May 25, 1954 T. J. MATEGORIN 2,679,207

HYDRAULIC CIRCUIT

Filed Sept. 18, 1950

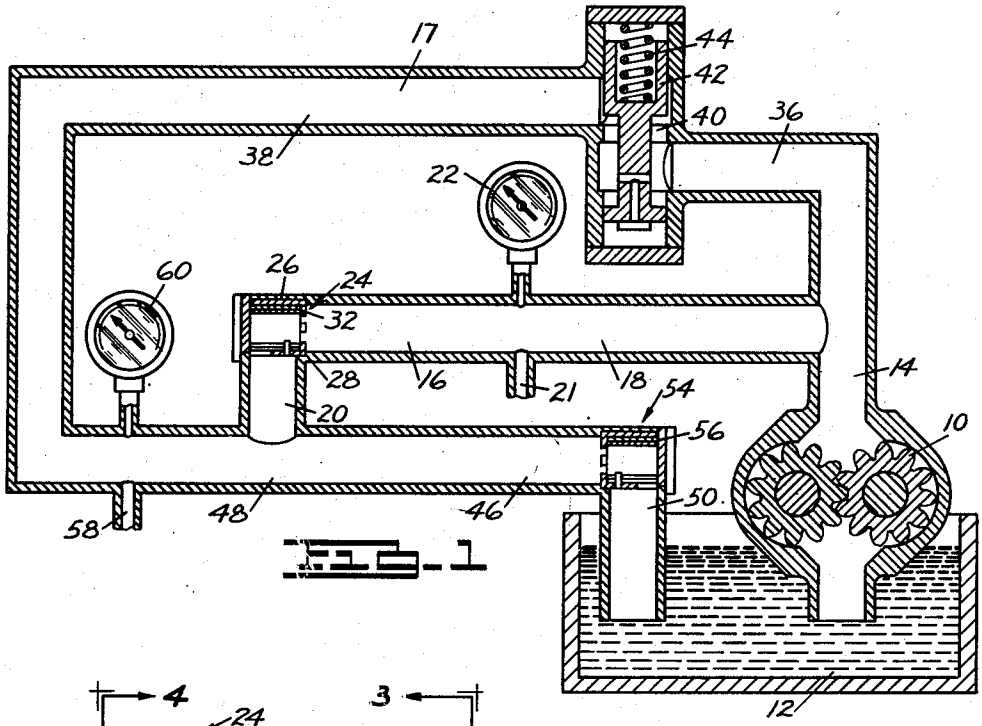


FIG. 1

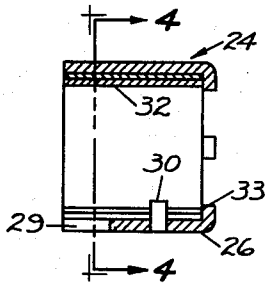


FIG. 3

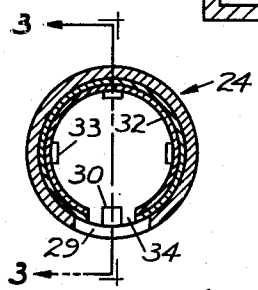


FIG. 4

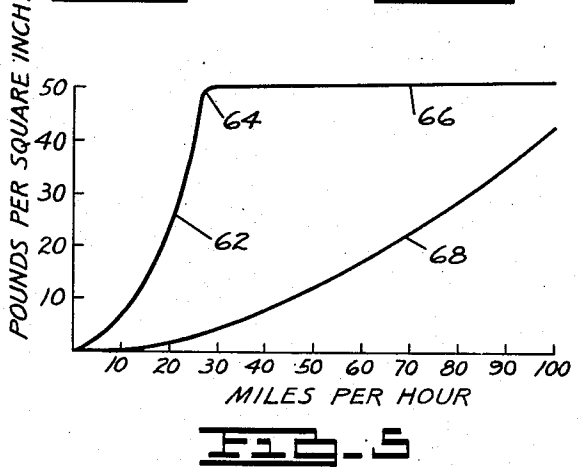


FIG. 5

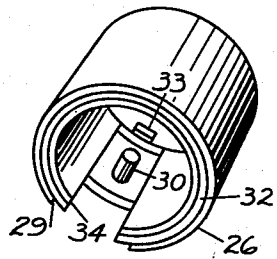


FIG. 2

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HYDRAULIC CIRCUIT

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7 Claims. (Cl. 103—42)

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This invention relates to apparatus for controlling the flow of a fluid and more particularly to apparatus for controlling the pressure exerted by the fluid.

