

March 14, 1944.

M. V. GROVES

2,343,901

COMPOUND HYDRAULIC COMPRESSOR

Filed Oct. 24, 1942

3 Sheets-Sheet 1

Fig. 1.

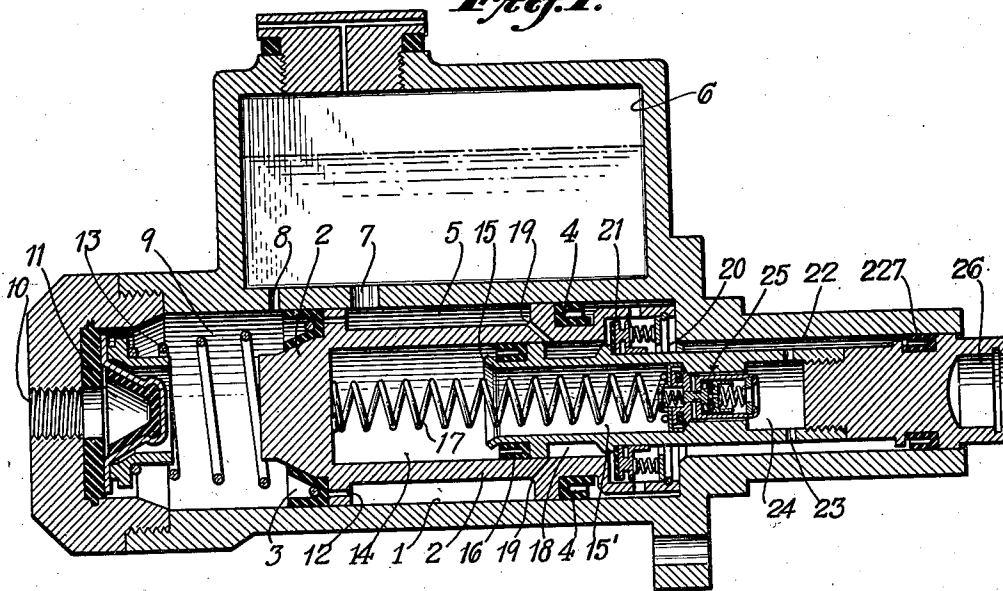


Fig. 2.

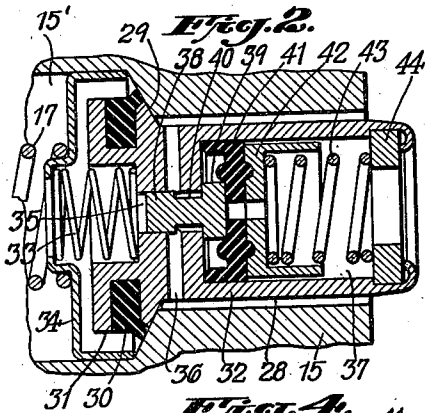


Fig. 4.

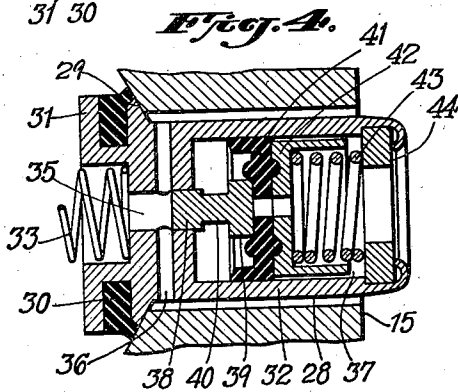


Fig. 3.

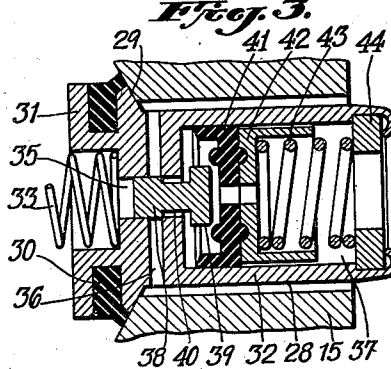
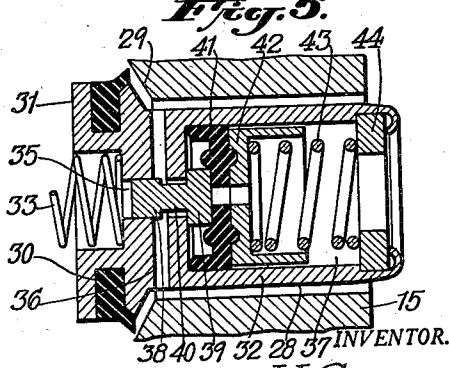


Fig. 5.



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Fig. 6.

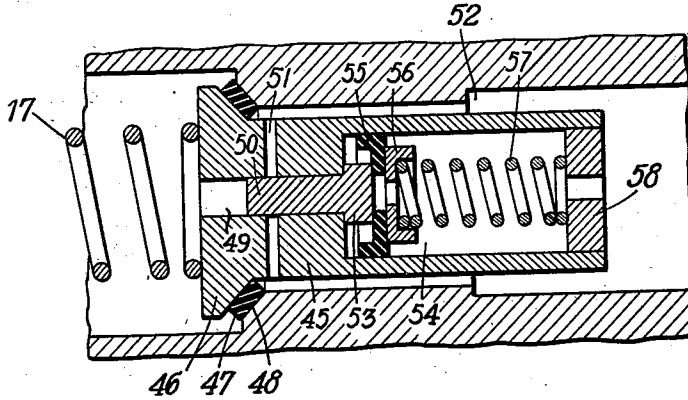


Fig. 7.

