Sept. 4, 1945. W. A. PATTON 2,384,394

FLOW CONTROL VALVE

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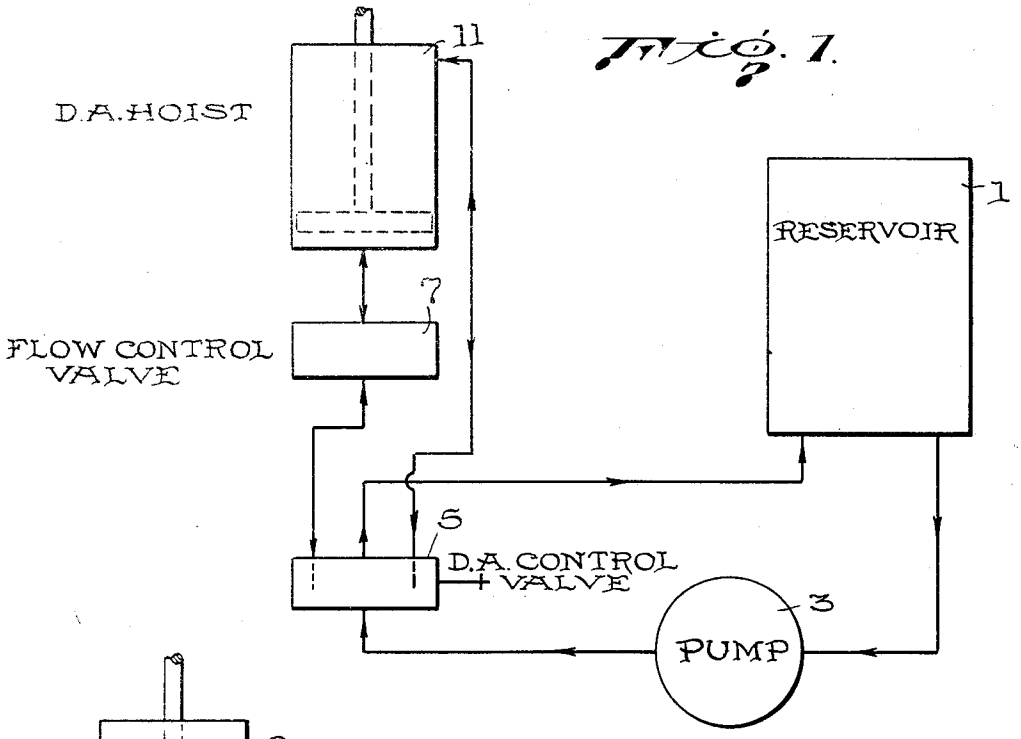


Fig. 1.

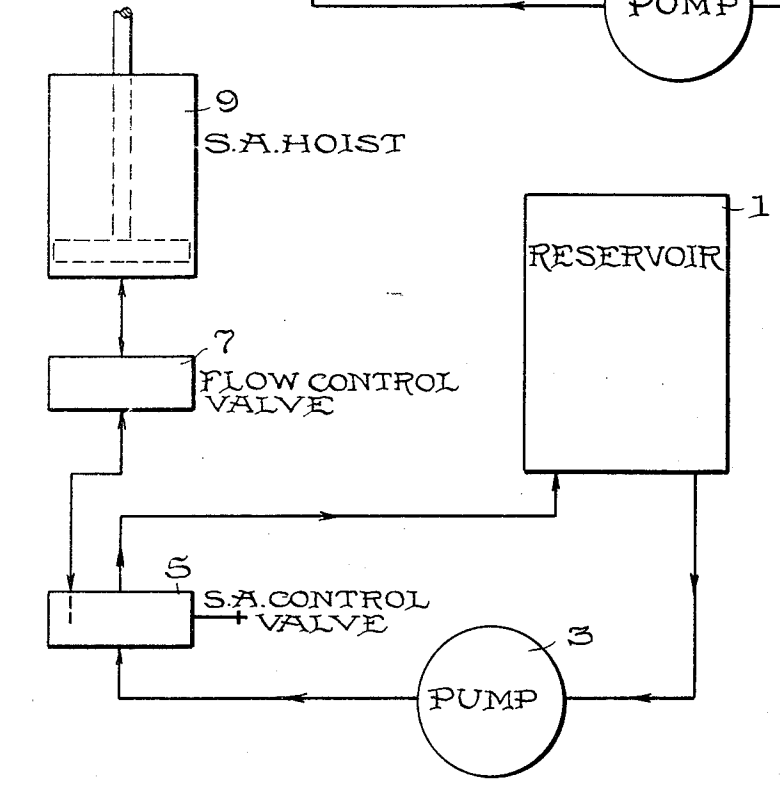


Fig. 2.

