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PUMP AND MOTOR HYDRAULIC TRANSMISSION SYSTEM

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FIG. 2.

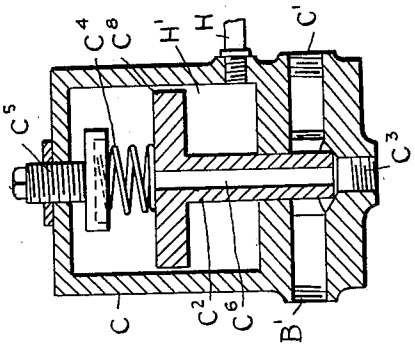
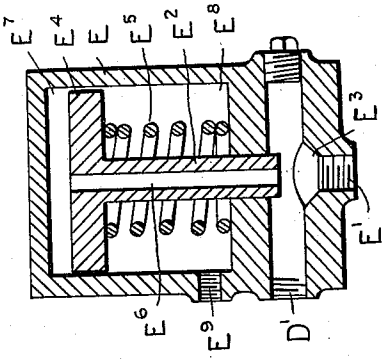


FIG. 3.



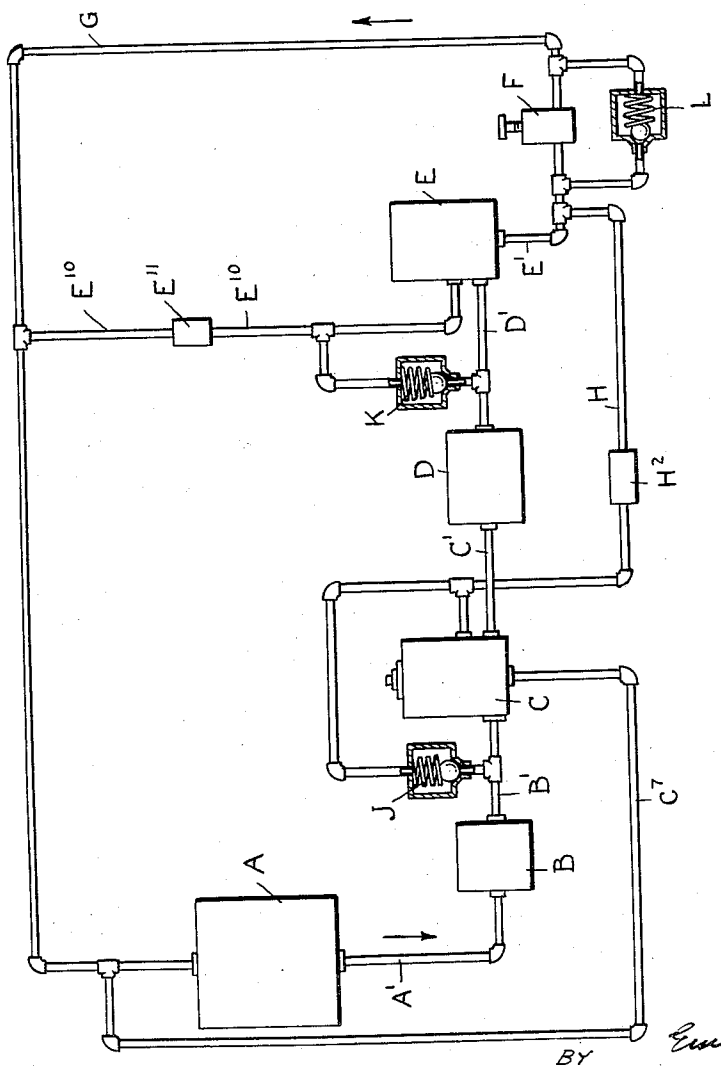


FIG. 1.

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PUMP AND MOTOR HYDRAULIC TRANSMISSION SYSTEM

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This invention relates to hydraulic power transmission systems of the kind comprising a power-driven pump by which liquid is delivered to a hydraulic motor, the speed of which is controlled by a control valve situated on the outlet side of the motor.

