

Oct. 31, 1944.

J. M. TOWLER ET AL

2,361,801

HYDRAULIC PISTON VALVE

Filed Feb. 18, 1943

4 Sheets-Sheet 1

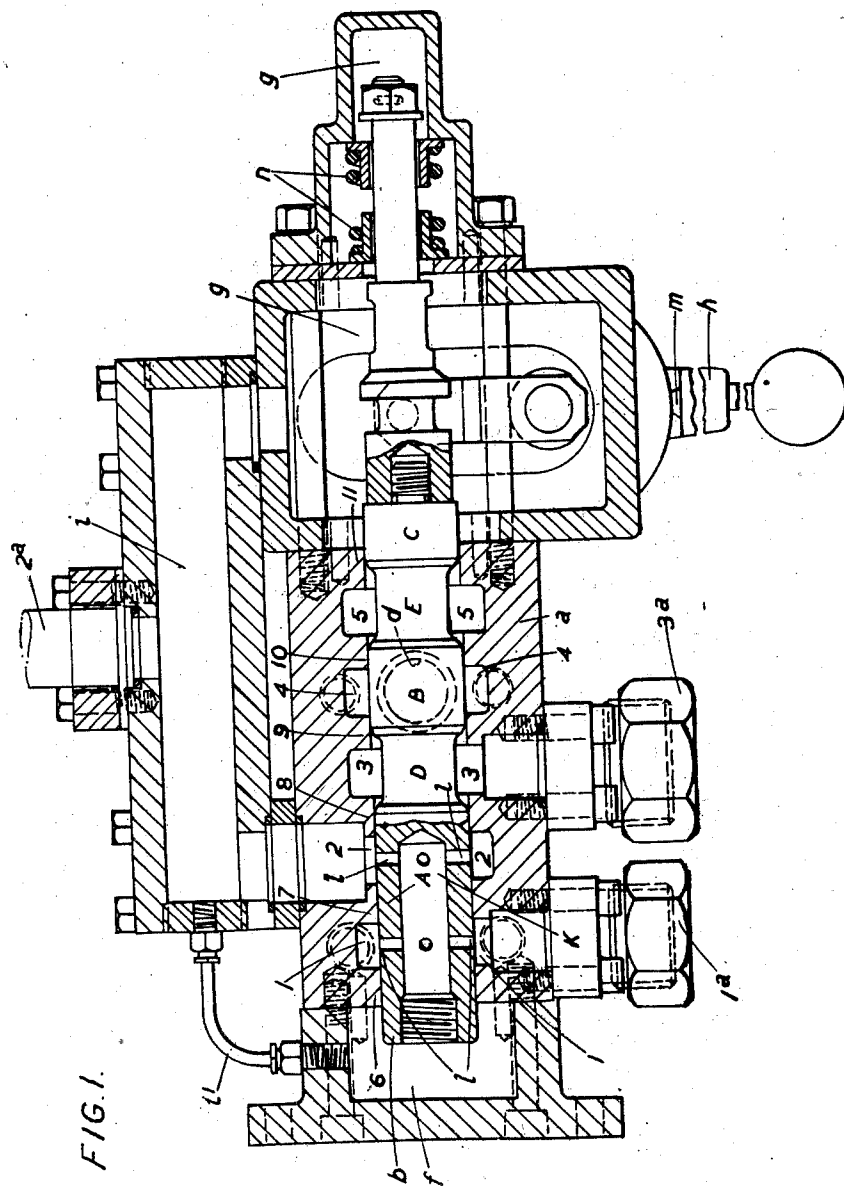


FIG. 1.

Inventors
John Maurice Towler
Frank Hudson Towler
By
Dane J. M. Towler
Attorney

Oct. 31, 1944.

