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Servo valve

Background of the Invention

There are many hydraulic applications in which a signal from a remote source such as an electric force motor is used to cause hydraulic response in a hydraulic control valve. Other workers in the prior art have utilized control pressure networks for establishing a movement in the main spool of the hydraulic valve in response to a movement in a remote control motor. For instance, the patent to W. C. Moog, Jr., 2,625,136, issued January 13, 1953, discloses a pilot stage circuitry in which a half-bridge pilot circuit with a stationary nozzle is disclosed. In the Moog patent, the torque motor is a force generating device whereas in the instant invention, a displacement-type force motor is used. In Moog, the control pressure P_c is fed back to the armature via a nozzle bore and reacts with the torque motor and reaction spring to achieve a constant P_c regardless of the pilot pressure P_s magnitude. In the present invention, the control pressures vary with pilot supply pressure since P_c is used as a feedback parameter. United States Patent 3,410,308, issued to W. C. Moog, Jr. on November 12, 1968, United States Patent 3,430,656, issued March 4, 1969 to J. W. Hawk, and United States Patent 2,934,765, issued April 26, 1960 to T. H. Carson, are also of interest.

Another patent of interest is that to E. C. Jupa, issued March 7, 1961, No. 2,973,746, which shows a bridge network. In Jupa, the adjustable nozzle is stationary and not attached to the main spool as in the instant invention. Thus, Jupa does not incorporate a moving nozzle with a one-to-one position feedback. Jupa also has two variable orifices. The flapper nozzle, of course, is adjustable and his needle valve, on the end of the spool, is also adjustable.

French Patent No. 2307209 discloses a hydraulic proportional adjustment valve which comprises an electromechanical converter which is screwed on to a valve housing in which a piston is slidably mounted having a shouldered portion of larger diameter, servo fluid being fed through equal orifices W_1 and W_2 then through another equally sized orifice W_4 in one end of the spool and through a variable orifice W_3 in the other end of the spool. The valve in French Patent No. 2307209 also makes use of a control stem acting on an orifice in the spool end to influence the position of the spool. However, the construction of the French Patent not only differs in detail from the construction of the present invention but also differs in principle in that there is no means by which pilot pressure can be isolated from the working pressure. In prior USA specification No. 2972999 an electro-hydraulic servo valve is disclosed in which a flow of hydraulic working fluid is provided proportional to a control signal. In specification No. 2972999 fluid at both pilot pressure and working pressure is used and to minimise the introduction of foreign matter in the pilot valve portion an independent source of hydraulic fluid may be used. On the other hand, the details of the valve disclosed in USA Patent No. 2972999 are entirely different from the valve in accordance with this invention. In this connection, the construction disclosed in USA Patent No. 2972999 does not achieve the main advantage obtained by isolating the pilot pressure from the working pressure because in No. 2972999 the working pressure has an effect on the position of the piston valve which is not desirable.

The main disadvantage of a construction in which the supply pressure can effect the position of a piston or spool in the valve is that variations in the load pressure may cause variations in the supply pressure causing undesired fluctuations of the spool. In the present invention the supply pressure is not only isolated from the pilot pressure but the chamber into which the valve spool and a control stem extend contains reduced pilot pressure and not tank pressure or supply pressure. This means that the spool is not subject to transient movements caused by variations in the supply pressure due to variations in the load pressure. In some cases this may be critical not only to the quality of the product to be made but also to the safety of the user.

Another prior proposal is to be found in USA Patent No. 4014509 which describes a proportional electromagnetic type direction and throttle controlling valve comprising a spring centered valve spool in a valve body, a pressure reducing valve, two flow restricting orifices, two DC solenoid controlled poppet valves and a vent port in each pressure chamber. Supply flow reduced to a fixed low pressure is divided into two branch lines with flow restricting orifices. The pilot pressure in each restricted flow passage with vent port is controlled by a DC solenoid-controlled poppet valve. The pilot pressure acting on the main spool end moves the spool against the spool centering spring force proportionally to the input DC current. Therefore, the flow rate through the throttling gap between the spool land and the mating valve body is controlled proportionally to input DE current. Vent ports are provided for rapid action of the spool.

Various prior proposals have been therefore put forward as mentioned above but none of the prior proposals solve the problem of providing an effective, reliable and relatively simple flow control servo-valve. The main disadvantage of Hamburgers proposal (French Patent No. 2307209) is that the construction is complicated and the pilot pressure is not isolated from the working pressure.

In USA Patent No. 2972999 the main

advantage of isolating the pilot pressure from the working pressure is not achieved and in USA Patent No. 4014509 although the pilot pressure appears to be effectively isolated from the working pressure nevertheless the construction of valve described is complicated and involves and includes solenoid-controlled poppet valves and other features all of which introduce additional possibilities of failure of the mechanism.

It is therefore an object of this invention to provide a flow control servo valve in which the pilot pressure, which controls the position of a valve spool is effectively isolated from the working pressure, the inlet and outlet paths for the pilot fluid being separate from the flow paths of the working fluid. It is also an object of the invention to provide a flow control servo valve using isolated pilot pressure that is more simple in construction than previous proposals and to this end the invention makes use of mechanism using three fixed orifices and one single adjustable orifice to control the position of the main valve spool.

According to the present invention there is provided a flow control servo valve comprising a valve housing having an axial bore therethrough, a valve control spool axially movable within the bore so as to take up a balanced position within the housing, first and second end chambers one disposed at each end of the spool, a source of pilot pressure connected through first and second equal orifices to the first and second end chambers respectively, a third orifice equal to the first and second orifices and extending between the axial bore and the first end chamber, a fourth orifice of variable size between the axial bore and the second end chamber and a force motor with an axially movable actuator member so arranged that axial movement of the actuator member varies the size of the variable orifice which in turn causes the control spool to move axially to assume a new position to reestablish the balance, characterised in that the pilot pressure is isolated from the working pressure so that when in operation reciprocal movement of the spool in the valve body is effected by the isolated pilot pressure which bathes each end of the spool, working fluid contacting the spool intermediate the length there of only, so that when the spool is moved away from a "null" position in one direction by the pilot pressure, the working fluid is allowed to flow past the spool to operate the load in one sense and, when the spool is moved away from the "null" position in the other direction by the pilot pressure, the working fluid is allowed to flow past the spool to operate the load in the other sense, and further characterised in that a continuous internal axial passageway is provided extending throughout the length of the valve spool, mechanical adjustment means being provided for bringing the spool to its null position. The invention also includes a fluid flow control servo valve comprising:—

1. A valve housing having a generally cylindrical bore extending therethrough,

2. A supply port extending into the valve housing to receive working fluid from an external pump,

3. A return port extending into the said valve housing to return working fluid from the said valve housing to a tank,

4. A generally cylindrical valve spool dimensioned to be slidably received within the valve housing bore,

5. A first chamber at one end (hereinafter called the first end) of the valve spool, a second chamber at the other end (hereinafter called the second end) of the valve spool, the said valve spool being exteriorly shaped to provide first and second cylindrical land areas at opposite ends of the valve spool and third and fourth cylindrical land areas axially spaced intermediate the first and second land areas, each of the land areas radially projecting from the valve spool and being dimensioned to intimately contact the valve housing in sliding engagement within the bore of the housing,