Hydraulic circuits are used extensively at present to control the operation of automobiles and other complex equipment. For example, a plurality of circuits may be used to control the speed and torque ratios of an automobile so as to provide automatic gear shifts as the automobile changes from the starting to the intermediate and final speeds. The hydraulic circuit at the starting speed may provide large increments of fluid pressure as the automobile speed increases in comparison to the pressure increments provided by the hydraulic circuit which operates at the final speed.

The apparatus now in use for controlling the pressure provided by the hydraulic circuits at the different operating speeds has several disadvantages. The apparatus is heavy and cumbersome, and it has moving parts which often become stuck or, at the least, sluggish after operation for some time.

This invention provides a simple, reliable and compact apparatus for regulating the fluid pressure in a plurality of hydraulic circuits. The invention incorporates a fluid control device similar to that disclosed in Patent 2,512,956 issued to me on June 27, 1950, in such a manner that no moving parts are required to vary the pressure.

An object of the invention is to provide apparatus of the above character for regulating the fluid pressure in a plurality of hydraulic circuits.

Another object is to provide apparatus of the above character for increasing in a predetermined manner the fluid pressure in each of a plurality of hydraulic circuits as the speed at which the fluid is driven increases.

A further object is to provide apparatus of the above character for giving a differently sloped pressure characteristic in each of a plurality of hydraulic circuits without the use of any moving parts.

Still another object is to provide apparatus of the above character for regulating the fluid pressure in a polarity of hydraulic circuits in accordance with the fluid speed and independently of the fluid temperature.

A still further object is to provide apparatus of the above character which is simple, compact, efficient, reliable and inexpensive.

Other objects and advantages will be apparent from a detailed description of the invention and from the appended drawings and claims.

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Figure 1 is a schematic diagram, partially in section, of a plurality of hydraulic circuits and the pressure regulators for controlling the fluid pressure in each of the circuits;

Figure 2 is an enlarged perspective view of a pressure regulator for controlling the fluid pressure in one of the hydraulic circuits;

Figure 3 is an enlarged sectional view of the pressure regulator shown in Figure 2, the view being taken substantially on the line 3—3 of Figure 4;

Figure 4 is a sectional view of the pressure regulator substantially on the line 4—4 of Figure 3; and

Figure 5 shows curves illustrating how the fluid pressure in the individual hydraulic circuits vary with speed.

In one embodiment of the invention, a constant delivery pump 10 is provided for directing a fluid, such as oil, from a sump 12 into a main hydraulic line 14. The main line 14 is partitioned into a hydraulic circuit 16 and a by-pass circuit 17 in parallel with the circuit 16. The hydraulic circuit 16 has two subsidiary lines 18 and 20. An outlet conduit 21 is provided in the subsidiary line 18 to utilize the pressure built up in the fluid, and a gauge 22 may be connected in the line 18 to measure the fluid pressure.

A pressure regulator, generally indicated at 24, is provided in the subsidiary line 18 adjacent the line 20 to control the flow of fluid between the lines. The regulator 24 includes a sleeve 26 positioned by a shoulder 28 in the line 18. The sleeve 26 has a slot 29 extending axially along part of its length and a pin 30 extending radially inwardly from the part of the sleeve axially contiguous to the slot 29.

A bi-metallic split ring 32 having an outer surface which is more responsive to changes in temperature than its inner surface is retained within the sleeve 26 by inwardly turned lugs 33. The ring 32 has a slot 34 extending axially through the ring with a smaller width than the slot 29 in the sleeve 26. The ring 32 is positioned within the sleeve 26 by the pin 30, which extends radially into the slot 34. The pin 30 prevents the ring 32 from rotating through an angle which would cause the slot 29 to shut off part of the slot 34.

The hydraulic circuit 17 also has two subsidiary lines 36 and 38 communicative with each other by a port 40. The opening between the port 40 and the line 38 is controlled by a valve 42. A spring 44 acts upon the valve 42 in opposition to

the force exerted by the fluid in the line 36 and at low fluid speeds positions the valve to prevent any fluid from flowing between the port 40 and the line 38.