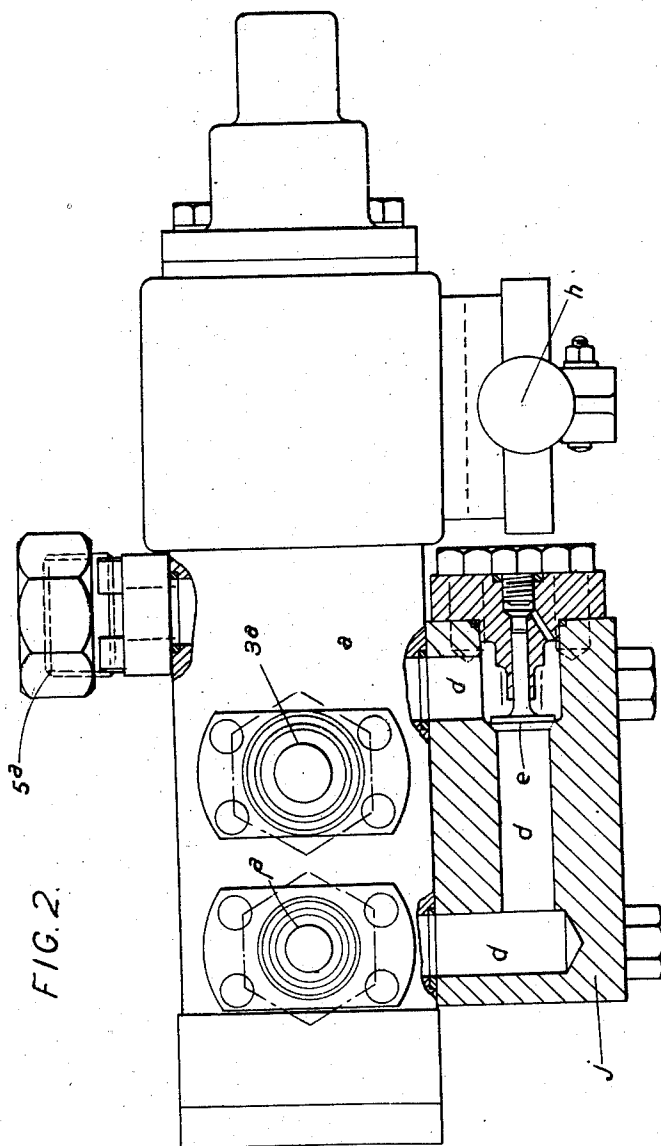
J. M. TOWLER ET AL

2,361,801

HYDRAULIC PISTON VALVE

Filed Feb. 18, 1943

4 Sheets-Sheet 2



Inventors
J. M. Towler
Frank H. Harker
By
D. J. M. M.
Attorney

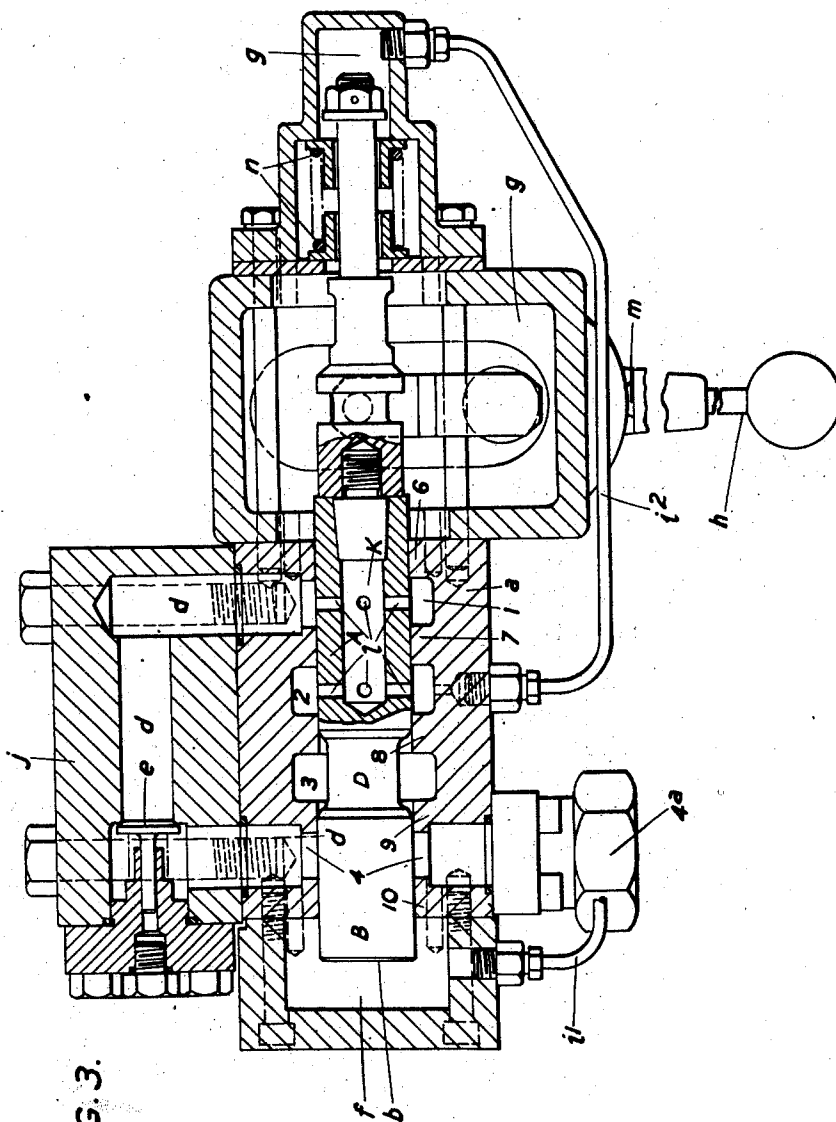
Oct. 31, 1944.

