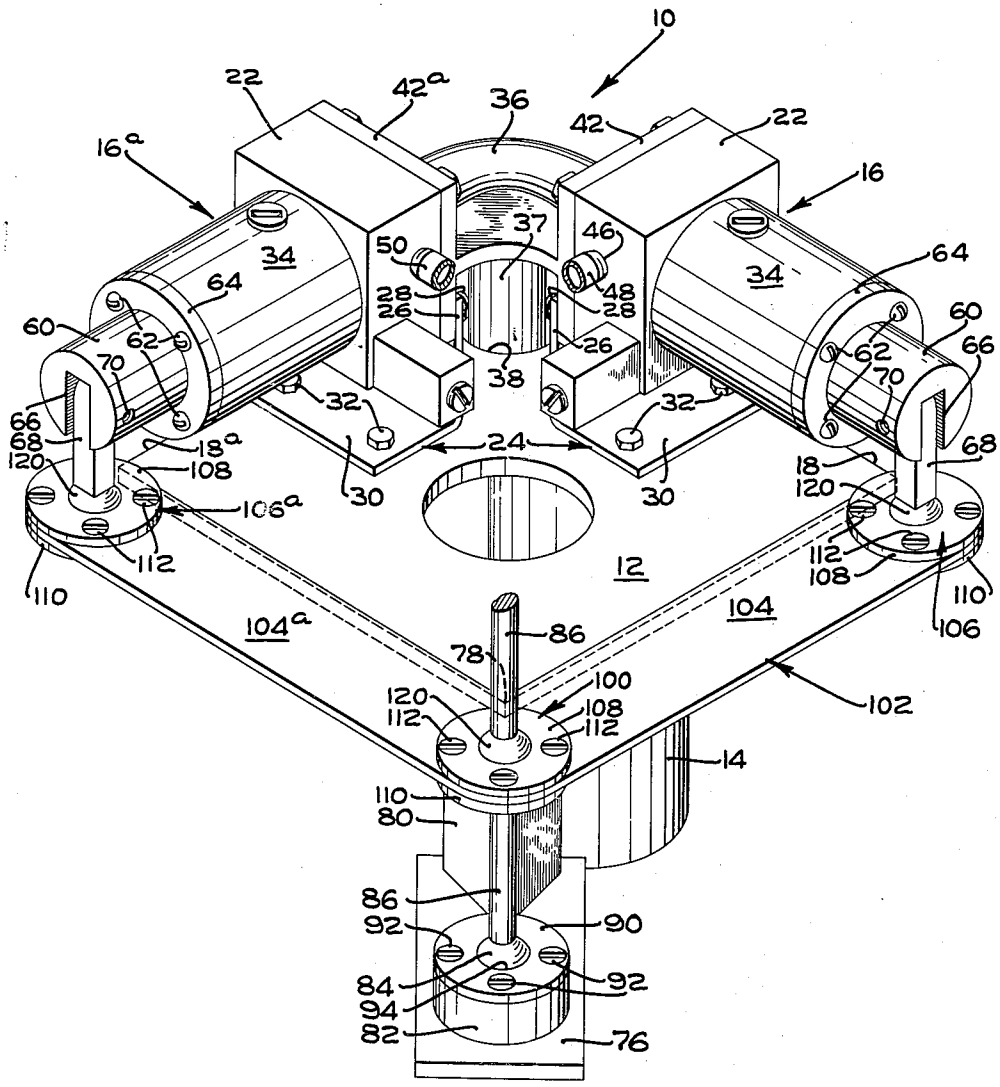
March 28, 1961 J. A. MISCOVICH 2,976,742

