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Winter

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[54] **HYDRAULIC SYSTEM**

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[51] **Int. Cl.**.. **F16h 39/46**

[58] **Field of Search**...................... 60/381, 445, 448, 60/450, 451

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[57] **ABSTRACT**

A hydraulic system has an adjustable hydraulic pump which feeds a hydraulic motor through a first conduit. A pressure sensitive valve is connected to the hydraulic discharge point of the motor. The pressure sensitive valve includes a spring biased closure means which communicates the pressure in the first conduit to a second conduit the latter of which cooperates with the hydraulic motor to adjust the pumping of the same. A hydraulic correcting valve is connected in series with the second conduit and has a proportional-derivative characteristic so that the motor output is initially reduced to a greater extent than thereafter in response to opening of said closure means.

8 Claims, 3 Drawing Figures

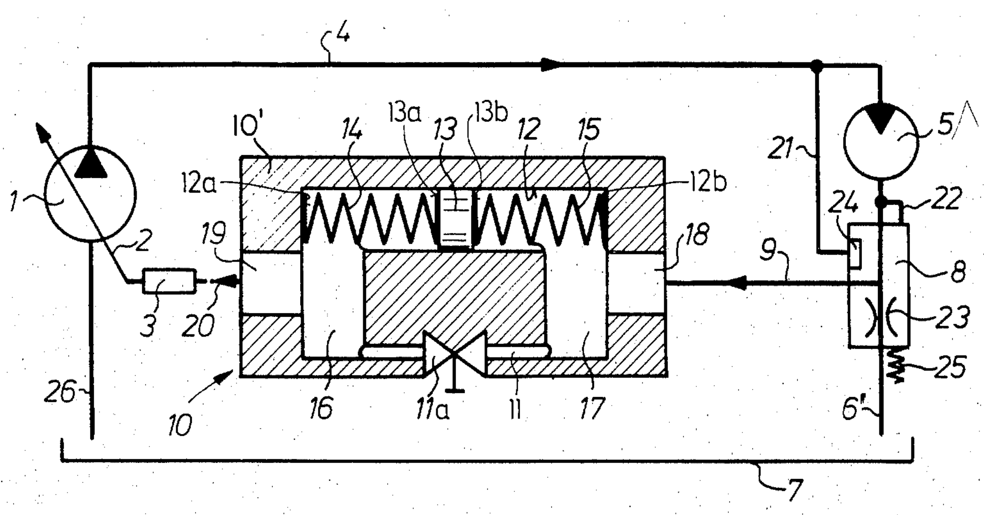


Fig. 1

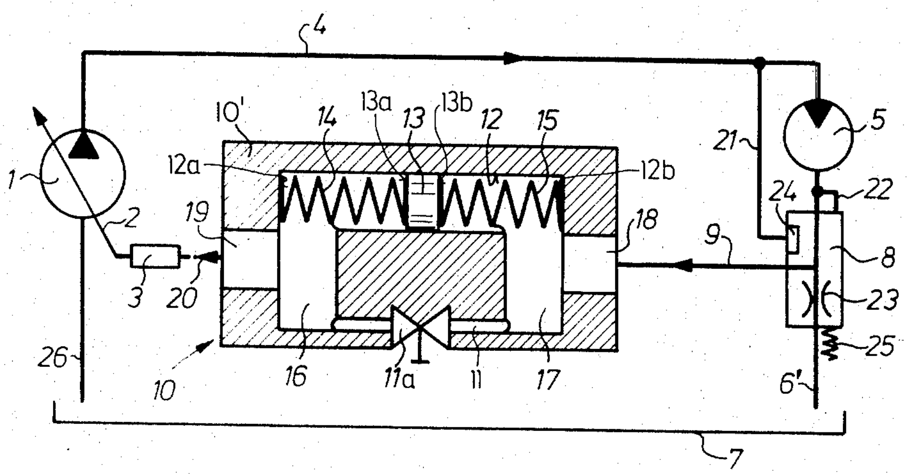

4
1
2
3
20
19
10'
12a
14
13a
13
13b
12
15
12b
18
9
21
5
24
22
8
23
25
6'
26
10
16
11a
11
17
7

