

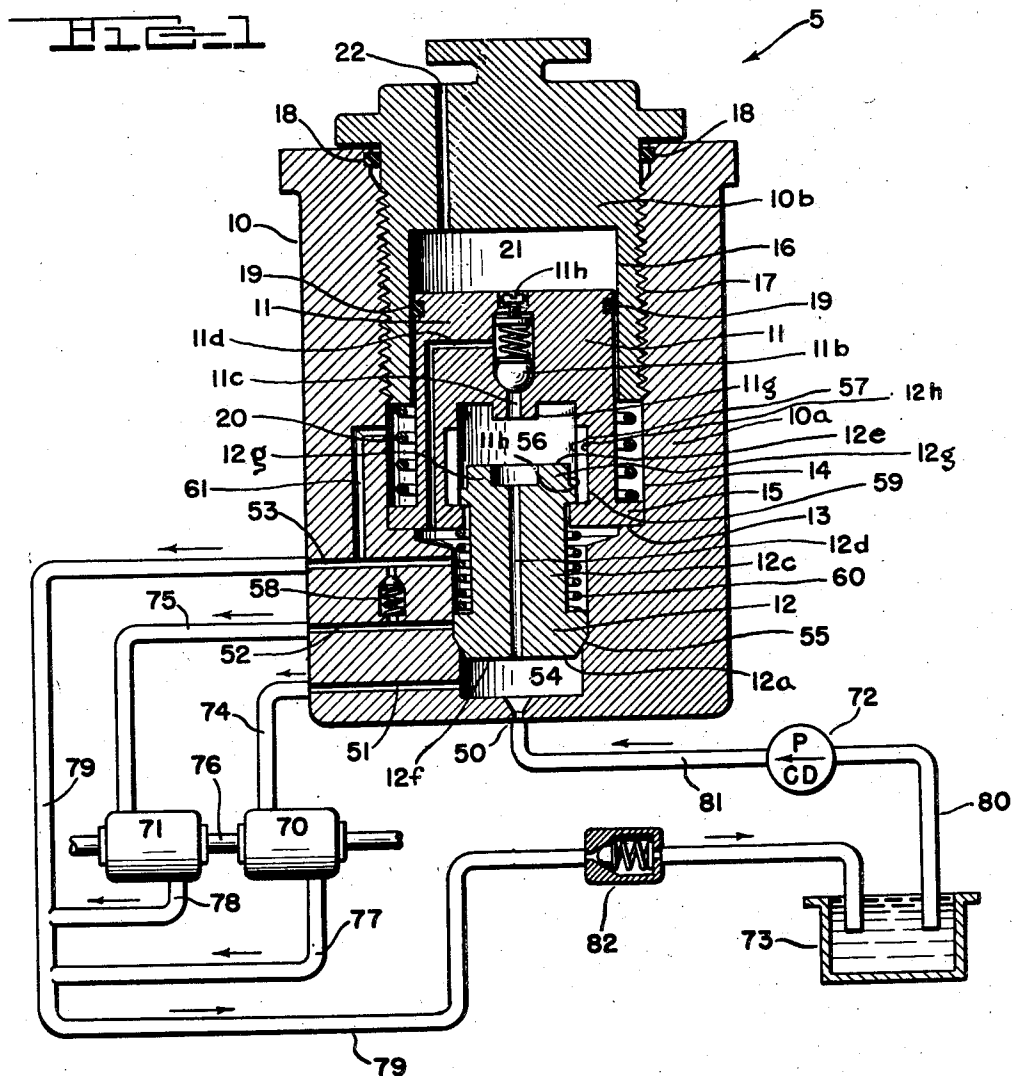
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G. I. CHINN
FLUID DISTRIBUTING VALVE

