown in FIG. 4 so that the cam surface 136 engages the cam surface 118 of the plunger 102 to push back the plunger against the force of the compression spring 110. This allows the pressure of the fluid on the inlet port to force the valve rod 28 to the left to the attitude shown in FIG. 4, thereby allowing fluid to flow to the cylinder and force a piston in the cylinder to the left, as viewed in FIG. 13. It may be appreciated that the fluid behind the piston is then pushed through piping 162 into the other cylinder port, and thus a force is applied to the end of the valve rod 30. Since the force of the spring on the yoke 90 is relieved by the action of the cam 134, the force of the fluid displaces the rod until it engages the yoke 90, allowing the fluid from behind the piston to be expelled out through the valve port 76 and to the exhaust port 46. It is important to note that since the rod of the cylinder 160 is also being drawn in at the same time, much more liquid must be expelled from behind the piston as liquid is added to the piston for the same amount of movement of the piston in the cylinder. The instant arrangement allows for a balancing of the operation of the valves. As the pressure is built up behind the piston, the rod 30 is pushed out further than the rod 28 since the yoke 90 can pivot on pivot head 124, thereby achieving a balanced flow of fluid.

It is also important to note that the present construction allows the instant valve to be used in a throttling operation. FIG. 6 shows a valve rod in a completely closed or seated attitude, whereby there is no flow of fluid. It may be appreciated that by appropriate rotation of the cam 134, the appropriate spring may be retracted only slightly so that the pressure of the fluid pushes the nose of the rod out only slightly to the attitude such as that shown in FIG. 7, wherein the nose 152 is still in the passage 154, restricting the flow of fluid through that passage and to have a limited flow. It is important to note that the flow of fluid is in the same direction as the direction in which the valve rod is displaced, thereby eliminating chatter of the valve rod, thus providing a smooth and uniform flow of the fluid. This particular arrangement allows the flow of fluid to be even a minuscule flow, but at a steady, even rate which allows a very fine throttling of a device which is operated by a fluid.

The valve 20 is adjusted to an open center very simply so that the ports are selectively closed. In order to make the valve an open-center valve, the pivot pins 122 and 128 are retracted in their respective plunger heads 180 and 114 by inserting a tool into the respective hollow bodies and turning the pivot pins. When the pivot pins 122 and 128 are pulled back, the valve rods are pushed back by the fluid flowing through the valve ports, also pushing back the respective yokes. Thus, there is a flow of liquid constantly through the valve ports. Since the valve rods are retracted, the springs 110 and 116 hold the plunger heads in engagement with the cam 134.

In order to close a pair of valve ports, the cam 134 is rotated, which retracts further one of the spring plungers and allows the other spring plunger to move toward the valve ports, thereby positioning the nose of each of the valve rods connected to the other spring plunger into its respective valve port. When the cam is sufficiently rotated, a pair of valve ports is closed. It may be appreciated that in this instance the two camming surfaces 136 and 138 are in constant engagement with the respective heads and the cam disengages the head only when one of the yokes is in a position wherein the valve ports are completely closed since it is necessary for the valve rods to seat completely to prevent further inward motion of the spring plunger.

It is apparent that the pivot pins need not be retracted to such a degree that the noses of the respective valve rods are completely out of the valve ports. Thus, there may be a very fine control of the flow of fluid through the valve ports without any chatter of the valve.

Referring now to FIGS. 14 through 16, a three-way valve generally indicated by numeral 200 embodying the present invention is shown therein. Valve 200 generally includes a manifold block 202, a cam block 204 and a spring block 206 with a valve operator 208 mounted therein.

The manifold block 202 includes a cylinder port 210 having a threaded opening 212 for receiving a fitting. An inlet port 214 opens on one side of the block, and an exhaust block 216 opens on the same side of the block. A first valve port 218 provides a communication path between the inlet port 218 and the cylinder port 210. An axial rod aperture 220 is aligned with the first valve port 218. A second valve port 222 provides communication between the exhaust port 216 and the cylinder port 210. A second axial rod aperture 224 is aligned with the second valve port 222. Seals 226 mounted on the end of the axial rod apertures are

identical to the seals 84. The specific construction of the valve ports 218 and 222 is identical to the construction of the valve ports in manifold block 22 set forth in detail above.

Slideably mounted in the axial rod apertures 220 and 224 are valve rods 228 and 230, respectively. The rods 228 and 230 have a nose identical to the construction of the valve rods described in detail above. The rod 228 is sealingly engageable with the first valve port 218 for regulating the flow through that port, and the rod 230 is engageable with the second valve port 222 for controlling the flow of fluid through that valve port.

