June 12, 1956 R. VESTRE 2,749,709

DUAL MOTOR HYDRAULIC DRIVE AND CONTROL VALVE THEREFOR

Original Filed Jan. 8, 1947

Fig. 1.

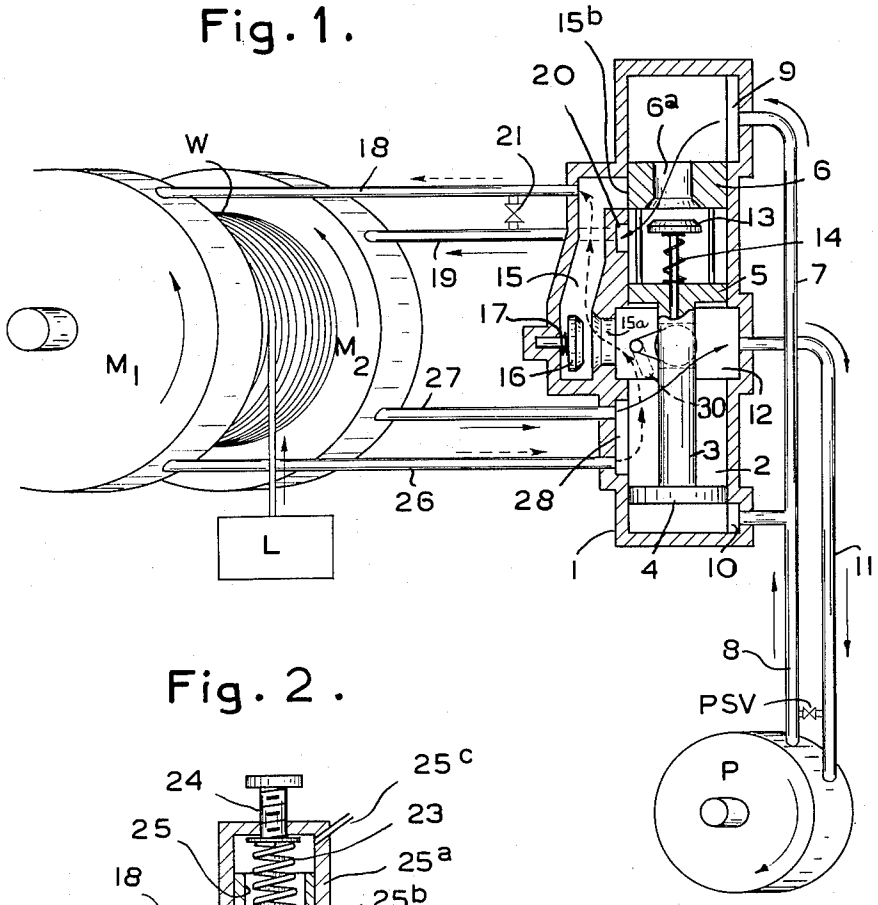
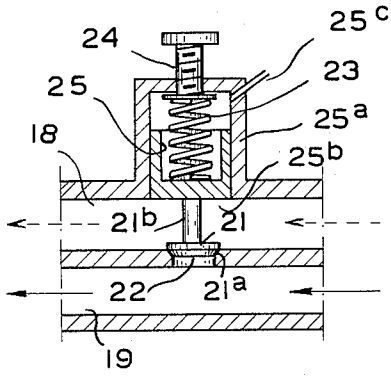


Fig. 2.



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United States Patent Office 2,749,709 Patented June 12, 1956

2,749,709

DUAL MOTOR HYDRAULIC DRIVE AND CONTROL VALVE THEREFOR

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Original application January 8, 1947, Serial No. 720,885, now Patent No. 2,618,291, dated November 18, 1952. Divided and this application October 10, 1952, Serial No. 314,120

Claims priority, application Norway May 2, 1946

4 Claims. Cl. 60—53)

This application is a division of application No. 720,885 filed January 8, 1947, now U. S. Patent No. 2,618,291 of November 18, 1952.

