

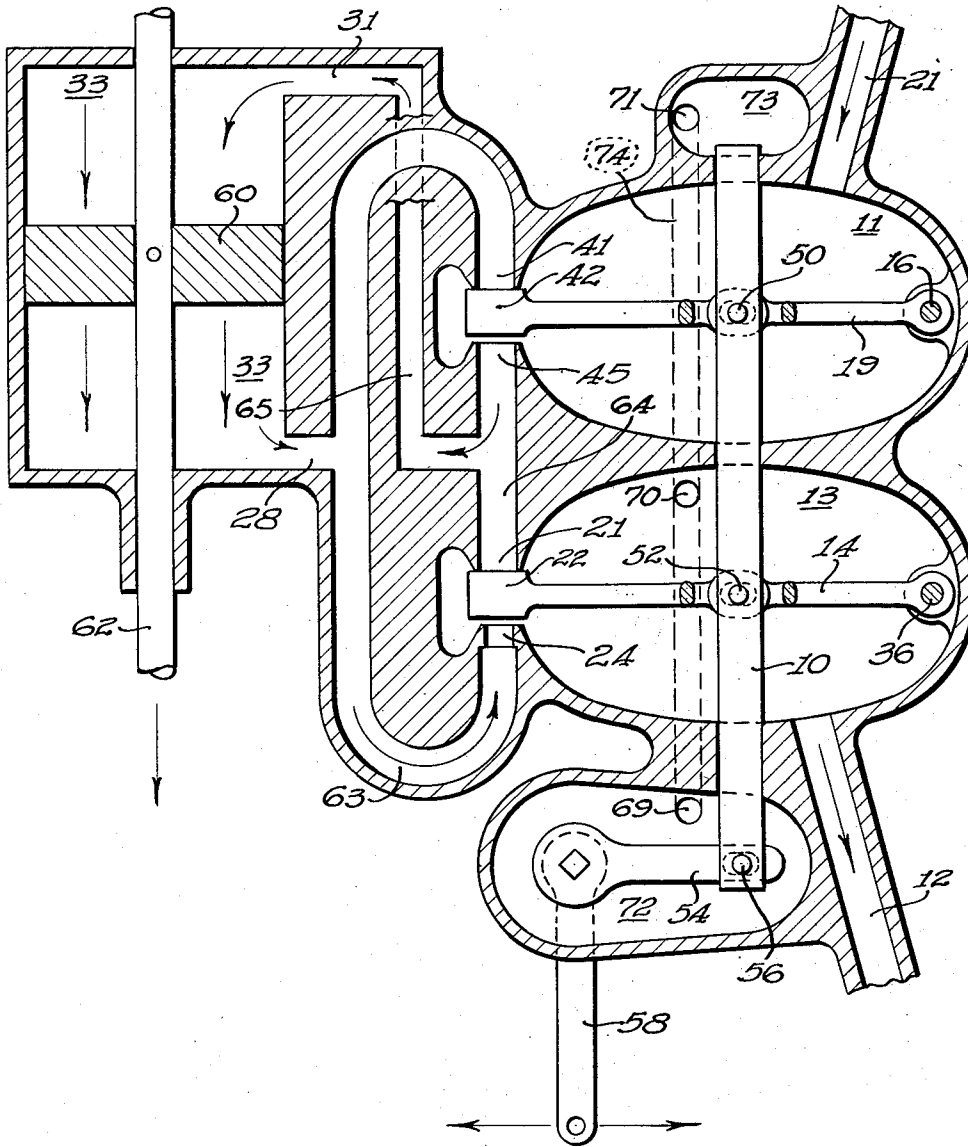
April 14, 1959

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2,881,740

SERVO VALVE

Filed Nov. 23, 1953



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2,881,740

SERVO VALVE

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Application November 23, 1953, Serial No. 393,748

6 Claims. (Cl. 121—46.5)

The object of this invention is to devise a servo valve which is unaffected by dirt, is cheap to build and which also has negative hysteresis characteristics built in.

