SHUT-OFF VALVE AND ASSOCIATED PRESSURE RELIEF MEANS

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FIG. 1

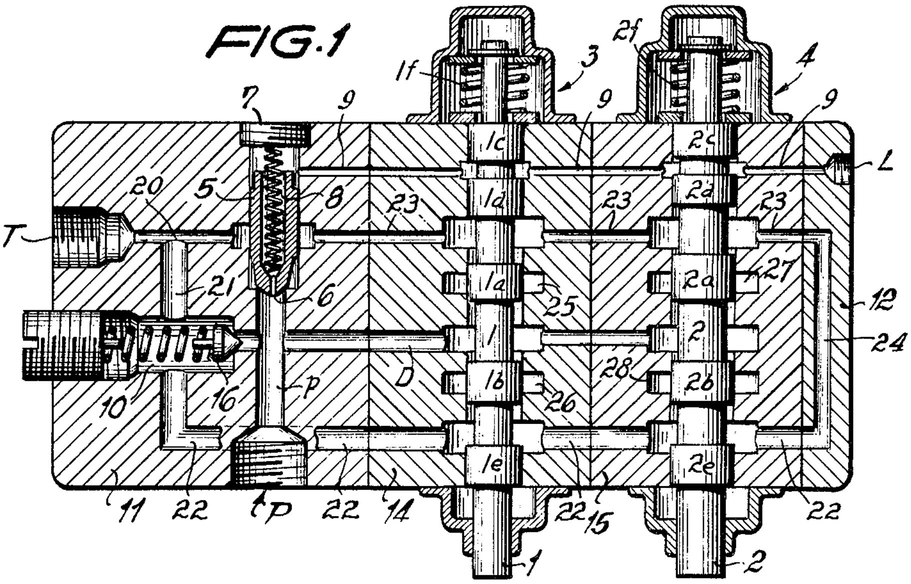


FIG. 2

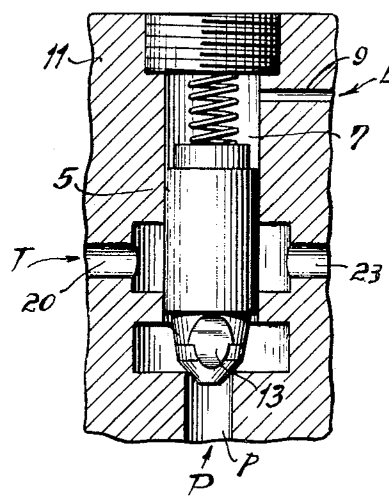
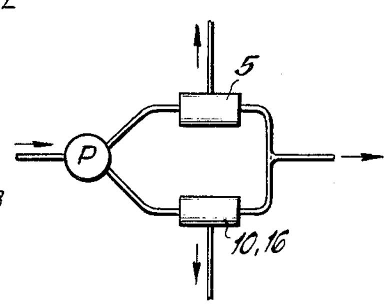


FIG. 3



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SHUT-OFF VALVE AND ASSOCIATED PRESSURE RELIEF MEANS

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This invention relates in general to hydraulic control devices, and in particular to a new and useful device for controlling the feeding of liquid from a pump so that, for operation in which the devices consuming the fluid pressure are switched off, the pump is arranged to feed oil at low pressure.

The hydraulic control device according to the present invention represents an improvement and marked advance over known hydraulic fluid control devices which control or regulate the transmission of hydraulic fluid to fluid utilization devices such as hydraulic motors etc. One example of such a prior art control system is disclosed in the United States Patent No. 2,489,435 issued November 29, 1949 to James Robinson. Other earlier typical prior art devices are referred to and identified in the Robinson patent.