2,500,627

Filed July 15, 1947

2 Sheets-Sheet 1



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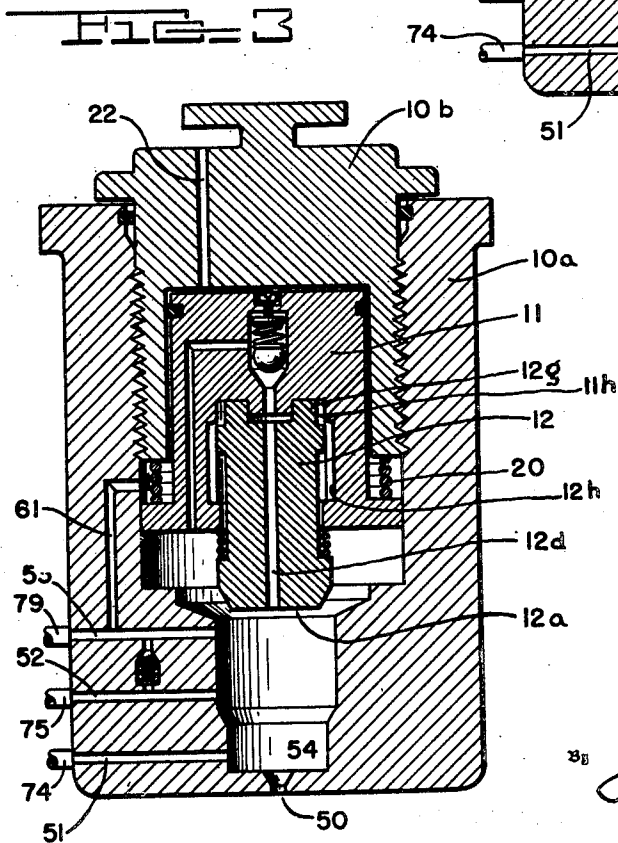
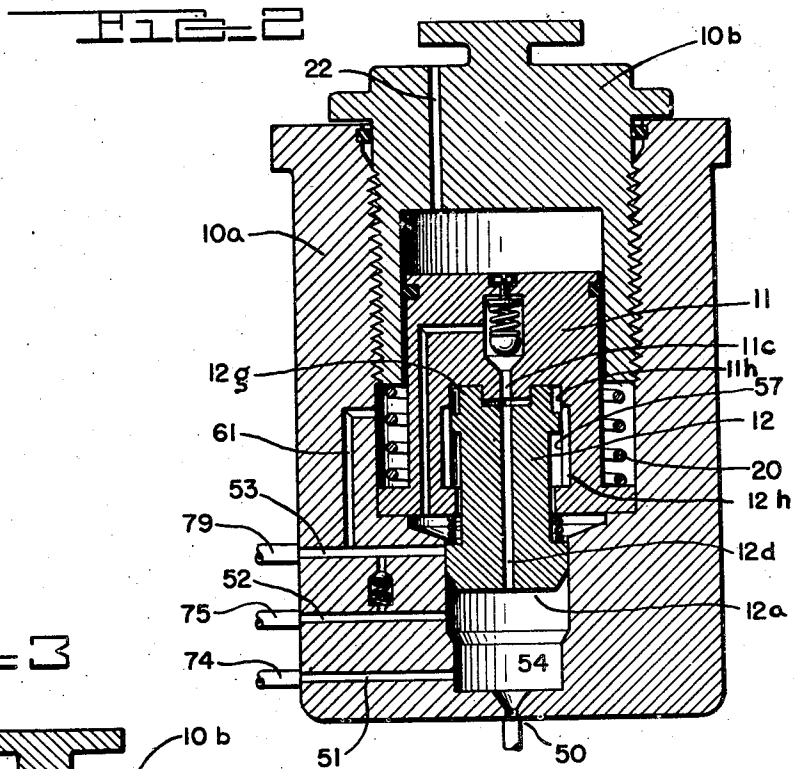
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2 Sheets-Sheet 2



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FLUID DISTRIBUTING VALVE

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My invention relates to valves, and more especially to pressure-actuated control valves and systems including the same.

An object of my invention is the provision of a simple, reliable and highly practical automatic load control valve which effectively distributes fluid power supply to one or more hydraulic motors as a function of motor load encountered during the course of operation.

