March 25, 1924. 1,488,013

E. O. LUNDBLAD

HYDRAULIC VALVE

Filed June 27, 1923 2 Sheets-Sheet 1

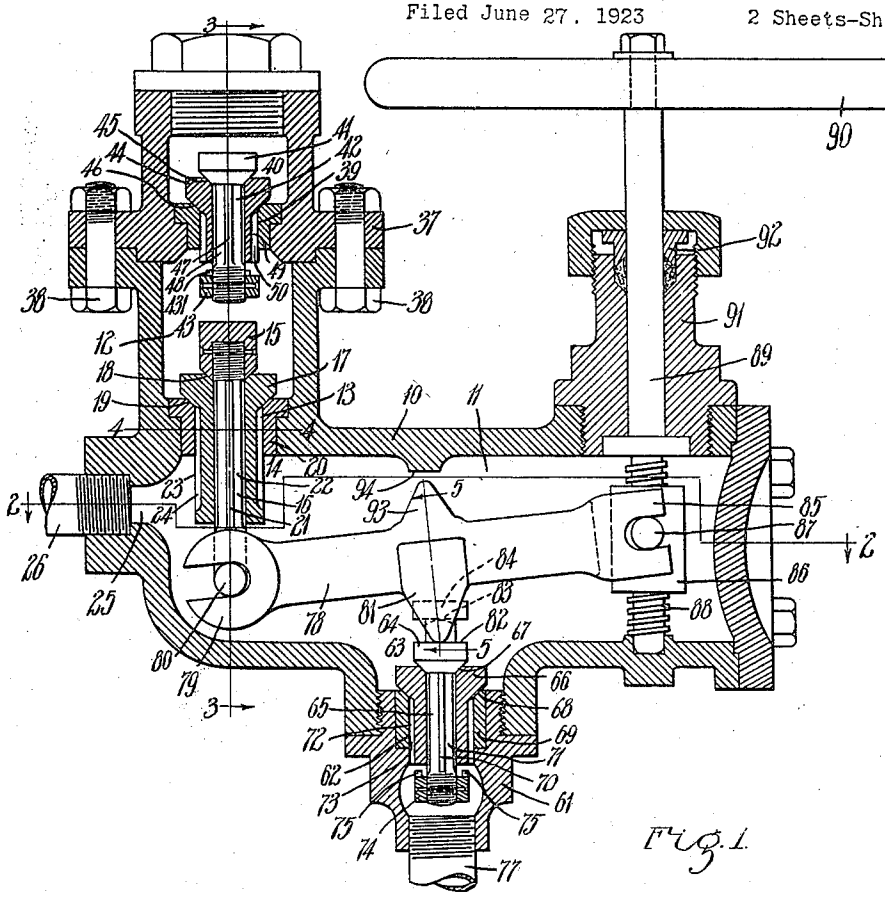


FIG. 1.

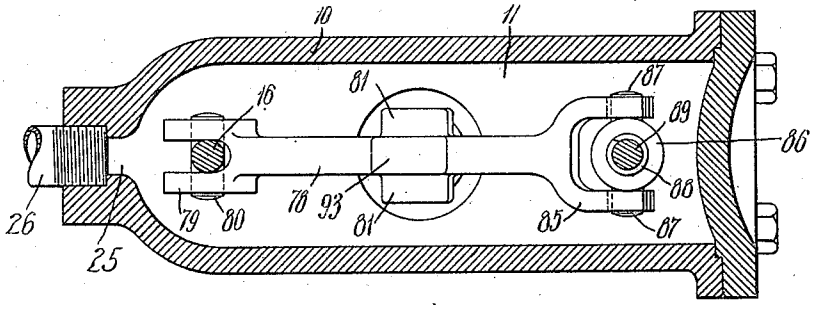


FIG. 2.

Inventor:
Emil O. Lundblad
by his attorney,
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March 25, 1924.