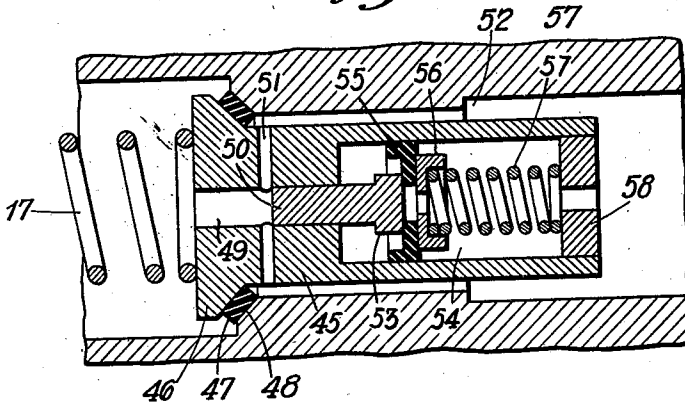
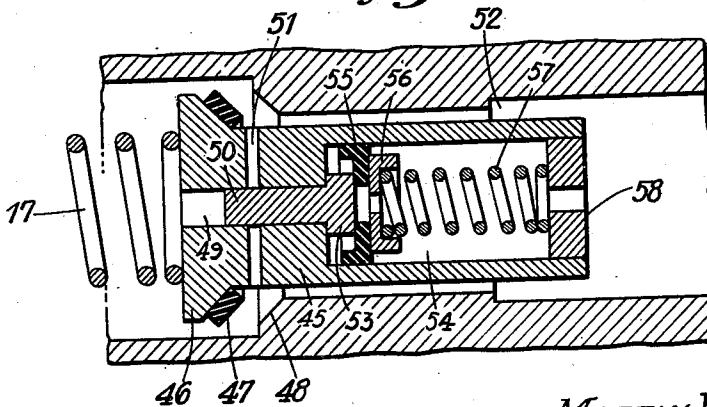


Fig. 8.



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Fig. 9.

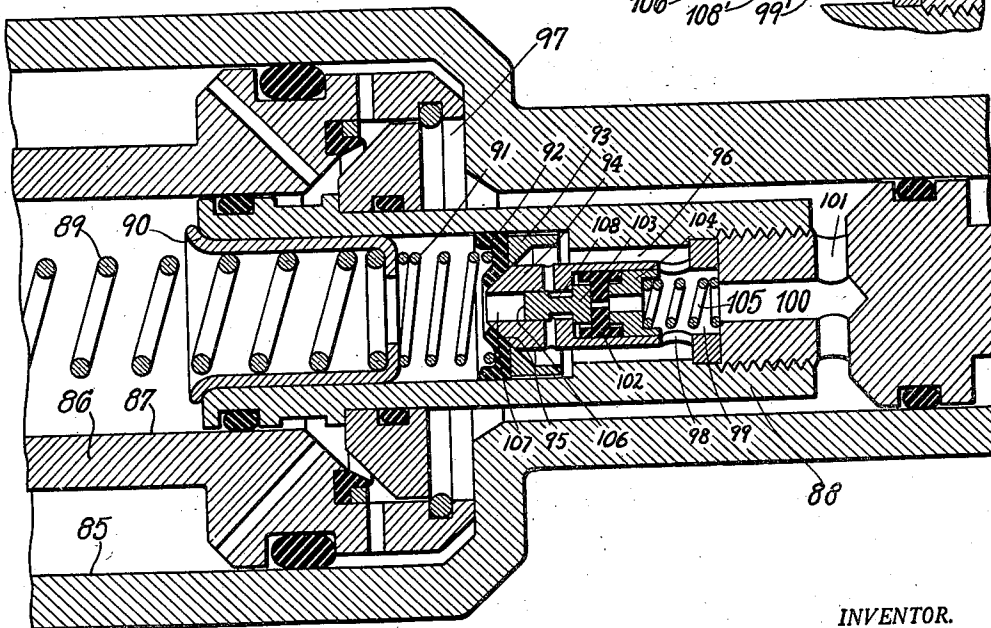
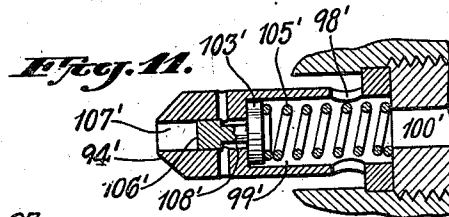
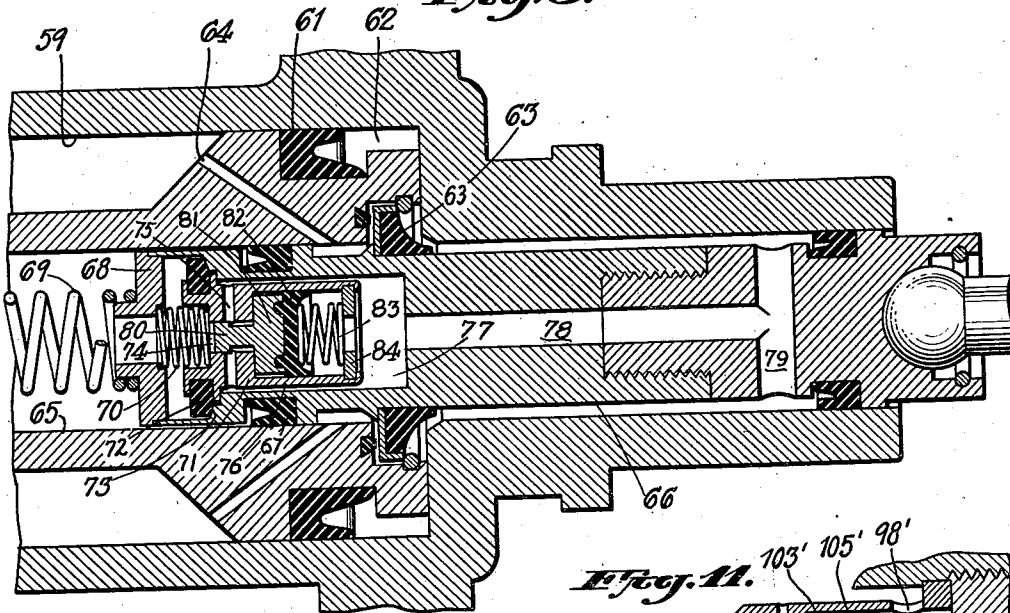


Fig. 10.