A further object of my invention is the provision of a compact and efficient hydraulic multiple motor system in which fluid is reliably distributed to appropriate motors in accordance with motor output power demands encountered, and which system is well balanced, and positive in operation throughout the several intended stages of use.

Other objects and advantages in part will be obvious and in part pointed out hereinafter.

The invention accordingly consists in the combination of elements, features of construction and arrangement of parts and the relation of each of the same to one or more of the others as described herein, the scope of the application of which is indicated in the claims.

In the accompanying drawing illustrating an embodiment of my invention:

Figure 1 represents a fluid distributing valve and fluid motor system;

Figure 2 shows a different operating position of the valve as compared with Figure 1; and

Figure 3 represents a still further operating portion of valve as compared with the previous figures.

As conducive to a clearer understanding of certain features of my invention, it may be noted at this point that frequent recourse is had in the prior art to a variety of types of hydraulic motors and the like which are required to adapt themselves to varying load factors, this illustratively being in any of a wide range of industrial arts and sciences, as in the instance where planers, lathes, or milling, pressing and stamping machines are operated. These machines often are subjected to a considerable range of loading. Under certain conditions heretofore known, anticipated peak loads on the machines have been accounted for by the installation of a single motor of sufficient capacity. This often has resulted in a high initial cost of installation, as well as uneconomical operation at minimum power demands.

As an incident upon the problem of operating a single motor it sometimes has become desirable to cut in, operate, and cut out additional units to meet the varying loads and, in the event of overload, to relieve all power units and stop overall operation. It follows that where a plurality of motors is installed and operated, the problem of efficiently, effectively and properly

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cutting in or out the additional power is confronted. At times, this involves supplying fluid as to a single hydraulic motor where the load is commensurate, and where an overload is encountered a problem develops of introducing a supply of fluid to an aiding motor or motors for sharing the load until conditions are appropriate for returning to single motor operation. Without some automatic shifting arrangement which is responsive to motor load, reliance must be had upon the discretion of an attendant for keeping the proper number of motors running under load. A shift back to the single motor, however, whether automatic or manual, if effected at an inappropriate time in view of the load often is responsible for such difficulties as inefficiencies, breakdown and wear from repeatedly imposing an overload and great stress on the single engine.

An outstanding object of my invention accordingly is the provision of a simple, practical and reliable multiple hydraulic motor system having highly effective automatic distributing valve control over the motors therein in accordance with varying motor power demands, and which system is easy to install and maintain in satisfactory operating condition.

Referring now more particularly to the practice of my invention, an embodiment of the hydraulic distributing valve which I provide will first be described. This embodiment represented by the valve 5 (see Figure 1) comprises a casing 10 which for example houses two interfitting plungers 11 and 12 for controlling a fluid power supply. The plunger 11 is a fundamental plunger, illustratively an overload relief plunger, which has an offset end lip 15 fitting into a cylindrical bore 14 of the portion 10a of the casing and abutting inset 13 of this portion of the casing. A head element 10b of the valve casing receives the other end of the plunger 11 in a cylindrical bore 16, this head element being adjustably secured by threads 17 to the inner surface of the casing portion 10a and sealed fluid-tight by the same, for example by means such as a sealing ring or packing 18.

There is a compartment or clearance space 21 defined between the head element 10a and plunger 11, this for permitting sliding movement of the latter to a sufficient extent for the purpose hereinafter described. I usually employ a sealing ring 19 between the plunger and bore surface of the head element, for ensuring against fluid leakage. An air vent 22 leads from the compartment 21 to the atmosphere for enabling free movement of the plunger.

A coil spring 20 is compressed between the innermost end of the head element 10b and the adjacent surface of offset lip 15 of the plunger, for pressing this lip to a seating relation against

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inset 13 of the casing. The compression of this spring conveniently is adjusted by screwing or unscrewing the threads 17. To account for any adjustment of the threads, the packing means 18 usually is changed, or reset by suitable means not shown.