In hydraulic transmission systems where a motor-driven hydraulic pump delivers a constant uni-directional flow of fluid to a single hydraulic motor, which may drive, for example a winch, the amount of fluid supplied to and from said hydraulic motor is being regulated by a manually adjustable control valve. In such systems the hydraulic pump is usually protected against breakages or overwork by a safety non-return valve, which is interposed between the pipes leading from the pump to said manually adjustable control valve and the return pipe therefrom to the pump. The said safety valve is adjusted to "blow" or open for a certain pressure, say 30 kg./cm.^{2}, which corresponds to a lifting capacity of load, say 3 tons, and when said pressure is exceeded the liquid is bypassed from the pressure pipe leading from the pump over to the return pipe of the pump without circulating through the manually adjustable control valve or the hydraulic motor, which latter consequently will be kept at rest without doing any work. The pressure for which the said safety valve is adjusted consequently corresponds with the maximum weight of load the winch in question is capable of lifting. A winch of this type should not continuously be driven at top load, which will give the transmission system reduced life time. A varying load from zero to maximum, with an average of one half to two thirds of the maximum load seems to be the most economical and a winch may run for years under such conditions without any noticeable wear and tear.

Here other types of hydraulic transmission systems said motor driven pump delivers a constant uni-directional flow of fluid to two hydraulic motors which are keyed to a main shaft, which may drive for example a winch, the amount of fluid supplied to and from said hydraulic motors also being regulated by a manually adjustable control valve. Also in this case the pump may be protected against breakage or overwork by a safety valve interposed between the pipes leading from the pump to said manually adjustable control valve and the return pipe therefrom to the pump. The manually adjustable control valve may be adjusted to a position where both motors are driving with their greatest combined torque, or adjusted to a position where one motor is idling and only one motor driving, but running a correspondingly greater speed than when both motors are driving. If now the winch in question, with both motors driving, is capable of lifting, say 2 tons, with a fluid pressure of 20 kg./cm.^{2} and a hoisting speed of 4 m. pr. second, it will then with only one motor driving be capable of lifting the same 2 tons with a hoisting speed of 8 m. pr. second and develop a fluid pressure of 40 kg./cm.^{2}. As the safety valve of the pump is adjusted to "blow" for a fluid pressure of the above mentioned 30 kg./cm.^{2} (which is the maximum lifting capacity of the winch) the winch will stop driving if this pressure is exceeded while the pump is still running on top load circulating its fluid in a closed circuit through

the safety valve. To avoid this the manually adjustable control valve must be manually readjusted to a position wherein also the second motor is coupled into the system so that both motors drive and take part in the work. As it is natural and a temptation for the operator to utilize the greater hoisting speed which the transmission system gives with only one motor driving, this motor will often constantly be running on its top load (nearly the load for which the safety valve "blows"). It is therefore likely that this motor and the pump will be constantly overworked and have a short life time, which in the long run may be expensive because the pump and motors must be frequently changed.

The object of the present invention is to provide a control device for use with hydraulic transmission systems of the type described wherein means are provided to permit overflow of the pressure liquid from the pressure pipe of the one driving motor to the pressure pipe of the second idling motor, when the manually adjustable control valve is adjusted to such a position that a certain difference of fluid pressure in the two pressure pipes is exceeded, that is to say when one motor is idling and only one driving. By this means a part of the pressure liquid, which drives the said one motor, will flow over to the pressure pipe of the second, idling motor which then automatically will be coupled into the driving system and take its part of the load, and both motors will then work with a consequent corresponding reduced working speed and reduce pressure. As soon as the said pressure diminishes caused by a lower load the second motor is cut out of the driving system, so that said second motor idles again and only the first motor will drive and take all the work.

Further characteristic features will be revealed in the following and upon the annexed drawing where one embodiment of the invention is schematically illustrated and wherein:

Figure 1 is a vertical section through the manually adjustable control valve showing also the hydraulic pump and both hydraulic motors and the pipes interconnecting these parts;

Figure 2 is a vertical section view in a larger scale of the non-return pressure-responsive relief valve which is placed between the pressure pipes (delivery pipes) to the two motors.

In Figure 1 of the annexed drawing the letter P indicates the hydraulic pump which is continuously driven in one determined direction by an engine (not shown) and delivers a constant quantity of pressure liquid to the two hydraulic motors M_1 and M_2, which are coupled to a main shaft, by way of an example shown driving a winch-drum W to handle load L.