1,488,013

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2 Sheets-Sheet 2

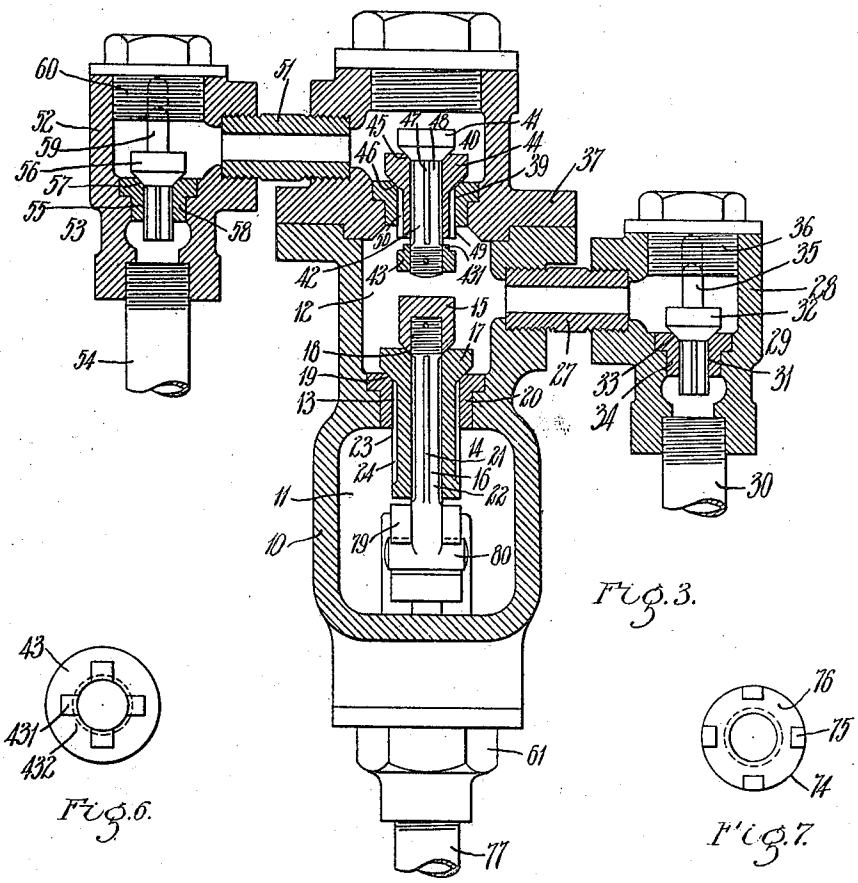


Fig. 3.

Fig. 6.

Fig. 7.

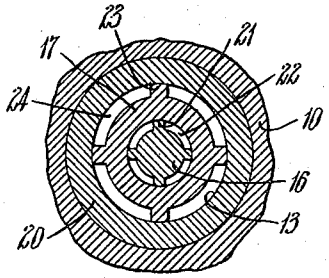


Fig. 4.

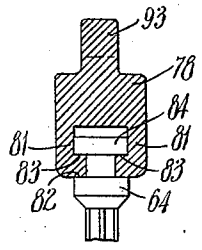


Fig. 5.

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Patented Mar. 25, 1924. 1,488,013

UNITED STATES PATENT OFFICE.

EMIL O. LUNDBLAD, OF MEDFORD, MASSACHUSETTS.

HYDRAULIC VALVE.

Application filed June 27, 1923. Serial No. 648,155.

To all whom it may concern:

Be it known that I, EMIL O. LUNDBLAD, a subject of the King of Sweden, residing at Medford, in the county of Middlesex and State of Massachusetts, have invented new and useful Improvements in Hydraulic Valves, of which the following is a specification.

This invention relates to a hydraulic valve and has for its object to provide a triple valve of the character mentioned, particularly adapted to control by a single operating member both the admission and discharge of pressure fluid to and from hydraulic presses.

Another object of the invention is to provide a valve capable of first delivering the fluid to a hydraulic press under a comparatively low pressure and then under a relatively higher pressure, it being impossible at any time to apply other than the lowest pressure obtainable first.

Still another object of the invention is to so arrange the inlet valves that they may be opened consecutively to admit the fluid of different pressures, each inlet valve other than the main inlet valve being opened by another inlet valve located directly in alignment therewith.