The ordinary servo valve is expensive to make, is oversensitive to dirt and has a positive hysteresis due to friction. A slightly negative hysteresis is sometimes a desirable characteristic in order to cancel out this friction hysteresis. I have discovered that I can make a moving rod move two levers, each having a double ended pad sealing two outlets. A low pressure chamber surrounds one pair of ports and one lever and a high pressure chamber the other pair of ports and the other lever. Each pad seats on an inlet or outlet port from the high and low pressure chambers so that alternatively when the high pressure is admitted to one end of a cylinder of a slave motor, the low pressure is admitted to the other end of the cylinder. If the two low pressure ports differ in size, then the system will be unbalanced when it is about to increase speed. From this unbalance is derived the fact that after a given speed has been attained and the servo valve has acted to reduce speed, it is moved rapidly to reverse.

Specifically, after the desired speed has been reached, then the speed goes on increasing considerably above that value and on the return motion (deceleration)—because of friction—we would normally have to go to a much lower speed to reverse the slave and to restore speed.

The operating rod, for example, moves up; e.g. at 2000 r.p.m., as we increase speed to 4,000 r.p.m. for example, the negative pressure difference comes into action when we decrease from 4,000 to 2,000 r.p.m. and it then acts promptly to cancel out or minimize the normal friction "dead band." By my invention the servo valve "plasters" shut the moment the speed falls to 2,000 r.p.m. being assisted in moving by this difference in area of one pair of ports (in this case the low pressure ports). Otherwise, due to the weak force operating when the speed responsive element is at 2,000 r.p.m. and when the speed just falls below 2,000 r.p.m. at which the governor is set, the speed would have to fall to say 1800 r.p.m. before there was sufficient force to overcome friction.

The figure shows the preferred form of my invention. In the figure 21 is the entrance passage of high pressure operating fluid to high pressure chamber 11.

12 is the exit passage from the low pressure chamber 13.

14 is the low pressure lever mounted in the low pressure chamber 13 and hinged on pin 36.

19 is the high pressure lever mounted in the high pressure chamber 11 hinged on pin 16.

10 is the central operating rod which engages the high pressure lever 19 at pin 50 and the low pressure lever 14 at pin 52 and the operating lever 54 at pin 56.

41 is one high pressure port.

45 is the other high pressure port, both being of equal size.

42 is the pad on the end of the lever 19 which engages the two ports 41 and 45.

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21 is the larger of the two low pressure ports and is equal in area to the area of ports 41 and 45.

24 is the smaller of the two low pressure ports.

22 is the pad on the end of the lever 19 which engages the ports 21 and 24.

With air pressure at from 30 to 150 p.s.i., I have found a diameter of 21, 45 and 41 equal to 0.040" and have found a diameter of 24 at 0.030" satisfactory.

When lever 58 is moved to the right (counter-clockwise) in response to some actuating device such as a high speed governor, rod 10 moves upward causing the high pressure lever 19 and low pressure lever 14 to move clockwise about pivots 16 and 36 respectively. This movement will result in pads 42 and 22 seating on ports 41 and 21 respectively.

At this time, it will be noticed, that the ports thusly sealed off are equal in cross-sectional area. The high pressure fluid then enters port 45, through high pressure chamber 11, fills conduit 64 and continues through port 31 so as to fill the upper part of cylinder 33 and force slave piston 60 downward. The fluid leaving the lower part of cylinder 33 flows through port 65, conduit 63 and through port 24 into chamber 13 which in turn exhausts into conduit 12. At the same time, the fluid exhausting the lower part of cylinder 13 creates a static pressure against the face of pad 22 which is held against port 21. It can be seen that the pressure pads 42 and 22 are for all practical purposes in balance with respect to the upward and downward forces.

Assuming now that the lever 58 has been moved to the left (clockwise), the rod 10 and pads 42 and 22 would then be moved downward to seat against ports 45 and 24 respectively. It follows then that the high pressure fluid in chamber 11 would flow through port 41, conduit 63 (at which point it would become static against pad 22), and port 28 into the lower part of cylinder 33 thus causing piston 60 to move upwardly. The fluid which was in the upper part of cylinder 33 would exhaust through port 31, conduit 65 and port 21 into chamber 13 and then through conduit 12. This exhausting fluid also fills the upper half of conduit 64 and becomes static against pad 42 which has sealed off port 45.

It will be noticed that at this particular condition, the forces acting upon the upper and lower surfaces of the respective pads 42 and 22 are not in balance, and the net effective forces is actually tending to keep the pads against the ports 45 and 24. Therefore, it can readily be seen, that it will require greater force, applied at arm 58, to move the said arm in one direction than in the opposite direction. In this particular example, it requires a greater force to move arm 58 to the right (counter-clockwise).