CONTROL APPARATUS FOR MULTI-VALVES AND THE LIKE

Filed Nov. 4, 1957

3 Sheets-Sheet 1

FIG_1



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CONTROL APPARATUS FOR MULTI-VALVES AND THE LIKE

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3 Sheets-Sheet 2

FIG_2

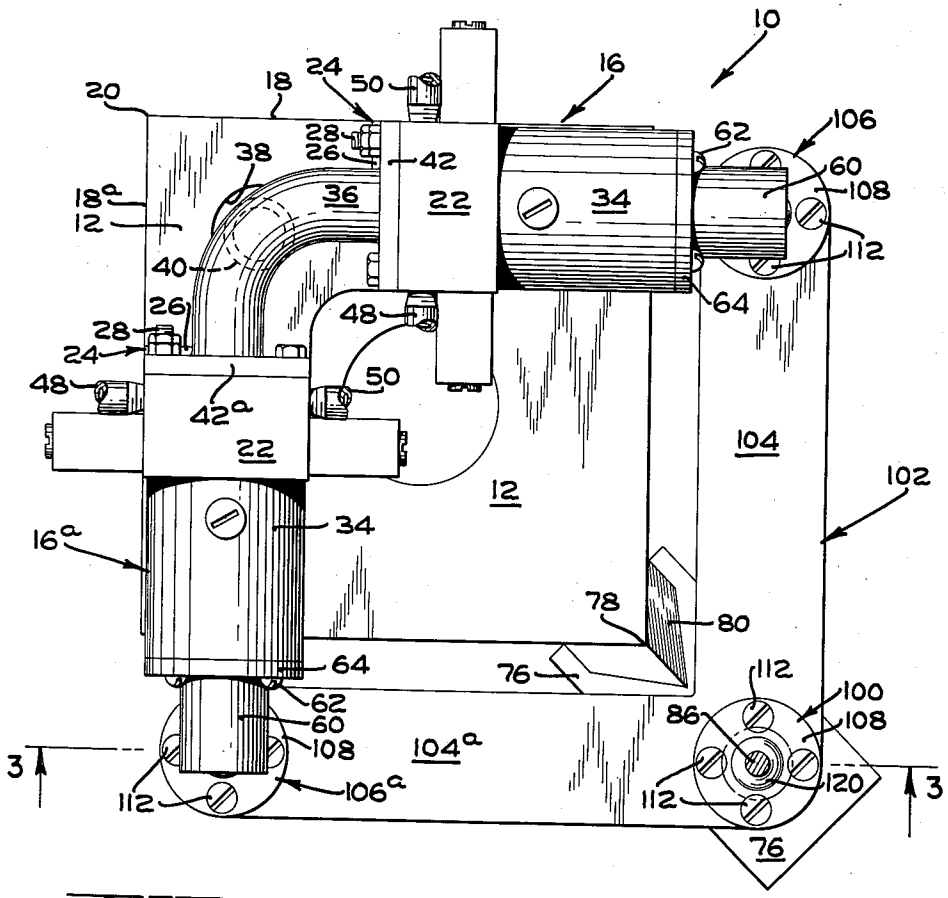


FIG_4

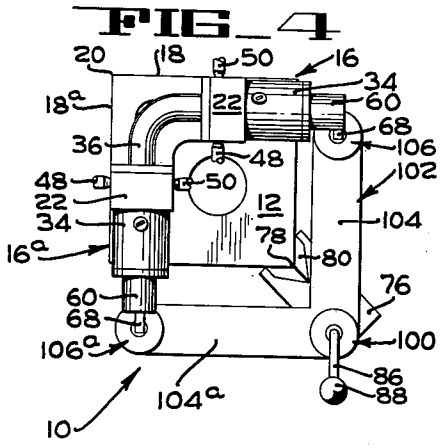
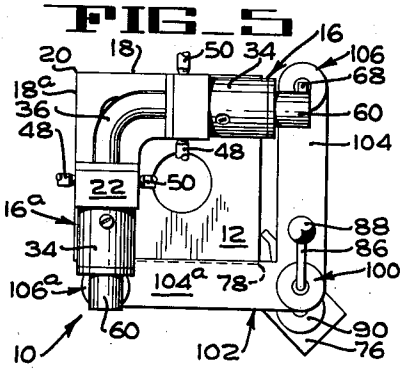