The valve casing 10 has a plurality of fluid openings through the body thereof, for example, these being an inlet port 50, and outlet ports 51, 52 and 53. The inlet port leads into a fluid receiving chamber 54 which preferably is constantly in open communication with the outlet port 51 for affording a fluid outlet supply. Under certain conditions to be more fully exemplified hereinafter, one or both of the remaining outlet ports 52 and 53 are opened to the chamber 54 by control plunger 12 or are substantially closed off by the latter. An end portion 12a of this control plunger confronts the valve inlet opening 50 and under conditions of relatively low fluid pressure in the chamber, seals against an annular seat 55 formed in the casing wall at points between outlet ports 51 and 52, and thus constitutes a wall of the chamber. The opposite end portion 12b of the control plunger, this being remote from the valve seat 55, fits for sliding movement in a substantially cylindrical bore 57 in the body of the overload relief plunger 11 and accordingly forms fluid bleed-off chamber 56 with the same. The control plunger has a reduced diameter portion 12c intermediate the ends thereof which is guided by the inner surface of end lip 15 of the overload relief plunger. A coiled spring 60 surrounds the reduced diameter portion and is compressed between the lip 15 and the back of portion 12a of the control plunger, thus positively urging this plunger away from the overload relief plunger and against the annular valve seat 55. The spring is relatively weak, as compared with the coil spring 20 which resists displacement of the overload relief plunger 11.

Control plunger 12 has a longitudinal bleed line 12d extending through the body thereof and interconnecting the receiving chamber and bleed-off chamber of the valve. One function served by this bleed line, during certain phases of operation of the valve, is that of admitting fluid under pressure to the bleed-off chamber and against end area 12e of the control plunger, thereby partly or fully counteracting the effect of substantially the same unit fluid pressure against the plunger end area 12f. The end areas 12e and 12f preferably are of substantially the same effective size for receiving a like total pressure and thus hydraulically balancing the control plunger under varying unit pressure conditions within the limits of closure of bleed-off valve 11b, full reliance for example being had upon the force of coil spring 60 for loading the control plunger to closing position against seat 55.

The bleed-off valve 11b is a pressure responsive valve in the overload relief plunger 12 and serves to close bleed-off chamber 56 so long as a certain pressure in the chamber is not exceeded. An adjusting means 11h usually is provided for varying the pressure limit of close-off. The bleed-off valve controls outlet port 11c in the overload relief plunger and also fluid line 11d leading from the valve through the plunger to outlet 53 in the casing portion 10a.

The overload relief plunger 11 and control plunger 12, respectively have protruding annular lips 11g, 12g which nest one within the other when the control plunger is displaced to the posi-

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tion indicated in Figure 2. It will be observed that in this position the end area 12e of the control plunger is masked against the pressure effect of fluid, and that the bleed line 12d empties directly into port 11c of the overload relief plunger, the bleed-off chamber 56 being substantially nonexistent. Also of further significance, with the control plunger in this position, both of the outlet ports 51 and 52 are open for discharging fluid from the receiving compartment 54. Both of the plungers, while in the position indicated in Figure 2, are ready for unitary displacement against the action of coil spring 20 to the position indicated in Figure 3, thus to open outlet port 53 to the fluid receiving compartment 54. A fluid bleed line 61 serves for adjusting fluid to and from the space occupied by spring 20 to facilitate displacement of the latter.

An illustrative embodiment of my hydraulic motor operating system, this including the hydraulic distributing valve 5, is schematically represented in Figure 1. This system comprises two rotary hydraulic motors, the motors 70 and 71, both having their rotors connected to power take-off shaft 76 for driving the same. The rotary hydraulic motor 70 has a sufficient horsepower rating to drive the shaft 76 throughout a first stage of operation until a certain high load condition of the shaft is reached, after which, in a second stage of operation, the motor 71 will share the load.

To supply the necessary hydraulic fluid for motor operation, I usually employ a suitable hydraulic pump 72, such as a constant delivery rotary pump, this having an intake line 80 illustratively from reservoir 73 which contains the supply fluid. The output or pressure side of the pump is interconnected by conduit 81 with inlet port 50 of the distributing valve 5 and thus with the valve chamber 54 where the fluid is received.