J. M. TOWLER ET AL
HYDRAULIC PISTON VALVE

2,361,801

Filed Feb. 18, 1943

4 Sheets-Sheet 3



Inventors
John M. Macmillan
Frank H. Harden
By *David J. Macmillan*
Attorney

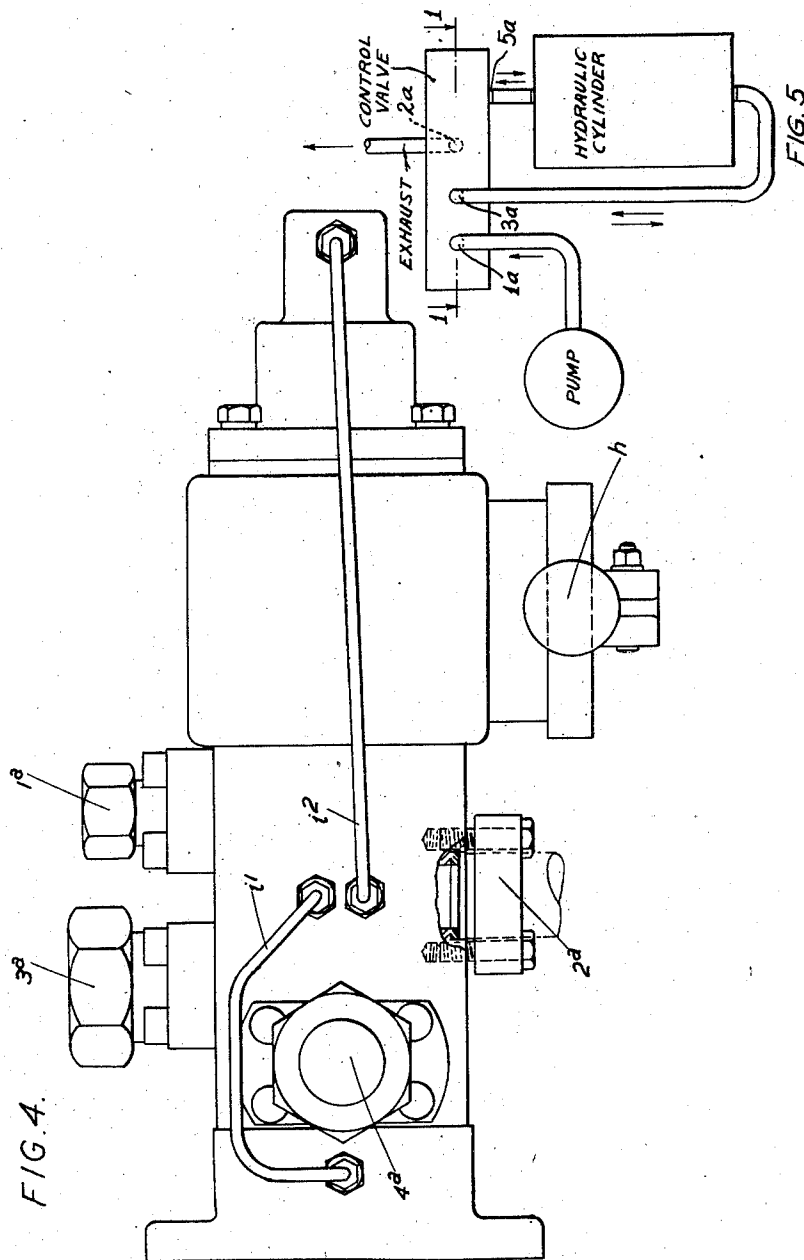
Oct. 31, 1944.