Still another object of the invention is to prevent the waste of pressure fluid by providing a device having a main inlet valve and an exhaust valve, both of which may be located in their closed positions simultaneously but only one of which may be opened at a time, it being impossible to open the main inlet valve if the exhaust valve is also open, or to open the exhaust valve if the main inlet valve is open.

The invention consists in the combination and arrangement of parts whereby the above objects and certain other objects hereinafter appearing may be attained as set forth in the following specification and particularly pointed out in the claims thereof.

Referring to the drawings:

Figure 1 represents a central vertical section through a valve embodying my invention.

Fig. 2 is a horizontal section taken on the line 2—2 of Fig. 1.

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 1.

Fig. 4 is an enlarged detail horizontal section through the main inlet valve, as taken on the line 4—4 of Fig. 1.

Fig. 5 is a detail transverse section taken on the line 5—5 of Fig. 1.

Fig. 6 is an enlarged detail plan view of the nut forming a part of the high pressure inlet valve.

Fig. 7 is an enlarged detail plan view of the nut forming a part of the exhaust valve.

Like numerals refer to like parts throughout the several views of the drawings.

In the drawings, 10 represents a casing in the interior of which is a main pressure chamber 11 and an auxiliary pressure chamber 12, said chambers being connected by a main inlet passage 13 in which is a main inlet valve 14. The main inlet valve 14 embodies therein a primary valve member 15 fast to a valve stem 16 and movable in unison therewith, and a secondary valve member 17 loosely mounted upon and surrounding the said valve stem. The primary valve member 15 is normally seated at 18 upon the secondary valve member 17, while the latter is normally seated at 19 upon a bushing 20 located between the auxiliary pressure chamber 12 and the main pressure chamber 11. The valve stem 16 is provided with a plurality of radially disposed ribs 21, the outer edges of which engage the interior bore of the secondary valve member 17 and said ribs co-operate with said secondary valve member to form ports 22 which extend longitudinally of the main inlet valve 14 between the valve stem 16 and the secondary valve member 17. The secondary valve member 17 is also provided with a plurality of radially disposed ribs 23, the outer edges of which engage the interior bore of the bushing 20 and said ribs co-operate with said bushing to form ports 24 which extend longitudinally of the main inlet valve 14 between the secondary valve member 17 and the bushing 20. The pressure fluid admitted to the auxiliary pressure chamber 12 as will be hereinafter more fully described, acts against the upper extremities of the primary and secondary valve members 15 and 17 respectively and normally holds both seated and therefore closed and normally prevents the entrance of said pressure fluid into the main pressure chamber 11.

Pressure fluid after entering the main pressure chamber 11 passes therefrom

through an outlet passage 25 and outlet pipe 26, the latter having screw-threaded engagement with the casing 10 and extending from said casing to a hydraulic press or other device utilizing hydraulic power.

Secured at one end thereof in the casing 10 is a nipple 27 upon the other end of which a casing 28 of a check valve 29 is mounted, and a pipe 30 connects said casing 28 with a suitable source of fluid supply from which pressure fluid under a comparatively low pressure is supplied. A check valve 29 is provided with a low pressure inlet passage 31 in which a valve member 32 is slidably mounted and normally rests upon a seat 33 provided in a bushing 34. The movable valve member 32 embodies therein a valve stem 35 which projects into an opening provided in a screw plug 36 and the latter limits the extent to which the valve member 32 may be raised from its seat 33. The low pressure fluid passes from its source of supply through the inlet pipe 30, check valve 29 and nipple 27 to the auxiliary pressure chamber 12.

