HYDRAULIC VALVE SLEEVE

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The present invention relates to hydraulic valves and more particularly to that type used in hydraulic servo systems.

Hereinbefore, valves of this nature have had the disadvantage that at least six critical machining dimensions were required in the manufacture thereof, since the distance between the inlet and outlet ports on the moving part, and the distance of these ports from their respective ends of the fluid part had to be held to very close tolerances, and said dimensions, in addition, had to match very closely the matching dimensions on the stationary part.

While means for adjustment of the moving part with respect to the ports on the stationary part have been devised, these have seldom been effective on those types of valves that are too small to be internally adjustable.

It is therefore, one of the objects of the present invention to provide a hydraulic valve for a servo system wherein the foregoing disadvantages are eliminated, and to do so in a novel and effective manner.

Another object of the present invention is to provide a servo valve designed in two pieces to reduce the number of critical machining dimensions.

Still another object of the invention is to provide an adjustment means within a servo valve which will be effective on valves that are too small to be internally adjustable.

Still another object of the invention is to provide a hydraulic valve for a servo system which shall be simple and economical to manufacture, durable and reliable in operation, and yet positive and effective in performance.

The foregoing and other objects and advantages will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawing wherein one embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawing is for the purposes of illustration only and is not to be construed as defining the limits of the invention.

The drawing is a view partly in section of a hydraulic mechanism embodying the device.

Referring now to the drawing wherein like reference characters designate like parts, a hydraulic servo mechanism 10 includes a casing 12 including valves 14 and 16 and a torque motor 18 and a servo motor 18a having a power piston 18b. The torque motor 18 may be of a type well known in the art wherein the motor shaft, not shown here, is adapted to revolve selectively in either direction. Dual arms 20 and 21 are mounted on the motor armature for reasons hereinafter explained.

A pair of inlet pressure ports 22 and 24 connect to passageways 26 and 28 respectively, in the casing 12 which lead to inlet ports 30 and 32 in sliding valve sleeves 34 and 36. A pair of bores 38 and 40 in the casing 12 house the valve sleeves 34 and 36 which in turn accommodate the moving valve elements 42 and 44 which in turn control the valve ports 46 and 48, respectively, in the sleeves 34 and 36.

A pair of fluid passages 50 and 52 connect the drain ports 54, 56 and 58 and 60 of the sleeves 34 and 36 to a common fluid pressure drain outlet 61. To provide means whereby the port 46 may be placed in communication with either the inlet port 30 or the drain port 54, the valve member 44 is provided with a land 76 that is adapted to control the port 46. The land 76 is constructed so as to have the outer dimensions thereof closely match the port 46 and a centrally disposed annular groove 77 may be formed in the land 78 in order to reduce the weight of the valve member 44. The valve member 44 is further provided with annular grooves 79 and 81 that are axially disposed to the right and left respectively of the land 78. The grooves 79 and 81 need not be accurately machined since they serve merely as conduits or passageways between the inlet 30 and the port 46 and the drain 54 and port 46, respectively. Thus, the only element of the valve member 44 requiring accurate axial dimensioning is the land 78 and therefore, the construction or manufacture of the valve member 44 is greatly simplified.

Land 85 and 87 formed at the opposed extremities of the valve member 44 and a land 89 formed intermediate the lands 78 and 85 serve principally to guide the valve member 44 during its reciprocation and to prevent axial leakage of fluid along the member 44.

Due to the foregoing construction upon a movement of the valve member to the left the port 30 is placed in communication with the port 46 through annular groove 79 while a movement of the valve member 44 to the right connects the port 46 to the drain port 54 through annular groove 81.

The fluid entering inlet 30 is under a relatively high pressure and therefore axial leakage along the valve 44 past the land 89 may occur. Such leakage, however, is accommodated by the drain port 56 which directs the fluid through passageway 50 to the drain 61. On the other hand, the fluid flowing between port 46 and drain port 54 is under a relatively low pressure and hence axial leakage past the land 87 is slight and is taken care of by drain port 83 which communicates to the atmosphere at exterior of the casing 12. The drain port 83 also prevents the hydraulic locking of the valve member 44.