6. The radially projecting land areas of the spool forming first and second cylindrical spool end grooves between the first and third land areas and fourth and second land areas respectively and a third cylindrical central spool pressure groove between the third and fourth land areas,

7. A first passage extending through the valve housing to connect the first and second cylindrical spool end grooves to the return port so that hydraulic working fluid within either the first or second spool end groove, may be returned to the tank,

8. A second passage extending from the supply port to the third cylindrical central spool groove to deliver pressurised hydraulic fluid into the valve housing,

9. Third and fourth passages for respectively and selectively connecting the first and second cylindrical spool end grooves to a load and the third central spool groove to a load, depending on the position of the valve spool relative to the valve housing,

10. An end cap releasably mounted upon the valve housing in a position coaxial with respect to the generally cylindrical valve spool so as to form the outer end of the second chamber at the second end of the valve spool,

11. An end gland releasably mounted upon the valve housing in a position generally coaxial with respect to the generally cylindrical valve spool to form the outer end of the first chamber,

12. The third and fourth land areas of the valve spool are dimensioned axially so that a "null" position can be established wherein the flow of hydraulic working fluid from the central spool groove of the valve spool into the third or fourth passage and return flow of the hydraulic working fluid to the tank via passage is prevented,

13. A fifth passage for fluidically connecting a pilot pressure port to the first chamber via a second fixed orifice and a sixth passage fluidically connecting the pilot pressure port to the second chamber via a third fixed orifice, the fixed orifices being of equal size,

Characterised in that:—

A. A continuous internal passageway is provided axially extending throughout the length of the valve spool connected for fluid communication at the first end to the first chamber and connected for fluid communication at the second end to the second chamber,

B. a first fixed orifice is mounted within the continuous internal passageway in the valve spool generally at the first end thereof and providing the fluid communication between the continuous passageway and the first chamber,

C. a variable orifice is provided within the said continuous internal passageway at the second end of the valve spool and providing the fluid communication between the continuous internal passageway and the second chamber,

D. a generally radial aperture is provided projecting into the valve spool for fluidically connecting the continuous internal passageway of the spool with the first passage through the valve housing so that hydraulic fluid within the continuous internal passageway of the valve spool may be returned to the tank through the return port in the valve housing,

E. mechanical adjustment means, for bringing the valve spool to its "null" position and for retaining the valve spool in its "null" position with the pressure in the chambers equal,

F. the source of pilot pressure is an isolated pilot pressure port,

G. means for altering the isolated pilot pressure in one of the chambers, e.g. the second chamber relative to the pressure in the other chamber, e.g. the first chamber, by altering the size of the variable orifice in order to move the valve spool from its null position so that hydraulic working fluid can flow to the load in one direction or the other.

These and other objects of the invention will become more apparent to those skilled in the art by reference to the following detailed description given by way of example when viewed in light of the accompanying drawings.

Brief Description of the Drawings

FIGURE 1 is a side view of a servo valve according to this invention;

FIGURE 2 is an elongated cross-sectional view, partially schematic, of the principal elements of the servo valve shown in Figure 1;

FIGURE 3 is an enlarged section of the variable nozzle portion of Figure 2; and

FIGURE 4 is a schematic of the control pressure network of the apparatus of Figure 1.

Detailed Description of the Presently Preferred Embodiment

Referring now to the drawings wherein like numerals indicate like parts, the numeral 10 indicates a valve housing having a bore 12 therethrough. Reciprocally received within the bore 12 is a spool 14 equipped with four land areas 16, 18, 20, and 22. Between land areas 16 and 18 is a groove area 24, and between land areas 20 and 22 is a groove area 26. Land areas 18 and 20 are machined with close tolerances for reasons which will become apparent hereinafter.

The valve housing 10 is machined with four internal grooves 28, 30, 32 and 34 located opposite the axial extremities of the land areas 18 and 20 when the spool 14 is in the position shown in Figure 2. Groove areas 24 and 26 communicate with a tank 36 (shown only in Figure 4) by way of a passageway 38 and a return port 40. Internal grooves 28 and 30 can communicate with a load 42 by way of passageway 44, and internal grooves 32 and 34 can communicate with the load 42 by way of a passageway 46. Passageways 44 and 46 are closed and opened by the movements of land areas 18 and 20, respectively; in the location of the spool 14 shown in Figure 2, both passageways are closed.

In the middle of spool 14, between land areas 18 and 20, is a pressure groove 48 which communicates via passage 51 with a port 50 shown in Figure 1. The port 50 is connected to the output of a pump 52, so that pressure from the pump 52 is communicated to the pressure groove 48 and can then be communicated to either passageway 44 or passageway 46, depending on the position of spool 14. Of course, in the position shown in Figure 2, pressure from the pressure groove 48 is communicated to neither passageway. However, as the spool 14 moves to the left as viewed in Figure 2, pressurized fluid will flow to the load 42 through internal groove 30 and passageway 44 and return to tank 36 via passageway 46 and internal groove 34. Conversely, as the spool 14 moves to the right as viewed in Figure 2, pressurized fluid will flow to the load 42 through internal groove 32 and passageway 46 and return to tank 36 via passageway 44 and internal groove 28.

At the left end of bore 12 as viewed in Figure 2 is a chamber 54 closed by an end gland 56 retained in position on the valve housing 10 by clips 58 and bolts 60. End gland 56 receives a piston 62, a screw 64, a jam nut 66, and a centering spring 68. At the right end of bore 12 is a chamber 70 which receives a second centering spring 72 and which is closed by apparatus described hereinafter. The piston 62, the screw 64, the jam nut 66 and the two centering springs 68 and 72 collectively serve as a mechanical "null" adjustment for the spool 14. That is, by adjusting screw 64 it is possible to initially locate land areas 18 and 20 on the spool 14 so that the internal grooves 28 and 30 align with land 18 and grooves 32 and 34 align with land 20 of spool 14.

Chambers 54 and 70 are subjected to intermediate control pressures by means of orifices 74 (A_1) and 76 (A_2), which communicate with the chambers 54 and 70 via the conduits 78 and 80, respectively. The orifices 74 and 76 are of fixed dimensions and are equal to each other. An isolated pilot port 82, which serves as a source of isolated pilot pressure, communicates with the orifices 74 and 76 via an internal filter 84 which protects those orifices from fluid contamination.

Throughout the length of spool 14 is a conduit 86. The conduit 86 communicates at its right end with the groove area 26 via a hole 88 in the spool 14 and at its left end with the chamber 54 via a third fixed orifice 90 (A_3) which is equal to orifice 74 (A_1) and orifice 76 (A_2).

Attached to the right end of valve housing 10, as seen in Figure 2, by means of a mounting cap 92 is a force motor 94 having a force motor stem 96 terminating in a planar end 98 which extends toward the right end of the spool 14. As best seen in Figure 3, the end of the spool 14 which faces the force motor 94 carries a pressed-in nozzle 100 having a planar annular surface 102 disposed opposite and parallel to the planar end 98 of the force motor stem 96. The area between the planar end 98 of the force motor stem 96 and the planar annular surface 102 on the nozzle 100 constitutes a fourth orifice 104 (A_4), which, as explained hereinafter, is of variable area. As is well known in the art, the force motor 94 preferably includes a built-in bias spring to overcome any force built up on the force motor stem 96 due to the pressure at the nozzle 100 opening.