FIG_5



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CONTROL APPARATUS FOR MULTI-VALVES AND THE LIKE

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3 Sheets-Sheet 3

FIG_3

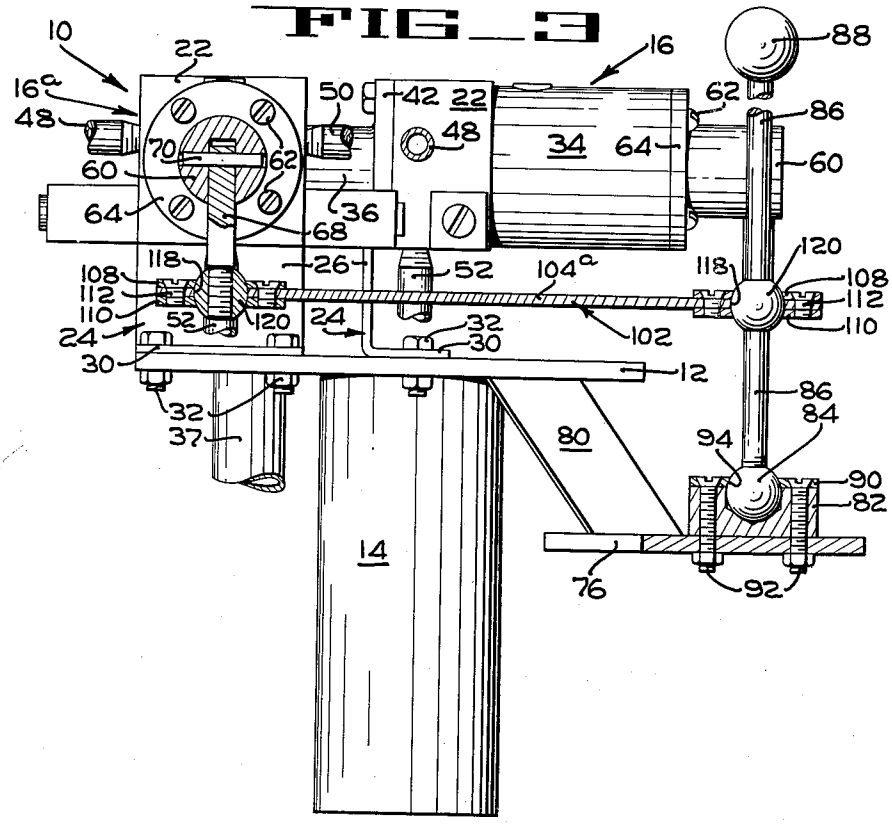


FIG_6

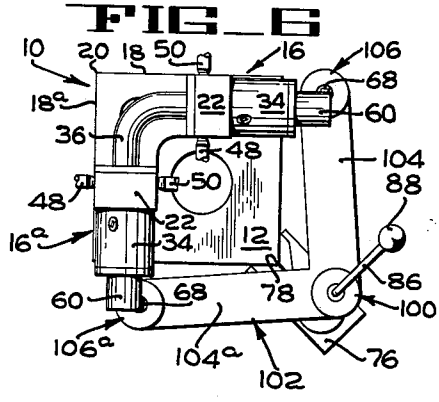
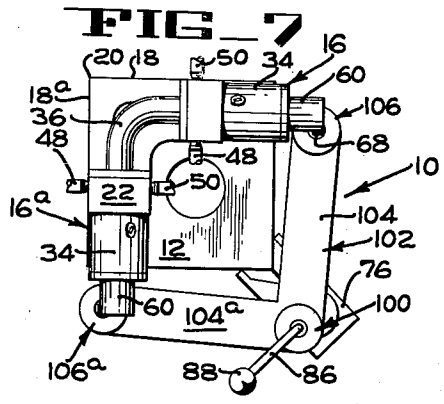


FIG_7



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United States Patent Office 2,976,742
Patented Mar. 28, 1961

2,976,742

CONTROL APPARATUS FOR MULTI-VALVES AND THE LIKE

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Filed Nov. 4, 1957, Ser. No. 694,202

2 Claims. (Cl. 74—471)

This invention appertains to valves for controlling the supply of fluid under pressure to hydraulically operated apparatus, and relates more particularly to devices for operating a plurality of such valves either individually or simultaneously.

An object of the invention is to provide an improved hydraulic control apparatus.

Another object is to provide an improved hydraulic valve operating mechanism.

Another object is to provide a control mechanism whereby a plurality of hydraulic valves can be operated either individually or simultaneously by a single control lever.

Another object of the invention is to provide a valve operating mechanism having a single control lever so connected to each of two hydraulic valves that either valve can be operated through its entire range of movement or any desired fractional part thereof without necessarily altering the adjustment of the other valve regardless of the setting of said other valve.

Another object is to provide a valve operator whereby a single control lever can be manipulated to adjust or regulate two valves either individually or simultaneously to cause each valve to be adjusted optionally in either of two directions and to any desired degree within the limits of its adjustability.

Another object of the present invention is to provide a control mechanism whereby a single actuator member, such as a pivotally mounted lever, is operable to regulate two valves of the rotary type either simultaneously or individually.

Another object is to provide a dual valve control mechanism of the character indicated which is particularly adapted for, but is not necessarily limited to, the operation of equipment driven by two independent hydraulic motors, such as a derrick boom or the universally pivotable nozzle of a hydraulic monitor, and adapted to be elevated or lowered by one reversible hydraulic ram and to be swung horizontally in either direction by another, independently operable, reversible hydraulic ram.

These and other objects and advantages of the present invention will become apparent from the following description and the accompanying drawings, in which:

Fig. 1 is a perspective, partially broken away, of the hydraulic control apparatus of the present invention.

Fig. 2 is a plan, partly broken away, of the control apparatus of Fig. 1.

Fig. 3 is a section along lines 3—3 of Fig. 2.

Figs. 4–7, inclusive, are plan views drawn to a reduced scale and showing the hydraulic control apparatus of the invention in various differently adjusted positions.

