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[54] **HYDRAULIC SYSTEM**

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[58] **Field of Search**.....417/308, 286, 287, 288, 428

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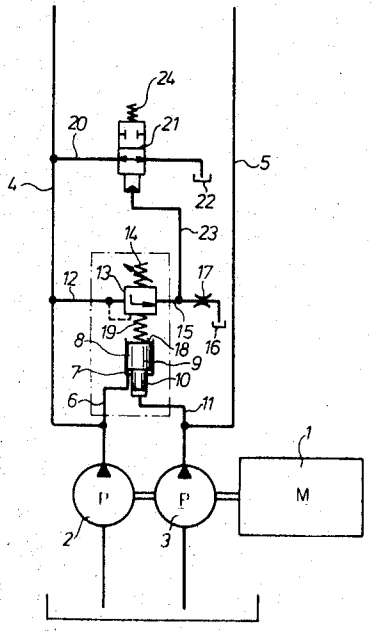
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[57] **ABSTRACT**

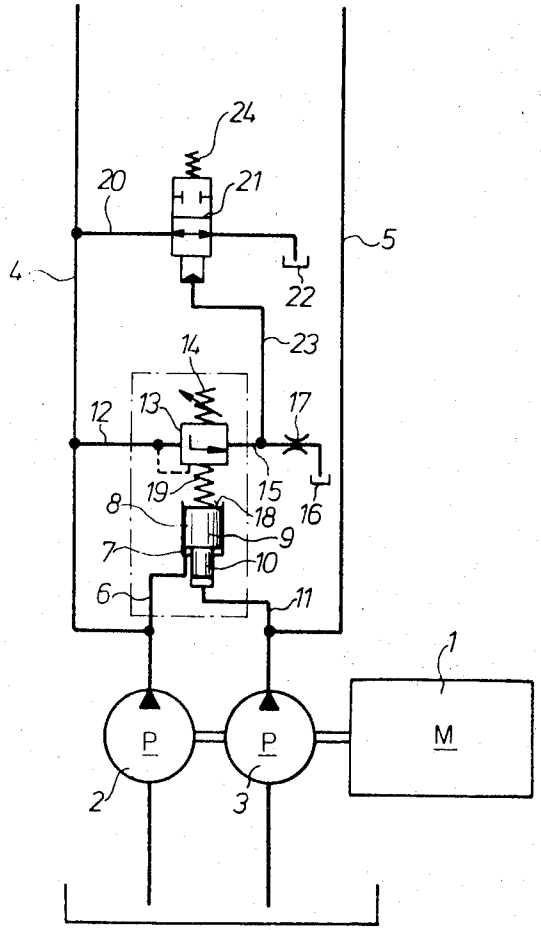
The user circuit for a pump having an output greater than the maximum output that can be accepted by the prime mover for the pump has a relief valve for shunting hydraulic fluid from the user circuit when the pressure within the circuit demands an output from the pump that exceeds the output available from the prime mover. The delivery side of the pump is connected to a piston that acts on the relief valve to open the latter in response to pressure within the user circuit.

7 Claims, 1 Drawing Figure



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HYDRAULIC SYSTEM

BACKGROUND OF THE INVENTION

The invention relates to an hydraulic system having at least one constant volume delivery pump operated by a prime mover, the maximum available power output of which latter is less than the maximum output of the pump. A user circuit is connected to the delivery side of the pump, a resiliently loaded relief valve being connected to protect the circuit or the pump.

The relief valve of this commonly used system does protect the user circuit from excessive pressure by opening. It can occur, however, where the pump or pumps are capable of a very large output, that the prime mover is overloaded.

If the prime mover is an internal combustion engine, the engine can stall. If it is an electric motor, the windings of the motor can be burned out, ruining the motor. Moreover, the discharging of the hydraulic fluid through the relief valve undesirably heats the fluid.

One solution to these problems is to use pumps with variable delivery, the delivery being dependent upon the pressure. When the pressure increases, the amount of fluid delivered by the pump decreases, so as not to exceed the maximum power output of the prime mover.

These systems, such as hydrostatic drives for vehicles, have, however, the disadvantage that they are expensive, because a variable delivery pump is appreciably more expensive than a constant volume delivery pump.

SUMMARY OF THE INVENTION

An object of the invention is an hydraulic system that is very simple and inexpensive and yet dependably protects the prime mover from overloading.

Another object of the invention is an hydraulic system of the preceding object that is equally suitable for one pump or for several pumps.

Briefly, the invention consists of pump means with constant volume delivery, driving means for operating the pump means, the maximum output of the driving means being less than the maximum output that can be delivered by the pump means, user circuit means connected to the delivery side of the pump means for accepting the hydraulic fluid delivered by the pump means, resiliently loaded relief valve means for the user circuit means, and pressure responsive means, acting on the relief valve means, connected to the delivery side of the pump means and responsive to the pressure thereat to reduce, with increasing pressure at the delivery side, the pressure on the relief valve means required to open the latter so that the relief valve means opens to reduce the pressure in the user circuit means before the driving means can stall.

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 drawing.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE shows schematically one embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the FIGURE, a prime mover, such as an internal combustion engine **1**, drives two constant volume delivery pumps **2** and **3**. Pump **2** is connected to a user circuit **4**, and pump **3** to a user circuit **5**.