The reference numeral **1** indicates the control valve housing, the interior of which is formed as a cylinder **2** within which is arranged a slidably movable valve member **3** provided with axially spaced pistons **4**, **5** and **6**. The construction and operation of this valve is more fully illustrated in Patent No. 2,618,291. The valve member is moved by a handle and associated means **30** by which all necessary adjustments of the valve are effected. The upper and lower ends of the cylinder **2** are in communication through a pipe or conduit **7**, which opens into enlarged recesses **9**, **10** in the cylinder wall. A supply pipe **8** from the hydraulic pump P is connected to the pipe **7**. Connected approximately at the middle of the cylinder is a return pipe **11** leading to the pump, the cylinder having an enlarged internal annular recess **12** at this point of connection. The reference letter PSV indicate a pump safety valve, which is interposed between the delivery pipe **8** from the pump and the return pipe **11** back to the pump. This safety valve is adjusted for a certain pressure of fluid in the pipe **8** corresponding to a certain maximum weight

of load the winch is capable of lifting. This pressure is by way of an example stated to be 30 kg./cm.

In combination with the valve member 3 there is a non-return valve 13 urged against a seat in the piston 6 by a spring 14 so as normally to close a passage 6a through said piston. The valve 13 is such that it will open when pressure is applied from the pipe 7 through the recess 9, but is immediately closed when this pressure is cut off or a greater pressure is supplied to the valve at the reverse side.

Also communicating with the annular recess 12 is a port 15a opening into a by-pass passage or transfer conduit 15 which leads back to the cylinder somewhat higher up and opening thereinto through a port 15b. In this conduit 15 there is a non-return valve 16, which is held against its seat by a spring 17 so as normally to close the conduit from the passage 15a and recess 12. The valve 16 opens by pressure of liquid admitted to the passage 15a through the recess 12, but will close again as soon as this pressure is cut off or a greater pressure is applied through the conduit 15 to its reverse side.

The liquid supply pipes to the motors M_1 and M_2 are indicated by the numerals 18 and 19. The pipe 18 is connected to the upper part of the conduit 15 and the pipe 19 is connected to the cylinder 2 somewhat below to a recess 20 in the cylinder wall.

The return pipes from the motors M_1 and M_2 to the control valve are indicated at 26 and 27. Both of these pipes are connected to the lower part of the cylinder 2 and open into a by-pass recess 28 in the cylinder wall.

When the valve member 3 is adjusted to the position shown upon Figure 1 of the drawing, the uppermost piston 6 completely blocks the passage 15b of the cylinder 2 (blocks the pipe 18). All the liquid will then flow through the pipe 19 to the motor M_2, which then will be driven alone with correspondingly greater speed of rotation than when the valve member is adjusted to the position in which both motors are driving. The motor M_1 will then be running without load and driven as a pump, circulating its liquid practically without pressure through the pipe 26, the one-way valve 16, the conduit 15 the pipe 18 and back to the motor M_1. Both motors will thereby obtain increased speed of rotation, but power will be transmitted only through motor M_2, which will be driven in the direction for hoisting the load. In this position of the valve member 3 it will be seen that there are two fluid circuits one of which is associated with and drives the motor M_2 as shown with full drawn arrows and the other of which is associated with the idling motor M_1 as shown with dotted arrows. The latter circuit is closed by the piston 6 covering the port 15b, the suction action produced in the motor M_1 creating a drop in pressure in the conduit 15 and the pipe 18 which maintains the one-way valve 16 open.

Between the pipes 18 and 19 there is a non-return, pressure-responsive relief valve 21, shown in detail in Figure 2, the purpose of which is to prevent overload of the motor M_2, when same is driving alone and motor M_1 is idling, as will later be described.

The valve 21 is normally held by a spring 23 against a seat 21a in a passage 22 between the pipes 18 and 19. This spring is received in a cylindrical pocket 25a extending from the wall of the pipe opposite the passage 22 and acts upon one side of a piston-formed guide 25 from the reverse side of which extends a narrow stem 21b, which carries the valve 21. The cross-sectional area of the pipe 18 may be somewhat widened here so that the stem 21b does not restrict the free flow of fluid through the pipe 18 at this point. The pressure of the spring 23 is adjustable by a screw 24 and by adjusting the pressure of the spring the valve 21 is normally held against its seat 21a for normal conditions of load. The piston-formed guide 25 provides a shoulder 25b opening into the pipe 18 and which has a larger area than the area of the valve 21. The numeral 25c indicates a drainage pipe to dispose of the liquid enclosed in the pocket 25a above the piston 25.