Mounting cap 92 is retained in position on the valve housing 10 by clips 106 and bolts 108. At the left end of mounting cap 94 is a flat washer 110 which abuts the centering spring and which limits the travel of the spool 14 in the right-hand direction. The force motor 94 is mounted in the mounting cap 92 by threads 112 and retained for locking purposes by locking ring 114. This arrangement allows external adjustment of the force motor stem 96, which in turn permits external manual adjustment of the variable orifice 104 (A_4).

Initially, after the screw 64 has been adjusted to align the spool 14 in the valve housing 10 as shown in Figure 2, the force motor 94 is adjusted so that the variable orifice 104 (A_4) equals the fixed orifices 74 (A_1), 76 (A_2), and 90 (A_3) in effective area. At that point, the pressures in each of the chambers 54 and 70 is exactly half the pilot supply pressure applied to pilot port 82. Since the pressures in the chambers 54 and 70 are equal to each other, the spool 14 is held stationary, which is called the "null" of the valve.

When current or voltage applied to the force motor 94 causes the force motor stem 96 to move to the left toward spool 14, orifice 104 (A_4) is reduced in area. As a result, the pressure in chamber 70 increases, and the spool 14 moves to the left, causing pressurized fluid to actuate the load 42 through internal groove 30 and passageway 44. Correspondingly, when current or voltage applied to the face motor 94 causes the force motor stem 96 to move to the right away from spool 14, orifice 104 (A_4) is increased in area. As a result, the pressure in the chamber 70 decreases, and the spool 14 moves to the right, causing pressurized fluid to actuate the load 42 through internal groove 32 and passageway 46. In each case, of course, the spool 14 will move only that amount necessary to re-establish the force balance. When the forces are again in balance, the spool 14 is held in the newly attained position. If the input to the force motor 94 is later varied, the spool 14 will quickly move to a new position re-establishing the force balance. In particular, if the input to the force motor 94 later ceases, the spool 14 will return to the "null" of the valve. Similarly, lack of controlling pressures in the chambers 54 and 70 caused, for instance, by failure of the pump 52 (if the isolated pilot pressure is derived from the pump 52) will cause the spool 14 to return to its "null" position.

The foregoing control pressure bridge is displayed schematically in Figure 4. As shown therein, the subject invention provides a pilot pressure bridge arrangement in which there are four orifices, only one of which is variable. An automatic feedback is thus developed which provides accurate, continuous control.

Claims

1. A flow control servo valve comprising a valve housing having an axial bore therethrough, a valve control spool axially movable within the bore so as to take up a balanced position within the housing, first and second end chambers one disposed at each end of the spool, a source of pilot pressure connected through first and second equal orifices to the first and second end chambers respectively, a third orifice equal to the first and second orifices and extending between the axial bore and the first end chamber, a fourth orifice of variable size between the axial bore and the second end chamber and a force motor with an axially movable actuator member so arranged that axial movement of the actuator member varies the size of the variable orifice which in turn causes the control spool to move axially to assume a new position to reestablish the balance, characterised in that the pilot pressure is isolated from the working pressure so that when in operation reciprocal movement of the spool (14) in the valve body (10) is effected by

the isolated pilot pressure which bathes each end of the spool (14), working fluid contacting the spool (14) intermediate the length there of only, so that when the spool (14) is moved away from a "null" position in one direction by the pilot pressure, the working fluid is allowed to flow past the spool (14) to operate the load (42) in one sense and, when the spool (14) is moved away from the "null" position in the other direction by the pilot pressure, the working fluid is allowed to flow past the spool (14) to operate the load (42) in the other sense, and further characterised in that a continuous internal axial passageway (86) is provided extending throughout the length of the valve spool (14), mechanical adjustment means being provided for bringing the spool (14) to its null position.

2. A fluid flow control servo valve comprising:—

1. A valve housing (10) having a generally cylindrical bore (12) extending therethrough,

2. A supply port (50) extending into the valve housing (10) to receive working fluid from an external pump (52).

3. A return port (40) extending into the said valve housing (10) to return working fluid from the said valve housing (10) to a tank (36).

4. A generally cylindrical valve spool (14) dimensioned to be slidably received within the valve housing bore (12).

5. A first chamber (54) at one end (hereinafter called the first end) of the valve spool (14), a second chamber (70) at the other end (hereinafter called the second end) of the valve spool (14), the said valve spool (14) being exteriorly shaped to provide first and second cylindrical land areas (16, 22) at opposite ends of the valve spool (14) and third and fourth cylindrical land areas (18, 20) axially spaced intermediate the first and second land areas (16, 22) each of the land areas (16, 18, 20, 22) radially projecting from the valve spool (14) and being dimensioned to intimately contact the valve housing (10) in sliding engagement withinn the bore (12) of the housing (10),

6. The radially projecting land areas (16, 18, 20, 22) of the spool (14) forming first and second cylindrical spool end grooves (24, 26) between the first and third land areas (16, 18) and fourth and second land areas (20, 22) respectively and a third cylindrical central spool pressure groove (48) between the third and fourth land areas (18, 20),

7. A first passage (38) extending through the valve housing (10) to connect the first and second cylindrical spool end grooves (24, 26) to the return port (40) so that hydraulic working fluid within either the first or second spool end groove (24, 26), may be returned to the tank (36),

8. A second passage (51) extending from the supply port (50) to the third cylindrical central spool groove (48) to deliver pressurised hydraulic fluid into the valve housing (10),

9. Third and fourth passages (44, 46) for respectively and selectively connecting the first and second cylindrical spool end grooves (24, 26) to a load (42) and the third central spool groove (48) to a load (42), depending on the position of the valve spool (14) relative to the valve housing (10),

10. An end cap (92) releasably mounted upon the valve housing (10) in a position coaxial with respect to the generally cylindrical valve spool (14) so as to form the outer end of the second chamber (70) at the second end of the valve spool,

11. An end gland (56) releasably mounted upon the valve housing (10) in a position generally coaxial with respect to the generally cylindrical valve spool (14) to form the outer end of the first chamber (54),

12. The third and fourth land areas (18, 20) of the valve spool (14) are dimensioned axially so that a "null" position can be established wherein the flow of hydraulic working fluid from the central spool groove (48) of the valve spool (14) into the third or fourth passage (44 or 46) and return flow of the hydraulic working fluid to the tank (36) via passage (44 or 46) is prevented,

13. A fifth passage for fluidically connecting a pilot pressure port to the first chamber via a second fixed orifice (74) and a sixth passage (80) fluidically connecting the pilot pressure port to the second chamber (70) via a third fixed orifice (76), the fixed orifices (90, 74, 76) being of equal size,

Characterised in that:—

A. A continuous internal passageway (86) is provided axially extending throughout the length of the valve spool (14) connected for fluid communication at the first end to the first chamber (54) and connected for fluid communication at the second end to the second chamber (70),