Outlet ports 51 and 52 of the valve are connected by fluid lines 74 and 75 respectively to the high pressure or inlet sides of the motors 70 and 71. There are outlet lines 77 and 78 individually leading from the respective hydraulic motors. These outlet lines connect into a conduit 79, which extends from outlet port 53 of the valve 10 to the fluid supply reservoir 73 and bypasses the inlet sides of the motors. A ball check valve 58, as for example disposed in the body of the casing of valve 5 between the outlet ports 52 and 53, conveniently safeguards against the pumping of air by the motor 71 during the second stage of operation of the hydraulic system.

Assuming now that the hydraulic pump 72 is operatively pumping fluid from reservoir 73 through conduits 80 and 81 to receiving chamber 54, and that control plunger 12 is in the initial position represented in Figure 1, the fluid leaves the valve through outlet 51 and conduit 74 and passes to the motor 70. This fluid drives the motor, thus causing a rotation of the shaft 76, and returns through conduits 77 and 79 to the reservoir 73. At the outset of this distribution, the bleed line 12d in control plunger 12 admits fluid to bleed-off chamber 56, where hydraulic pressure is exerted on the plunger end area 12e and is resisted by the bleed-off valve 11b which remains closed. The hydraulic pressure on the plunger area 12e and the force of the coil spring 60, hold the control plunger to a sealing relation with seat 55 by counteracting pressure exerted on plunger area 12f while the motor 70 is in first stage operation. Under these conditions, fluid in the receiving chamber 54 is effec-

tively blocked, by the control plunger, from outlet ports 52 and 53. The motor 71 therefore does not aid in driving the shaft 76 at this time; instead, the motor idles under the driving action of motor 70 and tends to suck air. The sucking of air advantageously is avoided, for example by using a ball check valve 82, which impedes the return of fluid through conduit 79 to the reservoir 73 by an amount sufficient to back up fluid in the conduit to ball check valve 58 thereby opening the same and filling the line 75 leading to motor 71. This fluid accordingly satisfies the volumetric capacity of the idling motor and feeds through line 78 to the conduit 79 for recirculation through the valve 58 or for return to the reservoir.

When the motor 70 begins laboring under an excessive load, this is hydraulically reflected by an increase in back pressure in the line 81 and receiving chamber 54. The pressure increase also is transmitted through the fluid in bleed line 12d and bleed-off chamber 56 to bleed-off valve 11b. Where this pressure reaches a certain value, say for example 900 pounds per square inch, outlet 11c is opened by the valve 11b resulting in the escape of fluid from bleed-off chamber 56 through bleed line 11d to the by-pass conduit 79. As this escape progresses, there is a lowering of pressure in the chamber 56 as compared with the pressure still exerted on end face 12f of the control plunger 12. When pressure in chamber 56 reaches a certain low value, the coil spring 60 is no longer able to resist the force of fluid on plunger face 12f. The control plunger 12 accordingly is unseated from the seat 55 thus enlarging the chamber 54 and opening the latter to the outlet port 52. The unseating displacement of the control plunger is stopped by abutment of this element with the innermost end of bore 57 in the overload relief plunger 12. In this position (see Figure 2) the end area 12e of the plunger preferably is partly or wholly masked from the effect of fluid pressure, the masking illustratively being by the overload relief plunger as by abutment with the lip 12g. The annular lip 11g nests into the annular lip 12g and preferably falls short of abutment with the control plunger 12 so as to leave an effective portion of the end area 12e uncovered, this facilitating return of the plunger to seat 55 under appropriate pressure conditions.

The outlet 53 is still blocked by the plunger 12 against the direct passage of fluid from receiving chamber 54. While the bleed-off valve remains open under the high pressure conditions, however, fluid passes through bleed line 12d and directly into the outlet opening 11c and thence through the valve and bleed line 11d and line 53 to the motor by-pass conduit 79. The main distribution of fluid coming from the pump to the receiving chamber 54, nevertheless is through the outlet ports 51 and 53, through the respective conduits 74 and 75, and into the motors 70 and 71. Both of the motors thus are hydraulically driven in an aiding direction and accordingly share the load of the shaft 76. The fluid leaves the motors through lines 77 and 78 and returns through conduit 79 to the reservoir 73.