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Fig. 5.

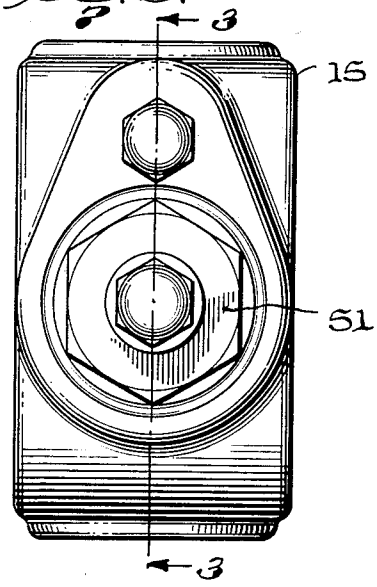


Fig. 4.

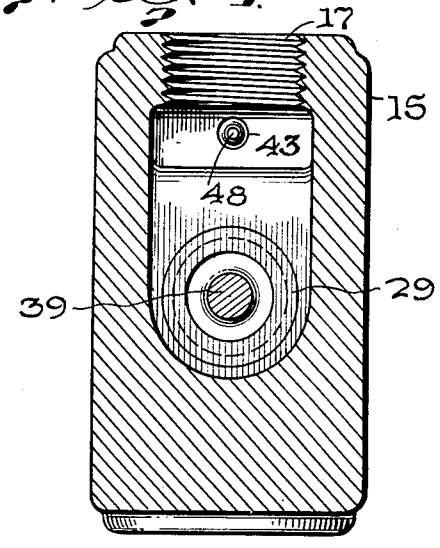


Fig. 3.