Most hydraulic conduit valves are constructed so that in the position in which the connected consumers are switched off, the pump feeds the oil at low pressure. The circulation of the oil at low pressure is interrupted after the conduit valve has been brought into its working position and the consumer or the consumers thus are connected into the pump line. If one proceeds in this manner, it is known by experience that relatively strong pressure loads or jolts can occur because the consumer, for example, a cylinder or an oil motor, and the parts which are moved with this consumer, very often possess a large mass which, at the instance of switching in, has to be accelerated from a zero speed to the required operating speed. This causes a pressure increase which in turn causes the opening of the safety valve. However, all safety or excess pressure valves have a finite response time during which the oil pressure can rise up to 200% relative to the adjusted operating pressure. These oil jolts whch are possible during the switching of the device have a very serious and damaging influence on the entire plant.

It has been attempted to reduce these pressure jolts or surges thereby that the control edges in the conduit valve are constructed so that first the connection from the pump to the consumer is opened and that only thereafter the circulation at low pressure is closed. Such a construction is generally designated as "negative covering." By using such an arrangement, it is true that the pressure jolts are prevented if the conduit valves are switched in a slow manner. However, if the valves are actuated in rapid manner, then very high pressure jolts will still take place because the response time of the excess pressure valve is greater than the switching time of the conduit valves. Further, such "negative cover" has the disadvantage that charged consumers may operate in a reverse manner since, in a condition of negative cover, the consumer presses its oil back into the pump line and from there into the low pressure circulation which has not been closed as yet.

Another known embodiment for obtaining low pressure circulation resides in the use of an excess pressure valve and in providing the control line with a branch off between the valve pistons and this valve. This branch off is separated from the remaining oil carrying lines of

the conduit valves and acts as a control line which is influenced by the movement of the pistons of the conduit valves in such a manner that in the zero or center position of the pistons said control line has a free discharge into the discharge line but, however, will be closed when the pistons of the conduit valves are displaced from the center position. The action or effect which is obtained in this manner is an opening of the excess pressure valve in the center position of the conduit valves and the closing of the excess pressure valve when the conduit valves are displaced from the center position. Such an arrangement has several disadvantages. The excess pressure valve can no longer be used as a safety valve for the consumers, which consumers during rest position, that is, when the conduit valves are in the center position, are influenced by extraneous forces, for example, by earth working machines, because the excess pressure valve is opened in the center position of the conduit valve in order to produce the low pressure circulation. Again, pressure jolts will take place when the low pressure circulation should be closed by displacement of the conduit valves. The reason for this is that at the instant of the closing of the control lines through the pistons of the conduit valves, the piston of the excess pressure valve closes rapidly, however immediately has to be opened again since, as previously mentioned, the excess pressure valve, during the starting procedure, has to open for a short period of time. The mass of the valve piston, therefore, has to be accelerated in counter direction. Further, a time delay occurs between opening of the pre-control valve and opening of the piston of the excess pressure valve so that the excess pressure valve is closed for a short period of time. Both these characteristics result in pressure jolts. Generally, however the movement of the piston of the excess pressure valve is effectively softened or dampened which, on the other hand, has the disadvantage that there will occur a considerable time delay between the switching of the conduit valves and the interruption of the low pressure circulation. For magnetic valves which switch rapidly, such an arrangement is therefore not at all advantageous.

From the above, it is clear that the use of a pre-control excess pressure valve is not a suitable solution for the functioning of the low pressure circulation.

In order to prevent these disadvantages, the invention proposes to provide a separate blocking member between pump line and discharge line for the low pressure circulation. This separate blocking member is situated parallel to the built-in excess pressure or safety valve and is constructed as a piston which is charged on both sides via an axially extending throttle bore. One side of the piston is charged directly by the pump pressure while the other side is charged by the pressure behind an axial throttle bore and additionally is charged by the force of a closing spring. The spring space is connected with a control line which, upon displacement of the pistons of the conduit valves away from the center position, is closed while in the center position of all the pistons of the conduit valves, flow into the discharge is possible.