When the power demand has been met by the combined operation of the motors, the pressure in receiving chamber 54 drops, and control plunger 12 returns to abutment against seat 55, thus closing the outlet port 52 and cutting out the motor 71. The hydraulic distributing valve usually is made for reverting from multiple motor

feed to single motor feed at a considerably lower pressure than is required to initiate the multiple feed, this for example by proper masking of one end of the control plunger and by appropriate strength of the spring 60 and appropriate resistance to opening by the bleed-off valve 11b. This ensures ample running speed of the motor shaft 76 before going back to single motor operation. I usually employ small grooves 11h in the bore wall of the overload relief plunger and an inset 12h in the annular lip 12g. The inset and grooves serve to pass liquid between chambers 54 and 56 to improve pressure conditions, such as by relieving vacuum, when control plunger moves immediately in the vicinity of the annular lip 11g.

With the end area 12e of the control plunger entirely or partially masked during combined operation of the motors, the return to single motor operation depends upon a considerable drop in pressure in the receiving chamber 54, say to 500 pounds per square inch. This low pressure on the plunger face 12f enables the coil spring 60, acting alone or together with hydraulic pressure on any unmasked portion of the face 12e, to start the control plunger toward seating position for single motor operation. The bleed-off line 12c and bleed-off chamber 56 then become active for supplying fluid to the entire plunger face 12e which exerts a pressure in favor of seating the control plunger. Outlet port 52 accordingly is closed and single motor operation ensues until pressure in the bleed-off chamber 56 again becomes sufficiently high (illustratively 900 pounds per square inch) as to open the valve 11b.

In the event an extreme load, beyond the capacity of both of the motors, is thrown upon shaft 76 the overload control plunger 11 until that time serving as a stop for the control plunger 12 is displaced for by-passing fluid around the motors. This displacement is effected by an increased back pressure from the motors on area 12f of the control plunger (say for example 1000 pounds per square inch), and is prevented at lower back pressures by the coil spring 20. Under the increased pressure, control plunger 12 stops against the overload relief plunger and transmits the hydraulic force on face 12f to the same. The overload relief plunger then retracts in bore 16, against spring 20, the retraction being sufficient (see Figure 3) to carry the control plunger 12 clear of outlet port 53. Fluid supplied from the pump 72 then passes through port 53 and conduit 79 back to the reservoir 73, thus by-passing the motors and saving undue stress on the system. Under favorable pressure conditions in chamber 54 the overload relief plunger returns to the position occupied during normal operation of the system (see Figures 1 and 2).

A selective distribution of fluid therefore is automatically achieved in the fluid system of my invention upon variations in the motor working load being reflected by predetermined increase or decrease in the input pressure on the motor or motors, whether for example the motors be of the rotary type or reciprocative rams. This selective distribution supplies working motor units or other hydraulic mechanisms, whether the units are connected or are independent of the power output of each other. Further, when a maximum torque or other load is reached, the hydraulic input pressure is automatically relieved, by a by-pass around the power units, and this relief so

remains until conditions are corrected, thus avoiding damage to the system.

The automatic hydraulic distributing valve makes possible the use of like or widely different power units with regard to volumetric consumption and power rating of each. The valve is readily installed so as to operate effectively and continuously for long periods of time with a minimum of supervision, adjustment and expense. During operation the valve appropriately distributes a dependable power head to each motor and ensures adjustment of the system for varying loads.

Thus it will be seen that in this invention there are provided a distributing valve and a hydraulic motor system in which the various objects hereinbefore noted together with many thoroughly practical advantages are successfully achieved. It will be seen that the system readily adjusts itself for efficiently and economically meeting varying torque or other load conditions encountered by the hydraulic motor or motors. It will be seen also that the distributing valve is simple, practical and reliable, and is well suited for supplying fluid from one or more outlets as prompted by different pressure conditions.