In such systems, it is usual to provide a relief valve between the pump and motor to by-pass excess liquid delivered by the pump and it has been proposed to effect opening of this relief valve by means of a piston usually incorporated therein, subject to pressure (hereinafter called the controlling pressure) derived from a point between the motor and the control valve so as to facilitate relief and reduce the useless work performed by the pump. Such an arrangement considerably relieves the pump especially at low motor speeds and when the motor is stopped, but does not deal adequately with the problem of preventing over-running of the motor during transition periods when sudden reductions in load on the motor or sudden closing of the control valve takes place.

The object of the present invention is to provide an improved hydraulic power transmission system of the kind referred to in which, as far as possible, the positive control of the motor speed in accordance with the setting and changes of setting of the control valve will tend to be achieved at all times.

To this end a hydraulic power transmission system of the kind referred to according to the present invention includes not only a relief valve between the pump and motor controlled by the pressure in an operating chamber connected to a point between the motor and control valve so that the control valve opens when this pressure exceeds a predetermined value, but also an automatic braking valve disposed between the control valve and the motor and so controlled by the pressure at this point that it closes if and when such pressure exceeds a predetermined value.

Conveniently, means are provided for adjusting to fine limits the relative pressures at which respectively the relief valve opens and the braking valve closes so as to enable the relationship between these pressures to be adjusted to ensure that the relief valve opens at a slightly lower pressure than that at which the braking valve closes without, however, there being any substantial band of pressures over which the relief valve and the braking valve are both open so that close control of the motor speed is lost and without there being any pressure at which

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both valves tend to remain closed with the consequent tendency for instability of conditions in the system and undesired loading of the pump.

The invention may be carried into practice in various ways, but one construction according to the invention is illustrated, somewhat diagrammatically by way of example in the accompanying drawing in which—

Figure 1 is a diagrammatic view of a complete hydraulic power transmission system embodying the invention,

Figure 2 is a vertical cross-section through the relief valve embodied in the system shown in Figure 1 and

Figure 3 is a similar view to Figure 2 of the braking valve embodied in the system shown in Figure 1.

The system shown in Figure 1 comprises a reservoir A for liquid from which the liquid is drawn through a pipe A^1 by a power-driven pump indicated at B and delivered via a pipe B^1 through a relief valve indicated generally at C and a pipe C^1 to a hydraulic motor indicated generally at D from which the liquid returns through a pipe D^1, a braking valve E, a pipe E^1, a control valve F and a pipe G to the reservoir A.

The braking valve E is normally continuously open and control valve F controls the speed of the motor D by controlling the rate at which liquid is permitted to flow through it and is arranged in known manner so that for each setting of the valve there will be a corresponding appropriate speed of the motor D which will tend to be maintained in spite of variations in the load on the motor.

To this end the relief valve C as shown clearly in Figure 2 comprises an operating piston C^3 mounted to move axially in the casing C and rigid with the valve member C^2 which controls a relief port C^3 situated at the junction of the pipes B^1 and C^1 which are in free communication with one another.

The underside of the piston C^3 is subject to the pressure in an operating chamber H^1 which is connected through a pipe H to a point in the pipe E^1, that is between the motor D and control valve F. This pressure is opposed on the piston C^1 by a spring C^4 the loading of which can be varied by an adjustment of an adjustable abutment C^5. A passage C^6 through the valve C^2 serves to ensure that both ends thereof are subject to relief pressure only. It will thus be seen that when pressure between the motor D and the control valve F exceeds a predetermined value, the relief valve C^2 will be opened against

the action of the spring C^4 so as to facilitate the flow of fluid through the relief port C^3 which is connected by a return pipe C^7 to the reservoir A. In this way, a constant pressure tends to be maintained in the pipe E^1 on the pressure side of the control valve F, and hence a constant flow tends to take place through this valve F for any given setting thereof. This operation will be clear when it is considered that increases in the load on the motor D will produce a reduction in the pressure in the pipe E^1 and hence on the control valve F and in the chamber H^1. This reduction in pressure causes a closing movement of the valve C^2 which will thereby increase the pressure of fluid supplied to the motor D to a degree sufficient to meet the increased load and restore the pressure in the pipe E^1 and hence in the chamber H^1.