As illustrated in Figs. 1, 2 and 3, the hydraulic control apparatus 10 of the present invention is mounted upon a base plate 12 rigidly secured as by welding to the upper end of a suitable pedestal 14. The base plate 12 is in the form of a flat metal plate of suitable rigidity and preferably is square. It is to be understood, however, that, depending upon the circumstances of installation, the base plate 12 may be mounted directly upon

the hydraulically driven machine that the apparatus 10 of the invention is adapted to control.

Two rotary valves 16 and 16*a* are fixedly mounted upon the base plate 12 with their major axes perpendicular to each other. Preferably, the valves 16 and 16*a* are arranged with their respective major axes parallel to and spaced but a short distance from two adjacent edges 18 and 18*a* of the base plate 12 that meet in a corner 20 of the plate 12. Each valve 16 and 16*a* is mounted on the base plate 12 by means of an angle bracket 24, the vertical flange 26 of which is secured to a stationary part of the associated valve by stud and nut assemblies 28 (Fig. 1) while the horizontal flange 30 of each bracket is secured to the base plate 12 by bolt and nut assemblies 32.

Whereas the requirements of the present invention impose no restrictions as far as the particular variety of rotary valve to be employed therein is concerned, the valves 16 and 16*a* illustrated are of the type disclosed in my copending application Serial No. 694,245, filed November 4, 1957 for Hydraulic Valve, to which application reference may be had for a full disclosure of the construction and manner of operation of the valves 16 and 16*a*. Inasmuch as the two valves 16 and 16*a* are of identical construction, the following brief description of but one of these valves, referring only to those features thereof that are essential to an understanding of the present invention, will suffice for the purposes of the present disclosure.

The valve 16 includes a body portion 22, this being the stationary part of the valve to which the associated angle bracket 24 is secured. A cylindrical valve core housing 34 is mounted on the body portion 22 with its axis coinciding with the major axis of the valve 16, for rotational adjustment about said axes with respect to the body portion 22. Hydraulic fluid under pressure is supplied to both valves 16 and 16*a* by an inlet manifold 36 to which hydraulic fluid under pressure is supplied by a suitable conduit 37. Since it is usually convenient to extend the supply conduit 37 upward through the base plate 12, an aperture 38 is provided in the base plate to accommodate the supply conduit and the coupling member 40 (Fig. 2) for connecting the supply conduit to the manifold 36 which is provided on the underside of the manifold 36 in registry with the aperture 38. The ends of the manifold 36 are provided with flanges 42 and 42*a* which are bolted to the body portions 22 of the valves 16 and 16*a*, respectively. Consequently, the common inlet manifold 36 serves as the source of fluid under pressure for both valves 16 and 16*a*.

The valve 16 has two ports 46 (only one of which is shown, Fig. 1) in opposite sides of the body portion 22, which are internally threaded to receive fluid lines 48 and 50, respectively (Fig. 2). These fluid lines 48 and 50 hereinafter will be called the "working lines" inasmuch as they connect the control valve 16 to opposite ends of a reversible hydraulic engine (not shown) intended to be controlled by means of the valve 16. The body portion 22 of the valve also is provided with a downwardly opening port (not shown) threaded to receive a fluid line 52 (Fig. 3) which hereinafter will be called the exhaust line since it is adapted to convey exhaust fluid from the valve 16 back to a supply reservoir (not shown) or other suitable point of discharge.

As explained in the hereinbefore mentioned copending application, the internal structure of the valve 16 is such that when the valve core housing 34 is in its neutral or intermediate position as illustrated in Figs. 1–3 the valve is closed. When the valve core housing 34 is rotated as far as possible in a counter clockwise direction as viewed in Fig. 1, fluid will be permitted to flow from the manifold 36, through the valve 16, and through the discharge

port 46 whence the valve pressurized fluid can flow through the working line 48 to one end of the fluid engine (not shown) that the valve 16 is intended to control. At the same time that connection is established between the manifold 36 and the working line 48, fluid conducting connection is likewise established within the valve 16 between the working port to which the working line 50 is connected and the discharge port to which the exhaust line 52 is connected. Thus, fluid escaping from the other end of the hydraulic motor will return to the valve through the working line 50 and be returned to the supply reservoir through the exhaust line 52. Thus, when the valve core housing 34 of the valve 16 is turned counterclockwise as viewed in Fig. 1 the hydraulic motor with which the valve 16 is associated is caused to operate in a certain direction. When the valve core housing 34 is turned as far as possible in the opposite direction the manifold 36 is connected to the working line 50 while the working line 48 is connected to the exhaust line 52 so that the associated hydraulic engine is caused to operate in the opposite direction.

It will be appreciated, therefore, that since the present invention provides means for operating two hydraulic valve 16 and 16*a*, the control apparatus of the invention is adapted for use in controlling operation of various types of machinery wherein an element such as a derrick boom is moved either up or down by a double acting or reversible hydraulic ram, which ram can be controlled by one reversing valve while the same boom is caused to move horizontally in either direction by another reversible hydraulic ram controlled by another reversing valve.