Fig. 2

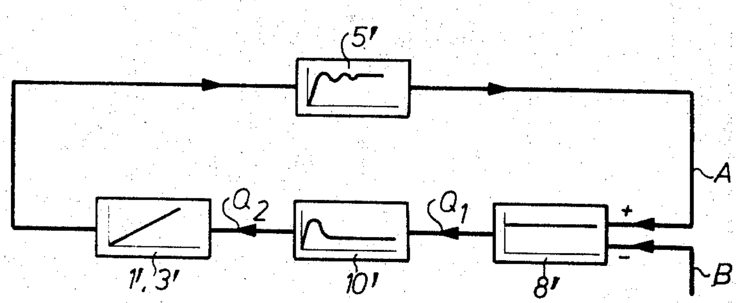
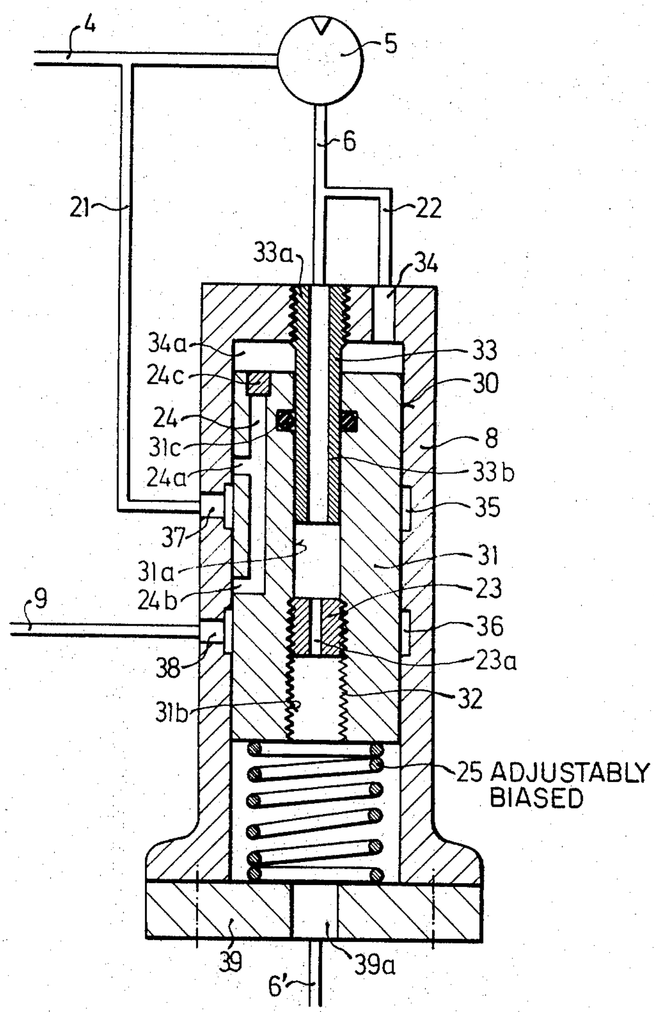

5'
A
Q2
Q1
+
-
B
1', 3'
10'
8'

Fig. 3


4
5
6
21
22
33a
34
34a
33
24c
30
24
8
31c
24a
33b
35
37
31
31a
23
24b
9
36
38
23a
31b
32
25 ADJUSTABLY BIASED
39
39a
6'

HYDRAULIC SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to hydraulic systems, and particularly to a system having a hydraulic adjustable pump and a hydraulic motor driven by said pump and a hydraulic feedback system for adjusting the pumping action of the hydraulic pump in response to the load imposed on the hydraulic motor.

Such a hydraulic system can be utilized to regulate the flow of hydraulic fluid from a hydraulic pump to a hydraulic motor to regulate the same at a substantially constant speed or to a hydraulic cylinder to operate the same at a substantially constant thrusting speed. In each case, the speed of rotation of the hydromotor or the thrusting speed of the hydraulic cylinder, the actual value of the operating parameter is, in the first instance, controlled by the amount of fluid which the pump conveys.