In the drawings:

FIG. 1 is a longitudinal section through the control device;

FIG. 2 shows a control valve according to FIG. 1 on enlarged scale;

FIG. 3 shows an arrangement of a control valve and of a safety valve between the pump and the tank line in parallel arrangement.

As shown at FIG. 1, three valve bodies, or blocks, 11, 14 and 15 are aligned together by suitable securing means together with an end cover member 12.

The valve block 11 includes therein the chambers, or bores, **7** and **10** which, respectively, serve as the chambers for a pressure valve and a safety valve.

The pressure valve is comprised of: the chamber **7**; the hollow piston, or valve closure element, **5** within chamber **7**; the spring **8**, which normally biases the piston **5** to the position shown in FIG. 1. As shown, the nose portion of the hollow piston **5** has a small bore **6** therethrough which defines a passage between the chamber **7** and a bore *p*; the bore *p* terminating in a side of the valve body **11** at an inlet port P.

The safety valve is comprised of: the chamber **10** and the spring-biased piston, or valve closure element, **16** which is within the chamber **10**. The piston **16**, being spring-biased, is normally in the position shown in FIG. 1; i.e., blocking or closing communication between the chamber **10** and the bore D; the bore D extending from valve block **11**, through valve block **14**, to the valve block **15** as illustrated.

Also, the valve block **11** has therein the bore **20**. One end of the bore **20** terminates in a port communicating with the chamber **7** of the pressure valve; the opposite end of the bore **20** being terminated in the port T in the side wall of the block **11**. Also, extending between the bore **20** and the chamber **10** and defining a communicating passage therebetween is the bore **21**. As shown, the bore **22**, which is in line with the bore **21**, communicates with th chamber **10** at the opposite side. The bore **22**, thereafter, extends through the blocks **11**, **14** and **15** where the bore **22** communicates with the bore **24** in the end cover **12**.

Also, another bore **23** runs from a port communicating with valve chamber **7** through the blocks **11**, **14** and **15** where this bore **23** communicates with the bore **24** in the end cover **12**.

The bore **9**, as shown, has one end thereof in communication with the valve chamber **7** and runs therefrom through the blocks **11**, **14** and **15**, through the end cover **12** to the port L in the side of the end cover **12**.

As shown, the valve blocks **14** and **15** serve to house the control or conduit valves which are designated, generally, by the reference numbers **3** and **4**. The control valves, **3** and **4**, are of the so-called spool or slide-type.

In the valve block **14** the control valve **3** is comprised of a longitudinal chamber having situated therein the piston rod, or slide, **1** which, as shown, has a number of large diameter spools such as **1***a*. Also, as shown, there is provided a biasing, or centering, spring **1***f* at one end of the slide rod **1**. This spring **1***f* normally maintains the rod **1** and its associated spools **1***a*–**1***e* in the centered position shown at FIG. 1. The longitudinal chamber of the control valve **3** is, as shown at FIG. 1, in communication with the bore sections **9**—**9**, **23**—**23**, D—D, and **22**—**22**; the aforementioned bore sections being in communication via the longitudinal chamber of control valve **3**.

Similarly, in the valve block **15** the control valve **4** is comprised of another longitudinal chamber having the piston, or slide, rod **2** and the associated large diameter spools **2***a*–**2***e* situated therein. The biasing, or centering, spring **2***f* normally maintains the slide rod **2** and spools **2***a* in the centered position shown in FIG. 1; i.e., said longitudinal chamber defining a passage between the bore sections **9**—**9**, **23**—**23**, and **22**—**22**. Also, as shown, the bore section D can communicate with the longitudinal chamber of control valve **4**.

In the enlarged section view of FIG. 2, the nose portion of the piston **5** of the pressure valve has a suitably contoured throttling surface **13**. By providing the surface **13** on the piston's nose there is ensured a controlled gradual, rather than a sudden or abrupt, opening cross section defined between the bore *p* and the bores **20** and **23**. Also, by virtue of the throttling surface **13** when the piston **5** is moving into its closure position (FIGS. 1 and 2) the opening cross section between the bore *p* and bores **20** and **23** does not suddenly or abruptly decrease; rather the cross sectional opening decreases exponentially.