A casing member 37 is secured to the main casing 10 through the medium of a plurality of bolts 38 and extending through said casing member 37 is a high pressure inlet passage 39 in which a high pressure inlet valve 40 is mounted. The inlet valve 40 embodies therein a primary valve member 41 fast to a valve stem 42 and movable in unison therewith, and a secondary valve member 44 loosely mounted upon and surrounding said valve stem 42. The primary valve member 41 is normally seated at 45 upon the secondary valve member 44 while the latter is normally seated at 46 upon a bushing located within the casing member 37. A nut 43 is fast to the lower end portion of the valve stem 42 and said nut is illustrated in detail in Fig. 6, and upon the upper surface of said nut are provided a plurality of projections 431 which are adapted to engage the lower extremity of the secondary valve member 44 when the primary valve member 41 is lifted, as will be hereinafter more fully described and between said projections 431 are located a plurality of ports 432. The valve stem 42 is provided with a plurality of radially disposed ribs 47, the outer edges of which engage the interior bore of the secondary valve member 44 and said ribs co-operate with said secondary valve member to form ports 48 which extend longitudinally of the valve 40 between the valve stem 42 and secondary valve member 44. The secondary valve member 44 is also provided with a plurality of radially disposed ribs 49, the outer edges of which engage the interior bore of the bushing in which it is seated, and said ribs co-operate with said bushing to form ports 50 which extend longitudinally of the valve 40 between said secondary valve member 44 and said bushing. The pressure of fluid above the valve 40 acting against the upper extremities of the primary and secondary valve members 41 and 44 respectively normally holds both seated and therefore closed and prevents the entrance of said pressure fluid into the auxiliary pressure chamber 12.

Fast at one end thereof in the casing member 37 is a nipple 51 on the other end of which a casing 52 of a high pressure check valve 53 is mounted and said casing is connected by a high pressure inlet pipe 54 to a suitable source of fluid supply. The casing 52 has an inlet passage 55 provided therein in which a valve member 56 is slidably mounted and which, when closed, rests upon a seat 57 provided in a bushing 58 mounted in the casing 52. The movable valve member 56 has a valve stem 59 formed integral therewith which projects into an opening provided in a screw plug 60 and the latter limits the extent to which the valve member 56 may be lifted from its seat 57. Fluid of a pressure relatively higher than that supplied through the low pressure pipe 30 passes through the pipe 54, lifting the valve member 56 and passes through the nipple 51 into the chamber above the high pressure inlet valve 40 and normally holds said valve in its closed position until it is opened by mechanism hereinafter to be described.

In order to exhaust fluid from the main pressure chamber 11, a plug 61 has screw-threaded engagement with the casing 10 and mounted within an exhaust passage 62 extending through said plug 61 is an exhaust valve 63 which embodies therein a primary valve member 64 having a valve stem 65 formed integral therewith, and a secondary valve member 66 loosely mounted upon and surrounding said valve stem. The primary valve member 64 is normally seated at 67 upon the secondary valve member 66, while the latter is normally seated at 68 upon a bushing 69 provided in the plug 61. The valve stem 65 is provided with a plurality of radially disposed ribs 70, the outer edges of which engage the interior bore of the secondary valve member 66, and said ribs co-operate with said secondary valve member to form ports 71 which extend longitudinally of the exhaust valve 63 between the valve stem 65 and the secondary valve member 66. The secondary valve member 66 is also provided with radially disposed ribs 72, the outer edges of which engage the interior bore of the bushing 69 and said ribs co-operate with said bushing to form ports 73 which extend longitudinally of the exhaust valve 63 between the secondary valve member 66 and bushing 69.

Fast to the lower end portion of the valve stem 65 is a nut 74 illustrated in detail in

Fig. 7 upon the upper surface of which are a plurality of projections 75 which are adapted to engage the lower extremity of the secondary valve member 66 when the primary valve member 64 is lifted, as will be hereinafter more fully described, and between said projections 75 are located a plurality of ports 76. An exhaust pipe 77 connects with a plug 61 and extends to any suitable point where it is desired to discharge the exhaust pressure fluid.

The main inlet valve 14 is opened to admit pressure fluid into the main pressure chamber 11 and although normally closed by the pressure fluid, said inlet valve is also at times positively closed to prevent leakage therethrough into said main pressure chamber and the exhaust valve 63 is opened to discharge said pressure fluid from said main pressure chamber by mechanism as follows: Located within the main pressure chamber 11 is a lever 78, one end of which is forked at 79 and loosely connected to a transversely extending end portion 80 of the valve stem 16. The forked portion 79 of the lever 78 is constructed and arranged to engage the lower extremity of the secondary valve member 17 in order that the latter may be lifted from its seat 19 and the portion 80 of the valve stem 16 at times during the operation of the device constitutes a pivot for the lever 78. The lever 78 has a pair of downwardly projecting arms 81, the lower extremities of which rest upon a shouldered portion 82 of the primary valve member 64, thereby forming a fulcrum for said lever and the arms 81 have oppositely disposed shoulders 83 which engage the under surface of a head 84 formed at the upper extremity of the primary valve member 64 and provide a means for lifting the latter.