In hydraulic systems of this type, it often happens that during regulation of the pumping action of the hydraulic pump in response to a deviation from a desired value of an operating parameter, an adjusting or positioning device which controls the pumping action of the pump operates thereon for a period of time which is longer than necessary. Such results frequently occur because of the time constants involved with such control systems. The result of such prolonged action is that the desired value of the parameter is often exceeded or surpassed. Accordingly such regulation is not particularly accurate and is often susceptible to oscillations about the desired value. For these reasons, such hydraulic systems are not suitable for all purposes.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a hydraulic system which does not have the disadvantages known in systems of this type.

It is another object of the present invention to provide a hydraulic system which is simple in construction and economical to manufacture and which can accurately control the operation of the hydraulic pump.

It is still another object of the present invention to provide a hydraulic system of the type under discussion which can regulate the pumping action of an adjustable hydraulic motor as a function of both the rate of flow of the hydraulic fluid so pumped or the hydraulic pressures which are developed in said fluid.

It is a further object of the present invention to provide a hydraulic system wherein a hydraulic pump feeding a hydraulic motor can easily and accurately be adjusted as a function of the load placed on the hydraulic motor.

It is still a further object of the present invention to provide a hydraulic system which accomplishes the above objects by regulation action of the hydraulic pump through proportional-derivative action based on the parameter of interest.

With the view of achieving the above objects, the present invention for a hydraulic system comprises, in combination, an adjustable hydraulic pump adapted to deliver hydraulic fluid. First conduit means are provided which are connected to said adjustable hydraulic pump. A hydraulic motor is arranged in said first conduit means and driven by said hydraulic fluid delivered by said adjustable hydraulic pump. Hydraulically actuated adjusting means are provided for reducing the amount of hydraulic fluid delivered by said adjustable hydraulic pump including second conduit means connecting said hydraulically actuated adjusting means with said first conduit means so that said hydraulically actuated adjusting means regulate said pump in dependence upon fluid pressure in said first conduit means. Closure means are provided in said second conduit means and means for opening said closure means in dependence upon the fluid pressure in said first conduit means after said hydraulic motor are provided. Hydraulic correcting means are arranged in said conduit means and constructed so that the hydraulic fluid passing through said second conduit means from said first conduit means to said adjusting means will exert, during a short period after opening said closure means, a higher regulating pressure on said hydraulically actuated adjusting means than thereafter, so that during said period of air pressure the output of said adjustable pump is reduced to a greater extent than thereafter.

According to a presently preferred embodiment, said hydraulic correcting means comprises a hydraulic proportional-derivative controller which comprises first and second parallel fluid paths. The paths are connected in series with said second conduit means. Said first fluid path includes first pressure responsive means arranged to transmit substantially instantaneous pressure changes from one end to the other end of said second conduit means. Said second fluid path includes second pressure responsive means arranged to transmit pressures through one end of said second conduit means which are proportional to the pressures at the other end thereof. More particularly, said first pressure responsive means comprises a piston having two pressure bearing surfaces slidable in said first fluid path between two end positions in response to pressure differentials on said surfaces of said piston. Biasing means for positioning said piston in a normal predetermined position are provided for restoring said piston to said predetermined position when the pressures have equalized in said second conduit means at said two surfaces. Said second pressure responsive means comprises a pressure regulating valve which is adjustable.

According to another feature of the invention, biasing means are provided which cooperate with said closure means to maintain the latter closed, said biasing means being adjustable, whereby the opening of said closure means is a function of both the pressure in said first conduit means and the adjustment of said biasing means.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a hydraulic system, shown schematically in accordance with the present invention;

FIG. 2 is a functional block diagram of the hydraulic system as shown in FIG. 1; and

FIG. 3 is a side elevational view, in cross-section, of a pressure sensitive valve utilized in the hydraulic system shown in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein similar reference numerals have been used to designate similar parts throughout, and first referring to FIG. **1**, the reference numeral **1** designates an adjustable hydraulic pump having a positioning element **2**. The positioning element **2** controls the amount of hydraulic fluid pumped by the hydraulic pump **1** and may be provided with biasing means (not shown) which returns the positioning element **2** to a normal position wherein the adjustable hydraulic pump **1** pumps its rated or maximum amount of fluid needed per unit time.