The chamber H^1 may also be connected through a spring-pressed valve J to a point in the pipe B^1 between the pump B and the relief valve C, while a restriction indicated at H^2 is provided in the pipe H so that if and when excess pressure occurs in the pipe B^1, the valve J will lift to permit flow therethrough in excess of that which the restriction can accommodate thus producing increased pressure in the chamber H^1 which will cause the relief valve C^2 to lift. The valve J is set so that it opens only if an excessive pressure greater than the maximum at which the apparatus is designed to operate occurs in the pipe B^1, this valve thus being in the nature of a safety valve.

The braking valve E is as shown, arranged between the motor D and the control valve F so that all liquid passing through the pipes D^1, E^1, between the motor D and the control valve F has to pass through the braking valve. This valve, which as mentioned above is normally continuously open, comprises a casing E containing an axially movable valve member E^2 adapted to control the outlet port E^3 and provided with a piston E^4 on which acts a spring E^5 tending to maintain the valve open so that free flow of fluid can take place between the pipes D^1 and E^1. The valve member E^2 is provided with a bore E^6 so that an operating chamber E^7 above the piston E^4 is subject normally at all times to the pressure in the pipes D^1, E^1. The space E^8 below the piston communicates through a port E^9 and pipe E^{10} containing a restriction E^{11} with the reservoir A.

It will be seen that the braking valve will normally be maintained open by the spring E^5 but that if and when the pressure in the pipes D^1, E^1 exceeds a predetermined value, this pressure, acting on the top of the piston E^4 will cause the valve to close and thus prevent flow of liquid through the pipe D^1. If desired, a point in the pipe D^1 may be connected through a spring pressed safety valve K to the chamber E^8 through the part of the pipe E^{10} on the adjacent side of the restriction E^{11}. The valve K is then arranged so as to open only if and when a pressure occurs in the pipe D^1 in excess of the maximum for which the apparatus is designed. It will be seen that with this arrangement, should such an excessive pressure be experienced, the valve K will open so that pressure is admitted to the chamber E^8 to open the braking valve. In addition, a spring pressed safety valve L may be provided in parallel with the control valve F, this safety valve also being adapted to open only on the occurrence of a pressure thereon in excess of the maximum for which the apparatus is designed.

The setting of the spring C^4 is so adjusted in relation to that of the spring E^5 that the relief valve C^2 will open at a pressure in the pipe H slightly less than that at which the braking valve E^2 closes, but preferably with as little difference between these two pressures as can be ensured with certainty. Thus, when the pressure in the pipes D^1, E^1 slightly exceeds that at which the valve C^2 is set to open, the valve C^2 is opened, and if under these conditions the pressure in the pipes D^1, E^1 remains substantially constant, as will normally be the case, the braking valve E^2 remains open. If, however, in these circumstances, the pressure in the pipes D^1, E^1 shows an appreciable increase above that at which the relief valve C^2 opens, as may occur for example due to sudden removal of the load on the motor D, or to the fact that the motor is suddenly driven for example by the falling of a hammer or other member which it operates, the braking valve E^2 will at once close and thus positively prevent the speeding up of the motor D. It will thus be seen that the speed of the motor D is positively controlled under substantially all conditions.

What we claim as our invention and desire to secure by Letters Patent is:

1. A hydraulic power transmission system including in combination a power driven pump, a hydraulic motor to which liquid is delivered by the pump, a control valve controlling the flow of liquid from the motor, a relief valve situated between the pump and motor and including means tending to close the relief valve and an operating member disposed in an operating chamber the pressure in which acts on the operating member to tend to open the valve, means for connecting the operating chamber to a point between the motor and the control valve, and an automatic braking valve disposed between the motor and the control valve and including means tending to open the braking valve, an operating member disposed in an operating chamber the pressure in which acts on the operating member in a direction to close the braking valve and means connecting the operating chamber of the braking valve to a point between the motor and the control valve.