The other end portion of the lever 78 is also forked at 85 to partially surround a nut 86 and the furcations of said forked portion engage arms 87 which project from the opposite sides of said nut. The nut 86 is mounted upon a screw-threaded portion 88 of a shaft 89 at the upper end of which is a hand wheel 90. The shaft 89 is mounted to rotate in a bearing member 91 through which leakage of the pressure fluid is prevented by a stuffing box 92. A projection 93 is provided upon the lever 78 and at times said projection is brought into contact with a flat surface 94 provided within the interior of the casing 10, and said projection forms a fulcrum for said lever as will be hereinafter more fully explained.

The general operation of the device is as follows:—Assuming that a suitable fluid at about 200 pounds pressure is entering the auxiliary pressure chamber 12 through the inlet pipe 30 and check valve 29 and that a similar fluid at approximately 2500 pounds pressure is entering the casing member 37 through the inlet pipe 54 and check valve 53, and also assuming that the main inlet valve 14 and exhaust valve 63 are closed as illustrated in Fig. 1, said main inlet valve being held closed by the pressure of the fluid in the auxiliary pressure chamber 12 above said main inlet valve and the exhaust valve 63 being held closed by the lever 78 and nut 86, when it is desired to admit said pressure fluid to the main pressure chamber 11 from which it may pass through the outlet pipe 26 to a hydraulic press or other device actuated by fluid pressure, the operating wheel 90 is turned to rotate the shaft 89 in the proper direction to feed the nut 86 downwardly upon the screw-threaded portion 88 of said shaft. This movement of the nut 86 rocks the lever 78, the arms 81 of said lever constituting a fulcrum therefor, thereby lifting the primary valve member 15 of the main inlet valve 14 and admitting the low pressure fluid through the ports 22 into the main pressure chamber 11. If the nut 86 is only lowered a short distance, the primary valve member 15 alone is opened, but if, however, the hand wheel 90 is still further rotated, the nut 86 is lowered sufficiently to rock the lever 78 so that the upper surface of the forked end 79 thereof will engage the under extremity of the secondary valve member 17 of the main inlet valve 14, thereby lifting said secondary valve member off of its seat 19 and thereafter also admitting pressure fluid to the main pressure chamber 11 through the ports 24 of said secondary valve member. As soon as the pressure fluid enters the main pressure chamber 11, said pressure fluid acts upon the exhaust valve 63 to hold the members thereof tightly closed and said exhaust valve will thereafter be held closed as long as the pressure is maintained within said pressure chamber.

The low pressure fluid now having been turned on to its greatest extent, a still further rotation of the hand wheel 90 in the same direction will cause the lever 78 to be still further rocked, thereby lifting the primary valve member 15 of the main inlet valve 14 into engagement with the lower extremity of the valve stem 42 of the primary valve member 41 of the high pressure inlet valve 40, thereby lifting said valve member and admitting the high pressure fluid through the ports 48 into the auxiliary pressure chamber 12. The high pressure fluid will immediately cause the valve member 32 of the check valve 29 to automatically close but as both members of the main inlet valve 14 are opened, said high pressure fluid will immediately pass to the main pressure chamber 11 and as the exhaust valve 63

is still held closed, it will pass outwardly through the outlet pipe 26 to the hydraulic press.