The valve operator includes a pair of spring plungers 232 and 234 which are identical in construction to the spring plungers 102 and 104. The spring plunger 232 includes a hollow body 236 with a head 238 formed thereon. The head 238 has a cam surface 240 formed integral therewith. A dog pointed set screw 241 is threadedly mounted in the head 238 and may be axially positioned relative to the plunger. The set screw 241 is engageable with rod 228 for axially positioning the rod. A compression spring 242 is mounted on the hollow body 232 in engagement with the head 238. The spring plunger 234 includes a hollow body 244 and a head 246 formed integral therewith. A cam surface 248 is formed on the head 246. A compression spring 250 is mounted on the hollow body 244 in engagement with the head 246. A dog pointed set screw 251 is threadedly mounted in the head 246 so that it may be positioned axially relative to the spring plunger. The set screw 251 is engageable with rod 230 for positioning the rod.

A cam 252 is rotatably mounted in the cam block 204 and is engageable with the cam surfaces 240 and 248. The cam is connected to an arm 254 and handle 256, whereby the cam is positioned relative to the cam surfaces.

A plurality of screws 258 which are identical to screws 96 hold the cam block and the spring block in engagement with each other and mounted onto the manifold block 202.

The valve 200 is adjusted in the same manner in which the valve 20 is adjusted so that the force of the springs 242 and 250, applied to the plunger rods, is transmitted by the valve rods axially relative to the springs. In order to release one of the valves, the handle 256 is rotated so that the cam 252 retracts either one or the other of the spring plungers and allows the fluid to flow through the appropriate valve port. It should be noted that as with the aforementioned valve 20, the fluid flow is against the valve rod so that the throttling may be quite close.

The valve 200 is also adjustable to an open center in the same manner in which valve 20 is adjusted. The set screws 241 and 251 are adjusted in their respective plunger heads 238 and 246 so that the heads are in engagement with the cam 252 while the rods are out of contact with their respective valve ports. When the cam 252 is rotated, one of the rods is forced to move into closing engagement with its respective valve port.

Although a specific embodiment of the instant invention has been shown and described in detail above, it is readily apparent that those skilled in the art may make various modifications and changes in the present invention without departing from the spirit and scope thereof. It is to be expressly understood that the specific disclosure set forth is solely for purposes of illustration in accordance with the applicable patent laws and is in no way deemed to limit the scope of the present invention. The instant invention is limited only by the appended claims.

What is claimed is:

1. A valve comprising: a manifold having an exhaust port, an inlet port, a first cylinder port, a second cylinder port, a first valve port providing a communication path between the inlet port and the first cylinder port, a second valve port providing a communication path between the exhaust port and the first cylinder port, a third valve port providing a communication path between the inlet port and the second cylinder port, and a fourth valve port providing a communication path between the second cylinder port and the exhaust port; a first valve rod slideably mounted in the manifold and sealingly engageable with the first valve port for releasably closing said port; a second valve rod slideably mounted in the manifold and sealingly engageable with the second valve port for releasably closing said port; a third valve rod slideably mounted in the manifold and sealingly engageable with the third valve port for releasably closing said port; a fourth valve rod slideably mounted in the manifold and sealingly engageable with the fourth valve port for releasably closing said port; a first yoke pivotedly engaging the first and fourth valve rods; a first spring connected to the first yoke, urging the first and fourth valve rods into sealing engagement with their respective ports; a second yoke pivotedly engaging the second and third valve rods; a second spring connected to the second yoke, urging the second and third valve rods into sealing engagement with their respective valve ports; and means for selectively relieving the springs to allow the valve rods to disengage their respective valve ports.

2. A valve as defined in claim 1 wherein each of the springs is a compression spring, and including a spring plunger having a body positioned in each of the springs and a head engaging one end of its respective spring, and a pivot pin mounted on each of the spring plungers and pivotedly engaging its respective yoke.

3. A valve as defined in claim 2 wherein the pivot pin is axially positionable relative to the spring plunger to regulate the force applied by the compression spring.

4. A valve as defined in claim 3, including a tapered nose formed integral with one end of each of the valve rods, each tapered nose being cooperative with its respective valve port for regulating the flow of a fluid through the valve port by the axial position of the tapered nose relative to the valve port.

5. A valve as defined in claim 4, including a cam engageable with the spring plungers for selectively retracting each of the spring plungers against the force of the respective compression springs.

6. A valve as defined in claim 2, including a cam engageable with the spring plungers for selectively retracting one of the spring plungers against the force of the respective compression spring.

7. A valve as defined in claim 1 wherein each of the valve rods has a tapered nose on one end thereof extending axially from the valve rod, each said tapered nose being cooperative with its respective valve port for regulating the flow of fluid through its respective valve port.