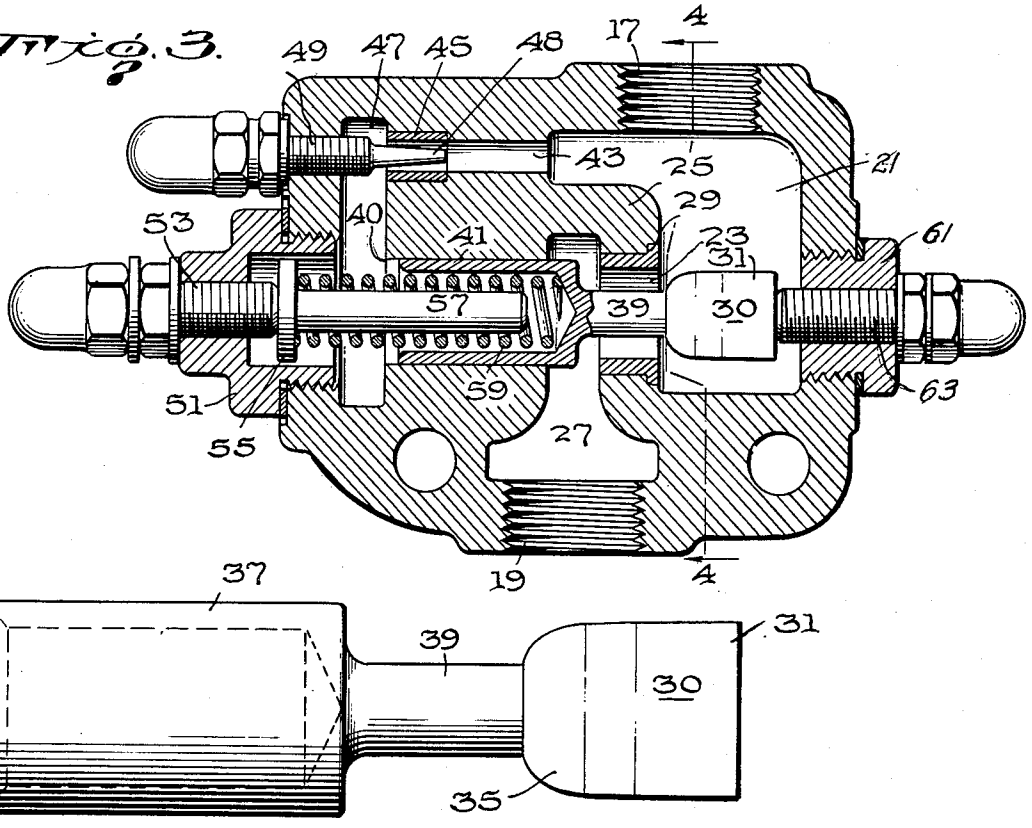


Fig. 6.

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UNITED STATES PATENT OFFICE

2,384,394

FLOW CONTROL VALVE

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Application September 28, 1943, Serial No. 504,156

12 Claims. (Cl. 138—43)

This invention relates to a flow control valve, and more particularly to a pressure regulating and control valve for use in hydraulic fluid systems.

An object of the invention is to produce a tapered plug reducing valve of the type useful in controlling fluid pressure to and from single and double acting hoists. In this connection the term "hoists" is used in defining a single or double acting power cylinder projected and/or retracted by means of a hydraulic fluid under pressure, such as oil.

A further object of the invention is to construct a fluid regulating the pressure reducing valve whereby fluid pressure may be passed therethrough in an unobstructed manner, whereby the hoist is rapidly raised, and for controlling the lowering of the piston, regardless of the weight of the load being handled, at a uniform rate of speed. The present flow controlling valve provides a regulating arrangement which permits the lowering of any load within the capacity of the hoist at approximately a uniform rate.

A still further object of the invention is to provide a flow controlled reducing valve having an adjustable orifice that is maintained at a size dependent on the flow of fluid therethrough as the hoist is being lowered whereby an automatic compensation is secured for variable loads.

Flow control valves of this general character have been proposed in the prior art where the lowering speeds of the hoist for variable weight loads have been controlled by throttling, that is, by having the operator open a line leading from the hoist to a reservoir, but here the load speed depends on the travel of the fluid release or operating plunger, and this proposal is open to the objection that the operator may open the port too far for safety of the load being lowered. Other types of valves of the prior art are in the majority of cases limited to lowering through a fixed orifice whose size is based on the heaviest load to be encountered. When lighter loads are used with the above fixed orifice the lowering time is increased. This characteristic is undesirable. If the flow of fluid to raise the hoist is also passed through the above fixed orifice it will be found that the power requirements for raising will be higher than if the flow were not restricted. This too is undesirable. In some of the prior valves an auxiliary passage controlled by a check valve provides unrestricted flow to the hoist for raising while still providing for restricted lowering. This eliminates the latter undesirable feature, but requires a more complicated circuit and a multiplicity of parts. This present valve construction permits a uniform rapid or slow lowering speed regardless of the weight of the load being lowered, provides for unrestricted raising with resulting minimum power requirements and allows for simplified construction with a minimum of parts.

In addition to the novel features of valve combination, the invention includes a valve plunger per se, which is useful for fluid control in valves other than fluid controlling or reducing valves to which the invention is primarily directed.

In the drawings,

Figs. 1 and 2 show diagrammatic layouts of the flow control or reducing valve inserted in single acting and double acting hoist systems;

Fig. 3 is a horizontal section partly in cross-section of the flow control or reducing valve taken on line 3—3 of Fig. 5;

Fig. 4 is a vertical section taken on line 4—4 of Fig. 3 in the direction of the arrows;

Fig. 5 is an end plan view showing the external adjusting elements of the valve; and

Fig. 6 is a side elevation showing the valve plunger per se, and particularly the formation of the conical-spherical surface formed on one fluid controlling end of the valve plunger.