When it is desired to exhaust the pressure fluid from the main pressure chamber 11 and its connections to the hydraulic press, the hand wheel 90 is rotated in a reverse direction and the nut 86 is lifted, thereby rocking the lever 78 and utilizing the arms 81 thereof as a fulcrum and again seating the primary and secondary valve members of the main inlet valve 14 upon their respective seats. As soon as the main inlet valve 14 is closed, a continued movement of the nut 88 upwardly will first lift the primary valve member 64 of the exhaust valve 63, allowing the pressure fluid within the main pressure chamber to pass outwardly through the ports 71 and still further movement of said hand wheel and nut 86 will cause the nut 74 at the lower end of the valve stem 65 to engage the under extremity of the secondary valve member 66 and lift the latter from its seat 68 thereby allowing the pressure fluid to also flow outwardly through the ports 73 and said fluid will pass off through the exhaust pipe 77. As soon as the pressure is released from the main pressure chamber, the action of the high pressure fluid will close the high pressure inlet valve 40, whereupon the low pressure fluid will be again admitted to the auxiliary pressure chamber 12 and said pressure fluid will act to hold the main inlet valve 14 tightly closed.

It is evident that at the end of a day's work, or at other times, the pressure of fluid above the main inlet valve 14 might be reduced to such an extent that said fluid would not hold said inlet valve tightly closed, in which case the fluid might leak therethrough. At such times said inlet valve may be positively held closed by turning the hand wheel 90 in the proper direction to lift the nut 86 to rock the lever 78 so that the projection 93 will contact with the surface 94 at the top of the main pressure chamber 11 and said projection 93 will act as a fulcrum for said lever and will cause the latter to force the primary and secondary valve members of the main inlet valve tightly against their respective seats. At this time the primary and secondary valve members of the exhaust valve 63 will both be open.

It will be noted that during the operation of the device while it is possible for the main inlet valve 14 and exhaust valve 63 both to be located in their closed positions simultaneously, that it is impossible for both to be opened simultaneously as whenever the main inlet valve is open, the exhaust valve is closed, and in like manner whenever the exhaust valve is opened, the main inlet valve is closed, the result being a great saving of the pressure fluid which usually goes to waste in hydraulic presses.

It will also be noted that whenever the pressure fluid is turned on through the medium of the device of the present invention, that the lowest pressure obtainable will always be turned on first, and that it is impossible to turn on the higher pressure fluid until the low pressure fluid has been entirely turned on, and that both of said pressure fluids are turned on and shut off through the medium of the same operating member.

I claim:

1. A device of the character described comprising, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages, one of which communicates with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage and means to open separately all of said valves.

2. A device of the character described comprising, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages, one of which communicates with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage and means to open separately all of said valves, each of said valves being adapted to be closed by the pressure of fluid thereon.

3. A device of the character described comprising, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages, one of which communicates with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage and means to open said inlet valves consecutively and also to open said exhaust valve.

4. A device of the character described comprising, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages, one of which communicates with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage, a lever operatively connected to said exhaust valve and one of said inlet valves and means to operate said lever and thereby open separately all of said valves.

5. A device of the character described comprising, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages, one of which communicates with said pressure chamber, said pressure chamber also having an outlet

passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage, a lever operatively connected to said exhaust valve and one of said inlet valves and means to operate said lever and thereby open separately and positively close separately both of said valves to which said lever is connected.

6. A device of the character described comprising, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages, one of which communicates with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage, a lever pivotally mounted upon said exhaust valve and operatively connected to one of said inlet valves and means to operate said lever and thereby open separately all of said valves.

7. A device of the character described comprising, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages, one of which communicates with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage, a lever operatively connected to said exhaust valve and one of said inlet valves and means to operate said lever and thereby open separately and positively close separately both of said valves to which said lever is connected, all of said valves also being adapted to be closed by the pressure of fluid thereon.

8. A device of the character described comprising, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages, one of which communicates with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage, a lever located within said pressure chamber pivotally mounted upon said exhaust valve and operatively connected to one of said inlet valves and means to operate said lever and thereby open separately all of said valves.

9. A device of the character described comprising, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages, one of which communicates with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage, a lever located within said pressure chamber pivotally mounted upon said exhaust valve and operatively connected to one of said inlet valves and means to operate said lever and thereby open separately all of said valves and also positively close separately both of said valves to which said lever is connected.