The fluid flowing through the circuits 16 and 17 is introduced into a hydraulic circuit 46 having a pair of subsidiary lines 48 and 50. A pressure regulator, generally indicated at 54, having a bi-metallic ring 56 similar to the ring 32 in the regulator 24 is provided in the subsidiary line 48 adjacent the line 50 to control the opening between the lines. The line 48 has an outlet conduit 58 for the flow of fluid and may have a gauge 60 to measure the pressure of the fluid in the line. The line 50 communicates with the sump 12, which is exposed to the atmosphere to cool the hot oil flowing from the line 50.

Since the fluid in the lines is circulated by the pump 10, the speed of the fluid increases with increases in the pump speed. As the fluid in the line 18 speeds up, an increased amount of fluid is unable to pass through the slots 34 and 29 in the ring 32 and sleeve 26, respectively. The resultant increase in the amount of fluid backing up in the line 18 produces an increase in the pressure of the fluid in the line. This is illustrated in Figure 5 by the rising portion 62 of the curve 64, which represents a typical relationship between the speed of an automobile and the fluid pressure in the line 18. The rate at which the pressure increases is determined by many factors, such as the viscosity of the fluid, the axial length of the slot 29 in the sleeve 26, the composition and thickness of the two different materials in the metallic ring 32, and the width of the slot 34 at ambient temperatures.

As disclosed in Patent 2,512,956 issued to me on June 27, 1950, the rate at which the fluid back pressure in the line 18 increases is substantially independent of fluid temperature. The reason for this is that the ring 32 expands with increases in fluid temperature and reduces the size of the slot 34. Thus, the tendency of the fluid to flow more easily because of its increased viscosity at the higher temperatures is compensated by the decrease in the area of the slot 34.

The fluid in the line 36 has the same pressure as the fluid in the line 18. At a predetermined fluid pressure in the lines 18 and 36, such as 50 pounds per square inch, the upward force exerted upon the valve 42 by the fluid exceeds the downward force exerted upon the valve by the spring 44. The valve 42 rises from its seat in the port 40 and provides an opening for the flow of fluid between the subsidiary lines 36 and 38. The subsidiary lines 36 and 38 thus provide a by-pass for the fluid after the pressure of the fluid in the line 18 has reached a predetermined value. This causes the fluid pressure in the line 18 to be maintained at a substantially constant and predetermined value with further increases in the speed of the pump 10, as illustrated by the substantially horizontal portion 66 of the curve 64 in Figure 5.

The bi-metallic ring 56 in the valve 54 operates in a manner similar to the operation of the ring 32 in the valve 24. However, the ring 56 is not as responsive to changes in fluid speed as the ring 32 and produces in the line 48 a pressure characteristic illustrated in Figure 5 by the curve 68, which rises at a relatively slow rate compared to the slope of the curve 64. The curve 68 does not have a saturated response at a predetermined fluid pressure as does the curve 64, since no by-pass circuit similar to the circuit 17 is provided in parallel with the circuit 46.

The pressures produced by the regulators 24 and 54 may be used in a number of ways. For example, after an automobile has been started, the fluid back pressure produced by the regulator 24 may be utilized to activate a torque converter which drives the automobile at the low speeds. When the automobile reaches a speed, such as 20 or 25 miles per hour, which approaches its cruising speed, a shift may be effectuated from the curve 64 to the curve 68, and the pressure of the fluid in the line 48 may be subsequently utilized to activate apparatus for producing fast increases in speed when the driver wishes to pass other automobiles.

In addition to utilizing the fluid pressures in the lines 18 and 48 individually, the pressures may be utilized in various combinations, such as the addition of the two pressures. Furthermore, a plurality of different pressures may be obtained by employing regulators having different response characteristics.

There is thus provided apparatus for efficiently and reliably regulating the pressure of a fluid in a plurality of hydraulic circuits. The apparatus controls the various fluid pressures without requiring any moving parts.

Although this invention has been disclosed and illustrated with reference to particular applications, the principles involved are susceptible of numerous other applications which will be apparent to persons skilled in the art. The invention is, therefore, to be limited only as indicated by the scope of the appended claims.