While my distributing valve is described herein as serving the useful function of admitting fluid to a certain motor by-pass line during conditions of motor overload, it will be understood that at times this line instead has a motor connected therein as for aiding the other motors already described.

As many possible embodiments may be made of my invention and as many changes may be made in the embodiment hereinbefore set forth, it will be understood that all matter described herein is to be interpreted as illustrative and not as a limitation.

I claim as my invention:

1. A fluid distributing valve, comprising, in combination, a casing having an inlet and a plurality of fluid distributing outlets, stop means within said casing and biased for yielding to force applied beyond a certain limit of resistance, an outlet control plunger in the casing and normally advanced from said stop means to close at least two of said fluid distributing outlets substantially from said inlet and having opposing end areas susceptible to substantially the same unit pressure, and means for relieving pressure in excess of a certain value from one plunger end area for setting up a sufficient pressure differential to displace the plunger to abutment with the stop means and thus opening at least one of said closed fluid outlets, said plunger in the abutting position being susceptible to fluid pressure exceeding the certain limit of resistance of said stop means for unitary displacement with the latter element to open at least another of said fluid outlets.

2. A fluid distributing valve, comprising, in combination, a casing having an inlet and a plurality of fluid distributing outlets, stop means within said casing and biased for yielding to force applied beyond a certain limit of resistance, an outlet control plunger in the casing and normally advanced from said stop means to close at least two of said fluid distributing outlets substantially from said inlet and having opposing end areas susceptible to substantially the same unit pressure, and means for relieving pressure in excess of a certain value from one plunger end area for setting up a sufficient pressure differential to displace the plunger to abutment with the

stop means and thus open at least one of said closed fluid outlets, said plunger in the abutting position being at least partially masked at the pressure relieved end area by said stop means and susceptible to fluid pressure for effecting unitary movement with the same to open at least another of said fluid outlets.

3. A fluid distributing valve, comprising, in combination, a casing having an inlet and a plurality of fluid distributing outlets; a reciprocative fundamental plunger received within said casing and biased at one end for yielding to force applied beyond a certain limit of resistance to the opposing end; a reciprocative outlet control plunger in the casing substantially closing off at least two of said outlets and having opposing end faces respectively adjacent to a fluid receiving chamber at said inlet and a fluid bleed-off chamber at the bias-opposing end of the fundamental plunger, said chambers being interconnected by a bleed line; and means for relieving fluid pressure in excess of a certain value from the bleed-off chamber for setting up a sufficient pressure differential across the opposing ends of said control plunger to displace the latter to abutment with the fundamental plunger and thus open at least one of said closed fluid outlets, said control plunger in the abutting position being susceptible to fluid pressure in the receiving chamber exceeding the certain limit of resistance of said fundamental plunger for unitary displacement with the latter element to open at least another of said fluid outlets.

4. A fluid distributing valve, comprising, in combination, a casing having an inlet and a plurality of fluid distributing outlets; a reciprocative fundamental plunger received within said casing and biased at one end for yielding to force applied beyond a certain limit of resistance to the opposing end; a reciprocative outlet control plunger in the casing substantially closing off at least two of said outlets and having opposing end faces respectively adjacent to a fluid receiving chamber at said inlet and a fluid bleed-off chamber at the bias-opposing end of the fundamental plunger, said chambers being interconnected by a bleed line extending through the body of the control plunger; and a pressure relief valve and bleed-off line controlled by the same, in said fundamental plunger for relieving pressure in excess of a certain value from said bleed-off chamber for setting up a sufficient pressure differential across the opposing ends of said control plunger to displace the latter to abutment with the fundamental plunger and thus opening at least one of said closed fluid outlets; said control plunger in the abutting position being at least partially masked at the pressure relieved end and susceptible to fluid pressure in the receiving chamber exceeding the certain limit of resistance of said fundamental plunger for unitary displacement with the same to open at least another of said fluid outlets.

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