A cylindrical head or boss 60 (Figs. 1, 2 and 3) is rigidly attached to the outer end of the valve core housing 34 of the valve 16 by means of headed screws 62 extending through a flange 64 on the inner end of the boss and tightened into tapped holes (not shown) provided for the purpose in the outer end of the valve core housing. A radial slot 66 is formed in the outer end portion of the head 60, in such position that the slot is open both at the outer end of the boss and along one side thereof. The head 60 carries an arm or lever 68, the upper end of the arm being loosely fitted into the slot 66 and pivotally connected to the head by a pin 70 (Fig. 3) rigid with the head and extending diametrically thereof across the slot 66 and through the upper end of the arm. The arm 68 of each valve 16 and 16*a* hangs vertically downward from its pivot pin 70 when the associated valve core housing 34 is in its neutral or closed position, i.e., that position in which the associated valve 16 or 16*a* prevents flow from the inlet manifold 36.

Whereas the upper part of each arm 68 is disposed within the associated slot 66 the lower part of the arm projects radially downward from the lower side of the associated head 60, thus providing a lever by which the head and the valve core housing to which it is attached can be turned by swinging the lower end of the arm either clockwise or counterclockwise about the axis of rotation of the associated valve core housing. It is particularly to be observed however, that in view of the manner in which the upper end of the arm is pivotally connected to the associated head 60, i.e., by means of the diametrically extending pivot pin 70, each arm 68 is free to swing toward and away from the associated valve core housing 34 without any accompanying rotary motion of the same.

As hereinabove explained, the two valves 16 and 16*a* are mounted in fixed position upon the base plate 12 with the axis of rotation of their respective valve core housings 34 perpendicular to each other. Consequently, the planes in which the two valve operating arms or levers 68 are free to swing are perpendicular to each other, as are likewise the respective directions in which the two arms 68 swing when effecting rotary motion of their respectively associated valve core housings 34. More specifically stated, the plane in which the valve actuating arm 68 of

the valve 16 is free to swing, is parallel to the proximate edge 18 of the base plate 12 and the direction in which this arm 68 moves when imparting rotary motion to its associated valve core housing 34 is perpendicular to the edge 18 of the base plate 12. Similarly, the plane in which the actuating arm 68 of the valve 16*a* is free to swing without imparting any motion to the associated valve core housing 34 is parallel to the proximate edge 18*a* of the base plate 12 while the direction in which this arm 68 moves when imparting rotary motion to the associated valve core housing 34 is perpendicular to the edge 18*a*.

An auxiliary platform 76 is supported in a position projecting out from below the corner 78 of the base plate 12 opposite the hereinbefore mentioned corner 20 at which the two edges 18 and 18*a* of the base plate meet. The platform 76 is rigidly supported, preferably in a plane parallel to and spaced below that of the base plate 12, by a downwardly and outwardly inclined bracket 80 (Figs. 1, 2 and 3). The platform 76 supports on its upper surface a socket member 82 (Figs. 1 and 3) within which a ball 84 is fitted in a manner permitting the ball to turn freely in any direction. The ball 84 is affixed to the lower end of an operating lever 86 (Figs. 1, 2 and 3) that projects upward from the socket member 82 and preferably carries at its upper end a knob 88 (Fig. 3) that provides a convenient handle comfortably grasped by the hand of an operator. The ball 84 at the lower end of the lever 86 is retained within the socket member 82 by means of a collar 90 (Figs. 1 and 3), the collar 90 being retained in position by screws 92 that extend not only through the collar 90 but likewise through the socket member 82 and auxiliary platform 76 to anchor the socket member and the collar in operative position. The central aperture 94 of the collar 90 is of a diameter slightly smaller than the diameter of the ball 84 and the edge of the aperture 94 is contoured to the curvature of the ball so that the collar 90 prevents displacement of the ball from the socket member 82 while permitting unrestricted universal pivotal movement of the lever 86 about a point at the center of the ball 84.

A second ball joint 100 (Figs. 1, 2 and 3) is provided intermediate the ends of the lever 86, whereby an L-shaped link member 102 is connected to the lever 86 for universal movement thereby substantially in a horizontal plane. The ball and socket joint 100 is situated at the juncture of the two legs 104 and 104*a* of the L-shaped link member 102. Similar ball and socket joints 106 and 106*a* are provided at the outer ends of the two legs 104 and 104*a*, respectively. Each of the ball and socket joints 100, 106 and 106*a* comprises upper and lower annular collars 108 and 110, respectively, secured to the upper and lower surfaces of the link member 102 by screws 112. The central openings of the two collars 108 and 110 of each ball and socket joint 100, 106 and 106*a* are disposed in axial alignment with a circular opening 118 in the link member 102, and since the openings of the collars 108 and 110 are slightly smaller in diameter than the associated openings 118 of the link member the collars of each ball and socket joint 100, 106 and 106*a* are adapted to prevent displacement of a ball 120 from the associated opening 118 of the link member. In the case of the ball and socket joint 100 the ball 120 is carried by and is rigidly secured to the control lever 86, whereas in the cases of the ball and socket joints 106 and 106*a* the balls 120 are rigidly secured to the lower ends of the actuating arms 68 of the valves 16 and 16*a*, respectively.