2. A hydraulic power transmission system including in combination a power driven pump, a hydraulic motor to which liquid is delivered by the pump, a control valve controlling the flow of liquid from the motor, a relief valve situated between the pump and motor and including means tending to close the relief valve and an operating member disposed in an operating chamber the pressure in which acts on the operating member to tend to open the valve, means for connecting the operating chamber to a point between the motor and the control valve, an automatic braking valve disposed between the motor and the control valve and including means tending to open the braking valve, an operating member disposed in an operating chamber the pressure in which acts on the operating member in a direction to close the braking valve, means connecting the operating chamber of the braking valve to a point between the motor and the control valve, and means for adjusting within fine limits the relative pressures at which respectively the relief valve is opened and the braking valve closes.

3. A hydraulic power transmission system including in combination a hydraulic pump, a hydraulic motor having its inlet connected to the outlet from the pump, a control valve controlling the flow of fluid through the outlet from the motor, a relief valve situated between the pump

and the motor and comprising a valve member, a spring tending to maintain the valve closed, an operating chamber and a piston in the operating chamber connected to the valve so as to open the valve when the pressure in the operating chamber exceeds a predetermined value, means for connecting the operating chamber to a point between the motor and the control valve, an automatic braking valve disposed between the control valve and the motor and comprising a valve member, a spring tending to maintain the valve open, an operating chamber and a piston in the operating chamber adapted to close the valve when the pressure in the operating chamber exceeds a predetermined value, and means connecting the operating chamber of the braking valve to a point between the motor and the control valve.

4. A hydraulic power transmission system including in combination a hydraulic pump, a hydraulic motor having its inlet connected to the outlet from the pump, a control valve connected to the outlet from the motor for controlling the flow of fluid through the motor, a relief valve in the connection between the pump and the motor and comprising a valve member, a counterbalancing spring tending to maintain the valve closed, an operating chamber and a piston in the operating chamber connected to the valve so as to open the valve when the pressure in the operating chamber exceeds a predetermined value, fluid pressure conducting means connecting the operating chamber to a point in the connection between the motor and the control valve, an automatic braking valve in the connection between the control valve and the motor and comprising a valve member, a counterbalancing spring tending to maintain the braking valve open, an operating chamber having fluid pressure conducting means between it and the connection from the motor to the control valve, a piston in the operating chamber adapted to close the braking valve when the pressure in the operating chamber exceeds a predetermined value, and means for varying the relative forces of the counterbalancing springs acting on the pistons respectively of the relief valve and braking valve to enable the pressures at which these valves respectively open and close to be adjusted in relation to one another so that the relief valve opens at a slightly lower pressure than that at which the braking valve closes whereby the speed of the motor is automatically controlled.

5. A hydraulic power transmission system including in combination the elements set forth in claim 3 in which a spring pressed pilot valve is situated between the pump and the relief valve and arranged when opened to deliver liquid under pressure to the operating chamber of the relief valve, and a restriction is provided between this operating chamber and the point in the connection between the motor and the control valve to which it is connected.

6. A hydraulic power transmission system including in combination the elements set forth in claim 3 in which a point between the motor and the control valve is connected through a spring pressed pilot valve to a chamber in which lies the face of the piston of the braking valve remote from the operating chamber of the braking valve so that when this pilot valve opens it admits pressure tending to open the braking valve.

7. A hydraulic power transmission system including the elements claimed in claim 4 in which a spring pressed pilot valve is situated between the pump and the relief valve and arranged when opened to deliver liquid under pressure to the operating chamber of the relief valve, and a restriction is provided between this operating chamber and the point in the connection between the motor and the control valve to which it is connected; and a point in the connection between the motor and the braking valve is connected through a second spring pressed pilot valve to a chamber in which lies the face of the piston of the braking valve remote from the operating chamber of the braking valve so that when this pilot valve opens it admits pressure tending to open the braking valve.

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