In the Fig. 1 position of the valve member 3 the valve 21 will normally be held against its seat 21a by the spring 24, because the adjusted pressure of the spring 23 is greater than the fluid pressure in pipe 19 against the valve face 21. If now the predetermined pressure in the pipe 19 should be exceeded, in other words that the single driving motor M_2 becomes overloaded, the excess pressure in pipe 19 will act upon piston 25, overcome the pressure of the spring 23 and thus open the valve 21. The liquid traversing the pipe 19 will then be divided and a part thereof will pass through the bore 22 into the pipe 18, into the idling motor M_1 and drive the latter in exactly the same way as if the valve member 3 had been in the Figure 3 position of Patent No. 2,618,291.

Since the shoulder 25a of the valve guide 25 has a greater effective area than that of the back of the valve 21 (the side facing into the pipe 18), the pressure liquid passing from pipe 19 through the bore 22 into pipe 18 will also act on said shoulder 25b and hold the valve 21 open until the pressure in the pipe 19 has fallen to a value below the pressure of the spring 23, whereafter the valve 21 will close. Thus the valve 21 will be kept open by a liquid pressure below the opening pressure of the valve. Consequently the motor M_1 is cut off from the drive and motor M_2 will be the sole driving motor as previously described.

Thus if the valve 21 is adjusted to open for a pressure of, say 20 kg./cm.^{2}, the pressure in the pipes—for a load corresponding thereto will sink to approximately 10 kg./cm.^{2} when both motors drive and the valve 21 must consequently be kept open by this reduced pressure. This is why the shoulder 25b has a correspondingly larger area than the valve 21. The area of the two faces 25b and 21 should in the practice be chosen in the ratio approximately 2.2:1 corresponding to ratio of diameter 1.5:1. The valve will then close for a pressure approximately 9 kg./cm.^{2} and by a corresponding load the pressure will then raise to approximately 18 kg./cm.^{2} when only one motor drives again. If now the slide member 3 is adjusted to the Figure 3 position of the parent application, the valve 21 will not close until the pressure in the pipes has dropped to 9 kg./cm.^{2}.

It should be apparent from the foregoing that the valve 21 works fully automatic. When in the Figure 1 position of the valve member 3 the motor M_2 should become overloaded, the idling motor M_1 is automatically coupled into the driving system to take its part of the load. As soon as the load has been reduced sufficiently the valve 21 automatically closes and motor M_2 again becomes the sole driving motor. If the load should be too heavy for both motors to handle the pump safety valve PSV will blow in known manner.

The springs 14 and 17 which control the valves 13 and 16 respectively have just enough pressure to keep the valves closed, provided there is an even fluid pressure upon both sides of such valves. If there were no liquid in the valve housing and the atmospheric air could act freely through the valve housing, the valves 13 and 16 both would be kept closed by their spring. Only a very small force is needed to open them. If the springs 14 and 17 were too heavy, there would have to be a too heavy fluid pressure to open them, which would mean a loss of energy.

I claim:

1. In an apparatus having a shaft, first and second hydraulic motors, both bidirectionally couped to said shaft, a first supply conduit for leading liquid to the first motor, a second supply conduit for leading liquid to the second motor, return conduits from said motors, and liquid control means to control the supply of liquid, said liquid control means comprising a housing provided with a valve chamber and having a first admission port for the admission of fluid from a pressure fluid source, two main delivery ports connected to said first and second supply conduits, all of said ports opening into the valve cham-

ber, a valve member within the valve chamber, said valve member being adjustable to one position in which liquid is fed to the first supply conduit and to another position in which liquid is fed to both said supply conduits simultaneously, a duct between said supply conduits, and a one-way relief valve means normally closing said duct whereby, when the said first supply conduit alone is fed with liquid by said liquid control means, the relief valve means opens when the pressure exceeds a predetermined value to admit liquid from the said first supply conduit to the second supply conduit to drive both motors during periods of overload.