J. M. TOWLER ET AL
HYDRAULIC PISTON VALVE

2,361,801

Filed Feb. 18, 1943

4 Sheets-Sheet 4



Inventors
J. M. Towler
Frank H. H. Towler
By
D. J. H. H. Towler
Attorney

UNITED STATES PATENT OFFICE

2,361,801

HYDRAULIC PISTON VALVE

John Maurice Towler and Frank Hathorn Towler,
Yorkshire, EnglandApplication February 18, 1943, Serial No. 476,352
In Great Britain July 4, 1942

12 Claims. (Cl. 121—46.5)

This invention relates to hydraulic control valves of the piston type such as are used, for example, for controlling the supply of pressure liquid to single or double-acting hydraulic cylinders from a continuously driven positive displacement pump, and which unload the pump automatically when the valve is operated to cut off delivery to the hydraulic apparatus.

The object of the present invention is to provide an improved control valve of the above type and broadly such an improved valve has a bore in which slides the valve piston, said bore being enlarged interiorly to provide a plurality of chambers, two at least of which chambers are interconnected by a passage containing a non-return valve, one of said chambers being adapted to receive pressure liquid from a pump for transference past the non-return valve to the other chamber for distribution to the cylinder of hydraulic apparatus under the selective control of the piston valve.

An improved valve according to the present invention may be adapted for use with hydraulic apparatus having a double-acting cylinder by disposing the chamber which receives the pressure liquid that passes the non-return valve between two further chambers to each of which it is connectable in turn by the selective operation of the piston valve, said further chambers being connected to each end of the double-acting hydraulic cylinder.

In adapting the improved valve for use with hydraulic apparatus having a single-acting cylinder, the chamber which receives the pressure liquid that passes the non-return valve is in permanent connection with the annular end of the single acting cylinder and is connectable, by selective operation of the piston valve, with a further chamber which in turn is in permanent connection with the other or major pressure end of the hydraulic cylinder.

With a control valve according to the present invention the pump may be unloaded by connecting the chamber which first receives pressure liquid from the pump with an outlet to exhaust by means comprising a longitudinal passage within the interior of the valve piston and radial openings leading to the outside of the piston body, said openings being spaced longitudinally so that they may be brought simultaneously into correspondence with the chamber and exhaust outlet to be connected, by endwise movement of the valve piston.

The distribution of the pressure liquid between the chambers under selective control of the valve

piston is preferably effected by means of portions of reduced diameter in the length of the valve piston, said portions being brought into relation with adjacent pairs of chambers, so as to bridge the same, by predetermined endwise movement of the valve piston. The same means may also, conveniently, be used for selectively connecting one or both ends of the hydraulic cylinder to exhaust.

So that the valve piston may at all times be hydraulically balanced, the ends thereof may open into spaces both of which are maintained at substantially the same pressure, preferably atmospheric.

In order that the invention may be clearly understood and carried into effect two embodiments of the improved control valve, for use respectively with a double-acting and a single-acting hydraulic cylinder, will now be described by way of example, by aid of the accompanying drawings in which—

Fig. 1 is a longitudinal horizontal section through the valve on line I—I of Fig. 5 for use in connection with a double-acting hydraulic cylinder and

Fig. 2 is a partly sectional plan view of the same.

Fig. 3 is a view, similar to Fig. 1, but illustrating the valve for use in connection with a single-acting hydraulic cylinder, and Fig. 4 is an underside plan view of the same.

Fig. 5 is a view diagrammatically illustrating a hydraulic apparatus incorporating a control valve according to the invention.

The valves, in both examples illustrated, are of the packingless piston type in which fluid tightness is maintained by making the piston a very close sliding fit in the bore of the valve body and as certain features are common to both embodiments like references will be used to indicate like parts throughout the following description.

