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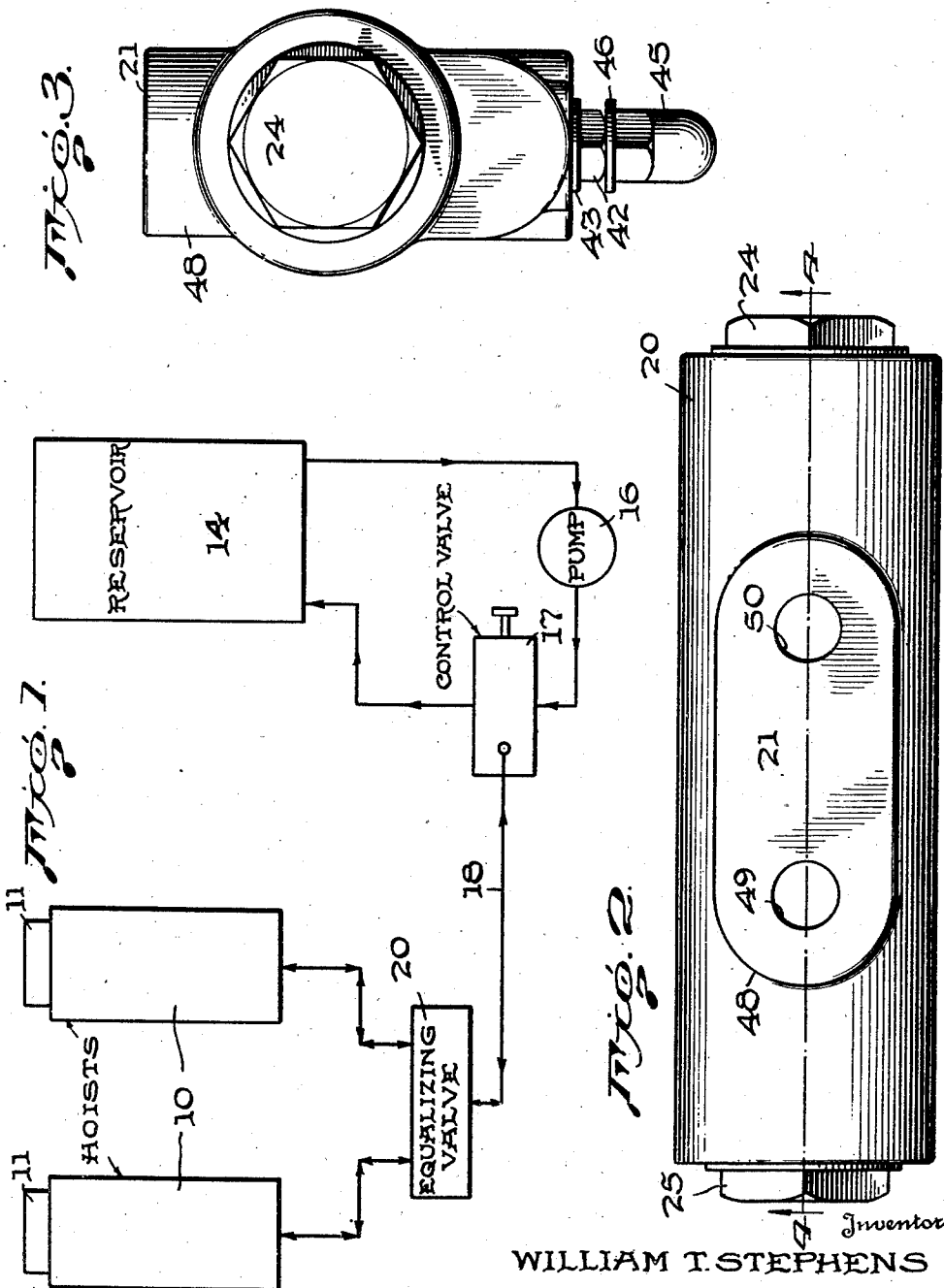
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EQUALIZING VALVE