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UNITED STATES PATENT OFFICE

2,343,901

COMPOUND HYDRAULIC COMPRESSOR

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Application October 24, 1942, Serial No. 463,165

14 Claims. (Cl. 60—54.6)

My invention relates to compound hydraulic brake compressors or the like, and more particularly to a valve structure for controlling the operation of said compressor.

This application is a continuation in part of my copending applications Serial No. 366,333, filed November 20, 1940, for "Compound hydraulic brake compressor" and Serial No. 436,584, filed March 28, 1942, for "Hydraulic actuating mechanism."

In structures of this character, the operation comprises in general two stages; the first stage representing the low pressure stage and the second stage the high pressure stage. In passing from one stage to the other, the operation is controlled by a high pressure or unloading valve which comes into operation at a predetermined pressure. It is desirable in such structures to have this valve operate in such a way that the "carry-over" from one stage to the other be effected with a smooth action so that the change from simple to compound action may be brought about without any noticeable surge in the system. This is particularly important where the compressor is utilized to deliver an ultimate relatively high pressure.

Additionally, in compressors of the type disclosed in said copending applications, the valve serves as a hydraulic coupling between the primary and secondary pistons causing them to move together as one unit during the first or low pressure stage and permitting relative movement between said pistons during the second or high pressure stage; and in such a structure, it is likewise desirable that the coupling and uncoupling of the two pistons be effected smoothly and without appreciable jerk.

An object of the present invention is to provide a high pressure or unloading valve structure providing a smooth change-over from low pressure to high pressure.

Another object of the invention is to provide a valve structure which responds quickly without undue jerk or surge.

Another object of the invention is to provide mechanism permitting "rocking" or successive rapid actuating impulses without losing pressure.

A further object of the invention is to provide a compound compressor unit comprising such a pressure valve mechanism in combination with a priming valve.

Further objects and advantages of the invention will more fully appear from the following description taken in connection with the ac-

companying drawings which show, by way of example, present preferred embodiments of the invention.

The invention consists in the novel features, arrangement, and combination of parts embodied by way of example in the mechanism hereafter described as illustrative of the present preferred forms of the invention, and the inventions will be more particularly pointed out in the appended claims.

Referring to the drawings:

Fig. 1 is a longitudinal sectional view illustrating the compressor unit embodying the invention;

Fig. 2 is a somewhat enlarged view of certain parts of Fig. 1 showing the pressure and priming valve structure, with both valves closed;

Fig. 3 is a view similar to Fig. 2 but with the pressure valve commencing to open;

Fig. 4 is a view similar to Fig. 2 but showing the pressure valve fully open;

Fig. 5 is a view similar to Fig. 2 but showing the priming valve open with the pressure valve in closed position;

Fig. 6 is an enlarged longitudinal sectional view showing a modified structure of pressure and priming valve, with both valves in closed position;

Fig. 7 is a view similar to Fig. 6 but showing the pressure valve open, with the priming valve in closed position;

Fig. 8 is a view similar to Fig. 6 but showing the priming valve open with the pressure valve in closed position;

Fig. 9 is a longitudinal cross-sectional view of a portion of a compressor unit, showing a somewhat modified form of structure;

Fig. 10 is a longitudinal cross-sectional view of a portion of the compressor unit showing a further modified form of structure; and

Fig. 11 is an enlarged longitudinal cross-sectional view showing a modified and somewhat simplified high pressure valve structure.

Since the invention relates more particularly to a valve mechanism and arrangement, only such portions of the remaining structure of the compressor unit will be described as necessary to show the full and complete relationship of the parts. Details of the invention described but not claimed herein form the subject matter of said copending applications above referred to.

Referring more particularly to Fig. 1, a primary cylinder is designated as 1, and positioned therein for reciprocal movement is a primary pis-

ton 2 provided with spaced apart heads comprising sealing cups 3 and 4. The piston is somewhat reduced in diameter intermediate the cups 3 and 4 to provide an annular chamber 5 which is in constant communication with the reservoir 6 through a port 7. The reservoir 6 is provided with a further port 8 which is in communication with the space 9 provided in the cylinder 1 forward of the head 3 when the piston is in retracted position, as indicated in the drawings. The space 9 provides a pressure chamber adapted to be placed in communication, as by an outlet 10, which the pressure line, such as a brake system, and egress and ingress is controlled by suitable check valve mechanism designated in its entirety as 11. A plurality of ports 12 provide passage of fluid from the annular chamber 5 to the pressure chamber 9 to provide for bleeding the system, and the sealing cup 3 prevents reverse passage of the fluid from the chamber 9 into the chamber 5. The primary piston 2 is urged rearwardly by a retractile spring 13.

The primary piston 2 is provided with an axial bore 14 which serves as a secondary cylinder within which is provided a secondary piston 15 provided with a head comprising a sealing cup 16. The secondary piston 15 is provided with an axial bore 15' in which is seated the rear end of a retractile spring 17 whose forward end is seated against the forward head of primary piston 2.

The secondary piston is somewhat reduced in diameter rearwardly of its forward end so as to provide a space 18 which is in communication with the space 5 through a series of ports 19. To the rear of the sealing cup 4 and within the cylinder 1, there is provided a chamber 20, which for purposes of convenience will be referred to as the primary chamber. Between this chamber 20 and the space 18, there is provided a check-valve designated as 21, so constructed and arranged that in the retracted position of the parts as indicated in Fig. 1, the valve is open, placing the space 18 and chamber 20 in communication; and during the actuation of the compressor, the valve is closed so as to prevent passage of fluid from the chamber 20 into the space 18. The chamber 20 extends rearwardly into a reduced bore 22, forming a rearward extension of the cylinder 1, and a plurality of passages, such as 23, serve to place the chamber 20 in communication with a chamber 24 provided in the secondary piston 15. The chamber 24 is adapted to be placed in communication with and shut off from the secondary cylinder or chamber 14 by means of valve mechanism designated in general as 25, and this valve mechanism will be more particularly described with reference to Figs. 2-5, inclusive. The secondary piston extends rearwardly and provides an engageable portion 26 which is adapted to be manually operated. A sealing cup 27 is in sealing engagement between the secondary piston and the bore 22.