In Fig. 1 the present invention is illustrated in combination with a fluid flow system including a double acting hoist and control valve, while in Fig. 2 the invention is shown in connection with a single acting hoist and control valve. In both of these systems it will be observed that the fluid from reservoir 1 is drawn therefrom by a pump 2 and passed through a suitable hydraulic control valve 5 and thence through the flow regulating valve 7 which is the subject of the present invention. After passing through the flow control valve 7 the fluid passes to a single acting piston and cylinder arrangement or hoist 9 or to a double acting hoist arrangement 11 for lifting and lowering some desired object or apparatus. While the present invention has its broad application in controlling the raising and lowering fluid passing to any type of a hydraulic hoist, the invention has found particular aptitude in controlling the hoists used on lifting trucks.

In Fig. 3 the specific valve structure is shown in detail. Here the flow controlling valve member comprises a casing 15 having an inlet port 17 connected by suitable fluid pressure piping to a single or double acting control valve 5. The opposite side of the flow control valve casing 15

is provided with a port 19 leading to a single or double acting hoist.

Interiorly of the valve casing 15 the port 17 leads into an enlarged chamber 21 connected by a fluid passage 23 formed in the valve body portion 25 and thence through a right angle passage 27 opening into the port 19 connected to the hoist. The longitudinal fluid passage 23 joining the chamber 21 and fluid passage 27 is lined with a hard metal bushing or ferrule 29. This bushing has a base diameter very slightly larger than the maximum diameter of the skirt of the conical-spherical plug 31 that forms a part of the valve plunger 30.

The valve plunger is illustrated in detail in Fig. 6 and comprises an elongated body having a progressively increasing spherical-conical plug section 31 previously mentioned. The conical-spherical section 31 of the plug is joined to an enlarged diameter hollow cylindrical portion 37 by a reduced diameter central extension 39. It will be observed that the outside diameter 49 of the enlarged hollow cylindrical section 37 is greater than the diameter of the rear edge of the conical-spherical portion 31 of the plunger.

From enlarged view 6 it will be observed that the conical-spherical plug section 31 of the sliding valve is gradually tapered from its forward curved face portion 35 to its rearward skirt portion 31. The extreme rear diameter of the conical-spherical plug is very slightly smaller than the diameter of the hardened orifice bushing 29.

The enlarged cylindrical portion 37 is mounted in and adapted to slide within a bore 41 formed in the solid valve body 25. The valve body 25 is also provided with a second reduced diameter bore or passage 43 lying in spaced parallel relation to the plunger bore 41 and joining a lateral extension of the main fluid passage 21 adjacent the port 17. Reduced diameter passage 43 is fitted with a hardened bushing 45 at the end of the passage terminating in a transverse fluid passage 47 which extends between and joins the bores 41 and 43. The effective diameter of passage 43 is controlled by the position of a tapered valve pin 48 positioned in bushing 45 and having a shank 49 which is screw threaded through the end of the valve casing and terminating exteriorly of the casing in an adjusting means and lock nut arrangement as is conventional in the art.

The outer end of bore 41 is enlarged in diameter throughout the portion extending between the transverse fluid passage 47 and the exterior of the valve casing for the reception of a threaded plug 51 having an adjusting screw 53 extending therethrough and terminating exteriorly in an adjusting head and lock nut arrangement. The inner end of the adjusting screw 53 bears against the enlarged head 55 of a guide rod 57 positioned within a coil spring 59. This coil spring is positioned within the hollow of portion 37 of the valve plunger and is held between the inner end of said hollow and the under side of the enlarged head 55 of the guide rod 57. It is obvious that by regulating the position of adjusting screw 53 that the tension of the spring 59 may be readily adjusted to vary the pressure exerted on the valve plug. Under the action of this spring the entire valve plunger is moved to the right until the end 31 contacts the adjusting stop screw 63 threaded in plug 61 which in turn is threaded into the casing directly behind the end of the plunger. Adjusting screw 63 is provided with a lock nut arrangement on its exterior end.