B. a first fixed orifice (90) is mounted within the continuous internal passageway (86) in the valve spool (14) generally at the first end thereof and providing the fluid communication between the continuous passageway (86) and the first chamber (54),

C. a variable orifice (104) is provided within the said continuous internal passageway (86) at the second end of the valve spool (14) and providing the fluid communication between the continuous internal passageway (86) and the second chamber (70),

D. a generally radial aperture (88) is provided projecting into the valve spool for fluidically connecting the continuous internal passageway (86) of the spool (14) with the first passage (38) through the valve housing (10) so that hydraulic fluid within the continuous internal passageway (86) of the valve spool (14) may be returned to the tank (36) through the return port (40) in the valve housing,

E. mechanical adjustment means (62, 64, 66, 68, 72) for bringing the valve spool to its "null" position and for retaining the valve spool in its "null" position with the pressure in the chambers (54) and (70) equal,

F. the source of pilot pressure is an isolated pilot pressure port (82),

G. means for altering the isolated pilot pressure in one of the chambers e.g. chamber (70) relative to the pressure in the other chamber e.g. chamber (54) by altering the size of the variable orifice (104) in order to move the valve spool from its null position so that hydraulic working fluid can flow to the load in one direction or the other.

3. A servo valve according to claim 2 characterised in that the variable orifice (104) is coaxially arranged within the said continuous internal passageway (86).

4. A servo valve according to claim 2 or 3 characterised in that first and second cylindrical bore grooves (28, 30) are provided radially projecting outwardly from the cylindrical bore of the valve housing (10) and are located at the axial extremities respectively of the third cylindrical land area (18).

5. A servo valve according to claim 4 characterised in that third and fourth cylindrical bore grooves (32, 34) are provided projecting outwardly from the said cylindrical bore of the valve housing (10) and are located at the axial extremities respectively of the fourth cylindrical land area (20).

6. A servo valve according to claim 5 characterised in that in the "null" position of the valve spool (14) the passage of hydraulic working fluid from the central spool groove (48) of the valve spool (14) into the second cylindrical bore groove (30) or the third cylindrical bore groove (32) radially projecting into the valve housing will be prevented and in which the return bore grooves (28) and (34) will also be closed.

7. A servo valve according to any of the preceding claims 2 to 6 characterised in that the mechanical adjustment means comprises a piston (62) mounted for translation within an end gland (56) the piston being coaxially aligned with respect to the valve spool (14) and arranged to extend adjacent to the first chamber (54).

8. A servo valve according to claim 7 characterised in that a first compression spring (72) is mounted within the second chamber (70) to bias the valve spool (14) away from its null position, an electro-magnetic force motor (94) is coaxially mounted within an end cap (92) and has a generally cylindrical stem (96) mounted for selective reciprocation within the force motor and has a planar end surface (98) and that a second compression spring (68) is mounted within the first chamber (54) and extends coaxially with the spool at the first end of the valve spool between one side of the piston (62) and the end of the valve spool (14), the second spring (68) being operable to bias the valve spool (14) in a direction opposing the bias of the first spring (72).

9. A servo valve according to claim 8 characterised in that the mechanical adjustment means (64, 66) is connected to the end gland (56) and abuts against the other side of the piston (62) for selectively translating the piston (62) to mechanically react the second spring (68) against the first spring (72) and mechanically bring the valve spool (14) to its null position within the cylindrical bore (12) of the valve housing (10) so that hydraulic working fluid is blocked from flowing from the third central spool groove (48) to either to said second or third bore grooves (30, 32) from the first bore groove (28) into the first spool groove (24) and from the fourth bore groove (34) into the second spool groove (26).

Revendications

1. Servovalve de commande d'écoulement comprenant un corps percé de part en part d'une cavité axiale, un tiroir mobile en direction axiale dans cette cavité et capable de prendre une position d'équilibre dans le corps de la valve, une première chambre et une seconde chambre, chacune disposée à une extrémité respective du tiroir, une source de pression pilote reliée à travers un premier orifice et un second orifice égaux en section respectivement à la première chambre et à la seconde chambre d'extrémité, un troisième orifice égal en section aux premier et second orifices, s'étendant entre la cavité axiale et la première chambre, un quatrième orifice de section variable situé entre la cavité axiale et la seconde chambre et un moteur-force dont l'organe d'actionnement axialement mobile est agencé de manière que son mouvement axial fasse varier la section de l'orifice variable, ce qui fait se déplacer axialement le tiroir de commande, lequel prend alors une nouvelle position où l'équilibre est rétabli, cette valve étant caractérisée par le fait que la pression pilote est isolée de la pression de travail de sorte que, lorsque, en fonctionnement, le mouvement de va-et-vient du tiroir (14) dans le corps (10) de la valve est déterminé par la pression pilote isolée qui baigne chaque extrémité du tiroir (14) le fluide de travail vient en contact avec le tiroir (14) seulement dans la région moyenne de la longueur de celui-ci, et que, lorsque le tiroir (14) est écarté d'une position "zéro" dans un sens par la pression pilote, le fluide de travail est autorisé à s'écouler au delà du tiroir (14) pour actionner la charge (42) dans un sens et, lorsque le tiroir (14) est écarté de la position "zéro" dans l'autre sens par la pression pilote, le fluide de travail est autorisé à s'écouler au delà du tiroir (14) pour actionner la charge (42) dans l'autre sens, et en outre par le fait qu'un conduit interne axial (86) continu est prévu sur toute la longueur du tiroir (14) de la valve, des moyens d'ajustement mécanique étant prévus pour amener le tiroir (14) dans sa position "zéro".

2. Servovalve de commande d'écoulement

de fluide comprenant:

1°) un corps (10) de valve comportant une cavité (12) de forme générale cylindrique s'étendant de part en part,

2°) une tubulure d'admission (50) pénétrant dans le corps (10) de la valve pour recevoir le fluide de travail émis par une pompe externe (52),

3°) une tubulure de retour (40) pénétrant dans le corps (10) de la valve pour assurer le retour du fluide de travail du corps (10) de la valve vers un réservoir (36),

4°) un tiroir (14) de forme générale cylindrique, dimensionné de manière a être reçu à coulissement dans la cavité (12) du corps de la valve,

5°) une première chambre (54) à une extrémité (ci-après appelée "première extrémité") du tiroir (14), une seconde chambre (70) à l'autre extrémité (ci-après appelée "seconde extrémité") du tiroir (14), ce dernier étant conformé extérieurement pour offrir un premier segment (16) et un second segment (22) cylindriques aux extrémités opposées du tiroir (14) et un troisième segment (18) et un quatrième segment (20) cylindriques espacés axialement entre les premier et second segments (16, 22), chacun des segments (16, 18, 20, 22) faisant saillie radialement du tiroir (14) et étant dimensionnés pour être en contact intime avec le corps (10) de la valve et coulisser dans la cavité (12) de ce dernier,

6°) les segments (16, 18, 20, 22) du tiroir (14) faisant apparaître aux extrémités du tiroir une première gorge (24) et une seconde gorge (26) cylindriques respectivement entre les premier et troisième segments (16, 18) et les quatrième et second segments (20, 22), et au centre du tiroir, une troisième gorge de pression (48) cylindrique située centralement entre les troisième et quatrième segments (18, 20),