To control communication between the port 48 and either inlet port 32 or drain port 60, the valve member 42 is designed and constructed similar to the valve member 44. Thus, a land 76 having a centrally disposed annular groove 91 is dimensioned to closely match the port 48. Annular grooves 93 and 95 axially disposed on left and right sides respectively, of the land 76 afford means whereby either the inlet port 32 or drain port 60 is placed in communication with the port 48 upon the axial displacement of the valve member 42. Thus, when the valve member 42 is moved to the left, the inlet port 32 is connected to the port 48 and when the valve member 42 is moved to the right, the port 48 is connected to the drain 60.

The valve member 42 is provided at the opposed ends thereof with lands 97 and 99 and with a land 101 that is formed between the lands 76 and 97. Axial leakage past land 101 is returned to drain 61 through port 58 and passageway 50 while axial leakage past land 99 is past to the exterior of the casing through drain ports 83a. The drain ports 83a also serve to inhibit hydraulic locking of the valve member 42.

The valve ports 46 and 48 lead through passageways 46a and 48a to the power piston 18b of the servomotor 18a. For example, the valves 14 and 16 are operated in opposite directions so that when the position of the land 78 of valve member 44 connects the ports 46 and 30, then the position of the land 76 on valve member 42 will be connecting ports 48 and 60 thus high pressure fluid will flow to the power piston 18b at port 46 and drain fluid will be returned from the power piston 18b at port.
48. The motor 18 responsive to the requirements of the hydraulic system is adapted to provide motion to valves 42 and 44 so that either port 46 or 48 may be connected to the fluid 62 while the remaining ports 46 or 48 will thereby be connected to drain. The valve 14 governs the application of fluid pressure to and fluid exhaust from one side of the servo piston 18b while the valve 16 governs the application of fluid pressure to or fluid exhaust from the opposite side of the power piston 18a. The valves 14 and 16 are arranged for operation by the motor 18 so that upon movement of the motor 18 in the direction from the null position the valve 14 will connect one side of the servo piston 18b to the source of fluid pressure, while the valve 16 will connect the opposite side to fluid exhaust. Movement of the motor 18 in the opposite direction from the null position will have the opposite effect.

There is further provided means for independent adjustment of the valve elements 42 and 44 as follows: A flexible wire 62 is secured to the dual arms 20 and 21, as at 64 and 66, and to the valve elements 42 and 44, as at 68. The sliding sleeve elements 34 and 36 are held against a hollow externally threaded adjusting screw 70 by means of a relatively stiff spring 72 positioned against the opposite end of the sleeves 34 and 36 and anchored against the casing 12. A thin walled close fitting tube 74 made of the wire 62 for reinforcement purposes. As hereinbefore described, the drain ports 83 and 83a communicate with the atmosphere and therefore the ends of the valve members 44 and 42 adjacent these ports are exposed to the atmosphere at the exterior of the casing 12.

Having thus described the invention, it will now be apparent to those skilled in the art that when fluid under pressure is applied to the inlet ports 22 and 24, it will pass along passageways 26 and 28 through the inlet ports 30 and 32. Thereupon, dependent upon the position of the valve elements 42 and 44 containing the lands 76 and 78, high pressure fluid will pass through either port 46 or 48 and passageways 46a or 48a to drive the power piston 18. And the fluid on the opposite end of the power piston 18b will be returned through the remaining port 46 or 48 which is connected to drain port 54 or 60.

Since the opposed ends of the valve elements 44 and 42 are exposed to atmospheric pressure, it is apparent that the prevailing atmospheric pressure does not effect the operation of the device.

The valves 14 and 16 in the illustrated embodiment are shown in null position. The torque motor 18 which is responsive to the requirements of the hydraulic servo system governs the positioning of the valve elements 42 and 44 by means of wires 62 attached to the dual arms 20 and 21 which are attached to the motor shaft.