It will be apparent, therefore, that if an operator swings the operating lever 86 in the vertical plane that includes the axis of the pin 70 whereby the actuating arm 68 of the valve 16 is pivotally connected to the head 60 thereof, this head 60 and the associated valve core housing 34 will be caused to turn about its axis, thus operating the valve 16. However, this motion of the lever 86, i.e., either toward or away from the valve 16 will have

no effect upon the companion valve 16*a* because the accompanying motion of the socket 106*a* whereby the actuating arm 68 of the valve 16*a* is connected to the link member 102 is in a direction parallel to the axis of rotation of the valve core housing 34 of the valve 16*a* with the result that the only effect upon the valve 16*a* of motion of the control lever 86 toward or away from the valve 16 is to pivot the actuating arm 68 thereof about the axis of its associated pin 70 without imparting any rotary motion to the associated valve core housing 34. Conversely, motion of the control lever 86 toward or away from the valve 16*a* will cause the valve core housing 34 of the valve 16*a* to turn in a manner effecting operation of the valve 16*a* but will have no effect upon the valve 16 other than to cause the actuating arm 68 of the valve 16 to swing on its pivot pin 70 without imparting any rotary motion to the valve core housing 34 of the valve 16. By swinging the control lever 86 in the plane that bisects the angle between the axes of the valves 16 and 16*a*, both valves will be operated equally. However, if the operating lever 86 is swung in a plane more nearly perpendicular to the axis of one valve and, consequently, more nearly parallel to the axis of the other valve, both valves 16 and 16*a* will be operated simultaneously but the valve to which the plane of movement of the lever is more nearly perpendicular will be operated to a greater extent than the valve to which the plane of movement of the lever is more nearly parallel.

A specific example of an apparatus with which the control mechanism 10 of the present invention can advantageously be associated is the hydraulic mining giant or monitor (not shown) of the type disclosed in the Miscovich patent, No. 2,680,650, which includes a nozzle adapted to eject a high evlocity jet of water and mounted for universal pivotal movement. As explained in detail in the patent, two reversible hydraulic rams are associated with the giant, one in such a way that operation of one ram by supplying motivating fluid to one end of the ram elevates the nozzle and supplying fluid under pressure to the other end of the same ram reverses the ram and lowers the nozzle. The other hydraulic ram is so associated with the giant that operation of the second ram in one direction by connecting one end thereof to a source of fluid under pressure turns the giant horizontally in one direction and connecting the other end of the second ram to the fluid pressure source reverses the ram and causes the giant to turn horizontally in the other direction. Whereas the rams disclosed in the above identified patent are controlled automatically, the present invention provides means for manually operating such rams.

For the sake of convenience in the following description of the manner in which the apparatus of the present invention operates the control device 10 will be assumed to be operatively associated with the hydraulic mining giant (not shown) of the type indicated, with each of the working lines 48 and 50 of the valve 16 in fluid-conveying communication with one of the opposite ends of the ram (not shown) that moves the nozzle vertically. The connections should be made in such a way that when fluid under pressure is admitted to the line 50 of the valve 16, i.e., by movement of the lever 86 away from the valve 16, the ram will effect raising of the nozzle, and when motivating fluid is admitted to the line 48 of the valve 16, i.e., by movement of the lever 86 toward the valve 16, the nozzle will be lowered. The valve 16*a* should be connected with the ram (not shown) that moves the nozzle of the giant horizontally, and in such a way that when the lever is moved toward the valve 16*a*, causing fluid to be admitted to the line 50 of the valve 16*a* the nozzle will turn counterclockwise as viewed from above, and when fluid is admitted to the line 48 of the valve 16*a* by moving the lever away from the valve 16*a*, the nozzle will turn clockwise.

Figs. 1, 2 and 3 show the control apparatus 10 of the invention in its neutral position, i.e., with both valves 16 and 16*a* closed, with the result that both lines 48 and 50 of both valves 16 and 16*a* are banked off. Therefore, the nozzle of the giant remains stationary when the apparatus 10 is in this arrangement, in which the operating handle 86 is vertical, as are also the valve actuating arms 68 of both valves 16 and 16*a*.