Connected to the positioning element **2** is a hydraulically actuated adjusting means **3** whose output is connected to the positioning element **2** and which is movable to adjust the positions of the latter in response to changes in hydraulic pressure at its input.

A primary conduit **4** connects the hydraulic pump **1** with a hydraulic motor **5**. The hydraulic motor **5** is operated by the flow of hydraulic fluid passing through the primary conduit **4** under pressure established by the hydraulic pump **1**. After passing through the hydraulic motor **5**, the hydraulic fluid passes through a pressure sensitive valve **8**, shown schematically and to be described more fully with respect to FIG. **3**, to be discharged through an outlet conduit **6'** into a hydraulic fluid reservoir **7**.

The pressure sensitive valve **8** further includes a channel means **24**, to be further described in connection with FIG. 3, which communicates the primary conduit **4** with a secondary conduit **9**. The secondary conduit **9** forms part of a feedback path of the hydraulic system and is series-connected with a hydraulic correcting valve **10** which forms one of the important features of the present invention. The hydraulic correcting valve **10**, as will become evident from the description below, imparts a proportion-derivative characteristic to the operation of the hydraulic system, and particularly the feedback path thereof to thereby stabilize the system in a desirable manner.

The hydraulic correcting means **10** generally comprises a housing **10'** which is provided with two parallel fluid paths **11** and **12**. Connected in series with the fluid path **11** is a pressure regulating valve **11*a*** which is adjustable in a conventional manner.

The fluid path **12** is provided with shoulders **12*a*** and **12*b*** at its ends. A piston **13** is slidably mounted within the fluid path **12** and is configurated to seal the two portions of the fluid path **12** which it forms. The piston **13** has pressure bearing surfaces **13*a*** and **13*b*** which are exposed to the hydraulic fluid present at each side of the piston **13**. The hydraulic fluid applies pressures to the bearing surfaces **13*a*** and **13*b*** to thereby produce a differential pressure on the piston **13** which causes it to slide in one direction or another.

Biasing means in the form of springs **14** and **15** are respectively provided in a somewhat compressed state between the shoulder **12*a*** and the pressure bearing surface **13*a***, on the one hand, and between the pressure bearing surface **13*b*** and the shoulder **12*b***, on the other hand, respectively. The constants of the springs **14** and **15** are so selected that with equal pressures against the bearing surfaces **13*a*** and **13*b*** of the piston **13**, the same is positioned in a normally median position in the fluid path **12**. When a differential pressure acts upon the piston **13**, the piston moves in a direction corresponding to the direction of the differential pressure, said springs **14** and **15** restoring the normally median position of the piston **13** as soon as the differential pressure is removed. In accordance with the presently preferred embodiment, the springs **14** and **15** are identical to each other and are equally compressed to thereby provide a symmetrical biasing arrangement about the piston **13.**

Channels **16** and **17** connect to the respective ends of the fluid paths **11** and **12** to thereby bring these fluid paths into fluid communication with each other. The channel **17** is in fluid communication with an inlet opening **18** of the hydraulic correcting valve **10.** The secondary conduit **9** discharges into the inlet opening **18.** On the other hand, the channel **16** is in fluid communication with the outlet opening **19** of the hydraulic correcting valve **10** and the outlet opening **19** is in fluid communication with the input of the hydraulically actuated adjusting means **3.** The connection between the outlet opening **19** and the hydraulically actuated adjusting means **3** is through a conduit **20** which may be considered a part of the secondary conduit **9**, and wherein said hydraulic correcting valve **10** is connected in series with said secondary conduit.