2. In an apparatus having a shaft, first and second hydraulic motors, both bidirectionally coupled to said shaft, a first supply conduit for leading liquid to the first motor, a second supply conduit for leading liquid to the second motor, return conduits from said motors, and liquid control means to control the supply of liquid, said liquid control means comprising a housing provided with a valve chamber and having a first admission port for the admission of fluid from a pressure fluid source, two main delivery ports connected to said first and second supply conduits, all of said ports opening into the valve chamber, a valve member within the valve chamber, said valve member being adjustable to one position in which liquid is fed to the first supply conduit and to another position in which liquid is fed to both said supply conduits simultaneously, a duct between said supply conduits, and a pressure-responsive relief valve comprising a valve head normally closing said duct but adapted to admit liquid under pressure from the first supply conduit to the second supply conduit, a shouldered valve stem upon which the said head is mounted, and means for spring-loading said valve stem, the shouldered portion of the said valve stem having a greater surface area than that of the working face of the said valve head so that the liquid under pressure in the first supply conduit which forces open the said valve head finds a greater surface area upon which to act when it contacts the said shouldered valve stem and thus maintains said valve in the open position at a pressure lower than that required to open the valve.

3. In an apparatus having a shaft first and second hydraulic motors, both bidirectionally coupled to said shaft, a first supply conduit for leading liquid to the first motor, a second supply conduit for leading liquid to the second motor, return conduits from said motors, and liquid control means to control the supply of liquid, said liquid control means comprising a housing provided with a valve chamber and having a first admission port for the admission of fluid from a pressure fluid source, two main delivery ports connected to said first and second supply conduits, all of said ports opening into the valve chamber, a valve member within the valve chamber, said valve member being adjustable to one position in which liquid is fed to the first supply conduit and to another position in which liquid is fed to both said supply conduits simultaneously, a duct between said supply conduits, and a one-way relief valve means normally closing said duct whereby, when the said first supply conduit alone is fed with liquid by said liquid control means, the relief valve means opens when the pressure exceeds a predetermined value to admit liquid from the said first supply conduit to the second supply conduit to drive both motors during periods of overload, and means to hold the relief valve open at a pressure less than that required to open it initially.

4. In an apparatus having a shaft, first and second hydraulic motors, both bidirectionally coupled to said shaft, a first supply conduit for leading liquid to the first motor, a second supply conduit for leading liquid to the second motor, return conduits from said motors, said liquid control means comprising a housing provided with a valve chamber and having a first admission port for the admission of fluid from a fluid pressure source, a fluid discharge port, two main delivery ports connected to said first and second supply conduits, two return ports connected to the said return conduits, and a secondary delivery port, all of said ports opening into the valve chamber, said delivery ports and the said first admission port being located towards one end of said valve chamber, and the said return ports being spaced from the delivery ports towards the other end of said valve chamber, a second admission port at said other end of said valve chamber, a by-pass conduit connecting said secondary delivery port to one of said main delivery ports, a first one-way valve mounted on said secondary delivery port and positioned to permit the flow of pressure fluid through said by-pass conduit only from the valve chamber and said secondary delivery port and into said by-pass conduit, a valve member within the valve chamber and having a first opening therein positioned to conduct fluid from the second admission port to the delivery ports, a second one-way valve mounted in said valve member and positioned to permit the flow of pressure fluid through said opening from the second admission port, said valve member having a second opening therein positioned to permit flow of fluid from the return ports to the discharge port, said valve member being slidably adjustable to at least two different positions in one of which it directs the entering pressure fluid past said second one-way valve and through the first opening in said valve member to both said main delivery ports simultaneously, and in the other position said first opening is positioned to direct the pressure fluid only to the main delivery port which is connected to the first supply conduit at working pressure with the other main delivery port in communication with the return ports through said second opening and said secondary delivery port and first one-way valve and said by-pass conduit, a duct between said supply conduits, and a one-way relief valve means normally closing said duct whereby when the said first supply conduit alone is fed with liquid by said liquid control means the relief valve means opens when the pressure exceeds a predetermined value to admit liquid from the said first supply conduit to the second supply conduit to drive both motors during periods of overload.

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