FLUID PRESSURE SYSTEM FOR CONVERTING DIGITAL SIGNALS TO ANALOG SIGNALS

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References Cited
UNITED STATES PATENTS

2,229,903 1/1941 Schmohl et al.......................... 137/599

3,072,146 1/1963 Gizeski.......................... 137/599 X
3,081,942 3/1963 McClay.......................... 91/31

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ABSTRACT

A fluid pressure system for converting a digital pressure signal into an analog pressure by control of fluid pressure passing through at least a pair of restrictors in series and by monitoring the pressure between the two restrictors each one of which may be characterized by a subsonic or sonic flow rate thereafter so as to produce any combination of such flow rates therebetween, depending upon the input pressure and the cross-sectional area and geometric configuration of said restrictors.

4 Claims, 3 Drawing Figures
BACKGROUND OF THE INVENTION

In fluid pressure operable systems wherein valve devices are employed for effecting supply of control pressure at varying degrees to other fluid pressure operable devices, such as in a railway train brake system, for example, wherein a manually operable engineer's brake valve is operable to a plurality of positions for effecting supply of control fluid, at a preselected degree, to the relay portion of the brake control valve, the degree of such control pressure thus delivered to the brake control valve should be highly accurate in order to avoid overbraking or underbraking of the train. The engineer's brake valve device normally includes a manually operable handle which the operator moves to a selected position, according to his experience and judgment, that will effect delivery of control pressure at the desired degree. Although the operator's experience normally permits him to operate the brake valve with a high degree of accuracy in effecting delivery of control pressure at the desired degree, there is no positive assurance that such will occur with each operation, especially in the case of an operator with little experience.

SUMMARY OF THE INVENTION

The object of the present invention, therefore, is to provide apparatus for supplying control fluid at a precise, measured pressure, said apparatus being characterized in that it may be operated without the necessity of judgment in the part of the operator in positioning an operating handle.

Basically, the invention comprises a plurality of control pressure supply restrictors, either of identical flow rate capacities or of various flow rate capacities, connected in parallel relation to each other between an upstream source of control fluid at a constant preselected pressure and a downstream atmospheric restrictor. Respectively individually operable cut-off valve devices, which may be of the type operated manually or of the type operated by remote controlled power means, are connected to the downstream side of each of the supply restrictors in interposed relation between each of said supply restrictors so that one or more of said supply restrictors may be cut out or cut in, as desired, to produce the desired control pressure which is tapped off between said atmospheric restrictor and a common conduit connected to all of said supply restrictors and leading to the device to be supplied with such control pressure. A cut-off valve similar to those above described may be connected to the downstream or outlet side of the atmospheric restrictor for further control of the pressure tapped off via the common conduit for the device to be controlled thereby. The apparatus may be constructed in the form of a manifold in which the several cut-off valves may be disposed and in which the several restrictors may be machined according to specified dimensions and cross-sectional configuration.

In the drawing, FIG. 1 is a diagrammatic of the basic principle of operation of the invention; FIG. 2 is also a diagrammatic of a further development of the basic illustration shown in FIG. 1; and FIG. 3 is a sectional view of a digital to analog pressure converter device embodying the invention.
flow through restrictor 1 is stopped and the volume comprising pipes 4 and 6 is vented via restrictor 2 to produce an analog pressure at a second limit equal to atmosphere. By opening both valves 7 and 8 an analog pressure between the two limits is obtained, the value of such analog pressure thus obtained being dependent upon the relationship between the flow areas of the upstream and downstream restrictors 1 and 2 as well as the respective upstream pressure of each of said restrictors to determine the sonic/subsonic combination produced. The pressure limits obtainable for the four sonic/subsonic combinations possible with two restrictors in series are as follows:

<table>
<thead>
<tr>
<th>TYPE OF FLOW THROUGH THE RESTRICTORS</th>
<th>LIMITS OF ANALOG PRESSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPSTREAM RESTRICTOR</td>
<td>DOWNSTREAM RESTRICTOR</td>
</tr>
<tr>
<td>(a) Subsonic</td>
<td>Subsonic</td>
</tr>
<tr>
<td>(b) Sonic</td>
<td>Subsonic</td>
</tr>
<tr>
<td>(c) Subsonic</td>
<td>Sonic</td>
</tr>
<tr>
<td>(d) Sonic</td>
<td>Sonic</td>
</tr>
</tbody>
</table>

In considering combination (a), for example, in which both the upstream restrictor 1 and the downstream restrictor 2 are subsonic, it should be apparent that P₁ would be adjusted downwardly to approach one atmosphere (but not actually reduced to one atmosphere, otherwise there would be no flow). For purposes of convenience, however, this P₁ would be called one atmosphere. If the constriction of downstream restrictor 2 is reduced to a point just short of that point at which an increase of P₁ from one atmosphere up to a P₂ just short of producing a sonic flow through the upstream restrictor 1, then the highest possible P₂ for a subsonic/subsonic combination of the restrictors 1 and 2, respectively, would approach Pₐ, since, as above noted, Pₐ<P/2. For convenience, therefore, it is said that the highest limit of output or P₂ in the subsonic/subsonic combination is input pressure or Pₐ.

In considering combination (b), that is when upstream restrictor 1 is sonic and downstream restrictor 2 is subsonic, the lowest possible P₁ can be close to one atmosphere (that is, just above one atmosphere, as above discussed). P₁ then can be increased from one atmosphere up to a pressure just short of causing the downstream restrictor 2 to go into a sonic flow rate. In this case, since the pressure leaving the upstream restrictor 1, which is sonic, must be less than P₂/2, the upper limit of analog pressure at gauge 9 can only approach P₂/2.