Referring now to Figs. 1 and 2 of the drawings the valve illustrated comprises a valve body *a*, preferably of hardened steel, having a parallel bore to receive the piston *b*, which is also preferably of hardened steel. The bore of the valve body, in which the piston is a close sliding fit, is enlarged interiorly to form five chambers, which are numbered from left to right 1, 2, 3, 4, 5. Thus, the bore of the valve body is therefore divided into six narrow bands, which are numbered 6, 7, 8, 9, 10 and 11 from left to right. The bands 7, 8, 9 and 10 separate the chambers 1, 2, 3, 4, 5 and the bands 6 and 11 are disposed at each end of the valve body. Chamber number 1 is con-

nected to the pump through outlet 1a, chamber number 2 is connected to exhaust by outlet 2a, chamber number 3 is connected by outlet 3a to one side of the hydraulic piston and cylinder, chamber number 4 is connected through passage d and non-return valve e to chamber number 1 in such a way that liquid may pass from chamber number 1 past the non-return valve to chamber number 4, but not in a reverse direction; chamber number 5 is connected to the other side of the hydraulic piston and cylinder through outlet 5a. The valve piston passes right through the valve body and protrudes at each end into space f and g and suitable cover plates are provided to enclose such spaces and these spaces are connected to the exhaust outlet 2a leading back to the pump reservoir, so that the valve piston is at all times hydraulically balanced and suitable means such as the lever h is provided to move the valve piston longitudinally. To simplify construction, an exhaust manifold i is provided connecting chamber number 2 of the valve body and the right hand space g, a small pipe i' being provided to connect the manifold with the left hand space f. The passage d and the non-return valve e are shown in connection with a body member j which is attached to the valve body but such member and valve body may of course be made integral with each other. The valve piston b is in one piece and has three portions A, B, C, of substantially the same diameter as the valve bore, so as to be a close sliding fit in same. There is a reduced portion D between portions A and B and a reduced portion E between portions B and C. The portion A is longer than the portions B and C and is provided with a central bore k drilled from one end of the piston and plugged. Two rows of transverse holes l are drilled radially in the valve piston connecting the central longitudinal bore with the outside of the piston and these two rows of holes have their transverse centre lines spaced longitudinally substantially the same distance apart as the transverse centre lines of the chambers 1 and 2 in the valve body. The disposition of these rows of holes relatively to the reduced portions D and E is preferably such that admission of liquid to and its exhaust from the hydraulic cylinder commences before the said holes are completely closed. The valve piston has four distinct operating positions, which we will refer to in the description as W, X, Y and Z; position W being to the extreme left and position Z being to the extreme right and positions X and Y intermediate thereto. The ends of the cylindrical portions A, B and C adjoining the reduced portions D and E may be chamfered slightly as shown so that there is no chance of them catching against the sharp edge of one of the chambers in the valve bore and perhaps locking the valve piston and also these chamfers may be useful in providing a throttling effect on the liquid as it passes through the valve, so that there is no sudden change in the delivery of liquid as the valve piston is moved from one position to the other.

The operation of the valve is as follows:

*Position W of the valve piston (we will assume that the hydraulic piston is downwardly acting and is at the bottom of its stroke).—*In this position of the valve portion A of the valve piston is enclosed by bands 6 and 7 which also close the transverse holes l. Portion B of the valve piston is enclosed by the band 9 and portion C of the valve piston is enclosed by band 11. Reduced portions D and E of the valve piston are opposite

bands 8 and 10 and therefore there is free access longitudinally between chambers 2 and 3, and between chambers 4 and 5. Thus, in this position of the valve piston, the pump delivers to chamber 1 and from chamber 1 through the non-return valve to chamber 4 and thence to chamber 5, which is connected to the lower side of the hydraulic piston which therefore moves upwards. The upper side of the downwardly acting hydraulic piston is connected to chamber 2 in the valve body and therefore the liquid in this upper end of the cylinder is exhausted along the reduced portion D of the valve piston to chamber 2 in the valve body and thence to exhaust.

*Position X.—*The cylindrical portion A of the valve piston is now enclosed by bands 6 and 7 and it is just entering band 8 in the valve body. Cylindrical portion B of the valve piston is now enclosed by band 9 and it is just entering band 10 of the valve body. Cylindrical portion C is still enclosed by band 11 of the valve body. The transverse holes l in portion A of the valve piston are now uncovered so that there is now free access between chambers 1 and 2 through the transverse holes and along the central bore in the valve piston. Thus, in this position of the valve piston, the pump is allowed to deliver freely to exhaust and the liquid is locked on the lower side of the downwardly acting hydraulic piston both by the entry of cylindrical portion B of the valve piston into band 10 of the valve body and by the non-return valve l. Consequently, in this position of the valve piston the pump is allowed to deliver freely to exhaust and the pressure is held on the lower side of the downwardly acting hydraulic piston.