In the operation of either the single or double acting systems shown in Figs. 1 and 2, when the fluid control valves 5 are operated to raise the hoists, hydraulic fluid from the pump is introduced through the port 17 and passes freely through the valve casing and outwardly to the hoist through port 19. Fig. 3 shows the position of the parts of the flow regulating valve when the hoist is being raised. Fluid from the pump 3 passes inwardly through port 17 into enlarged chamber 21, through passage 23 and outwardly through lateral passage 27 and port 19. If it so happens that the valve plunger 30 is not in the fully opened position, as shown in Fig. 3, the incoming fluid pressure passing through passage 43 around tapered valve pin 48 into lateral passageway 47 and thence into the rear cylindrical bore or hollow formed within enlarged diameter portion 37 of the valve forces the valve plunger 30 to the right until end 31 abuts the screw 63 to maintain fluid passage 23 fully open.

When the control valve 5 is positioned to lower the hoist the flow of oil through the valve is reversed. Oil from the hoist enters the valve at port 19, flows through passages 27, 23 and 21 and leaves the valve at port 17, returning to the control valve 5 and then back to the reservoir. The oil entering port 19 is under pressure due to the load on the hoist and acts to move plunger 30 to the left because of the differential in area between portions 37 and 31. This movement is opposed by spring 59 which has been designed to take care of any reaction caused by the load on the hoist acting upon the before-mentioned differential in area of the ends of plunger 30 up to the full capacity of the hoist. Movement of plunger 30 to the left causes the conical-spherical plug 31 to enter passage 23 thereby causing a restriction in the flow orifice at the right end of passage 23. Since the volume of liquid flowing through an orifice is affected by the size of the orifice as well as by the pressure causing the flow, the longitudinal contour of plug 31 is such that a given movement to the left of plunger 30 by pressure causes a corresponding restriction of orifice size so that the volume of flow through the orifice is a constant regardless of the pressure causing the flow. As a result of the unique construction of plunger 30 as just described it is possible to have hoists 9 or 11 lower at a constant rate of speed regardless of whether they are lightly or heavily loaded. The construction and operation of this valve mechanism as already noted assures the flow orifice being wide open during the raising of the hoist and thus no appreciable restriction to flow is encountered during this phase of operation.

The purpose of adjusting screw 63 is to control the initial drop of the hoists by allowing for adjustment of the initial opening or orifice between passages 23 and 21. It is evident that when the control valve is positioned for lowering an initial momentary drop will be experienced by the hoists until plunger 30 reaches its balanced position at which time regulated lowering will be accomplished. Under ordinary circumstances plunger 30 would be adjusted to the left by means of screw 63, until a build up in pressure, when the valve is in the raise position, indicates that a restriction is being created between passages 21 and 23. The amount of this opening would then determine the amount of initial drop in the lowering position. Should this drop

be too great for existing conditions it can be lessened by further adjustment of plunger 30 to the left thus creating a further restriction. It is evident that when the initial drop must be less than normal a build up in pressure will result in the raise position. While this is not desirable as mentioned previously it may be the lesser of two evils depending upon conditions. Use of adjustment screw 63 also allows the present valve to operate successfully over a fairly large range of volume.

The headed rod 57 acts as a guide for spring 59 and also as a stop limiting the movement of plunger 30 to the left. This latter function while not absolutely necessary is an added precaution against overtravel of plunger 30 which might result in jerky or jumpy lowering of the hoists by completing shutting off flow through the orifice.

The rate of speed at which the hoists lower is governed by the setting of spring 59 which in turn is governed by the position of adjusting screw 53. Turning screw 53 inwardly increases the tension on spring 59 which decreases the amount of travel of plunger 30 for any given pressure in passage 27 thereby increasing the lowering speed of the hoists by allowing a larger orifice opening. Turning screw 53 outwardly releases the tension on spring 59, allows plunger 30 to travel farther to the left for a given pressure in passage 27 thus causing a greater restriction in orifice size which in turn results in slower lowering of the hoists.

Since passages 47 and 43 are always full of hydraulic fluid it is evident that any movement to the left of plunger 30 will cause a displacement of said fluid into passage 21. By governing the rate of flow of this fluid by means of a tapered valve pin 48 positioned inside of bushing 45 the speed at which plunger 30 reacts to the pressure in passage 27 is controlled. Thus any jumpy or jerky action which might result from sudden impulses or surges is cushioned with the result that even, steady lowering of the hoists is obtained. Because the hydraulic fluid in passage 47 has a definite function when the hoists are being raised and also when they are being lowered it is essential that pin 48 never entirely close off passage 43 if the valve is to function properly.