7°) un premier conduit (38) s'étendant à travers le corps (10) de la valve pour relier à la tubulure de retour (40) les première et seconde gorges (24, 26) situées aux extrémités du tiroir, de manière que le fluide hydraulique de travail se trouvant soit dans la première gorge (24), soit dans la seconde gorge (26) situés aux extrémités du tiroir puisse être renvoyé dans le réservoir (36),

8°) un second conduit (51) s'étendant de la tubulure d'alimentation (50) à la troisième gorge (48) située au centre du tiroir pour délivrer le fluide hydraulique sous pression à l'interieur du corps (10) de la valve,

9°) un troisième conduit (44) et un quatrième conduit (46) reliant respectivement et sélectivement les première et seconde gorges (24, 26) situées aux extrémités du tiroir à une charge (42) et la troisième gorge (48) située au centre du tiroir à cette charge (42) en fonction de la position du tiroir (14) par rapport au corps (10) de la valve,

10°) une douille d'extrémité (92) montée de manière amovible sur le corps (10) de la valve en une position coaxiale par rapport au tiroir (14) de forme générale cylindrique pour former l'extrémité extérieure de la seconde chambre (70) située à la seconde extrémité du tiroir,

11°) un chapeau d'extrémité (56) monté de manière amovible sur le corps (10) de la valve en une position sensiblement coaxiale par rapport au tiroir (14) de forme générale cylindrique pour former l'extrémité extérieure de la première chambre (54),

12°) les troisième et quatrième segments (18, 20) du tiroir (14) étant dimensionnés axialement de manière qu'une position "zéro" puisse s'établir dans laquelle l'écoulement du fluide hydraulique de travail à partir de la gorge centrale (48) de tiroir (14) dans le troisième ou le quatrième conduits (44) ou (46) et l'écoulement de retour du fluide hydraulique de travail vers le réservoir (36) via un conduit (44) ou (46) soient empêchés,

13°) un cinquième conduit le liaison fluidique d'un orifice de pression pilote à la première chambre via un second orifice fixe (74) et un sixième conduit (80) de liaison fluidique de l'orifice de pression pilote à la seconde chambre (70) via un troisième orifice fixe (76), les orifices fixes (90, 74, 76) étant d'égale section,

caractérisé par le fait que:

a) un conduit interne continu (86) est prévu axialement à travers toute la longueur du tiroir (14) de la valve, ce conduit étant agencé pour être en communication fluidique à la première extrémité avec la première chambre (54) et à la seconde extrémité avec la seconde chambre (70),

b) un premier orifice fixe (90) est prévu dans le conduit interne continue (86) du tiroir (14) de la valve dans la région de la première extrémité de celui-ci, qui assure la communication fluidique entre le conduit continu (86) et la première chambre (54),

c) un orifice variable (104) est prévu dans ledit conduit interne continu (86) à la seconde extrémité du tiroir (14) de la valve, cet orifice assurant la communication fluidique entre le conduit interne continu (86) et la seconde chambre (70),

d) une ouverture (88) sensiblement radiale est prévue dans le tiroir de la valve pour relier fluidiquement le conduit interne continu (86) du tiroir (14) au premier conduit (38) traversant le corps (10) de la valve, de manière que le fluide hydraulique se trouvant dans le conduit interne continu (86) du tiroir (14) de la valve puisse retourner dans le réservoir (36) via la tubulure de retour (40) située dans le corps de la valve,

e) des moyens d'adjustement mécanique (62, 64, 66, 68, 72) sobt prévus pour permettre d'amener le tiroir de la valve dans sa position "zéro" et de le maintenir dans cette position lorsque les pressions dans les chambres (54) et (70) sont égales,

f) la source de pression pilote est un orifice isolé (82),

g) des moyens sont prévus modifier la

pression pilote pilote isloée dans l'une des chambres, par exemple la chambre (70), par rapport à la pression dans l'autre chambre, par exemple la chambre (54), par variation de la section de l'orifice variable (104) afin d'écarter le tiroir de sa position "zéro" de manière que le fluide hydraulique de travail puisse d'écouler vers la charge dans un sens ou dans l'autre.

3. Servovalve selon la revendication 2, caractérisée par le fait que l'orifice variable (104) est disposé coaxialement par rapport audit conduit interne continu (86).

4. Servovalve selon la revendication 2 ou 3, caractérisée par le fait que des première et seconde gorges (28, 30) cylindriques dans la cavité font radialement saillie vers l'extérieur à partir de ladite cavité cylindrique du corps (10) de la valve et sont respectivement situées aux extrémités axiales du troisième segment cylindrique (18).

5. Servovalve selon la revendication 4, caractérisée par le fait que des troisième et quatrième gorges (32, 34) forées cylindriquement dans la cavité font radialement saillie ver l'extérieur à partir de ladite cavité cylindrique du corps (10) de la valve et sont respectivement situées aux extrémités axiales du quatrième segment cylindrique (20).

6. Servovalve selon la revendication 5, caractérisée par le fait que, dans la position "zéro" du tiroir (14) de la valve, le passage du fluide hydraulique de travail de la gorge centrale (48) du tiroir (14) vers la seconde gorve (30) ou la troisième gorge (32), de la cavité faisant radialement saillie dans le corps de la valve, est empêché, les gorges de retour (28 et 34) de la cavité étant également fermées.

7. Servovalve selon l'une quelconque des revendications 2 à 6, caractérisée par le fait que les moyens d'ajustement mécanique comprennent un piston (62) pouvant se déplacer en translation dans le chapeau d'extrémité (56), ce piston étant coaxialement aligné avec le tiroir (14) et agencé pour s'étendre au voisinage de la première chambre (54).

8. Servovalve selon la revendication 7, caractérisée par le fait qu'un premier ressort de compression (72) est monté dans la seconde chambre (70) pour tendre à écarter le tiroir (14) de sa position "zéro", un moteur-force (94) électromagnétique est coaxialement monté dans la douille d'extrémité (92) et possède une tige (96) de forme générale cylindrique pouvant être animée à volonté d'un mouvement de va-et-vient dans le moteur-force et offrant une surface d'extrémité plane (98), et qu'un second ressort de compression (68) est monté dans la première chambre (54) et s'étend coaxialement par rapport au tiroir à la première extrémité de ce dernier entre une face du piston (62) et l'extrémité du tiroir (14), ce second ressort (68) pouvant être actionné pour pousser le tiroir (14) dans un sens opposé à la poussée du premier ressort (72).

9. Servovalve selon la revendication 8, caractérisée par le fait que les moyens d'ajustement mécanique (64, 66) sont reliés au chapeau d'extrémité (56) et viennent en aboutement contre l'autre face du piston (62) pour déplacer en translation à volonté le piston (62), faire réagir mécaniquement le second ressort (68) à l'encontre du premier ressort (72) et amener mécaniquement le tiroir (14) dans sa position "zéro" à l'intérieur de la cavité cylindrique (12) du corps (10) de la valve, de sorte que le fluide hydraulique de travail soit empêché de s'écouler de la troisième gorge centrale (48) du tiroir vers soit la seconde gorge (30), soit la troisième gorge (32) de la cavité, de la première gorge (28) de la cavité vers la première gorge (24) du tiroir et de la quatrième gorge (34) de la cavité vers la seconde gorge (26) du tiroir.