The operator should take a position behind the control apparatus 10 and directly in line with the leg 104 of the link member 102. The leg 104*a* of the link member 102 will then project to the left of the operator. This makes it possible for him to aim the nozzle of the hydraulic giant in any desired direction within its range of movement by moving the operating handle 86 in the manner that is most natural, i.e., the manner that most closely simulates the desired movement of the nozzle. For example, if the jet stream from the giant is being directed against a vertical cliff or bank, and it is desired to swing the nozzle of the giant rapidly upward so that the jet stream impinges against a higher area of the bank, the operator should pull the lever 86 all the way back, i.e., straight toward himself, causing the apparatus to occupy substantially the position illustrated in Fig. 4. This will cause the valve core housing 34 of the valve 16 to turn clockwise as viewed in Fig. 1, to the limit of its movement in that direction. This establishes connection between the inlet manifold 36 and the working fluid line 50 of the valve 16 so that hydraulic fluid is admitted under full flow to the ram that turns the nozzle vertically and in such a way that the nozzle is elevated as rapidly as possible. If upward movement of the nozzle at a slower speed is desired, the handle 86 should be pulled back, toward the operator, but not as far as when maximum speed is desired. This will permit flow from the manifold 36 to the line 50 of the valve 16, but at a restricted rate, so that the ram will be operated in the same direction, but more slowly.

When it is desired to lower the nozzle of the giant so as to direct its jet stream against a lower area, the operator should push the control lever 86 forward, i.e., away from himself; and if maximum speed in attaining the new adjustment of the giant is desired the lever 86 should be moved as far forward as possible. The apparatus 10 will then occupy substantially the position illustrated in Fig. 5 wherein the actuating arm 68 of the valve 16 slopes downward and forward and the valve core housing 34 associated therewith will be turned as far as possible in a counterclockwise direction as viewed in Fig. 1. This will establish full communication between the inlet manifold 36 and the working fluid line 48 of the valve 16 causing fluid to flow at maximum rate to the ram that moves the nozzle vertically and in a manner causing the nozzle to swing downward. As in the previously-described instance, if a more moderate rate of movement of the nozzle is desired the operating handle 86 should not be moved so far forward.

It is to be observed that in both the Fig. 4 and Fig. 5 positions, in each of which the operating handle 86 has been moved only in a vertical plane substantially perpendicular to the axis of the valve 16, the actuating arm 68 of the valve 16*a* has likewise moved only in a vertical plane parallel to or including the axes of the valve 16*a*. Under these circumstances, the valve core housing 34 of the valve 16*a* remains motionless with the result that the valve 16*a* remains in its neutral position and both of its working lines 48 and 50 remain blanked off and the ram associated therewith, i.e., the ram that effects horizontal movement of the nozzle, likewise remains motionless.

Assuming now that while the nozzle of the giant is being moved downward as the result of shifting the operating handle 86 to the Fig. 5 position, it is desired to have the nozzle of the giant swing clockwise as viewed in Fig. 5, i.e., to the operator's right. The handle 86 can be swung to the right and if maximum speed of movement of the nozzle is desired the handle should be

moved as far as possible to the right. This will cause the parts of the apparatus **10** to assume substantially the position illustrated in Fig. 6 wherein the actuating arm **68** of the valve **16***a* is swung to the right, turning the valve core housing **34** of the valve **16***a* counterclockwise as viewed in Fig. 1 and thus establishing full flow of hydraulic fluid from the manifold **36** to the working line **48** of the valve **16***a* which, as stated hereinabove, is connected to the ram that effects horizontal movement of the nozzle of the giant and in such a way that the nozzle is caused to swing to the operator's right.

Since the ball **120** at the lower end of the actuating arm **68** of the valve **16** connects this arm **68** and the link **102** in a manner permitting universal relative movement between these two members, the leg **104** of the link member **102** may merely pivot about a vertical axis as the link member **102** moves from the Fig. 5 position to the Fig. 6 position, thus permitting the arm **68** of the valve **16** to remain motionless. Under some circumstances, however, the link member **102** will move from the Fig. 5 position to the Fig. 6 position in translatory motion, wherein the leg **104** remains parallel to its Fig. 5 position as it moves laterally. As this occurs, the arm **68** of the valve **16** will swing outward about the axis of its pivot pin **70** so that it will then slope outward and downward, projecting beyond the vertical plane of the end of the associated head **60** in a position corresponding to that of the arm **68** of the valve **16***a* illustrated in Fig. 4. Whether movement of the operating handle **86** from the Fig. 5 position to the Fig. 6 position is accompanied by pivotal movement of the leg **104** about the ball **120** of the valve **16**, leaving the associated arm **68** stationary, or whether such movement of the operating lever **86** causes the arm **68** of the valve **16** to swing outward, or whether a combination of both movements occurs, depends upon the relative amount of friction between the several relatively movable parts of the apparatus. The result, however, is the same because in any case the valve core housing **34** of the valve **16** remains motionless, and the setting of the valve **16** is not changed as the valve **16***a* is adjusted as the result of lateral movement of the handle **86**.