10. A device of the character described having, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages for fluids of different degrees of pressure, one of said passages communicating with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage and means to close said exhaust valve and to open said inlet valves to admit said fluid to said pressure chamber, the pressure of said fluid within said pressure chamber being increased consecutively from the lowest degree upwards.

11. A device of the character described having, in combination, a casing provided with a main pressure chamber and a plurality of aligning inlet passages for fluids of different degrees of pressure, one of said passages communicating with said pressure chamber, said pressure chamber also having an outlet passage and an exhaust passage communicating therewith, valves for said inlet passages, a valve for said exhaust passage and means to open said inlet valves consecutively to admit said fluid to said pressure chamber, the pressure of said fluid within said pressure chamber being thereby increased from the lowest degree upward.

12. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage and means to open separately all of said valves.

13. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve

for said exhaust passage, a valve for said high pressure inlet passage and means to open separately all of said valves, each of said valves being adapted to be closed by the pressure of fluid thereon.

14. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage, a lever mounted upon said exhaust valve and operatively connected to said main inlet valve and means to rock said lever and thereby open separately all of said valves.

15. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage, a lever located within said main pressure chamber and pivotally connected to said exhaust valve and also operatively connected to said main inlet valve and means to rock said lever and thereby open separately all of said valves.

16. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage, a lever located within said main pressure chamber and pivotally connected to said exhaust valve and also operatively connected to said main inlet valve and means to rock said lever and thereby open separately all of said valves, and also close both of said valves to which said lever is connected.

17. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage, a lever located within said main pressure chamber and pivotally attached to both said exhaust valve and said main inlet valve and means to rock said lever and thereby open separately all of said valves and positively close separately said main inlet valve and said exhaust valve.

18. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage, a lever located within said main pressure chamber and pivotally attached to both said exhaust valve and said main inlet valve and means to rock said lever and thereby open separately all of said valves and positively close separately said main inlet valve and said exhaust valve, all of said valves also being adapted to be closed by the pressure of fluid thereon.

19. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having an inlet passage for a low pressure fluid and an inlet passage for a high pressure fluid communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage, a check valve for said low pressure fluid, a check valve for said high pressure fluid, a lever mounted upon said exhaust valve and operatively connected to said main inlet valve and means to rock said lever and thereby open sep-

arately said exhaust valve and said inlet valves and positively close separately said main inlet valve and said exhaust valve.

20. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage, a lever located within said main pressure chamber and pivotally attached to both said exhaust valve and said main inlet valve and means to rock said lever and thereby open separately all of said valves and positively close separately said main inlet valve and said exhaust valve, said lever also being provided with a projection thereon adapted to constitute a fulcrum for said lever.

21. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage, a lever located within said main pressure chamber and operatively connected to said exhaust valve and said main inlet valve and means to operate said lever to open and close said exhaust valve and said main inlet valve, said main inlet valve being adapted to engage said high pressure inlet valve and thereby open the latter.

22. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage, a valve for said exhaust passage, a valve for said high pressure inlet passage embodying therein primary and secondary valve members, a lever located within said main pressure chamber and operatively connected to said exhaust valve and said main inlet valve and means to operate said lever to open and close said exhaust valve and said main inlet valve, said main inlet valve being adapted to engage said high pressure inlet valve and thereby open separately the members of the latter.

23. A device of the character described comprising, in combination, a casing provided with a main pressure chamber having a main inlet passage, an outlet passage and an exhaust passage communicating therewith, said casing also being provided with an auxiliary pressure chamber communicating through said main inlet passage with said main pressure chamber and having a low pressure inlet passage and a high pressure inlet passage communicating therewith, a valve for said main inlet passage embodying therein primary and secondary valve members, a valve for said exhaust passage, a valve for said high pressure inlet passage embodying therein primary and secondary valve members, a lever located within said main pressure chamber and operatively connected to said exhaust valve and said main inlet valve and means to operate said lever to open and close said exhaust valve and said main inlet valve, the primary valve member of said main inlet valve being adapted to engage the primary valve member of said high pressure inlet valve and thereby open separately the members of the latter.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

EMIL O. LUNDBLAD.

Witnesses:
FRANKLIN E. LOW,
HAZEL F. BATES.