*Position Y.—*The portion A of the valve piston is now enclosed by bands 6, 7 and 8, but the transverse holes l are still uncovered, so that there is free access between chambers 1 and 2 of the valve body. Portion B of the valve piston is now fully enclosed by band 10 and it is just leaving band 9 of the valve body. Portion C of the valve piston is now just leaving band 11 of the valve body; consequently, chamber 5 of the valve body is just being opened to exhaust along the reduced portion E of the valve piston and out into space g at the right hand end of the valve body. Thus, in this position of the valve piston, the pump is still delivering to exhaust, but any further movement of the valve piston to the right would cause the downwardly acting hydraulic piston to be lowered by the connection of chamber 5 in the valve body with the space g which is connected to the exhaust manifold.

*Position Z.—*The cylindrical portion A of the valve piston is now enclosed by bands 6, 7 and 8 of the valve body and the transverse holes l are covered by bands 7 and 8. Portion B of the valve piston is now enclosed by band 10 and portion C of the valve piston is now protruding into the space g. The reduced portions D and E are opposite bands 9 and 11 of the valve body respectively, and consequently there is free access between chambers 3 and 4, and between chamber 5 and exhaust through the space g at the right hand end of the valve body. Thus, in this position of the valve piston, the pump delivers through the non-return valve to chamber 4 in the valve body, thence along the reduced portion D of the valve piston to chamber 3 in the valve body and thence to the upper side of the downwardly acting hydraulic piston. Chamber 5 of the valve body is now open to exhaust along the reduced portion E of the valve piston to the space

g and thence to the exhaust manifold. Consequently, in this position of the valve piston, the pump delivers pressure fluid to the top of the downwardly acting hydraulic piston and the lower side of that piston is open to exhaust and therefore the piston moves downwards on its working stroke.

A spring detent *m* or other such mechanism may be provided to hold the valve piston in positions X or Y and a spring *n* provided to prevent the operator leaving the valve piston in positions W or Z. That is to say, the valve piston is automatically returned by the spring *n* to positions X or Y, immediately the operator releases the valve lever, so that the pump is automatically unloaded.

With the arrangement illustrated the pump is enabled to be connected to exhaust, so that it runs continuously, delivering liquid to exhaust whilst fluid is held in the press cylinder, this being made possible by the incorporation of the non-return valve which enables the pump to deliver through the non-return valve to the hydraulic cylinder or cylinders, but prevents the hydraulic cylinder or cylinders being exhausted when the pump is put to exhaust. It will be understood that in intermediate positions of the valve piston the said transverse holes may be partially covered so that a part of the delivery of the pump passes to exhaust and the balance passes through the non-return valve to the appropriate piston and cylinder, thereby reducing the speed of operation of the hydraulic piston and cylinder without increasing the working pressure of the pump.

The valve illustrated in Fig. 1 may be adapted for use with single-acting hydraulic cylinders by shortening the valve piston so as to omit the portions C and E and providing the valve bore with four annular chambers instead of five.

Such a modified valve is illustrated in Figures 3 and 4 and in the particular example shown the valve piston is reversed so that the portion A is at the right hand end of the valve. The chambers 1, 2, 3 and 4 are correspondingly reversed and the bore of the valve body is divided into five narrow bands instead of six, said bands corresponding to the bands 6, 7, 8, 9 and 10 in Fig. 1. A further omission in this embodiment is the exhaust manifold *i*, the spaces *f* and *g* being connected to the exhaust outlet by a pair of pipes *i'*, and whereas in the first embodiment the chamber 4 could be isolated by the valve piston from the hydraulic cylinder, in the present embodiment this chamber is in permanent connection with the annulus side of the hydraulic cylinder. In the mid-position of the valve shown in Fig. 3 the liquid delivered by the pump to the chamber 1 flows by way of passage *k* and holes *l* to chamber 2 and so to exhaust. In consequence the pump is unloaded whilst liquid in both ends of the hydraulic cylinder is locked against escape.

By moving the valve piston to its extreme left position the delivery of the pump passes from chamber 1 through passages *d*, past the non-return valve *e* into chamber 4, and as the chambers 3 and 4 in this position of the valve piston are bridged by the reduced portion D, the pressure liquid is delivered to both ends of the hydraulic cylinder simultaneously.

As the effective area of the hydraulic piston on the annulus side is less than that on the opposite side and assuming that said annular side is at the right end of the cylinder, said piston will

move to the right and the liquid thus displaced will pass around to the opposite side of the piston.