Referring more particularly to Figs. 2-5, inclusive: The bore 15' in the secondary piston 15 is reduced in diameter to provide a smaller bore designated 28, which is in communication with the chamber 24 (Fig. 1). Intermediate the bore 15' and the reduced portion 28, there is provided a seat 29 cooperating with a priming valve sealing cup 30 carried by a priming valve head 31 which is formed as an integral part with a valve body 32. The valve head and its sealing cup are urged against the seat 29 by means of a relatively light priming valve spring 33 which

is seated within a recess provided in a priming valve spring retainer washer 34 disposed within the bore 15' and seated against the valve seat 29. The washer 34 also serves to restrain the lower end of the secondary piston retractile spring 17, which being stiffer than the spring 33 maintains the washer 34 against its seat; sufficient clearance being provided beneath the washer 34 to permit the opening of the valve 30-31, against the action of the spring 33, to the open position shown in Fig. 5. The washer 34 is provided with a central opening so as not to obstruct passage of fluid from the secondary cylinder 14 and bore 15' to the bore 35.

The valve body 32 is provided with an axial bore 35 and with one or more outwardly radially extending passages 36; the bore 35 providing the inlet port, and the passages 36 providing the outlet ports of the high pressure or unloading valve. The body 32 rearwardly of the priming valve head 31 is of less diameter than that of the bore 28, to thereby provide an annular space or passage. The body 32 is also provided with a cylinder 37 in communication with the bore 35 and having its rear end opening into the chamber 24 (Fig. 1). A valve portion or plunger 38 is slidably disposed in the bore 35, and in the position shown in Fig. 2, serves to close the passages 36 from communication with the bore 35 at its intake or high pressure end where it is exposed to the pressure from the secondary chamber 14. The valve plunger 38 is provided with an enlarged head 39 disposed within the cylinder 37, and a relief groove 40 is preferably provided between the plunger 38 and head 39. A sealing cup 41, with its flange turned forwardly, is positioned within the cylinder 37 with its forward face resting upon the enlarged head 39 and with its rear face engaging the spring retainer cup 42 within which is seated the forward end of the spring 43 whose rear end is confined by a washer 44, which is held in place by the turned end of the body 32; the washer 44 being provided with an enlarged opening so as not to interfere with communication between the cylinder 37 and the space or chamber 24 (Fig. 1). The sealing cup 41 is provided with a concentric peripheral bead on its forward face within which is seated the enlarged head 39, and with a corresponding bead on its rear face seated in a cooperating groove formed in the cup 42 so as to maintain proper alignment between the parts and serving the additional function of confining the sealing cup (which is preferably made of relatively elastic material, such as rubber). The sealing cup 41 and spring retaining cup 42 are provided with registering axial openings, for the purposes to be more particularly described hereinafter in connection with the description of the operation of the mechanism.

Operation

When it is desired to provide pressure in the line attached to the opening 10, the device is actuated by applying pressure to the end 26 of the secondary piston. At this time, the priming valve 30-31 is seated against its seat 29 (Fig. 2) and the high pressure valve 35-38 is closed, thereby trapping the fluid in the chamber 14-15'. This acts as a fluid coupling between the pistons 2 and 15, causing them to move as one unit during the first or low pressure stage. As the piston 2 is moved forward, the port 8 (Fig. 1) is closed, and when a predetermined pressure is developed in the system by the forward movement of the piston 2, a corresponding pressure is imposed in

cylinder 14 and bore 15' so as to actuate the valve 38, whereupon the high pressure valve plunger 38 is moved rearwardly from the initial position (Fig. 2) to the position shown in Fig. 3, at which time the relief groove 40 is moved out of communication with the passages 36 and upon further movement of the valve plunger 38 and enlarged head 39, the sealing cup 41 is moved rearwardly against the force of spring 43. This creates a suction forwardly of the cup 41, i. e., a difference in pressure between the chamber formed forwardly of the cup (within which the head 39 is positioned) and the pressure on the rear side of the cup. This difference in pressure causes the fluid to flow through the aligned openings in the cups 41 and 42; the rate of flow being regulated by the strength of the spring 43, the diameter of the plunger head 39 and the fit of the valve plunger 38 in the bore 35. The fit of the plunger head 38 in the bore 35 is preferably a fairly close sliding fit, and therefore for a given pressure exerted on the forward end of the valve portion 38, the rate of flow from the rear side to the front side of the cup 41 is controlled by proper calibration of spring 43 and the diameter of head 39. By providing such a predetermined rate of flow, the movement of the valve plunger 38 to open position is damped, thus preventing an immediate snapping open of the high pressure valve and avoiding the rapidity of unloading which would result in an undesirable surge or too rapid change-over from the low pressure to the high pressure stage. The space between the adjacent faces of the head 39 and sealing cup 41 is greatly exaggerated in Fig. 3 in order to more clearly show the space through which the fluid passes at this stage of operation. It is noted that if the cup 41 is made sufficiently flexible, fluid will pass from the chamber 37 past the periphery of the cup 41 into the chamber forwardly of said cup. However, in the embodiment of Figs. 2-5 inclusive, the cup 41 is so formed and disposed as to afford no appreciable passage of fluid thereby; chief reliance being made for the passage of fluid by means of aligned openings formed in the cup 41 and cooperating backing cup 42. In other embodiments to be described following, the flexibility of a cup comparable to 41 is relied upon as the chief means for passage of the fluid into the locking chamber. Applicant's experience has indicated that a somewhat more accurate calibration has been obtained by utilizing the passages through the cup and backing member for calibration purposes; although he has successfully used the alternative structure, as well as a combination of the two.