I claim:

1. In a fluid pressure flow control valve adapted to remain fully open to flow in one direction and to control the rate of flow in the other, a housing provided with two fluid chambers joined by a restricted passage, a sliding valve plug controlling the flow of fluid through said passage, an adjustable spring loading means engaging and normally holding said valve plug in open position and a branch passageway leading from one of said chambers to the end of the valve plug engaged by said adjustable spring means to apply pressure thereto.

2. In a fluid pressure flow control valve adapted to remain fully open to flow in one direction and to control the rate of flow in the other, a housing provided with two fluid chambers, a sliding valve plug separating said chambers, a cavity in one end of said valve plug, an adjustable compression spring positioned therein normally holding said valve plug in open position, and a branch passageway leading from one of the said chambers to the said valve cavity.

3. In a fluid pressure flow control valve, a housing provided with ported chambers, a partition separating said chambers, said partition having an orifice joining said chambers, a sliding valve member having a slightly tapered conical-spherical plug controlling the area of said orifice, a connecting portion passing through the orifice and an enlarged diameter cylindrical portion, a spring behind the enlarged diameter cylindrical valve portion and normally holding said valve plug in open position whereby fluid may freely flow therethrough in one direction, and a restricted fluid passage leading from one of said chambers to the rear of said enlarged diameter cylindrical valve portion.

4. A fluid control valve as defined in claim 3 wherein the said enlarged valve member portion comprises a hollow cylinder surrounding the said spring, the inner solid end of said cylinder being reduced in diameter to form said connecting portion for carrying the spaced conical spherical valve plug of smaller diameter than the cylindrical portion, the maximum diameter of the remote end of said tapered conical-spherical valve plug closely approximating the diameter of said orifice.

5. An adjustable fluid pressure reducing valve comprising a housing, means dividing the housing into two compartments, the dividing means having an orifice joining said compartments, a reciprocating valve plug having enlarged diameter end portions and a reduced diameter central portion, one of said enlarged end portions controlling the flow of fluid through said orifice, said valve plug being normally held in open position by a spring engaging one end thereof, means external of the valve housing for adjusting the tension of said spring and a restricted fluid passage leading from one of said compartments to the end of said plug engaged by said spring.

6. A valve as defined in claim 5 wherein the fluid flow in said fluid passage leading from one of the said compartments to the end of the valve plug is controlled by a tapered valve adjustable from without the valve housing.

7. A valve as defined in claim 5 wherein one of the inner adjacent faces of the enlarged end sections of the reciprocating valve plug is of greater diameter and frontal area than the other of said end sections.

8. A valve as defined in claim 5 wherein the inner face of the enlarged end portion having the spring mounted thereagainst is flat and of greater diameter than the inner face of the adjacent enlarged end portion, said latter having a gradually tapered conical spherical face.

9. A valve as defined in claim 5 wherein the valve plug bore and the fluid passage leading from one of the compartments are in spaced parallel relation.

10. A flow regulating valve comprising a valve body provided with two compartments joined by an orifice, a reciprocating valve plunger regulating the flow of fluid through said orifice, said valve plunger consisting of an elongated member having a reduced diameter portion joined to enlarged end portions, the frontal area of one of said end portions adjacent the reduced diameter portion being greater than the other, spring means normally holding said valve plunger in fully open position whereby fluid may freely pass in one direction around the valve end portion of lesser frontal area, the pressure of fluid flowing in the opposite direction forcing the valve end portion of greater diameter to move said valve plunger against the tension of the said spring means and tend to position the end portion of

lesser frontal area in the orifice to restrict the fluid flow therethrough whereby the fluid flow is constant regardless of the pressure causing the fluid flow.

11. A flow regulating valve as defined in claim 10 wherein one of said compartments is in fluid communication at all times with the rear of the valve end of greater frontal area.

12. A flow regulating valve as defined in claim 10 wherein the compartment first receiving fluid when the said valve is in fully open position is in fluid communication at all times with the rear of the valve end of greater frontal area and adjustable flow controlling means in the path of said fluid communication.

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