What is claimed is:

1. Apparatus for controlling the flow of a fluid, including, a first circuit adapted to receive the fluid, means operative to increase the fluid back pressure in the first circuit at a relatively fast rate in accordance with changes in fluid speed, means for by-passing the first circuit for fluid back pressures above a predetermined value, a second circuit adapted to receive the fluid, and means operative to increase the fluid back pressure in the second circuit at a relatively slow rate with changes in fluid speed.

2. Apparatus for controlling the flow of a fluid, including, means for pumping the fluid at a variable speed, a first circuit adapted to receive the pumped fluid, means for varying the fluid back pressure in accordance with changes in the fluid speed, a by-pass circuit in parallel with the first circuit and adapted to receive an amount of fluid variable in accordance with the fluid back pressure in the first circuit, a second circuit adapted to receive fluid from the first and by-pass circuits, and means for varying the back pressure in the second circuit in accordance with changes in the fluid speed.

3. Apparatus for controlling the flow of a fluid, including, means for pumping the fluid at a variable speed, a first circuit adapted to receive the fluid, a bi-metallic regulator in the circuit for providing a fluid back pressure increasing at a relatively rapid rate with increases in fluid speed, a by-pass circuit, a valve in the by-pass circuit for regulating the fluid flow to maintain the back pressure in the first circuit substantially constant at a predetermined maximum value, a second circuit, a bi-metallic regulator in the second circuit for providing a back pressure increasing at a relatively slow rate with increases in fluid speed.

4. Apparatus for controlling the flow of a fluid,

including, means for pumping the fluid at a variable speed, a circuit adapted to receive the fluid, means for providing in the first circuit a fluid back pressure increasing at a relatively rapid rate with increases in fluid speed and independently of the fluid temperature, means for providing an auxiliary circuit for fluid back pressures in the first circuit above a predetermined value, a plurality of circuits associated with the first and auxiliary circuits, and means for providing in each of the circuits a fluid back pressure increasing at correspondingly reduced rates with increases in fluid speed and independently of the fluid temperature.

5. Apparatus for controlling the flow of a fluid, including means for pumping the fluid at a variable speed, a first circuit adapted to receive the pumped fluid, a bi-metallic regulator for varying the fluid back pressure in the first circuit in accordance with increases in the fluid speed, a by-pass circuit in parallel with the first circuit and adapted to receive an amount of fluid variable in accordance with the fluid back pressure in the first circuit, a plurality of circuits adapted to receive fluid from the first and by-pass circuits, and a bi-metallic regulator in each of the circuits for varying the back pressure in the circuit at a predetermined rate with increases in the fluid speed.

6. Apparatus for controlling the flow of a fluid, including, means for pumping the fluid at a variable speed, a first circuit adapted to receive the fluid, there being an opening in the circuit, a sleeve positioned in the circuit and having an axial slot to communicate with the opening, a hollow bi-metallic member, a lug extending from the sleeve to maintain the bi-metallic member in a fixed position relative to the sleeve, there being in the bi-metallic member an orifice having a width which is variable with temperature changes to regulate the fluid flow through the axial slot in the sleeve and to provide in the first circuit a fluid back pressure dependent substantially only upon fluid speed, a pin extending from the sleeve at a position adjacent to the axial slot to maintain the orifice in the bi-metallic member in substantial alignment with the slot in the sleeve, a by-pass circuit, and means in the by-pass circuit operative by the fluid pressure in the first circuit to regulate the flow of fluid in the first circuit.

7. Apparatus for controlling the flow of a fluid, including, means for pumping the fluid at a variable speed, a first circuit adapted to receive the fluid, there being an opening in the circuit, a hollow bi-metallic member in the circuit, there being in the member an orifice having a width which is variable in accordance with changes in fluid temperature to provide a fluid back pressure substantially independent of the fluid temperature and dependent substantially only upon fluid speed, a sleeve surrounding the member and having an axial slot in communication with the orifice in the bi-metallic member and the opening in the circuit, a pin extending from the sleeve into the orifice to maintain the orifice in the bi-metallic member and the slot in the sleeve in substantial alignment, a by-pass circuit, and means in the by-pass circuit to regulate the fluid pressure in the first circuit.

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