By moving the valve piston to its extreme right position, the reduced portion D will bridge chambers 2 and 3 and in consequence the left hand end of the hydraulic cylinder is opened to exhaust. The delivery from the pump will then pass into the annulus or right hand side of the cylinder by way of passages *d* and chamber 4, and in consequence the hydraulic piston will move to the left.

In both examples illustrated the chambers are annular and surround the valve piston whilst the closure of the ports occurs symmetrically. The valve piston is, therefore, at all times laterally balanced, hydraulically. As previously stated the valve piston is also longitudinally balanced, hydraulically, as a result of the spaces *f* and *g*.

What we claim is:

1. A valve mechanism for controlling the supply of pressure liquid to a hydraulic cylinder comprising a body having a bore, enlargements in said bore forming a plurality of longitudinally spaced chambers, an inlet for the delivery of pressure liquid to one of the chambers from a source of supply, an outlet connecting another of the chambers to exhaust, a piston valve reciprocable in said bore and adapted to selectively establish and interrupt communication between said inlet chamber and said exhaust chamber, a passage provided with a non-return valve connecting the inlet chamber to a further chamber for supplying pressure liquid thereto for operation of the hydraulic cylinder when communication between the inlet chamber and the exhaust chamber is interrupted, and means controlled by the piston valve for selectively supplying pressure liquid from said further chamber to the opposite ends of the hydraulic cylinder and exhausting the liquid therefrom.

2. A valve mechanism for controlling the supply of pressure liquid to a hydraulic cylinder comprising a body having a bore, enlargements in said bore forming a plurality of longitudinally spaced chambers, an inlet for delivering pressure liquid to one of the chambers from a source of supply, an outlet connecting another of the chambers to exhaust, a piston valve reciprocable in said bore and adapted to selectively connect said inlet chamber to said exhaust chamber and to isolate it from this latter, a passage provided with a non-return valve for connecting the inlet chamber to a further chamber to supply pressure liquid thereto when the inlet chamber is isolated from the exhaust chamber, an outlet connecting said further chamber to one end of the hydraulic cylinder to permit free access of the pressure liquid thereto, an outlet in another of the chambers for connecting said chamber to the opposite end of the hydraulic cylinder, said piston valve being effective in its reciprocation within the bore to selectively connect the last-mentioned chamber to the chamber which receives the pressure liquid from the inlet chamber and to the exhaust chamber, whereby pressure liquid is selectively supplied to and exhausted from said opposite end of the hydraulic cylinder under control of the piston valve.

3. A valve mechanism for controlling the supply of pressure liquid to a hydraulic cylinder comprising a body having a bore, enlargements in said bore forming a plurality of longitudinally spaced chambers, an inlet for delivering pressure liquid to one of the chambers from a source of supply, an outlet for connecting another of the chambers to exhaust, a piston valve reciprocable

in said bore and adapted to selectively connect said inlet chamber to said exhaust chamber and to isolate it from this latter, a passage provided with a non-return valve for connecting the inlet chamber to a further chamber to supply pressure liquid thereto when the inlet chamber is isolated from the exhaust chamber, an outlet in each of two chambers adjacent said further chamber for connection to the opposite ends of the hydraulic cylinder, said piston valve being effective in its reciprocation within said bore to alternately connect each of the last-mentioned chambers to the chamber which receives pressure liquid from the inlet chamber and to exhaust, whereby pressure liquid is alternately supplied to and exhausted from each end of the hydraulic cylinder.

4. A valve mechanism for controlling the supply of pressure liquid to a hydraulic cylinder comprising a body having a bore, enlargements in said bore forming a plurality of longitudinally spaced chambers, an inlet for the delivery of pressure liquid to one of the chambers from a source of supply, an outlet for connecting another of the chambers to exhaust, a piston reciprocable in said bore, means within the body of said piston adapted to selectively establish and interrupt communication between said inlet chamber and said exhaust chamber, a passage provided with a non-return valve connecting the inlet chamber to a further chamber for supplying pressure liquid thereto for operation of the hydraulic cylinder when communication between the inlet chamber and the exhaust chamber is interrupted, and means controlled by the piston valve in its reciprocation within said bore for selectively supplying pressure liquid from said further chamber to either end of the hydraulic cylinder and exhausting the liquid therefrom.