Filed April 28, 1943

2 Sheets-Sheet 1



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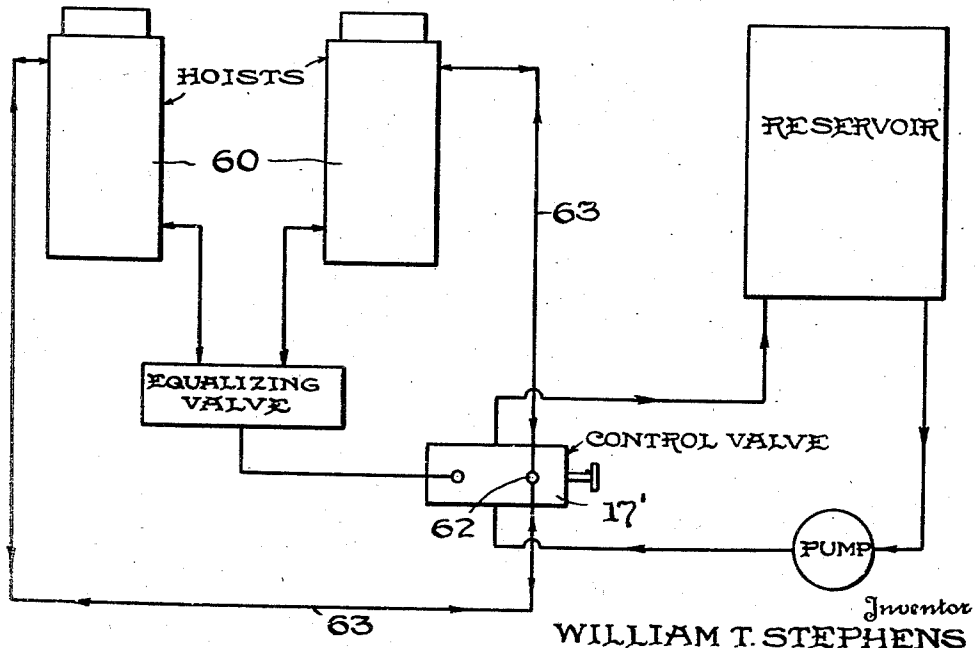
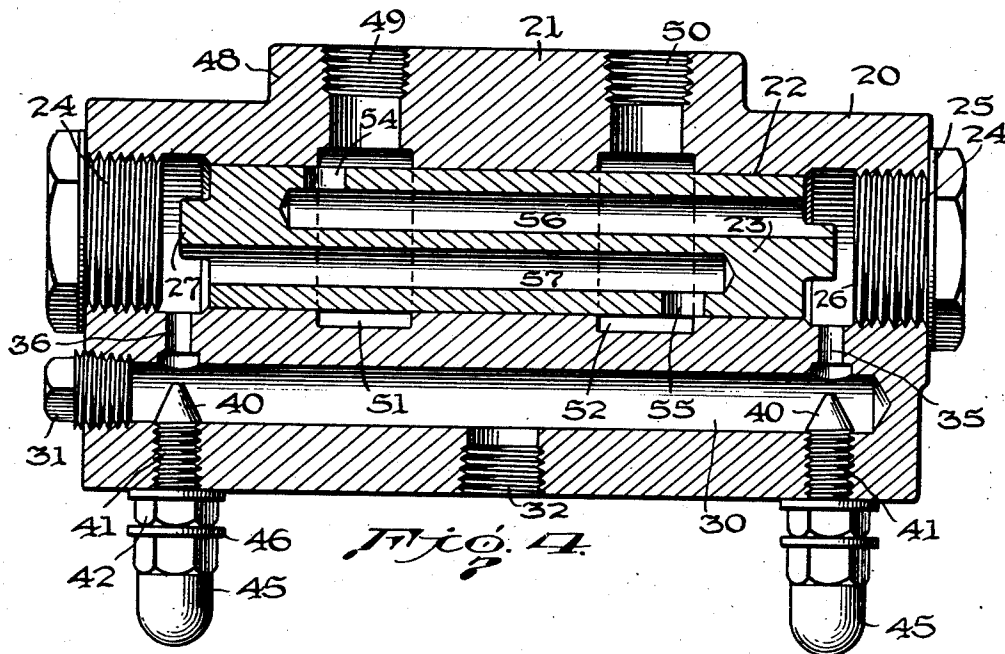
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EQUALIZING VALVE

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This invention relates to valves for hydraulic systems and more particularly to equalizing valves adapted to be interposed between a pair of hydraulic hoists or rams and a reservoir for the fluid used for actuating the same in order to maintain the same rate of motion of the two hoists in spite of unequal distribution of loads thereon.