Upon continued operation, the valve plunger 38 is moved to the position indicated in Fig. 4, at which time the bore 35 has been placed in complete communication with the passages 36 and this permits fluid from the secondary cylinder to pass rearwardly through the bore 28, into the space 24, through the port 23, and thence into the chamber 20 which has now been closed by the closing of valve 21 permitted by the forward movement of the secondary piston 15. Continued application of actuating pressure to the end 26 of the small piston 15 causes it to move forward within the cylinder 14 passing the relatively high pressure fluid into the chamber 20 and thereby producing a hydraulic advantage which moves the large piston 2 forward during the second or high pressure stage of operation. During this second stage of operation, it is desirable that the high pressure valve remain open

until the actuating pressure on the compressor is released, and even upon release, the valve should not close immediately since this will produce surge or jerky operation. With the parts as shown in Fig. 4, fluid is trapped in the chamber on the forward side of the sealing cup 41 and the plunger head 38 is locked in open position by the pressure exerted on the forward face of the head 39, thus preventing the high pressure valve from closing until the release of the fluid thus trapped, regardless of the pressure exerted by the spring 43 and the hydraulic pressure in the chamber 24. However, when the pressure in the secondary cylinder 14, which is exerted through the bore 35 upon the plunger 38, is relieved by removing actuating pressure from the part 26, the pressure of fluid through the openings in the cups 41-42 is exerted upon the head 39 thus pushing the head away from the cup 41, thereby breaking down the lock chamber seal and permitting the plunger 38 to move forwardly to the position shown in Fig. 3. Upon further movement of the plunger 38, the relief recess 40 places the locked chamber in communication with the passages 36 to assure the prompt and full closing of the high pressure valve by freely venting the locked chamber passage. After the high pressure valve has thus been closed, and upon the rearward movement of the parts under the influence of retractile springs 13 and 17, the rearward movement of the small piston 15 lowers the pressure in its cylinder 14, thereby opening the priming valve 30-31 to the position shown in Fig. 5 and permitting the flow of fluid from the chamber 20 through the port 23, through the chamber 24, through the bore 28 through the open priming valve into the bore 15' and cylinder 14.

It will thus be seen that the opening and closing of the high pressure valve is damped by the fluid pressure and in its open position is held open by the fluid pressure even though the pressure in the compressor is "rocked," i. e., successively raised and lowered, without permitting jerky operation due to the too rapid opening and closing of the high pressure valve. In this damping action, the head 39 in cooperation with the sealing cup 41 forms in effect a damping piston providing means for controlling the flow of the fluid from one side of the piston to the other; and the rate of flow of the fluid may be fixed at any predetermined value to effect the desired degree of damping.

Referring more particularly to Figs. 6, 7 and 8, a somewhat modified form of valve structure is shown in which the valve body is designated as 45 and its forward end is provided with a priming valve head 46 carrying suitably secured thereto a sealing ring 47 adapted to engage, when in closed position, a cooperating valve seat 48. In this embodiment, the priming valve is held in closed position by the secondary piston retractile spring 17; and it is noted in this connection that the use of the common spring for the priming valve and retraction of the secondary piston does not permit of as flexible adjustment and operation as the preferred form previously described in which a separate spring is used for the priming valve. The body 45 is provided with an axial bore 49 in which is slidably disposed a valve plunger 50 serving to open and close one or more passages, such as 51, which are in communication on their outer ends with an annular space 52 which is in communication with the chamber 20 (Fig. 1) in the manner and for the purposes previously described in connection with the valve

mechanism disclosed in Fig. 1. The valve plunger 51 carries an enlarged head 53 which is disposed in a cylinder 54 provided in the body 45 and the rear face of the head 53 engages the front face of a sealing cup 55 which is engaged on its rear face by a spring retaining cup 56 receiving the forward end of a compression spring 57 whose rear end is restrained by means of a retaining washer 58 suitably secured to the outer end of the body 45; and the washer is provided with an axial opening to permit free access of fluid between the cylinder 54 to the rear of the cup 55 and the chamber 20 (Fig. 1). In the operation of this embodiment, the passage of fluid from the rear compartment of cylinder 54 past the piston, comprising the head 53 and cup 55, is largely effected by leakage past the peripheral flange of the cup 55; while the passage of fluid rearwardly from beneath the piston takes place between the head 53 and the cup 55 and thence rearwardly through the aligned axial openings provided in the cups 55 and 56. A further distinction is that in this embodiment no relief groove is provided in the stem of the plunger 50 intermediate its forward end and the head 53, and accordingly the ultimate closing of a valve of this embodiment is not expedited to the extent of the valve previously described in connection with Figs. 1 to 5, inclusive. Fig. 7 shows the high pressure valve in open position, at which time the locked chamber between the forward side of the piston and the forward end of cylinder 54 is filled with fluid under pressure. In Fig. 8, the parts are shown in the cycle of operation previously described in connection with Fig. 1 when the high pressure valve is closed and the priming valve is moved forwardly from its seat to permit the free passage of fluid from the primary chamber to the secondary chamber. For example, during this operation, the valve 21 is closed and the fluid in chamber 20 to the rear of the large piston 4 escapes through the annular passage 22, the ports 23, the chamber 52 and past the valve 46—48 into the primary cylinder 14; the valve 46 being urged forwardly to its open position (Fig. 8) against the spring 13 which serves to retract the large piston. As soon as the large piston is moved rearwardly a sufficient distance relative to the small piston 16, the valve 21 is opened, thereby venting the chamber 20 through the open valve 21 and port 19, etc. The spring 17 then closes the valve head 46 against its seat 48 and the small piston is thereby retracted; the suction created in the cylinder 14, by the rearward movement of the piston 16, draws fluid from the annular space 18 past the sealing ring of piston 16 and into the cylinder 14.