Also, as shown in FIG. 1, each control valve unit **3** and **4** includes in its respective valve block **14** and **15**, the ports, or passages, **25**–**26** (block **14**) and **27**–**28** (block **15**). These ports, or passages, **25**–**28** are connected by conduits extending to pressurized fluid utilizing elements (not shown), such as hydraulic motors, etc.

A conduit (not shown) connects the port L with a tank (not shown) containing a supply of hydraulic fluid, such as oil. Another conduit (not shown) connects the port T with the supply tank. Also provided is a pump which draws oil from the supply tank and feeds it into port P to the bore *p*.

Operationally, the pump delivers pressurized oil from the tank to the port P and bore *p*. However, when the slide valves **3** and **4** have their slide rods, or pistons, **1** and **2** centered as shown in FIG. 1, the oil consuming devices connected with the ports, or channels, **25**–**28** cannot receive pressurized oil because these channels **25**–**28** are blocked by the spools **1***a*, **1***b*, **2***a* and **2***b*. But, oil passing through bore **6** of the pressure valve's piston **5** passes into the valve chamber **7** and from this chamber enters and passes through bore **9** to the port L. From port L the oil returns by gravity to the supply tank.

If, however, the slide rods **1** and **2** are moved off their normal center position pressurized oil passes through the bore D into the ports, or channels, **25**–**28** to supply oil to the consuming devices.

It is well known that, upon starting up, the oil pressure for a very short period will build up to a very high value, which pressure often may be more than two hundred per cent (200%) above the normal operating pressure. Due to such pressure surges, objectionable flow velocities occur. According to the present invention such pressure surges are substantially eliminated. Accordingly, the pressure valve piston **5** is arranged between the discharge port T and the input port P. Also, the pressure valve **5** is situated in parallel with the safety valve **10**, **16**. Also, as hereinbefore stated, the nose of the pressure valve piston **5** has the throttling contour surfaces **13** which permit an exponential change of the cross sectional flow area. As a result, the pressure in the input bore *p* rises exponentially during closure of the piston **5**. In addition, the nose of the piston **5** includes the throttling bore **6** which is so dimensioned that the safety valve piston **16** will already have opened before the pressure valve piston **5** is fully closed because the pressure valve piston **5** and the safety valve piston **16** are parallelly arranged in accordance with the invention.

Thus, pressure surges during start-up (i.e., when the consuming devices demand pressurized oil initially) are prevented because of the overlapping coaction of the safety valve and the pressure valve.

Moreover, the safety valve will open after the pressure in the system, upon start-up, has reached a predetermined value. This takes place at a time when the throttling surface **13** of the pressure valve piston **5** has not fully reached its closure point and the opening of the safety valve occurs for a very short duration of time only.

When one or both of the spool valve **3** and **4** are switched, the control oil line **9** is blocked and the piston of the pressure valve **5** closes the low pressure circulation under the action of the spring **8**. This closing procedure can be timely fixed by choice of a suitable diameter of the bore **6** of the valve **5**. In this manner, it is obtained that the connection from the pump line P to the tank line T does not occur suddenly, but within a predetermined period. At the same time, by providing throttle surfaces **13** in the pressure piston or valve **5** (see FIG. 2), it is assured that the opening cross section does not suddenly decrease, but decreases in dependence on the path in form of an exponential graph when the pressure piston closes. This causes that the pressure in the line P continuously and not impact-like will build up to a magnitude when the valves **3** and **4** are rapidly switched, at which magnitude the safety valve **10**, **16** will respond while the pressure piston **5**, however, will not yet be completely closed. During this entire procedure, the pump line is thus never completely closed. Either the pressure valve is opened or the safety valve is opened and, in fact, during a particular instance, both are opened. The result is a soft dampened and impact-free start, even if the conduit valves are switched rapidly.