Patentansprüche

1. Ein Servo-Stromventil bestehend aus einem Gehäuse mit einer axialen Durchgangsbohrung, einem zur Einnahme einer Gleichgewichtslage innerhalb des Gehäuses axial verschiebbaren Ventilsteuerschieber, einer ersten und zweiten Endkammer, von denen sich jeweils eine an den beiden Seiten des Steuerschiebers befindet, eine Hilfssteuerdruckquelle, die über die gleich große erste und zweite Öffnung mit der ersten bzw. zweiten Endkammer verbunden ist, einer dritten Öffnung, die ebenso groß ist wie die erste und zweite Öffnung, zur Verbindung zwischen Axialbohrung und erster Endkammer, einer vierten Öffnung veränderlicher Größe zwischen Axialbohrung und zweiter Endkammer, sowie einem Elektromotor mit axial beweglichem Stellglied, das so angeordnet ist, daß die axiale Bewegung des Stellgliedes die Größe der veränderlichen Öffnung modifiziert, wodurch wiederum der Steuerschieber zur Wiederherstellung des Gleichgewichts in axialer Richtung verschoben wird, gekennzeichnet dadurch, daß der Hilfssteuerdruck vom Arbeitsdruck getrennt ist, so daß bei Betrieb die Hin- und Herbewegung des Schiebers (14) im Ventilkörper (10) durch den gesonderten Hilfssteuerdruck bewirkt wird, mit dem das betreffende Ende des Schiebers (14) beaufschlagt wird, wobei das Treibmittel nur mit dem Mittelabschnitt des Schiebers (14) in Berührung kommt, so daß das Treibmittel, wenn der Schieber (14) durch den Hilfssteuerdruck aus der "Null"-Lage in eine Richtung ausgelenkt wird, am Schieber (14) vorbeiströmen und die Last (42) in der einen Richtung, und, wenn der Schieber (14) durch den Hilfssteuerdruck aus der "Null"-Lage in die andere Richtung ausgelenkt wird, am Schieber (14) vorbeiströmen und die Last (42) in der anderen Richtung verschieben kann, sowie des weiteren gekennzeichnet dadurch, daß im Innern des Ventilschiebers (14) ein sich über die gesamte Länge erstreckender durchgehender axialer Kanal (86) vorgesehen ist, wobei eine mechanische Einstellvorrichtung vorgesehen ist, um den Schieber (14) in seine

Null-Lage bringen zu können.

2. Ein Servo-Fluidstromventil bestehend aus:

1. einem Ventilgehäuse (10) mit einer insgesamt zylindrischen Durchgangsbohrung (12),

2. einer Zufuhröffnung (50) im Ventilgehäuse (10) zur Aufnahme von Treibmittel, das über eine externe Pumpe (52) zugeführt wird,

3. einer Rücklauföffnung (40) im Ventilgehäuse (10) für den Rücklauf des Treibmittels aus dem Ventilgehäuse (10) zu einem Behälter (36),

4. einem insgesamt zylindrischen Ventilschieber (14), der für gleitende Anordnung innerhalb der Ventilgehäusebohrung (12) bemessen ist,

5. einer ersten Kammer (54) am einen Ende (nachstehend als erstes Ende bezeichnet) des Ventilschiebers (14), einer zweiten Kammer (70) am anderen Ende (nachstehend als zweites Ende bezeichnet) des Ventilschiebers (14), wobei die äußere Form des Ventilschiebers (14) so gestaltet wird, daß eine erste und zweite zylindrische Stegfläche (16, 22) am jeweils entgegengesetzten Ende des Ventilschie ers (14) und eine dritte und vierte zylindrische Stegfläche (18, 20), axial zwischen der ersten und zweiten Stegfläche (16, 22) entstehen, wobei jede der Stegflächen (16, 18, 20, 22) ausgehend vom Ventilschieber (14) radial nach außen ragt und so bemessen ist, daß sie eng am Ventilgehäuse (10) anliegt und innerhalb der Bohrung (12) des Gehäuses (10) gleiten kann,

6. den radial nach außen ragenden Stegflächen (16, 18, 20, 22) des Schiebers (14), von denen die erste und zweite zylindrische Schieberendnut (24, 26) zwischen erster und dritter Stegfläche (16, 18) bzw. zwischen vierter und zweiter Stegfläche (20, 22) und eine zentral angeordnete zylindrische Schieberdrucknut (48) zwischen der dritten und vierten Stegfläche (18, 20) gebildet werden,

7. einem ersten Kanal (38) durch das Ventilgehäuse (10) zur Verbindung der ersten und zweiten zylindrischen Schieberendnut (24, 26) mit der Rücklauföffnung (40), so daß das hydraulische Treibmittel in der ersten oder zweiten Schieberendnut (24, 26) zum Behälter (36) zurückgeführt werden kann,

8. einem zweiten Kanal (51) von der Zulauföffnung (50) zur zentral angeordneten dritten zylindrischen Schiebernut (48), über den mit Druck beaufschlagtes Hydrauliköl in das Ventilgehäuse (10) strömen kann,

9. einem dritten bzw. vierten Kanal (44, 46) zur selektiven Herstellung einer Verbindung zwischen der ersten bzw. zweiten zylindrischen Schieberendnut (24, 26) und einer Last (42) bzw. zwischen der zentral angeordneten dritten Schiebernut (48) und iner Last (42), jeweils in Abhängigkeit von der Lage des Ventilschiebers (14) gegenüber dem Ventilgehäuse (10),

10. einer Endkappe (92), die lösbar mit dem Ventilgehäuse (10) verbunden und hinsichtlich des insgesamt zylindrischen Ventilschiebers (14) koaxial angeordnet ist, so daß die Kappe (92) das äußere Ende der zweiten Kammer (70) am zweiten Ende des Ventilschiebers bildet,

11. einer Endstopfbüchse (56), die mit dem Ventilgehäuse (10) lösbar verbunden und hinsichtlich des insgesamt zylindrischen Ventilschiebers (14) koaxial angeordnet ist, so daß die Kappe (92) das äußere Ende der ersten Kammer (54) bildet,

12. der dritten und vierten Steckfläche (18, 20) des Ventilschiebers (14), die axial so bemessen sind, daß sich eine "Null"-Lage einstellen läßt, in der das hydraulische Treibmittel daran gehindert wird, von der zentral angeordneten Schiebernut (48) des Ventilschiebers (14) in den dritten oder vierten Kanal (44 oder 46) zu strömen und von dort über einen Kanal (44 oder 46) in den Behälter (36) zurückzuströmen,

13. einem fünften Kanal zur strömungstechnischen Verbindung einer Hilfssteuerdrucköffnung mit dere ersten Kammer über eine zweite, nicht verstellbare Öffnung (74) sowie einem sechsten Kanal (80) zur strömungstechnischen Verbindung der Hilfssteuerdrucköffnung mit der zweiten Kammer (70) über eine dritte, nicht verstellbare Öffnung (76), wobei die nicht verstellbaren Öffnungen (90, 74, 76) von gleicher Größe sind,

dadurch gekennzeichnet, daß:

A. ein durchgehender, innen verlaufender Kanal (86) vorgesehen ist, der sich über die ganze Länge des Ventilschiebers (14) erstreckt und strömungstechnisch am ersten Ende mit der ersten Kammer (54) sowie am zweiten Ende mit der zweiten Kammer (70) verbunden ist,

B. eine erste, nicht verstellbare Öffnung (90) innerhalb des durchgehenden, innen verlaufenden Kanals (86) im Ventilschieber (14) regelmäßig an dessen erstem Ende angebracht ist und die strömungstechnische Verbindung zwischen dem durchgehenden Kanal (86) und der ersten Kammer (54) herstellt,

C. eine verstellbare Öffnung (104) innerhalb des durchgehenden, innen verlaufenden Kanals (86) am zweiten En de des Ventilschiebers (14) vorgesehen ist und die strömungstechnische Verbindung zwischen dem durchgehenden, innen verlaufenden Kanal (86) und der zweiten Kammer (70) herstellt,

D. eine in den Ventilschieber hineinführende, insgesamt radial angeordnete Öffnung (88) zur strömungstechnischen Verbindung des durchgehenden, innen verlaufenden Kanals (86) im Schieber (14) mit dem ersten Kanal (38) durch das Ventilgehäuse (10) vorgesehen ist, so daß das Hydrauliköl innerhalb des durchgehenden, innen verlaufenden Kanals (86) im Ventilschieber (14) über die Rücklauföffnung (40) im Ventilgehäuse in den Behälter (36) zurückgeführt werden kann,

E. eine mechanische Einstellvorrichtung (62, 64, 66, 68, 72) vorgesehen ist, mit der sich der Ventilschieber in seine "Null"-Lage bringen und in der "Null"-Lage halten läßt, wenn der Druck in den Kammern (54) und (70) gleich ist,

F. die Quelle für den Hilfssteuerdruck eine gesonderte Hilfssteuerdrucköffnung (82) ist,

G. ein Mittel zur Änderung des getrennten Hilfssteuerdruckes in einer der Kammern, z.B. (70), gegenüber dem Druck in der jeweils anderen Kammer, z.B. (54), durch eine Größenänderung der veränderlichen Öffnung (104) vorgesehen ist, damit der Ventilschieber aus seiner Null-Lage ausgelenkt werden kann, so daß das hydraulische Treibmittel in der einen oder anderen Richtung zur Last strömen kann.

3. Ein Servoventil nach Anspruch 2, gekennzeichnet dadurch, daß die veränderliche Öffnung (104) koaxial innerhalb des durchgehenden, innen befindlichen Kanals (86) angeordnet ist.

4. Ein Servoventil nach Anspruch 2 oder 3, gekennzeichnet dadurch, daß die erste und zweite Nut in der zylindrischen Bohrung (28, 30) vorgesehen sind, von der zylindrischen Bohrung des Ventilgehäuses (10) radial nach außen führen und den beiden axialen Enden der dritten zylindrischen Stegfläche (18) gegenüberliegen.

5. Ein Servoventil nach Anspruch 4, gekennzeichnet dadurch, daß die dritte und vierte Nut in der zylindrischen Bohrung (32, 34) vorgesehen sind, von der zylindrischen Bohrung des Ventilgehäuses (10) nach außen führen und den beiden axialen Enden der vierten zylindrischen Stegfläche (20) gegenüberliegen.

6. Ein Servoventil nach Anspruch 5, gekennzeichnet dadurch, daß in der "Null"-Lage des Ventilschiebers (14) das hydraulische Treibmittel daran gehindert ist, von der zentral angeordneten Schiebernut (48) des Ventilschiebers (14) in die zweite Nut (30) der zylindrischen Bohrung bzw. die dritte Nut (32) der zylindrischen Bohrung zu strömen, die jeweils radial im Ventilgehäuse angeordnet sind, und auch die Rücklaufnuten (28 und 34) der Bohrung geschlossen sind.

7. Ein Servoventil nach einem der vorstehenden Ansprüche 2 bis 6, gekennzeichnet dadurch, daß die mechanische Einstellvorrichtung einen Kolben (62) umfaßt, der innerhalb einer Endstopfbuchse (56) verschieblich angeordnet ist, wobei der Kolben koaxial auf den Ventilschieber (14) ausgerichtet und so angeordnet ist, daß er in den Bereich der ersten Kammer (54) vorgeschoben werden kann.

8. Ein Servoventil nach Anspruch 7, gekennzeichnet dadurch, daß innerhalb der zweiten Kammer (70) eine Druckfeder (72) zur Auslenkung des Ventilschiebers (14) aus seiner Null-Lage vorgesehen ist, ein Elektromotor (94) koaxial innerhalb einer Endkappe (92) angeordnet ist und über einen insgesamt zylindrischen Zapfen (96) verfügt, der innerhalb des E-Motors selektiv hin- und herbewegt werden kann und mit einer planen Endfläche (98) versehen ist, sowie dadurch, daß eine zweite Druckfeder (68) innerhalb der ersten Kammer (54) angebracht ist und am ersten Ende des Ventilschiebers koaxial mit dem Schieber zwischen einer Seite des Kolbens (62) und dem Ende des Ventilschiebers (14) angebracht ist, wobei die zweite Feder (68) so gestaltet ist, daß sie ggf. den Ventilschieber (14) in entgegengesetzter Richtung zur Vorspannung der ersten Feder (72) auslenkt.

9. Eine Servoventil nach Anspruch 8, gekennzeichnet dadurch, daß die mechanische Einstellvorrichtung (64, 66) mit der Endstopfbuchse (56) verbunden ist und an der anderen Seite des Kolbens (62) anliegt, um den Kolben (62) selektiv verschieben zu können, damit die zweite Feder (68) mechanisch auf die erste Feder (72) einwirken und den Ventilschieber (14) innerhalb der zylindrischen Bohrung (12) des Ventilgehäuses (10) mechanisch in seine Null-Lage bringen kann, so daß das hydraulische Treibmittel daran gehindert ist, von der zentral angeordneten dritten Schiebernut (48) in die zweite oder dritte Bohrungsnut (30, 32), von der ersten Bohrungsnut (28) in die erste Schiebernut (24) und von der vierten Bohrungsnut (34) in die zweite Schiebernut (26) zu strömen.