Referring more particularly to Fig. 9, a somewhat modified form of structure is disclosed in which the large cylinder is designated as 59 in which is provided a large piston 60 whose rear head comprises a sealing cup 61 to the rear of which is formed a low pressure chamber 62, corresponding to the chamber 20 of Fig. 1. A check-valve 63 is provided for opening and closing this chamber by way of ports, such as 64, corresponding to the ports 19 of Fig. 1. A small or secondary cylinder is designated as 65 and contains a secondary piston 66 provided with a head comprising a sealing cup 67. A spring retainer 68 is seated on a forwardly extending sleeve integrally formed with the secondary piston 66 and supports on its forward face a retractile spring 69 and on its rear face a priming valve spring 70 75

whose rear end is seated in the recess formed in the valve body 71 provided with a priming valve head in which is carried a suitable priming valve sealing ring 72 of suitable elastic material, such as rubber, for cooperative engagement with the priming valve seat 73. The valve body 71 is provided with an axial bore 74 and with one or more outwardly extending passages, such as 75, communicating with an annular passage 76 which is in communication with a chamber 77 which is placed in communication with the primary chamber 62 by means of an axial bore 78 and one or more outwardly extending passages 79. A valve plunger 80 is disposed within the bore 74 for the purposes previously described, and carries an enlarged head 81 disposed within the cylinder 77 and whose rear face is engaged by a sealing cup 82 carrying on its forward face a concentric bead engaging a cooperative groove in the head 81. The cup 82 and head 81, as well as the valve plunger 80, are urged forwardly by means of a spring 83 suitably retained in position by means of a washer 84 in the general manner previously described. The operation of this embodiment is quite similar to the embodiment previously described in connection with Figs. 1-5, inclusive, and therefore will not be set forth in further detail. It is noted, however, that in this embodiment, cup 82 is so formed and disposed that fluid from the rear thereof passes by the periphery of the cup when the same is urged rearwardly against the spring 83 by means of the head 81; the concentric bead on the cup 82, seated in a cooperating groove in the head 81, serving to center the head on the cup and the relatively thin peripheral flange of the cup 82 providing the necessary flexibility to permit the passage of fluid thereby under the differential of pressure between the rear and front of said cup. In practice, this arrangement has been found to give satisfactory result.

The modification shown in Fig. 10 is quite similar in general principles to that previously described in connection with Figs. 1 and 9, and therefore the parts will only be designated in general except as to certain portions of the valve structure which will be described in somewhat more detail. In this embodiment, the large cylinder is designated as 85, the large piston as 86, the small cylinder as 87, and the small piston as 88. The retractile spring for the small piston is designated as 89 and is retained at its rear end in a spring cup 90 which is seated in the forward end of a bore supplied in the secondary piston 88; and the rear end of the cup 90 serves to restrain a priming valve spring 91 whose rear end engages a priming valve sealing cup 92 mounted on a supporting ring 93. Unlike the preceding embodiments, in this structure the priming valve sealing cup 92 is movable with respect to the valve body 94, on the forward end of which is formed the priming valve seat 95, and the valve body 94 is rigidly secured to the secondary piston 88. The valve body 94 is in general constructed and arranged in the manner previously described except that in this embodiment an annular space 96 communicates with the primary compression chamber, designated 97, by means of ports 98, which allow fluid to pass from the annular space 96 into the valve cylinder 99, through an axial bore 100 and outwardly through one or more passages 101; instead of passing directly from the annular space 96 as in the previous embodiment. A further modification resides in the provision of a sealing cup 102 which is formed with forwardly

and rearwardly extending flanges, the forward flange surrounding the valve head 103 and the rear flange surrounding a reduced portion of a cup 104, whose rear face is recessed to receive a calibration spring 105. The double flange arrangement of the cup 102 assures somewhat greater rigidity against deformation than the embodiment of Figs. 1-5, inclusive, and it has been found that in dealing with relatively high pressures, the calibration of this type of structure gives entire satisfaction; the central opening through the cup 102 being relied upon for passage of the fluid to the left of the cup to give the desired damping action. The valve head 103 is integral with a valve plunger 106 having a sliding fit in the high pressure intake bore 107, and a relief groove 108 is provided as in the previous embodiments of Figs. 1-5, inclusive, and Fig. 9. The cycle of operation and function of this embodiment is in general similar to that previously described in connection with Fig. 1, and therefore will not be further elaborated upon.

Instead of utilizing a damping piston comprising the enlarged head of the high pressure valve in combination with a sealing cup, as in the previously described embodiments, Fig. 11 illustrates a modified form in which the sealing cup is eliminated. In the embodiment of this modification shown in Fig. 11, the structure is quite similar to that of Fig. 10 and to facilitate description, corresponding parts are designated by the same respective numerals with an added prime (') suffix. The valve body 94' is the same as in Fig. 10 and is similarly disposed. The high pressure valve head 103' is increased in diameter so as to serve as a piston without the sealing cup as heretofore described. This piston 103' is of such diameter as to provide for a restricted passage of fluid between its periphery and the cylinder walls of the cylinder 99'. The valve plunger 106' has a sliding fit in the bore 107' and a relief groove 108' is provided, all as heretofore described. In a brake compressor which unloads at approximately 150 pounds and whose high pressure stage builds up to approximately 2000 pounds, I have found that with the valve cylinder 99' having a diameter of approximately $\frac{7}{16}$ " the piston 103' having a clearance of about .005" has proven quite satisfactory where the bore 107' has a diameter of about $\frac{1}{8}$ " and the valve plunger 106' has a sliding clearance therein of about .0002".