It is the general object of the present invention to provide a novel and improved equalizing valve of the type described.

More particularly it is an object of the invention to provide an equalizing valve adapted for connection between a pair of hydraulic hoists and a reservoir for the liquid used in operating the same whereby the hoists may be lowered at substantially identical rates despite differences in load on the same.

An important feature of the invention consists in the provision of an equalizing valve having a floating piston arranged for the control of fluid passages in accordance with pressures exerted on the opposite ends of the same whereby uniform quantities of liquid are discharged from two sources in spite of differences in pressure existing at these sources.

A further important feature of the invention consists in the provision of an equalizing valve containing means responsive to pressures of fluids from two hoists to provide simultaneous longitudinal flow in opposite directions through a balanced piston for controlling the rates of flow in accordance with the pressures.

Still another important feature consists in the provision of an equalizing valve having a floating piston which makes use of all of the fluid flow from two hydraulic independent hoists for independent reaction against the opposite ends of the piston to control the quantity of liquid discharged from both hoists so that they can be lowered at identical rates.

At still further important feature of the invention consists in the arrangement of an equalizing valve having a floating piston, each end of which is exposed to the pressure of fluid flowing from a separate hydraulic hoist, the piston being in control of ports for regulating the fluid flow from the hoists and being arranged to automatically move to such a position as to restrict one or the other of the ports in accordance with the pressures on the ends of the piston so that fluid at the higher pressure flows through the more restricted port at the same rate as the fluid of lower pressure flows through the more enlarged port whereby hoists unequally loaded may be lowered at the same rate.

Other and further objects and features of the invention will be more apparent to those skilled in the art upon a consideration of the accompanying drawings and following specification wherein

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are disclosed a single embodiment of the invention and two illustrative uses of the same with the understanding that such changes and modifications may be made therein as fall within the scope of the appended claims without departing from the spirit of the invention.

In said drawings:

Fig. 1 is a schematic diagram of a dual hoist arrangement making use of an equalizing valve in accordance with the present invention, the hoists being of the single acting type.

Fig. 2 is a top plan view of the equalizing valve;

Fig. 3 is an end view of the same;

Fig. 4 is a vertical central section taken longitudinally on line 4-4 of Figure 2; and

Fig. 5 is a view similar to Figure 1 but showing the valve in use with double acting hoists.

In the use of hydraulic devices for handling loads it is often found that the so called hydraulic hoists or rams have insufficient capacity when used singly or that the requirements for balancing an unwieldy or distributed load are such that a pair of such devices is necessary for the proper manipulation of the same. By hydraulic hoists or rams is meant a simple plunger mechanism in which liquid under pressure causes a piston, plunger or ram to be extended from a cylinder for the purpose of lifting or moving machine parts or loads of material.

When using hydraulic hoists in multiple from a single source of supply of the fluid or oil used for their operation, there arises the problem of equalizing the distribution of the fluid to and from the hoists so that they operate at identical speeds in spite of differences in loading. The equalizing valve of the present invention is constructed for the purpose of assuring uniform flow of hydraulic fluid from two identical hoists. Since these hoists will usually have the same volumetric capacity, uniform flow from the two will provide uniform movement of their plungers or rams.

For a better understanding of the invention a consideration should be had of Figure 1 showing schematically a pair of conventional hydraulic hoists 10, identical in construction and size, each having a lifting and/or lowering ram 11. These, for purpose of illustration and in accordance with the showing of the present invention are preferably mounted vertically, and a single platform, beam or bail is supported jointly by the two rams. Liquid for raising the rams is contained in a reservoir or tank 14 and may be placed under proper pressure for lifting by any suitable form of pump as shown at 16.

A control valve 17 regulates the flow of liquid under the urge of the pump from the tank through the pipe 18 to the chambers of the two hoists 10, and when properly positioned may disconnect the pump from the hoists and associate them di-

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rectly with the reservoir so that the liquid may be returned and the hoists lowered. The control valve and the circuit so far described may be conventional. For the purpose of maintaining uniformity of flow from the two hoists however, the equalizing valve 20 of the present invention is introduced where the pipe 18 branches to deliver or receive fluid from the two hoist chambers 10.