As a further example of the manner in which the apparatus **10** can be operated to control the hydraulic giant, let it be assumed that it is desired to have the nozzle of the giant swing upward and to the operator's left. This is accomplished by swinging the handle toward the operator and to his left and if maximum speed of movement of the nozzle is desired the handle **86** should be moved as far as possible. The parts of the apparatus will then occupy the positions illustrated in Fig. 7 wherein both valves **16** and **16***a* have been actuated to admit fluid under pressure to the working line **50** of the valve **16** and to the working line **50** of the valve **16***a*. Consequently, both rams of the hydraulic giant will be operated simultaneously causing the nozzle to swing upward and to the left. The nozzle will continue to move thus until the handle **86** is moved to another position. If the handle is returned to its upright position, the nozzle will be immobilized in the position which it has then attained.

It is to be realized that the control lever **86** can be swung from any position to any other desired position without having to be returned to its neutral or upright position and that the actuating arms **68** of the two valves **16** and **16***a* will be moved accordingly by the link member **102** so as to adjust the valves **16** and **16***a* in accordance with the attained position of the control lever **86**. Moreover, the two valves **16** and **16***a* can easily and quickly be adjusted to any desired setting either individually or simultaneously and in either direction at the will of the operator. The extent of movement of each valve is proportional to the extent of movement of the operating lever **86** toward or away from that valve and any movement of the operating lever **86** toward or away from either valve has no effect upon the setting of the companion valve, and in the event that the lever is swung in a plane that is oblique to the axes of both valves, the valve whose axis is more nearly perpendicular to the plane of movement of the lever will be adjusted to the greater extent. Therefore, the operator has at his command an infinite number of settings of the operating lever **86** so that the apparatus **10** is effective to cause movement of the nozzle of the hydraulic giant in any desired direction within the limits of its adjustment and at any desired speed within the limits determined by the maximum velocity of flow of fluid through the various hydraulic lines.

In this same connection, it is to be observed that when the two valves **16** and **16***a* are operatively connected to the respective rams of the hydaulic giant in the manner explained hereinabove, the apparatus **10** of the invention enables the operator to control the hydraulic giant accurately and with the greatest ease, since the nozzle responds to movement of the control lever **86** practically immediately. Furthermore, in order to effect movement of the nozzle in a desired direction and at a desired speed, the manner in which the control lever **86** must be manipulated is precisely that which seems most natural to attain the desired result. This feature of the present invention makes the manual control of the hydraulic giant almost automatic with the operator, since only a minimum of mental effort is required therefor.

Although the apparatus **10** of the present invention has been described hereinabove as being effective to control movement of a derrick boom or the nozzle of a hydraulic giant, it is to be understood that these devices have been referred to hereinabove merely in an exemplary, and not in a limiting, sense, because the apparatus **10** is equally effective when used to control movement of other structures in two directions either simultaneously or otherwise by means of two independently operable hydraulic engines. Furthermore, while a particular embodiment of the present invention has been shown and described, it will be understood that the apparatus is capable of modification and variation without departing from the principles of the invention and that the scope of the invention should be limited only by the scope and proper interpretation of the claims appended hereto.

The invention having thus been described, what is believed to be new and desired to be protected by Letters Patent is:

1. In a control apparatus for a pair of rotary valves each including a member rotatable to effect operation of the valve, and with the axes of the members perpendicular to each other in a plane including both of said axes, an actuating arm projecting radially from each of said rotary members and mounted thereon for movement therewith about said axis of rotation of the associated rotary member and for pivotal movement relative thereto in a plane including said axis of the associated rotary member, an actuating lever mounted for universal pivotal movement, a link structure, means pivotally connecting said link structure to said lever for universal substantially planar movement by the lever, and means pivotally connecting each of said actuating arms to the link structure for pivotal movement thereby.

2. Control apparatus comprising two rotary control members, said control members being positioned with their axes of rotation perpendicular to each other in a plane including both of said axes, an actuating arm projecting radially from each of said rotary members and mounted thereon for movement therewith about the axis of rotation of the associated rotary member and for pivotal movement relative thereto in a plane including said axis of the associated rotary member, an actuating lever mounted for universal pivotal movement, a rigid link structure, means pivotally connecting said link structure to said lever for universal substantially planar movement by the lever, and means pivotally connecting

each of said actuating arms to the link structure for pivotal movement thereby.

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