Having thus described my invention with particularity with reference to the preferred embodiment of the same, and having referred to some of the possible modifications thereof, it will be obvious to those skilled in the art, after understanding my invention, that other changes and modifications may be made therein without departing from the spirit and scope of the invention, and I aim in the appended claims to cover such changes and modifications as are within the scope of the invention.

What I claim is:

1. An unloading valve for interconnecting a low pressure side and a high pressure side in a compound hydraulic actuator, comprising means of communication between said low pressure side and said high pressure side, a valve portion controlling the flow of fluid through said means of communication, resilient means for urging said valve portion to closed position, a piston movable with said valve portion, and a cylinder in which said piston is disposed and providing with the under side of said piston a fluid chamber, said cylinder on the other side of said piston being in

communication with said low pressure side, said valve portion and piston being movable against said resilient means by predetermined pressure on said high pressure side to open said means of communication, means to pass fluid in either direction between said fluid chamber and the low pressure side of said piston, whereby upon the opening of said valve fluid is passed into said fluid chamber from the low pressure side of said piston to hold the piston outwardly against said resilient means and the valve is held in open position until said predetermined pressure on said high pressure side is reduced, whereupon fluid is passed from said chamber to said low pressure side of said piston and the valve is returned to closed position.

2. An unloading valve for interconnecting a low pressure side and a high pressure side in a compound hydraulic actuator, comprising means of communication between said low pressure side and said high pressure side, a valve portion controlling the flow of fluid through said means of communication, resilient means for urging said valve portion to closed position, a piston movable with said valve portion, a cylinder in which said piston is disposed and providing with the under side of said piston a fluid chamber, said cylinder on the other side of said piston being in communication with said low pressure side, said valve portion and piston being movable against said resilient means by predetermined pressure on said high pressure side to open said means of communication, said piston being constructed and arranged so as to pass fluid from the outer side of said piston into said fluid chamber upon the opening of said valve to hold the piston outwardly against said resilient means whereby the valve is held in open position until said predetermined pressure on said high pressure side is reduced, and means disposed forwardly of said valve piston for venting said fluid chamber.

3. A valve structure comprising a valve body having a high pressure inlet bore provided with an outlet port, a valve movably disposed in said bore to open and close said port responsive to predetermined fluid pressure exerted on said valve, a valve piston movable with said valve and disposed within a cylinder provided in said body, spring means urging said valve to closed position and said piston forwardly in said cylinder, said piston defining a rear compartment and a front compartment which constitutes a fluid chamber, means for providing a restricted fluid path from said rear compartment to said fluid chamber during the rearward movement of said piston and from said fluid chamber to said rear compartment upon the forward movement of said piston, and means for passing fluid outwardly from said fluid chamber exteriorly of said rear compartment.

4. In a compound hydraulic master cylinder having a primary chamber and a secondary chamber, a valve for interconnecting said chambers comprising a cylinder body having a large bore in communication with said primary chamber and a small bore extending from said large bore and in communication with said secondary chamber and a port extending outwardly from said small bore and in communication with said primary chamber, a valve plunger having a large head in said large bore and a small head in said small bore, resilient means urging said plunger inwardly to close said port to fluid passage from said secondary chamber through said small bore, said plunger being movable outwardly against

said resilient means by a predetermined fluid pressure exerted on said small head from said secondary chamber, sealing means engaging said large bore and the outer face of said large head constructed and arranged to create suction behind said head upon the outward movement thereof and to pass fluid inwardly and beneath said large head upon its movement outwardly to thereby hold said valve in open position during the application of said predetermined pressure, and vent means comprising said sealing means and said large head to control the passage of fluid outwardly from beneath said head to release said valve when said predetermined pressure is reduced.

5. An unloading valve for interconnecting a low pressure side and a high pressure side in a compound hydraulic actuator, comprising means of communication between said low pressure side and said high pressure side, a valve portion controlling the flow of fluid through said means of communication, resilient means for urging said valve portion to closed position, a piston movable with said valve portion, and a cylinder in which said piston is disposed and providing with the under side of said piston a holding chamber, said cylinder on the other side of said piston being in communication with said low pressure side, said valve portion and piston being movable against said resilient means by predetermined pressure on said high pressure side to open said means of communication, means to pass fluid in either direction between said fluid chamber and the low pressure side of said piston, whereby upon the opening of said valve fluid is passed into said fluid chamber from the low pressure side of said piston to hold the piston outwardly against said resilient means and the valve is held in open position until said predetermined pressure on said high pressure side is reduced, whereupon fluid is passed from said chamber to said low pressure side of said piston and said valve is returned to closed position.

6. In a compound hydraulic brake compressor, a cylindrical body having fluid passages, a high pressure valve mounted in said body and controlling said passages and having a flange portion of smaller diameter than the internal diameter of said cylindrical body, a flexible valve cup slidably mounted in said cylindrical body and having a central opening engaging said flange portion, a piston engaging said cup and having an opening in communication with said central opening, resilient means urging said piston and valve cup and high pressure valve in one direction for urging the high pressure valve closed, whereby when fluid pressure forces said high pressure valve open, fluid is admitted past said cup and to the under side of said flange, locking the valve open until the fluid pressure falls, permitting said resilient means to close said valve with the fluid in said cup escaping through said openings.

7. In a compound hydraulic brake compressor, a cylindrical body having fluid passages, a high pressure valve mounted in said body and controlling said passages and having a flange body, a flexible valve cup slidably mounted in said cylindrical body and having a central opening engaging said flange portion, a piston engaging said cup and having an opening aligned with said central opening, resilient means urging said piston and valve cup and high pressure valve in one direction for urging the high pressure valve closed, whereby when fluid pressure forces said high pressure valve open, fluid enters past said

cup and flange, locking the valve open until the fluid pressure falls, permitting said resilient means to close said valve with the fluid in said cup escaping through said openings.