FIG.1

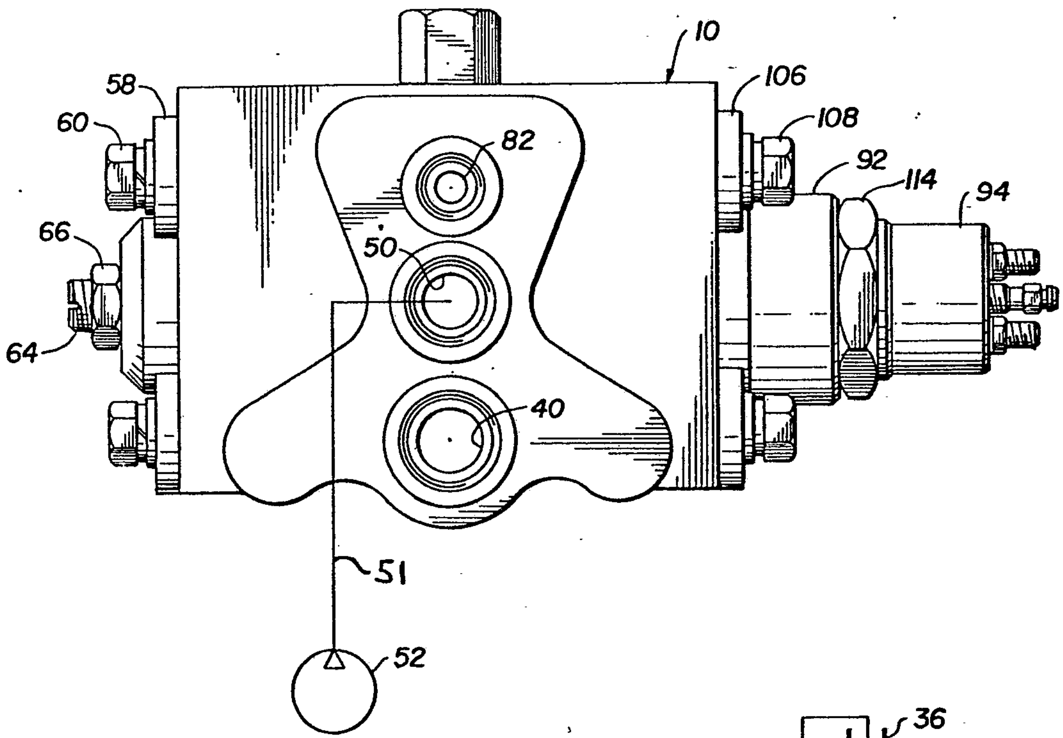
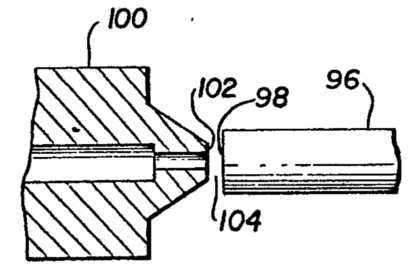


FIG.3



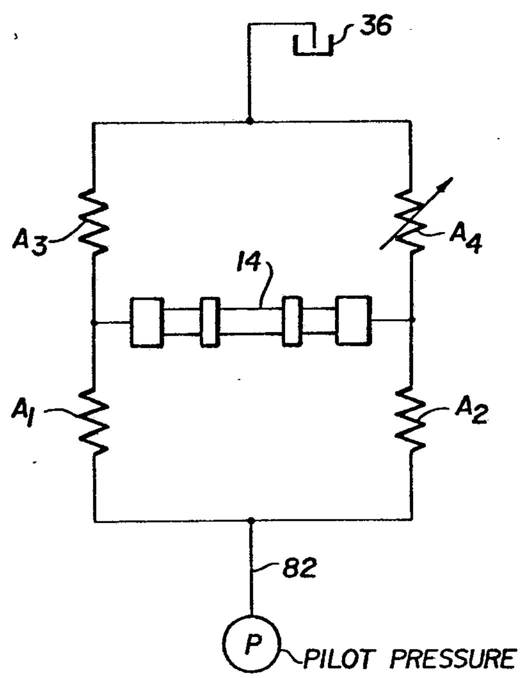
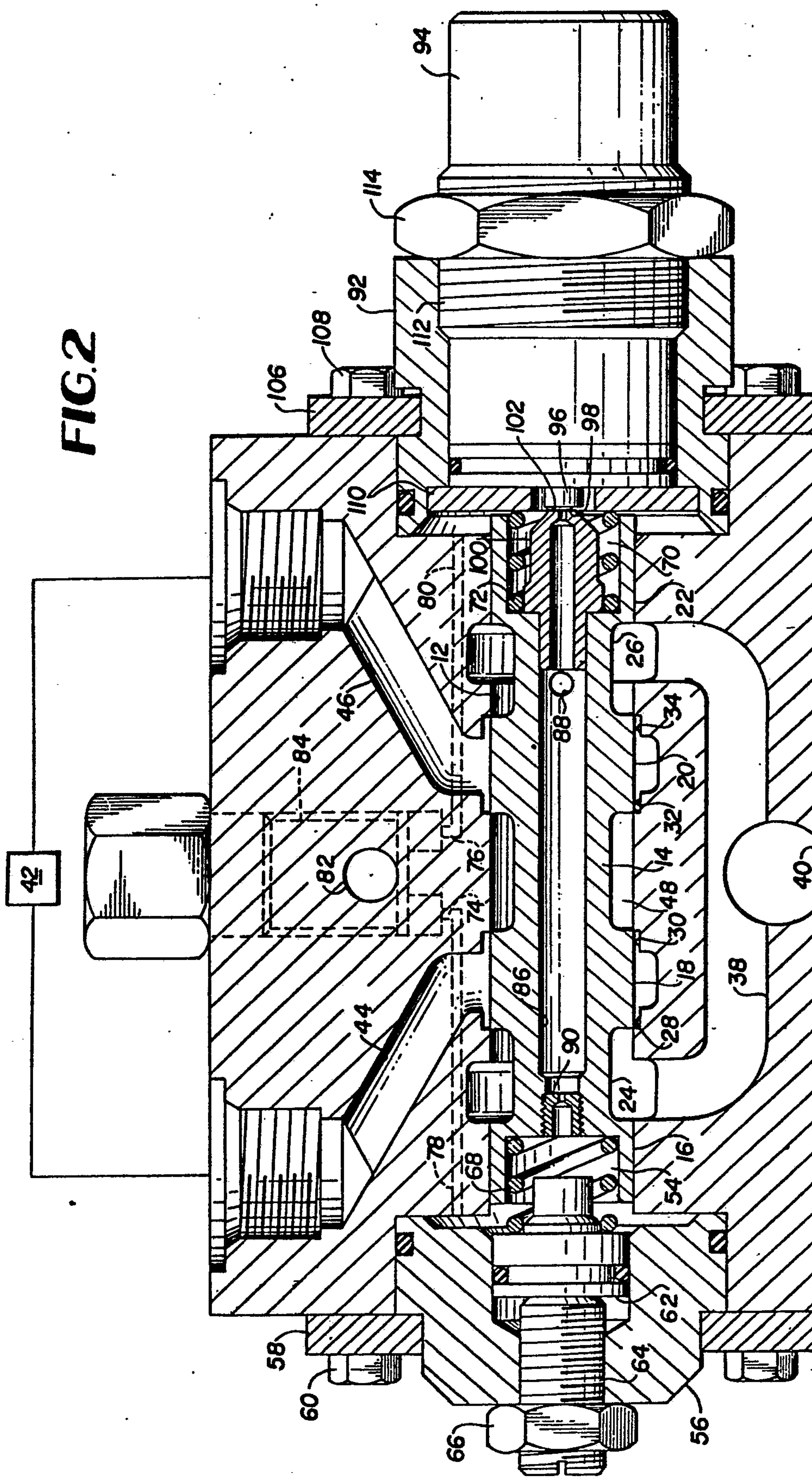


FIG.4

FIG.2



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