8. A valve as defined in claim 7, including a tapered crown between the valve rod and its respective nose on each of the valve rods, a tapered valve seat in each of the valve ports, each of the valve seats having an angle of taper slightly greater than the angle of taper of its respective tapered crown prior to the initial assembly thereof to allow coining of the crown and seat during initial assembly.

9. A valve as defined in claim 1, including a pivot pin connected to each of the springs between the spring and its respective yoke, each of the pivot pins being axially positionable relative to the spring to regulate the amount of spring force applied by the spring to the respective yoke, each of said pivot pins being pivotedly engageable with its respective yoke to allow the yoke to pivot about the pivot pin in response to forces applied to the yoke by its respective pair of valve rods.

10. A valve as defined in claim 9, including a tapered nose formed integral with one end of each of the valve rods, each tapered nose being cooperative with its respective valve port to regulate the flow of fluid through the valve port by axial displacement thereof relative to the valve port.

11. A valve as defined in claim 1, including a pivot connected to each spring, said pivot pivotedly engaging its respective yoke to allow the yoke to pivot in response to forces applied to the yoke by its respective pair of valve rods.

12. A valve as defined in claim 11 wherein each of the valve rods includes a tapered nose formed integral with one end of each of the rods, each tapered nose being cooperative with its respective valve port for regulating flow of fluid through the valve port by axial displacement thereof relative to the respective valve port.

13. A valve as defined in claim 1 wherein each of the valve rods moves axially to open and to close its respective valve port and the direction of axial movement for opening the respective valve port is in the same direction as the direction of flow of fluid through the valve port.

14. A valve comprising; a manifold having a cylinder port, an inlet port, a first valve port providing a communicating path between the cylinder port and the inlet port, an exhaust port, and a second valve port providing a communicating path between the cylinder port and the exhaust port; a first rod slideably mounted in the manifold and sealingly engageable with the first valve port to close selectively said valve port; a second valve rod slideably mounted in the manifold and sealingly engageable with the second valve port for closing selectively said second valve port; each of the valve rods has a tapered nose on one end thereof extending axially from the valve rod, each of said tapered noses being cooperative with its respective valve port for regulating the flow of fluid through its respective valve port; a tapered crown between each of the valve rods and its respective nose, and a tapered valve seat in each of the valve ports, each of the valve seats having an angle of taper slightly greater than the angle of taper of its respective tapered crown prior to the initial assembly thereof to allow coining of the crown and seat during initial assembly; and a spring connected to each of the valve rods to urge the valve rods into a sealingly closed attitude with the respective valve ports.

15. A valve as defined in claim 14 wherein prior to initial assembly the angle of taper of the valve seat is ½° greater than the angle of taper of its respective tapered crown.

16. A valve comprising; a manifold having a cylinder port, an inlet port, a first valve port providing a communicating path between the cylinder port and the inlet port, an exhaust port, and a second valve port providing a communicating path between the cylinder port and the exhaust port; a first rod slideably mounted in the manifold and sealingly engageable with the first valve port to close selectively said valve port; a second valve rod slideably mounted in the manifold and sealingly engageable with the second valve port for closing selectively said second valve port; a spring connected to each of the valve rods to urge the valve rods into a sealingly closed attitude with the respective valve ports; and a spring plunger connected to each of the springs and a set screw connected to each of the valve rods for axial positioning of the valve rod relative to the spring plunger.

17. A valve as defined in claim 16, including a cam selectively engageable with each of the spring plungers to move a selected spring plunger against the force of its respective spring.

18. A valve comprising; a manifold block including a cylinder port, an inlet port, a first valve port providing a communicating path between the cylinder port and the inlet port, an exhaust port, and a second valve port providing a communicating path between the cylinder port and the exhaust port; a cam block mounted on the manifold block; a pair of valve rods slideably mounted in the cam block and the manifold block; each of said valve rods being cooperative, respectively, with one of the first and second valve ports for regulating the flow of fluid through the valve ports; a spring block mounted on the cam block; a pair of spring plungers slideably mounted in the spring block, each of the spring plungers being connected, respectively, to one of the valve rods; a compression spring mounted on each of the spring plungers; each of the valve rods has a tapered nose on one end thereof extending axially from the valve rod, each of said tapered noses being cooperative with its respective valve port for regulating the flow of fluid through its respective valve port; a tapered crown between each of the valve rods and its respective nose, a tapered valve seat in each of the valve ports, each of the valve seats having an angle of taper slightly greater than the angle of taper of its respective tapered crown prior to the initial assembly thereof to allow coining of the crown and seat during initial assembly; and a cam mounted in the cam block and being engageable with the spring plungers to retract selectively one of the spring plungers to allow a selected valve rod to open.

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