Referring to both FIGS. **1** and **3**, the pressure sensitive valve **8** is provided with a cylindrical bore **30** which has a smooth internal surface. A control plunger **31** is arranged within the bore **30** for sliding movement in directions along the axis of the bore **30.** The control plunger **31** forms a closure means, as will presently be described. The control plunger **31** is also provided with an axial bore **32** which has at least an upper smooth surface **31*a***. The lower portion **31*b*** of the axial bore **32** is threaded as shown. These threads are meshed with a cylindrical damper restriction **23** which itself is provided with a small diameter central bore **23*a***. A pipe **23** having an upper threaded portion **33*a*** is connected to the upper portion of the pressure sensitive valve **8** as shown to provide a fluid tight seal. The lower portion **33*b*** of the pipe **33** has a smooth external surface and has an outer diameter which is substantially equal to the inner diameter of the smooth inner surface **31*a***. In the same manner, the outer diameter of the control plunger **31** is made substantially equal to the inner diameter of the bore **30** so as to provide fluid tight seals between contiguous surfaces so as to prevent passage of hydraulic fluid therebetween. To further ensure the fluid tight sealed relationship between the smooth portion **33*b*** of the pipe **33** and the inner surface **31*a*** of the control plunger **31**, an annular sealing ring **31*c*** is provided in an annular slot of the control plunger **31** as shown and the annular sealing ring **31*c*** is made of resilient substance or material whose inner diameter is at least equal to the outer diameter of the smooth portion **33*b*** but is preferably smaller than the latter. In this manner, upon insertion of the pipe **33** through the annular sealing ring **31*c***, the latter deforms to some extent and its inner diameter becomes lodged to thereby intimately engage the smooth portion **33*b*** of the pipe **33** to thereby ensure that no fluid can pass in whatever clearance which may exist between a smooth portion **33*b*** and the smooth inner surface **31*a***.

The pipe **33** is provided with a central bore which is coaxial with the axis of the control plunger **31.** A conduit **6**, which is connected to the discharge output of the hydraulic motor **5** discharges into the pipe **33.**

Provided in the region of the pipe 33, an opening 34 is provided in the pressure sensitive valve 8 which communicates with a cylindrical cavity 34*a* formed by the pressure sensitive valve housing, the smooth portion 33*b* as well as the upper surface of the control plunger 31. Because of the fluid tight relationships described above, the cylindrical cavity 34*a* can only receive or discharge fluid through the bore 34. A conduit 22, in fluid communication with the conduit 6, discharges into the bore 34.

Formed along the inner surfaces of the bore 30 of the pressure sensitive valve 8 are first and second annular slots 35 and 36 which are in communication with the exterior of the housing by means of bores 37 and 38, respectively. A conduit 21, in communication with the primary conduit 4, discharges into the bore 37 while the secondary conduit 9 is in fluid communication with the bore 38.

The control plunger 31 has a channel 24 parallel to the axis of the bore 30. Two openings 24*a* and 24*b* communicate the channel 24 to the exterior of the control plunger 31, said openings being spaced a distance equal to the distance between bores 37 and 38. A plug 24*c* closes the channel 24 at the point where it was formed, e.g. by drilling.

The pressure sensitive valve housing 8 is provided with a cover 39 at one end thereof which has a bore 39*a* which is in fluid communication with the axial bore 32. The bore 39*a* is in fluid communication with the conduit 6' which discharges, as described above, into the reservoir 7.

The restriction 23 prevents sudden or abrupt responses in the movement of the control plunger 31 and therefore operates as a damping element on the control plunger 31. The amount of damping which the restriction 23 provides is a function of the diameter of the bore 23*a*. The restriction 23 therefore has the advantageous effect of reducing oscillatory motion of the control plunger 31 which would be undesirable in many applications.

Referring to FIGS. 1 and 3, the spring 25 is adjustable to thereby make it possible to select a desired pressure in the primary conduit 4. Although the spring 25 has not been shown to be adjustable in FIG. 3, the present invention contemplates that the spring can be made so adjustable in any known or conventional manner.

For the purposes of describing the present application, and for the claims which follow the detailed description, a first conduit means is to be defined as a conduit means including the conduits 26, 4, 6 and 6'. On the other hand, a second conduit means is to be defined as including secondary conduit 9 and conduit 20.