A branch line **6** connects the user circuit **4** to a stepped cylinder **7** in which a differential piston **8** is free to move. The piston **8** and cylinder **7** are in fluid-tight contact. The piston **8** has two sections **9** and **10** of which the latter has a smaller diameter than the former. The piston sections **9** and **10** are borne upon respectively by the hydraulic fluid conveyed through the branch lines **6** and **11**, the latter line being connected to the user circuit **5**. The resulting pressure acting on the differential piston **8** is the sum of the two pressures in the user circuits **4** and **5**.

Connected to the user circuit **4** is a further line **12** that leads to a relief valve **13**, the cut-off pressure of which is determined by a spring **14**. A discharge line **15** connects the relief valve to a vessel **16**. A valve **17** is connected in the discharge line **15**.

A spring **19** bears against the end face **18** of the differential piston **8** and acts on the relief valve **13** so as to counteract the pressure of the spring **14**. The cut-off pressure of the relief valve **13** is varied in dependence on the tension of the spring **19**, which tension is dependent on the position of the differential piston **8**.

Connected to the user circuit **4** is a further line **20**, which a two position valve **21** connects to a vessel **22** that is at atmospheric pressure. The valve **21** has a closed position and an opened position. This valve is controlled by the pressure in a line **23**, which is connected to the line **15** at a position between the discharge end of the relief valve **13** and the valve **17**. The pressure in the line **23** acts against a spring **24** of the valve **21**.

The sum of the pressures in the user circuits **4** and **5** act on the differential piston **8**. The movement of the latter tensions the spring **19**, which acts on the relief valve **13** with a force that opposes the force of the spring **14**, which latter normally determines the cut-off pressure of the relief valve. The cut-off pressure is consequently reduced, and the maximum pressure within the user circuit **4** and against which the pump **2** must operate is lowered. The maximum output—such as the torque, in the case of a hydrostatic vehicle propulsion—demanded of the prime mover **1** is therefore reduced. The sum of the outputs of the pumps **2** and **3** is consequently not greater than the maximum available output of the prime mover **3**, which latter is therefore prevented from stalling.

When a large amount of hydraulic fluid is shunted through the relief valve **13**, the fluid undesirably can heat up. In order to prevent this, the valve **21** is provided. The valve **17** backs up the hydraulic fluid, raising the pressure in the line **23** and thereby opening the valve **21**. Hydraulic fluid is now free to flow directly out of the overloaded user circuit **4**, without heating up. After the pressure in the user circuit **4** is reduced, the spring **24** again closes the valve **21**.

The invention can also be used for hydraulic systems having only a single pump. Its use is advantageous, however, only if the maximum output that can be demanded of the pump exceeds the maximum available output of the prime mover.

In accordance with the invention, a relief valve **13** and a two position valve **21** can be connected, in the described manner, in the second, or each additional, user circuit associated with the third or fourth pump. It is not necessary to use more than one differential piston. If, for example, the hydraulic system has three pumps, a differential piston of three steps is used, the piston acting on three springs, each spring cooperating with the relief valve **13** of a respective user circuit.

The kind of user determines which of the user circuits are provided with the arrangement of the invention.

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 constructions differing from the types described above.

While the invention has been illustrated and described as embodied in an hydraulic system, 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 the 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 claims.

1. A hydraulic circuit comprising, in combination, a first and a second pump with constant volume delivery; driving means for operating said first and said second pump, the maximum output of said driving means being less than the maximum output that can be delivered by said first and said second pump; a user circuit connected to the delivery side of each of said pumps for accepting the hydraulic fluid delivered by said first and said second pumps, respectively; relief valve means for the user circuit of at least one of said pumps and including resilient means for holding said relief valve means in closed position until the pressure in said user circuit of said at least one of said pumps exceeds a predetermined required pressure and pressure responsive means acting on said relief valve means in opposition to the resilient means of the latter and being connected to the delivery side of both said first and said second pumps and responsive to the pressure thereat to reduce, with increasing pressure at said delivery side, the said predetermined required pressure to open the relief valve means under the influence of the fluid pressure in said user circuit of said at least one of said pumps so that the relief valve means opens to thereby reduce the pressure in the last mentioned user circuit before said driving means can stall.

2. An hydraulic system as defined in claim **12**, wherein said pressure responsive means is a piston acting on said relief valve means to open the latter with increasing pressure at said delivery side of said one pump.

3. An hydraulic system as defined in claim **2**, including resilient means acting on said relief valve means to open the latter, said piston acting on said resilient means to increase the pressure of the latter on said relief valve with increasing pressure at said delivery side of said one pump.

4. An hydraulic system as defined in claim **1**, including pressure regulating valve means connected to the delivery side of said relief valve means; hydraulic fluid line means connected between said pressure regulating valve means and said relief valve means; vessel means at atmospheric pressure; and pressure responsive valve means connected to said hydraulic fluid line means and connecting said user circuit of said one pump to said vessel means, said pressure responsive valve means opening in response to increasing pressure in said hydraulic fluid line means to permit discharge from said user circuit means into said vessel means.

5. An hydraulic system as defined in claim **1**, said pressure responsive means having a discrete pressure bearing surface for each of said first and second pumps, each said surface bearing only the pressure at said delivery side of the associated pump.

6. An hydraulic system as defined in claim **5**, wherein said pressure responsive means is a differential piston.

7. An hydraulic system as defined in claim **6**, including resilient means acting on said relief valve means to open the latter, said differential piston acting on said first resilient means to increase the pressure of the latter on said relief valve means with increasing pressure at each said delivery side.

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