By applying similar logic to cases (c) and (d) in the above table, one skilled in the art can readily understand how the lower and upper analog pressure limits are derived for each case.

The principles relating to restrictors, as above described, may be applied to a device, which may be called a pilot device, used in providing a control pressure to a second operating or control device. If the characteristic of the control device is such as to require a wide range of analog control pressures, it would not be practical to try to provide said wide range of control pressure by varying the respective flow areas of the two restrictors 1 and 2. If, for example, it is desired to replace an engineer’s brake valve in a railway brake system with a more compact pilot valve device of equivalent versatility and of the type herein described and embodying the invention, such a device may be like the one shown in FIG. 3.

As shown in FIG. 3, the pilot valve device may comprise a casing having a restrictor section 10 and a valve section 11, the two sections being sealingly joined by any suitable means not shown. The restrictor section 10 has disposed therein a plurality or preselected number of upstream restrictors R₁, R₂, R₃, etc. having the input ends thereof connected in parallel relation via a passageway 12 to a common source of constant pressure, in this case a feed pipe 13 of the brake system.

The output ends of the restrictors R₁, R₂, R₃, etc. are connected to respective inlet ends of upstream flow control valve devices V₁, V₂, V₃, etc. of the open-closed type disposed in valve section 11, said valve devices having the outlet ends thereof connected in parallel relation via a passageway 14 to a downstream restrictor 15 which, in turn, is connected serially to the inlet of a downstream flow control valve device 16, both said downstream restrictor and downstream valve device also being disposed in valve section 11. The outlet side of downstream valve device 16 is connected to a pipe 18 leading to a device such as the relay valve portion (not shown) of the brake control valve device (not shown). If all the parallel connected upstream restrictors R₁, R₂, R₃, etc. are of identical flow area, then the analog pressure delivered via pipe 18 may be progressively increased by sequentially opening the appropriate upstream control valves V₁, V₂, V₃, etc. This simulates varying the flow area of a single restrictor in a step wise fashion to produce the desired analog pressure between the upstream and downstream restrictors, said analog pressure being fed via pipe 18 to the relay valve of the brake control valve, which in turn, as is well known to those skilled in the art, controls brake pipe pressure for applying or releasing the train brakes.

Since discrete steps of brake pipe pressure control are effected in the manner above described, a binary digital method of controlling operation of the valves V₁, V₂, V₃, etc. would possibly provide a very practical means of approaching a pure analog control pressure which is essential in obtaining smooth variations of brake pipe pressure control. The number of pressure levels obtainable with the pilot valve device shown in FIG. 3 is 2ⁿ⁻¹, where n indicates the number of upstream restrictors. The respective values of the pressure increments comprising a pressure level is determined by the respective restrictor sizes and the valves opened for effecting the resultant upstream to downstream flow range.

It should be apparent that the upstream restrictors R₁, R₂, R₃, etc., as well as the downstream restrictor 15, do not have to be of identical dimension. The dimensions and the number of the several restrictors may vary according to the specifications of the application of the invention. It should also be noted, however, that the total flow area resulting from the restrictor or con-
bination of restrictors, as effected by the binary control logic, should be such as to produce pressure steps of fairly close values so as to allow a smooth transition from one pressure level to the next.

Control of the upstream valves $V_1, V_2, V_3$, etc. may be effected in the desired binary fashion by any suitable well known manual, electrical, or fluid pressure means. An electrical valve controller 19 connected by multiple-wire conductors 20 and 21 to the several valve devices $V_1, V_2, V_3$, etc., and incorporating a binary code system, for example, is represented symbolically in the drawing, it being considered that such control means are so well known in the art that a detailed description thereof is not deemed essential to an understanding of the invention. The controller 19 is provided with a control panel 22 which the operator uses in selecting any combination of the valves $V_1, V_2, V_3$, etc. that he desires to operate in effecting the described analog control pressure.

Having now described the invention, what we claim as new and desire to secure by Letters Patent, is:

1. A control pressure pilot valve device for converting a digital pressure to an analog control pressure transmitted to a control device for operation thereof, said pilot valve device comprising:
   a. at least two upstream restrictors of preselected flow capacity and each having the upstream side thereof connected to first passage means via which fluid at a constant pressure may be supplied concurrently to said upstream restrictors;
   b. respective upstream valve devices each having one end connected to respective opposite sides of said upstream restrictors and each having the opposite end connected to second passage means,
   c. said upstream valve devices being selectively operable, either singly or in any combination thereof, to respective open positions, in which the respective upstream restrictor connected thereto is communicated with said second passage means, and to respective closed positions in which the said respective upstream restrictor is cut off from said second passage means, said second passage means being communicable with the control device for transmitting thereto analog control pressure at a degree effected by the combination of opened and closed positions of the upstream valve devices;
   d. a downstream restrictor having one end connected to said second passage means; and
   e. a downstream valve device having one side connected to the other end of said downstream restrictor, the other side of said downstream valve device being open to atmosphere, said downstream valve device being operable to an open position, in which said second passage means is opened to atmosphere, and being operable to a closed position, in which said second passage means is cut off from atmosphere, for further controlling the degree of analog pressure prevailing in the second passage means.

2. A control pressure pilot valve device, as set forth in claim 1, wherein the dimensions of the flow area of one or more of said upstream restrictors are different from the others.

3. A control pressure pilot valve device, as set forth in claim 2, further characterized by operator's control means for effecting selective operation of said upstream and downstream valve devices.

4. A control pressure pilot valve device, as set forth in claim 3, wherein said operator's control means comprises an electrical controller incorporating a binary code system and including a control panel for selecting the desired code and consequent combination of valve operation.

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