The operation of the present invention will now be described. In response to operation of the hydraulic pump 1, said pump draws hydraulic fluid from the reservoir 7 through the conduit 26 and conveys the same to the hydraulic motor 5 through the primary conduit 4. The hydraulic motor 5 rotates in a conventional manner and preferably drives a variable load (not shown) which causes the hydromotor 5 to rotate at faster and slower speeds about a preselected desired rotating speed. Assuming that there is some load on the hydraulic motor 5, the pressure in the conduit 6 will generally be lower than that in the conduit 4. However, at no load condition of the hydromotor, the pressures in the latter two conduits approach one another.

With the hydraulic motor operating at its desired speed, the hydraulic fluid leaving the hydraulic motor passes through the conduit 6, through the pipe 33, through the control plunger 31, the damper restriction 23 and finally through a conduit 6' to the reservoir 7. The passage of the hydraulic fluid through the damper restriction 23, causes the control plunger 31 to be urged in a downward direction. However, such downward movement of the control plunger 31 is resisted by the helical spring 25 and only downward forces above a predetermined value are effective to move the control plunger 31 sufficiently whereby the channel 24 places the conduits 21 and 9 into fluid communication with one another.

The pressure in the conduit 6 is monitored by the conduit 22 and this pressure is provided in the cylindrical cavity 34*a*. Although the conduit 22 has been illustrated as being connected to the conduit 6, it is within the scope of the present invention that the conduit 22 be connected directly to the hydraulic motor 5, at a suitable place thereof, wherein the hydraulic fluid has already been utilized to turn the blades of the hydraulic motor.

Under load, the pressure in the conduit 6, drops because of the decrease in the rate of flow of hydraulic fluid through the hydraulic motor 5. Therefore, the pressure differential between the conduits 4 and 6 increases. However, because of the low pressure in the conduit 6, a similarly low pressure will exist within the cylindrical cavity 34*a* and therefore a relatively small pressure will be exerted against the control plunger 31 in a downward direction. Therefore, the control plunger 31 will only move a small distance in the downward direction which is, however, not sufficient to place the conduits 21 and 9 into fluid communication. Therefore, it will be noted that with this arrangement, when the hydraulic motor is operating at or near full load, the hydraulic pump 1 is required to operate in its rated or maximum rate of fluid supply.

On the other hand, when the load on the hydraulic motor 5 is made very small or totally eliminated, then the pressure in the conduit 6 approaches that existing in the primary conduit 4 and, correspondingly, the pressure provided in the cylindrical cavity 34*a* likewise increases. In response to increased pressure in the cylindrical cavity 34*a*, the control plunger 31 will move in a downward direction and, depending on the adjustment of the biasing forces due to the helical spring 25, the control plunger 31 will move sufficiently downward to place the conduits 21 and 9 into fluid communication with each other and with the primary conduit 4. Referring to FIG. 3, this occurs when the channel 24 moves to a position wherein the openings 24*a* and 24*b* meet the bores 37 and 38. Such a meeting enables the higher pressure which exists in the primary conduit 4 to be transmitted to the secondary conduit 9. It should be noted that the increased pressure occurs as soon as the openings 24*a* and 24*b* become aligned with the bores 37 and 38 respectively so that the pressure difference in the secondary conduit 9 takes the form of a step function wherein the initial change in the pressures is instantaneous but remains substantially constant as long as the channel 24 maintains the conduits 21 and 9 in fluid communication with each other. The application of a sudden change in fluid pressure at the inlet opening 18 as well as in the channel 17 has two effects. First, as soon as a pressure is developed at the pressure bearing surface **13***b* which is larer than the pressure appearing at the pressure bearing surface **13***a*, the differential in pressures causes said piston **13** to move towards the left, as viewed in FIG. **1**, such movement simultaneously increasing the pressure in the channel **16** as well as the outlet opening **19.** The movement of the plunger **13** is almost instantaneous, and therefore, the responsiveness of the piston **13** to abrupt changes in differential pressures applied thereto is a function of the mechanical time constants involved in the circuit. For these reasons it is preferred that the mass of the piston **13** be made as low as possible. Thus, with such an arrangement, it is noted that input step functions of the pressure in the conduit **9** will be transmitted in the form of impulses by way of the fluid path **12.**