As seen in Figures 2, 3 and 4 this valve comprises a cast housing 21 of irregular shape containing a longitudinal cylindrical bore 22 for the reception of an elongated floating piston 23. For convenience of manufacture the bore 22 extends clear through the housing from end to end. The ends are closed by screw plugs 24 of identical construction, having external hexagonal heads beneath which gaskets 25 are clamped to provide fluid tightness. The inner ends of the plugs are preferably flat as shown at 26 to provide abutments against which the projecting small diameter stops 27 on the ends of the piston may engage to limit its longitudinal movement for a purpose later described.

The lower portion of the housing contains an integral inlet chamber 30 shown as drilled from the left and closed at that end by a conventional pipe plug 31. A tapped inlet port 32 is provided near the center of the bottom wall of the housing to permit liquid from the control valve, by way of pipe 18, to enter the chamber 30 in unrestricted volume or leave the same when the hoists are lowered.

From the chamber 30 connection is had to each end of the bore 22 by way of identical ports 35 and 36. These are of restricted diameter as indicated and have less flow capacity than any other passages or ports, in their normally open position, in the whole valve structure. The bores 35 and 36 are made as large as necessary for the maximum capacity of the equalizing valve but can be adjusted to smaller delivery volumes if desired or necessary for regulating the rate of movement of the hoist plungers by means of the conical plugs 40 forming the ends of screws 41 threaded through the lower wall of the housing and movable to cooperate with the bores 35 and 36 to restrict their capacity. The outer ends of the screws 41 may be conventionally kerfed to receive a tool for adjustment. Lock nuts 42 and gaskets 43 hold the screws in adjusted position. To prevent leakage around the threads of the screws as they pass through the nuts 42, cap nuts 45 and gaskets 46 are provided as shown.

The boss 48 formed on the upper portion of the housing is drilled to form ports 49 and 50 to accommodate pipes or tubes leading to the two hoists. These ports communicate respectively with annular enlargements 51 and 52 of the piston bore 22. These enlargements are of limiting longitudinal extent and are appropriately spaced longitudinally of the bore to cooperate with a pair of radial piston ports 54 and 55 for fluid flow regulation. Each of the piston ports communicates with a longitudinal bore 56 or 57 in the piston, the first of these bores opening through the right hand end and the second through the left hand end of the piston. There is a slight overlap between the cylinder wall adjacent the outer edge of each annular chamber and its corresponding piston port, as shown, when the piston is in the central position, but the exposed areas of the piston ports, in this position of the latter, are of greater flow capacity than the restricted ports 35 and 36. As the piston is moved from its central position one piston port is enlarged to its

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maximum capacity while the other is gradually reduced in flow capacity, but in no case can a piston port be completely closed off, for prior to the existence of this condition, the corresponding stop 27 at the proper end of the piston comes in contact with the inner end of the cylinder plug to limit the piston movement.

To understand the operation, it is assumed that the hoist plungers are in an elevated position, which may have been effected by proper operation of the control valve. The platform or other means supported by the hoist plunger is then loaded with material to be lowered by means of the hoists, which can be of such length as to lower loads for distances up to 10 or 15 feet. The rate of lowering of the load may be controlled by the setting of the control valve 17 which regulates the return of liquid from the hoists to the reservoir. In the event that the hoists are unevenly loaded the normal tendency would be for one hoist to lower more rapidly than the other which is undesirable from any number of standpoints. For instance, the load might be unduly tilted or the hoists might be canted into an undesirable position. The equalizing valve therefor takes control and in the manner to now be described insures a uniform return of liquid from both hoist chambers to the reservoir so that lowering of the two hoists is at the same rate in spite of unequal loading.