The independent adjustment of the valves 14 and 16 to a fine and sensitive degree is readily accomplished by turning the screws 76, thereby axially adjusting the moving sleeves 34 and 36 and hence the ports 46 and 48 thereof with respect to the lands 76 and 78. The rigid springs 72 bearing firmly against the sleeve 34 and 36 obviate the possibility that the sleeves will slide from their set position. Since in the manufacture of the sleeves 34 and 36 and the valve members 44 and 46 the only accurate axial dimensioning required is of the ports 46 and 48 in the sleeves 34 and 36 and in the valve members 44 and 46, it is apparent that a pile up of manufacturing tolerances along the length of the members 46 and 48 is relatively unimportant. Hence, the manufacture of the valves 14 and 16 is greatly simplified.

Moreover, the sleeves 34 and 36 are movable relatively to the valve members 44 and 46 respectively. Therefore, the mounting of the valve members 44 and 46 to the dual arms 21 and 20 respectively, does not require extreme accuracy since the sleeves 34 and 36 and therefore, the ports 46 and 48 may be adjusted relative to the lands 76 and 78 and the valve members 44 and 46. Thus it is possible to accomplish the setting and adjustment of valves that are relatively small and otherwise could not be adjusted internally.

Although only one embodiment and one application of the invention has been illustrated and described, other changes and modifications in the form and relative arrangement of parts, which will be apparent to those skilled in the art, may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In a hydraulic servo valve operated by a torque motor, a casing, a pair of bores in said casing, a slideable valve sleeve within each of said bores, adjustable threaded means in one end of each of said bores, spring means biasing said sleeves against said threaded means, a movable valve element within each of said sleeves, a wire attached to each movable element and extending through said threaded means, said wires diametrically attached to said motor, a pair of pressure inlet ports in said casing leading to said valves, ports in said sleeves for said inlets, a control port in each sleeve, a drain port in each sleeve and means for reinforcement purposes of said wires, control ports, a land on each movable element for governing fluid conditions at said control ports, said lands being positioned by said motor.

2. In a hydraulic servo valve, a casing including a through bore, an adjustable sleeve within said bore, spring means biasing one end of said sleeve, a hollow threaded member engaging the other end of said sleeve for adjusting said sleeve against said spring means, a hollow threaded member communicating one end of said bore to atmosphere, a pressure inlet and a control port in said sleeve, drain port means in said sleeve, a land on each said element for governing fluid conditions at said control ports, said drain port means in said casing and said hollow threaded member being operable on said control ports, a land on each movable element in communication with the ambient atmosphere.

3. For use in a hydraulic servo system where the flow of fluid supplied to a power piston is controlled by a pair of valves operated by a motor to apply fluid pressure to one side or the other of the piston; the combination comprising a casing including a pair of bores, a fluid pressure port and a fluid outlet for each bore, an adjustable sleeve in each bore, spring means biasing against each sleeve, threaded means for independently adjusting each sleeve against said spring means, mating ports for said fluid pressure and outlet in each of said sleeves, a control port in said sleeves, a movable valve element within each sleeve, wire means attaching each of said elements to said motor, a land on each element cooperating with said fluid pressure and outlet ports and said control ports, said motor slidably operating said elements in an opposite sense to control the fluid flow at said control ports.

4. For use in a hydraulic servo system where the flow of fluid supplied to a power piston is controlled by a pair of valves operated by a motor to apply fluid pressure to one side or the other of the piston; the combination comprising a casing including a pair of bores, a fluid pressure port and a fluid outlet for each bore, an adjustable sleeve in each bore, spring means biasing against each sleeve, hollow threaded means for independently adjusting each sleeve against said spring means, mating ports for said fluid pressure and outlet in each of said sleeves, a control port in said sleeves, a movable valve element within each sleeve,
wire means attaching each of said elements to said motor, a land on each element cooperating with said fluid pressure and outlet ports and said control ports, said motor slideably operating said elements in an opposite sense to control the fluid flow at said control ports, said casing having a port opening one end of the bore to atmospheric pressure, and said hollow threaded means opening the opposite end of this bore to atmospheric pressure so as to apply prevailing atmospheric pressure to opposite ends of the valve element and sleeve.

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