On the other hand, a step increase in pressure at the inlet opening **18** is also transmitted through the fluid path **11** and particularly the pressure regulating valve **11***a*. While the piston **13** operates as a differentiating controller, the pressure regulating valve **11***a* operates as a proportional controller so that at least for the time when the channel **24** places the conduits **21** and **9** in fluid communication with each other, the higher pressure existing at the right-hand side of the pressure regulating valve **11***a* is proportionally communicated to the left-hand side thereof until the pressures in channels **16** and **17** have equalized. As described above, during this condition, the piston **13** has again moved to its median position shown in FIG. **1.** By placing the paths **12** and **11** in parallel to each other and providing a different pressure responsive means in each of the channels, desirable operating and control characteristics of the hydraulic system can be obtained. More particularly, the type of control described above includes both derivative as well as proportional control. For this reason, the hydraulic correcting valve **10** may be defined as a proportional-derivative hydraulic controller.

Now, for the small or no load condition of the hydraulic motor **5**, the abrupt movement of the piston **13** causes the hydraulically actuated adjusting means to at least initially cause the adjustable hydraulic pump **1** to pump less fluid than would normally be desired. However, after the pressures in the channels **16** and **17** have equalized, the positioning element **2** comes to rest in a position corresponding to the small or no load operation which is manifested in the pressure in conduit **4.** Such subsequent increase in the pump output is urged by biasing means (not shown) which cooperate with said positioning element **2** to restore the same towards a normal, full load position.

However, it is clear from the above description that at no load or near zero load on the hydraulic motor, the present hydraulic control system will have the effect of making the adjustable hydraulic pump **1** operate at less than its full load capacity.

Although the hydraulic correcting valve **10** has been described as providing a proportional-derivative control action in the feedback conduit of the hydraulic system, the present invention also contemplates the utilization of proportional-integral or proportional-integral-derivative hydraulic controllers where such alternate forms of controllers are more suitable to properly stabilize a system. In the case of a three action controller, it may be necessary to add a third parallel path similar to paths **11** and **12** including pressure responsive means which provides an output which is a function of the integral of the input pressure. Naturally, if only proportional-integral action were desired, then the path **12** as well as the piston **13** and the springs **14, 15** would be deleted and the same would be replaced by an integral responsive means.

Referring to FIG. **2,** this shows a schematic block diagram of the hydraulic system, showing the characteristics of the respective elements of the system above-described. Here, the hydraulic pump **1'** and the hydraulically actuated adjusting means **3'** have been combined and are shown to have a linear response. Thus, the output of the hydraulic pump **1** is directly a function of the pressure applied to the input Q_2 of the hydraulically actuated adjusting means **3.** The hydraulic correcting means **10'** is represented by a characteristic curve which illustrates that during a short time period after the opening of the closure means, which comprises the control plunger **31**, a higher regulating pressure is applied to said hydraulically actuated adjusting means than thereafter, so that during said period of high pressure, the output of said adjustable pump **1** is reduced to a greater extent than thereafter. The characteristic curve of the pressure sensitive valve **8** is shown to be a step function since, ideally, the pressure Q_1 in the secondary conduits **9** is substantially equal to zero when there is no fluid communication between the conduit **21** and **9** to the channel **24**, the pressure Q_1 in the conduit **9** rising steeply in the critical position of the control plunger **31** when such fluid communication is achieved to a value which is substantially equal to the pressure existing in the primary conduit **4.**

The pressure sensitive valve **8'**, illustrated schematically in FIG. **2,** is shown to have two inputs A and B. The input A is in actuality the output from the hydraulic motor **5'**, the input of the latter being connected to the hydraulic pump, hydraulically actuated adjusting means combination **1'**, **3'** respectively. The input B, represents a desired value at the output of the hydraulic motor **5'**. Referring to FIG. **3,** the actual value A represents the pressure which exists in cylindrical cavity **34***a* and which is derived from the conduit **6** which represents the pressure at the output of the hydraulic motor **5.** The pressure which represents the actual value of the output pressure of the hydraulic motor operates on the plunger **31** to move the same in a downward direction. On the other hand, the helical spring **25**, which represents the desired value B, preferably adjustable, acts on the control plunger **31** in an upward direction. For this reason, the actual value A has been designated by a plus sign and the desired value B has been designated by a negative sign, these two signs illustrating that the desired and the actual values operate in different directions or are out of phase insofar as the pressure sensitive valve **8'** is concerned.