8. A valve structure comprising a valve body having a high pressure inlet bore provided with an outlet port, a valve movably disposed in said bore to open and close said port responsive to predetermined fluid pressure exerted on said valve, a valve piston movable with said valve and disposed within a cylinder provided in said body, spring means urging said valve to closed position and said piston forwardly in said cylinder, and means including said spring means and said cylinder and said piston for hydraulically holding said valve in open position and damping its opening and closing responsive to fluid pressure exerted on said valve whereby said valve is closed only when there is a definite pressure differential acting on the valve in the direction of said spring means.

9. A valve structure comprising a valve body having a high pressure inlet bore provided with an outlet port, a valve movably disposed in said bore to open and close said port responsive to predetermined pressure exerted on said valve, a valve piston movable with said valve and disposed within a cylinder provided in said body, spring means urging said valve to closed position and said piston forwardly in said cylinder, means including said spring means and said cylinder and said piston for hydraulically holding said valve in open position and damping its opening and closing responsive to fluid pressure exerted on said valve, whereby said valve is closed only when there is a definite pressure differential acting on the valve in the direction of said spring means. A second valve body having an opening concentric with and of larger diameter than said inlet bore, said first and second bodies being relatively movable one with respect to the other, one of said bodies providing a priming valve seat and the other a cooperating priming valve, and a priming valve spring urging said priming valve and seat to closed position and yieldable in the opposite direction to thereby provide a one-way priming valve.

10. A valve structure comprising a valve body having a high pressure inlet bore provided with an outlet port, a valve movably disposed in said bore to open and close said port responsive to predetermined pressure exerted on said valve, an enlarged head integral with said valve and disposed within a cylinder provided in said body, sealing means engaging the walls of said cylinder, spring means urging said sealing means against said head and urging said head to closed position, and means including said head and said sealing means and said spring means and said cylinder for hydraulically holding said valve in open position and damping its opening and closing responsive to fluid pressure exerted on said valve whereby said valve is closed only when there is a definite pressure differential acting on the valve in the direction of said spring means.

11. In a hydraulic brake compressor having a secondary cylinder and a secondary piston therein and a spring urging said piston outwardly, the combination of, a valve structure comprising a valve body having a high pressure inlet bore provided with an outlet port, a valve movably disposed in said bore to open and close said port responsive to predetermined pressure exerted on said valve, a valve piston movable with said valve and disposed within a cylinder provided in said

body, spring means urging said valve to closed position and said piston forwardly in said cylinder, means including said spring means and said cylinder and said piston for hydraulically holding said valve in open position and damping its opening and closing responsive to fluid pressure exerted on said valve, a second valve body having an opening concentric with and of larger diameter than said inlet bore, said first and second bodies being relatively movable one with respect to the other, one of said bodies providing a priming valve seat and the other a cooperating priming valve, and a priming valve spring urging said priming valve and seat to closed position and yieldable in the opposite direction to thereby provide a one-way priming valve.

12. In a compound hydraulic brake compressor having a primary chamber and a secondary chamber, a valve for controlling fluid passage between said chambers and comprising, a cylindrical body whose rear end is in communication with said primary chamber and whose forward end is provided with an axial bore in communication with said secondary chamber, a sealing cup movably disposed within said cylindrical body defining a rear compartment and a front compartment, resilient means urging said cup toward the forward end of said cylindrical body, a valve plunger extending into said axial bore with its forward end exposed to said secondary chamber fluid pressure and provided with a head of larger diameter than said bore positioned within said front compartment and urged into forward position by said cup under the influence of said resilient means, a port extending outwardly from said bore and in communication with said primary chamber, said port being closed to said secondary chamber by said plunger when in its forward position, said cup and said plunger head jointly providing means for controlling the passage of fluid between said rear and forward compartments.

13. In a compound hydraulic brake compressor having a primary chamber and a secondary chamber, a valve for controlling fluid passage between said chambers and comprising, a cylindrical body whose rear end is in communication with said primary chamber and whose forward end is provided with an axial bore in communication with said secondary chamber, a sealing cup movably disposed within said cylindrical body defining a rear compartment and a front compartment, resilient means urging said cup toward the forward end of said cylindrical body, a valve plunger extending into said axial bore with its forward end exposed to said secondary chamber

fluid pressure and provided with a head of larger diameter than said bore positioned within said front compartment and urged into forward position by said cup under the influence of said resilient means, a port extending outwardly from said bore and in communication with said primary chamber, said port being closed to said secondary chamber by said plunger when in its forward position, said cup and said plunger head jointly providing means for controlling the passage of fluid between said rear and forward compartments, said valve plunger intermediate its forward end and head being of reduced diameter providing a relief passage from said rear compartment to said port when said plunger approaches the forward end of its stroke.

14. In a compound hydraulic brake compressor having a primary chamber and a secondary chamber, a combined priming and high pressure valve for controlling fluid passage between said chambers and comprising, a cylindrical body whose rear end is in communication with said primary chamber and whose forward end is provided with a high pressure valve bore in communication with said secondary chamber, a sealing cup movably disposed within said cylindrical body defining a rear compartment and a front compartment, resilient means urging said cup toward the forward end of said cylindrical body, a high pressure valve plunger extending into said bore with its forward end exposed to fluid pressure in said secondary chamber and provided with a head of larger diameter than said bore positioned within said front compartment, said valve plunger being urged into forward position by said cup under the influence of said resilient means and being movable rearwardly against said resilient means by a predetermined high pressure in said secondary chamber, port means extending outwardly from said bore and in communication with said primary chamber, said port means being positioned to be closed to said secondary chamber by said plunger when in its forward position and to be opened to said secondary chamber when said plunger is in a rearward position, said cup and said plunger head jointly providing means for controlling the passage of fluid between said rear and forward compartments, a concentric priming valve seat of larger diameter than said high pressure valve bore disposed forwardly of said port means, a priming valve secured to said cylindrical body, and resilient means for yieldably holding said priming valve against its seat.

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