A passage 74 connects an opening 71 in chamber 73 with an opening 70 in chamber 13 with an opening 69 in chamber 72. The result is that the pressure acting on the two ends of rod 10 are exactly in balance. Usually the piston 60 is larger than shown. Obviously there is no restriction in size.

What I claim is:

1. In a servo mechanism a high pressure fluid entrance, a high pressure chamber connected thereto, two high pressure ports therein forming two fluid outlets therefrom, a low pressure fluid exit, a low pressure chamber connected thereto, two low pressure ports therein forming two fluid inlets thereto, a passage connecting one inlet port to one exit port, a second passage connecting the other inlet port to the other exit port, pressure responsive means connected to said passageways, mechanism to simultaneously close one of the two high pressure ports and to open one of the two low pressure ports and to open the other of the two high pressure ports and to close the other of the two low pressure ports so as to subject

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one passage to low pressure and the other passage to high pressure, the improvement which consists in making one port of less area than the other three so that when the servo actuating mechanism moves in one direction it is uninfluenced by the pressure of the actuating fluid, but when it moves in the other its motion is accelerated and assisted by this difference in area so as to give the servo mechanism a negative hysteresis characteristic.

2. In a fluid operated servo mechanism, a high pressure chamber, a low pressure chamber, a two-way fluid motor, a port in each of said chambers connected by a common passage to one side of said motor, a port in each of said chambers connected by a separate common passage to the other side of said motor, a valve disposed between the ports in each of said chambers, means for simultaneously actuating said valves so that said common passages between said motor and said chambers are always open through one of said ports in each of said chambers, and means to vary the forces required to operate said actuating means, said means comprising one of said ports having a smaller area than the other of said ports and said other ports having equal areas.

3. In a fluid operated servo mechanism, a chamber always at high pressure, a chamber always at low pressure, a two-way fluid motor, a port in each of said chambers connected by a common passage to one side of said motor, a port in each of said chambers connected by a separate common passage to the other side of said motor, a valve disposed between the ports in each of said chambers, means for simultaneously actuating said valves so that said common passages between said motor and said chambers are always open through one of said ports in each of said chambers, and means to vary the forces required to operate said actuating means, said means comprising one of said ports having a smaller area than the other of said ports and the other of said ports having equal areas.

4. In a fluid operated servo mechanism having a fluid motor, separate low and high pressure chambers with a port in each chamber connected by a separate common passage to each side of said motor, valves between the ports in each chamber to open and close the same, and means to simultaneously activate said valves so that each side of said motor is at all times in communication with one or the other of said chambers through one of said ports, a method of varying the forces required to operate

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said actuating means, said method comprising the steps of forming one of said ports with a smaller area than the areas of the other of said ports and forming the other of said ports with equal areas, none of said ports providing a restriction to the flow of fluid through said common passages.

5. In a fluid operated servo mechanism having a fluid motor, a pair of separate pressure chambers, one of said chambers being always at a higher pressure and the other of said chambers being always at a low pressure, a port in each chamber connected by a separate common passage to each side of said motor, valves between the ports in each chamber to open and close the same, and means to simultaneously activate said valves so that each side of said motor is at all times in communication with one or the other of said chambers through one of said ports, a method of varying the forces required to operate said actuating means, said method comprising the steps of forming one of said ports with a smaller area than the areas of the other of said ports and forming the other of said ports with equal areas, none of said ports providing a restriction to the flow of fluid through said common passages.

6. In a servo mechanism having a source of motivating hydraulic fluid and exhausting means communicating with a chamber of relatively lower pressure, a slave piston operative with a cylinder, a first conduit system communicating between said source and said cylinder, a second conduit system communicating between said chamber of relatively lower pressure and said cylinder, both said first and second conduit systems having a plurality of ports in said source and said chamber of lower pressure respectively, valve members located within said source and said chamber and adapted to concomitantly cover one port of said first mentioned conduit system and cover one port of said second mentioned conduit system, and means for creating a negative hysteresis in said valve members, said means comprising all of said ports except one being of equal and greater area than said excepted port.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 8,036	Adams	Jan. 8, 1878
1,524,497	Astrom	Jan. 27, 1925
2,240,163	Pick	Apr. 29, 1941