For the sake of the present discussion it will be assumed that the greater load is applied to the left hand hoist in Figure 1. The control valve 17 is now opened and preferably to its full extent. Under these conditions and bearing in mind that there is a continual movement of the liquid into the ports 49 and 50 and eventually out through port 32 it will be seen that the restricted apertures 35 and 36 are on the outlet side of the piston cylinder. These determine the rate at which liquid returns to the reservoir, if the control valve is sufficiently wide open, but being of equal diameter the one subjected to the greater pressure would normally pass the greater quantity of liquid. In so doing however, back pressure builds up so that in the right hand end of the cylinder greater pressure will exist than in the left end, because of the greater pressure entering the port 49, passing through the piston port 54 and longitudinal passage 56 to gain access to the restricted port 35. The pressure in the left end of the cylinder and exerted on the left end of the piston will be lower because of the lower pressure on the right hand hoist. Here it should be noted that each hoist exerts pressure on the piston at the opposite end of the valve by virtue of the crossed arrangement of the longitudinal passages in the piston.

The piston will be unbalanced because of the greater pressure on its right hand end and will move toward the left end. In so doing it will cause greater overlap of piston port 54 with the cylinder wall beyond the annular enlargement 51 thus restricting the flow from the hoist supporting the greater load. This condition takes place instantly when lowering is commenced and the piston finally and rapidly assumes such a position that flow through port 54 at its greater pressure is identical in quantity with flow through port 55 at its lower pressure thereby insuring that the two hoists will be lowered at an identical rate as desired.

It will be appreciated that if the other hoist in a subsequent operation has a greater load that the piston will act in the opposite manner and

handle this situation in the reverse of the manner just described. Since the equalizing condition just described is assumed very rapidly and with what may be termed "hydraulic damping" there is no jumpy motion of the hoist or teetering of the loading on the lowering platform.

The circuit shown in Figure 1 can be simplified by the elimination of the pump, where no load is to be lifted by the hoists except that of the empty platform, in which event springs may serve to extend the hoist plungers, exerting sufficient force to draw in the oil from the reservoir through the control valve without the use of the pump. An elevated position of the reservoir is helpful under these conditions.

The metering pins 40 shown in Figure 4 are helpful in controlling the lowering and raising speed of the hoists by controlling the effective areas of the restricted passages 35 and 36. In fact by their use two hoists of different volumetric capacities can be actuated by means of this equalizing valve.

In Figure 5 is shown an arrangement of double-acting hoists 60 where oil under pressure is used for lifting by being applied beneath the plungers and oil under pressure is used for lowering by being applied above the plungers or their pistons. The circuit is identical with that shown in Figure 1 except that the control valve 17' is here equipped with a second port 62 connected by pipes 63 to the upper sides of the hoist chambers. Operation in this arrangement is the same as already described. It will be appreciated that the unequal loads on the hoists plus the pressures applied by means of the pump to the upper sides of the plungers will endeavor to provide unequal flow of liquid from the hoists back to the reservoir but this will be controlled by the equalizing valve with the same facility as in connection with the arrangement of Figure 1.

In the raising operation there will be substantially no load on the hoists and they will therefore be balanced so that uniform flow will take place in the reverse direction through the equalizing valve.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A valve for use between a reservoir for liquid and two identical hydraulic hoists, including, a housing, a chamber therein having a port through the housing wall, a valve cylinder, separate restricted ports connecting opposite ends of said cylinder to said chamber, a piston in said cylinder having limited longitudinal movement therein without restricting said ports, a separate longitudinal passage extending from each end of the piston toward but not through the opposite end, a port connecting each passage near its closed end to the surface of the piston, an annular enlargement in the cylinder wall for registry with each piston port in the central position of the piston, each enlargement being connected to a port leading externally of the valve, each piston port being constructed and arranged for adjustable overlapping with the cylinder wall adjacent the corresponding annular enlargement on the side opposite from the end of the piston to which it is connected.

2. A valve for use between a reservoir for liquid and two hydraulic hoists, including, a valve housing, a chamber therein having an outlet port through the housing wall, a valve cylinder, separate restricted ports connecting opposite ends of said cylinder to said chamber and forming the

sole exits from the cylinder ends, an elongated piston in said cylinder capable of limited longitudinal movement therein without restricting said ports under the action of differential pressures, on its ends, a separate longitudinal passage extending from each end of the piston toward but not through the opposite end, a port connecting each passage to the surface of the piston, spaced annular enlargements in the cylinder wall one for cooperation with each piston port, each enlargement being connected to a port leading externally of the valve, the piston ports in the central position of the piston being equally open to the annular enlargements, and so cooperating therewith that movement of the piston when unbalance pressures exist at its ends is in the direction to restrict the piston port subject to the greater fluid pressure.