5. A hydraulic control valve comprising a body having an inlet connected with a source of pressure liquid supply, a chamber in said body communicating with the inlet, an outlet connectable with said chamber, a second chamber longitudinally spaced from the first chamber, a passage provided with a non-return valve for interconnecting the chambers to supply pressure liquid to the second chamber, two further outlets connectable with this latter, and means reciprocable in the valve body for selectively controlling the distribution of the pressure liquid from the first chamber to its outlet and through the second chamber to either of the other outlets.

6. A hydraulic valve comprising a body having an inlet connected with a source of pressure liquid supply, a bore in said body having portions enlarged to form a plurality of longitudinally spaced chambers coaxial with said bore, one of said chambers being in communication with the inlet, means for connecting this chamber with a second chamber to supply pressure liquid thereto, an outlet connectable with the first chamber, two further outlets connectable with the second chamber, a piston reciprocable in said bore, and means provided in said piston adapted to act with the shifting of the piston from one position to another for selectively establishing communication between the first chamber and its outlet, concurrently shutting off the second chamber from its outlets, and between this latter and either of its outlets concurrently shutting off the first chamber from its outlet.

7. A hydraulic control valve comprising a body having an inlet receiving pressure liquid from a

source of supply, a bore in said body having portions enlarged to form a plurality of longitudinally spaced annular chambers, one of said chambers being in communication with the inlet, a passage provided with a non-return valve for connecting said chamber with a second chamber to supply liquid thereto, said second chamber being located between two other chambers, two outlets each communicating with one of the latter chambers, a further outlet connectable with the first chamber, a piston reciprocable in said bore, and means in said piston adapted to act with the shifting of the piston from one position to another for selectively establishing communication between the first chamber and its outlet and between the second chamber and either of the two chambers adjacent thereto, to control distribution of the liquid to the various outlets.

8. A hydraulic control valve comprising a body having an inlet receiving pressure liquid from a source of supply, a bore in said body having portions enlarged to form a plurality of longitudinally spaced annular chambers, one of said chambers being in communication with the inlet, a passage provided with a non-return valve for connecting said chamber with a second chamber to supply liquid thereto, said second chamber being located between two other chambers, two outlets each communicating with one of the latter chambers, a further outlet connectable with the first chamber, a piston reciprocable in said bore, and means in said piston adapted to act with the shifting of the piston from one position to another for selectively establishing communication between the first chamber and its outlet and between the second chamber and either of the two chambers adjacent thereto, to control distribution of the liquid to the various outlets, and means operable from the exterior of the valve body for selectively shifting the piston from one position to another.

9. A hydraulic control valve comprising a body having an inlet connectable with a source of pressure liquid supply, a bore longitudinally extending throughout the body and having portions enlarged to form a plurality of longitudinally spaced annular chambers, one of said chambers being in communication with the inlet, a passage provided with a non-return valve for connecting said chamber with a second chamber to supply pressure liquid thereto, said second chamber being located between two other chambers, two outlets each communicating with one of the latter chambers, a piston reciprocable in said bore, and means in said piston comprising piston portions of reduced diameter adapted to act with the shifting of the piston from one position to another for selectively establishing communication between the first chamber and its outlet and between the second chamber and either of the two chambers adjacent thereto, to control distribution of the liquid to the various outlets.

10. A hydraulic control valve comprising a body having an inlet connected with a source of pressure liquid supply, a chamber in said body communicating with the inlet, an outlet connectable with said chamber, a second chamber longitudinally spaced from the first chamber, a passage provided with a non-return valve connecting the first chamber with the second chamber to supply pressure liquid to this latter, an outlet in permanent communication with the second chamber, another outlet connectable with the same chamber, and means reciprocable in the valve body

for establishing communication between the first chamber and its outlet and for selectively establishing and interrupting communication between the second chamber and the outlet connectable therewith while the first chamber is isolated from its outlet, whereby the pressure liquid may be selectively caused to flow through the second chamber to one or to both of its outlets at a time.

11. A hydraulic control valve, as in claim 4, 10 wherein the means provided in the piston for establishing communication between the first chamber and its outlet comprise a longitudinal

passage in the piston and longitudinally spaced radial openings leading to the outside of the piston and adapted to be brought simultaneously into registration with the chamber and the outlet during the shifting of the piston in the bore.

12. A hydraulic control valve, as in claim 1, wherein the valve body is provided at the ends thereof with chambers maintained at substantially equal pressure and the ends of the piston protrude from the bore into said chambers whereby the piston is hydraulically balanced.

JOHN MAURICE TOWLER.
FRANK HATHORN TOWLER.