If the piston **1** or **2** is displaced from the center position as shown, then the control line **9** is blocked again so that no flow from P via the axial throttle bore **6** can take place. For this reason, there prevails the same pressure on both sides of the piston **5** which piston is displaced into its closing position by the spring **8**. In this manner, the low pressure circulation is closed and the pressure oil is now available to the consumers which are connected to the conduit valves **3** and **4**. The valve **16** in the valve block **11** opens then when the pressure in the system has reached the predetermined value by corresponding displacement of the piston **5** so that during a very short moment, the excess pressure or safety valve has already opened and the piston or pressure valve **5** has not yet been closed. Through this overlapping of the two movements, of the valve **16** within the valve block **11** and of the piston **5** together with the explained constructions of the control surface and of the axial throttle bore **6**, pressure jolts are safely prevented during starting of the arrangement.

It should be understood that, with respect to each valve **3** or **4**, one of the chambers **25** and **26** or **27** and **28** constitutes a pressure supply chamber connected to the consumer and the other of the two chambers constitutes an exhaust chamber connected to the consumer. Taking the particular example of operation of valve **3** by depressing plunger **1**, spool **1***d* will block the bore **9**. Spool **1***a* will establish connection between chamber **25** and high pressure bore D. Spool **1***b* will block chamber **26** from high pressure bore D, and spool **1***e* will block chamber **26** from return line **22**. As plunger **1** is released, spool **1***e* will establish communication between chamber **26** and return line **22** before spool **1***b* blocks this communication. Thus, during this particular interval, the exhaust chamber **26** is connected to the return line **22**. The same type of operation takes place with respect to operation of valve **4** by pressing plunger **2**.

What is claimed is:

1. In combination, a spool valve having a body with a first bore having an inlet adapted to be connected to a high pressure source of fluid and an outlet adapted to communicate with a fluid operable device; an independently operable spool member in said bore having a neutral position and constructed and arranged to stop flow through said inlet to said outlet when in said neutral position; a fluid pressure operated safety valve in communication on opposite sides thereof with said inlet and a region of low pressure and adapted to establish communication between said inlet and region of low pressure when pressure in said inlet exceeds a predetermined amount; a second bore in said body adapted to communicate with said region of low pressure and with said inlet; and means associated with said second bore to control flow through said second bore; said means comprising, a fluid pressure operated pressure valve including a passage connected at one end to said inlet and at the other end to an enlarged diameter chamber in communication with said region of low pressure; a valve seat in said chamber adjacent said passage; a piston in said chamber having a valve thereon adapted to cooperate with said valve seat, said piston being biased to move said valve to open position by pressure in said inlet and to closed position by pressure and spring means in said chamber; a restricted passage through said piston and valve establishing communiction between said inlet and said chamber; means associated with said spool member adapted to shut off communication between said chamber and said region of low pressure when said spool member is moved from its neutral position and rendered ineffective when said spool member is in its neutral position; a third bore in said body having one end in communication with said chamber adjacent the valve seat and the other end in communication with said region of low pressure; said valve being adapted to shut off flow of fluid from said inlet to said third bore when it is biased to its seat.

2. The combination, as in claim **1**, wherein the valve on the piston is provided with control surfaces which are so contoured that the fluid pressure coming from said source, during the closing procedure, increases along a predetermined curve.

3. The combination, as in claim **1**, wherein said restricted passage is so constructed that the closure movement of the piston cannot exceed a predetermined speed.

References Cited by the Examiner

UNITED STATES PATENTS

2,247,140	6/1941	Twyman	60—97
2,267,177	12/1941	Twyman	60—52
2,318,851	5/1943	Griffith	60—97
2,319,551	5/1943	Linden	60—97 XR
2,574,851	11/1951	Wagner	137—625.3

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