3. A valve for use between a reservoir for liquid and two hydraulic hoists, including a valve housing, a chamber therein having an outlet port, a valve cylinder, a single restricted port at and forming the sole connection for each end of said cylinder to said chamber, an elongated piston in said cylinder capable of limited longitudinal movement therein without restricting said ports under the action of differential pressures on its ends, a separate longitudinal passage extending from each end of the piston toward but not through the opposite end, a port connecting the inner end of each passage to the surface of the piston, spaced annular enlargements in the cylinder wall one for cooperation with each piston port, each enlargement being connected to a port leading externally of the valve, the piston ports in the central position of the piston being equally open to the annular enlargements, and so cooperating therewith that movement of the piston is in the direction to restrict the piston port subject to the greater fluid pressure whereby the piston always assumes a position resulting in restricting the ratio of flow through said piston ports to maintain uniform pressures in the cylinder ends.

4. A valve for use between a reservoir for liquid and two similar hydraulic hoists, including, a housing, a discharge port through the wall thereof, a valve cylinder, two similar restricted ports, one connecting each end of said cylinder to said discharge port, an elongated piston in said cylinder capable of limited longitudinal movement therein without further restricting said similar ports under the action of differential pressures on its ends, longitudinal passages, one extending from each end of the piston toward but not through the opposite end, a port connecting each passage near its inner end to the surface of the piston, spaced annular enlargements in the cylinder wall one for cooperation with each piston port and each of the same longitudinal extent, each enlargement being connected to an inlet port leading externally of the valve, the piston ports being so spaced and positioned that in the central position of the piston they are equally exposed to the respective annular enlargements, and so cooperating therewith that movement of the piston is in the direction to restrict the piston port subject to the greater fluid pressure whereby the piston comes to rest at a position to cause such quantity flow through said restricted ports as will cause equal pressures in the cylinder ends, said restricted ports handling the whole flow through said valve.

5. A valve for use between a reservoir for liquid and two similar hydraulic hoists, including, a

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housing, a discharge port through a wall thereof, a valve cylinder, two similar restricted ports, one connecting each end of said cylinder to said discharge port, an elongated piston in said cylinder capable of limited longitudinal movement therein without further restricting said similar ports under the action of a pressure differential between the two ends thereof, longitudinal passages, one extending from each end of the piston toward but not through the opposite end, a port connecting each passage near its inner end to the surface of the piston, spaced enlargements in the cylinder wall one for cooperation with each piston port, each enlargement being connected to a port leading externally of the valve, the piston ports being so spaced and positioned that in the central position of the piston they are equally exposed to the respective annular enlargements, whereby movement of the piston in either direction due to pressure unbalance between the ends thereof enlarges the piston port subjected to the lower pressure and restricts the other, each of said piston ports in their position of greatest opening having larger flow capacity than the said restricted ports and being in series therewith, and means to restrict movement of the piston so that the ports therein can never be fully closed.

6. A valve including a housing, a chamber therein having a port through the housing wall, a valve cylinder, flow metering means connecting opposite ends of said cylinder respectively to said chamber, a piston in said cylinder having limited longitudinal movement therein without restricting flow through said metering means, a

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separate longitudinal passage extending from each end of the piston toward but not through the opposite end, a port connecting each passage near its closed end to the surface of the piston, an annular enlargement in the cylinder wall for registry with each piston port in the central position of the piston, each enlargement being connected to a port leading externally of the valve, each piston port being constructed and arranged for adjustable overlapping with the cylinder wall adjacent the corresponding annular enlargement on the side opposite from the end of the piston to which it is connected.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,283,266	Kinsella	May 19, 1942
1,993,790	Kinsella	Mar. 12, 1935
2,242,002	Klein	May 14, 1941
2,266,921	Trautman	Dec. 23, 1941
2,200,578	Mahon	May 14, 1940
2,317,563	Tucker	Apr. 27, 1943
1,999,834	Ernst	Apr. 30, 1936
1,923,127	Veenschoten	Aug. 27, 1933
2,374,630	Tucker	Apr. 24, 1945

FOREIGN PATENTS

Number	Country	Date
549,211	Great Britain	1942