Although the present invention has been described in connection with the flow of hydraulic fluid from a pump for utilization in driving a hydraulic motor, it is also contemplated by the present invention that not only the quantity of hydraulic fluid pumped by a hydraulic pump can be regulated in this manner, but also the pressure at the output of a hydraulic pump can similarly be regulated. Thus, for example, instead of hydraulic fluid valves, pressure valves may be utilized instead.

With the above-described features of the present invention, as well as with others which will become readily apparent to those skilled in the art, it is possible to stabilize hydraulic circuits which are different to otherwise control in a satisfactory manner with very simple means. More importantly, the objects of the present invention can be achieved by the utilization of a hydraulic correcting valve as described above which is placed in the feedback path of the hydraulic system and which exhibits a proportional-derivative action in response to a change in pressure in the system to thereby regulate first abruptly, and then more gradually, the pumping action of an adjustable hydraulic pump.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of hydraulic systems differing from the types described above.

While the invention has been illustrated and described as embodied in a hydraulic system for the regulation of a hydraulic pump which drives a hydraulically driven component, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended

1. A hydraulic system comprising, in combination, an adjustable hydraulic pump adapted to deliver hydraulic fluid; first conduit means connected to said adjustable hydraulic pump; a hydraulic motor arranged in said first conduit means and driven by said hydraulic fluid delivered by said adjustable hydraulic pump; hydraulically actuated adjusting means for reducing the amount of hydraulic fluid delivered by said adjustable hydraulic pump including second conduit means connecting said hydraulically actuated adjusting means with said first conduit means so that said hydraulically actuated adjusting means regulates said pump in dependence upon the fluid pressure in said first conduit means; closure means in said second conduit means; means for opening said closure means in dependance upon the fluid pressure in said first conduit means after said hydraulic motor; and hydraulic correcting means arranged in said second conduit means and constructed so that the hydraulic fluid passing through said second conduit means from said first conduit means to said adjusting means will exert, during a short time period after opening of said closure means, a higher regulating pressure on said hydraulically actuated adjusting means than thereafter, so that during said period of higher pressure the output of said adjustable pump is reduced to a greater extent than thereafter.

2. A system as defined in claim **1**, wherein said hydraulic correcting means comprises a hydraulic proportional-derivative controller.

3. A system as defined in claim **1**, wherein said hydraulic connecting means comprises first and second parallel fluid paths connected in series with said second conduit means, said first fluid path including pressure responsive means arranged to transmit substantially instantaneous pressure changes from one end to the other end of said second conduit means, and said second fluid path includ-ing pressure regulating means arranged to transmit pressures to one end of said second conduit means which are proportional to the pressures at the other end thereof.

4. A system as defined in claim **3**, wherein said pressure responsive means comprises a piston having two pressure bearing surfaces slidable in said first fluid path between two end positions in response to pressure differentials on said surfaces of said piston; and biasing means for positioning said piston in a normal predetermined position and for restoring said piston to said predetermined position when the pressures have equalized in said second conduit means at said two surfaces.

5. A system as defined in claim **4**, wherein said first fluid path includes two shoulder portions in the regions of its ends, and wherein said biasing means comprises a pair of helical springs, each spring being compressively positioned between a respective shoulder portion and a pressure bearing surface of said piston.

6. A system as defined in claim **3**, wherein said pressure regulating means comprises a pressure regulating valve.

7. A system as defined in claim **6**, wherein said pressure regulating valve is adjustable.

8. A system as defined in claim **1**, further comprising biasing means cooperating with said closure means to maintain the latter closed, said biasing means being adjustable, whereby the opening of said closure means is a function of both the pressure in said first conduit means and the adjustment of said biasing means.

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