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HIGH-PRESSURE SPRAY GUN

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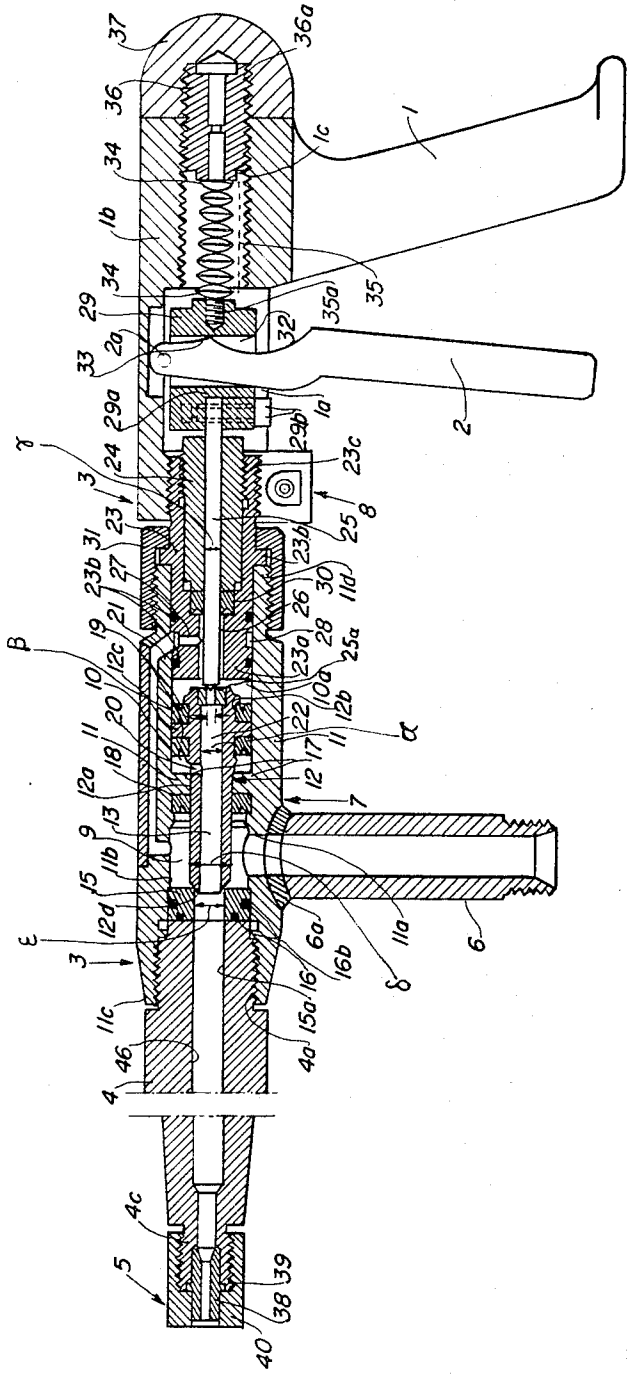

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HIGH-PRESSURE SPRAY GUN

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ABSTRACT OF THE DISCLOSURE

A high-pressure spray gun having a mutually controlled auxiliary valve and a main valve of larger flow cross-section which forms a differential piston at least partly displaceable under the fluid pressure, the main valve member being biased into a valve-closing position by the spring against which the auxiliary valve member can be shifted by a trigger lever of a piston grip.

Our present invention relates to spray devices for high-pressure fluid and, more particularly, to a spray gun for the controlled dispensing of high-pressure liquids.

It has been proposed hitherto to provide spray nozzles in the form of spray guns having a handle portion provided with a spring-loaded trigger or control lever as part of a piston grip for regulating the rate of flow through a valve means controlled by the lever. The basic elements of such a device thus include, in addition to the piston grip, a valve body through which the high-pressure fluid passes, a valve member controlled by the lever of the grip, and an outlet or nozzle supplied by the valve means. In general, high-pressure spray guns of this character require the fully mechanical opening and closing of the valve by the control lever such that substantially all of the effort required to open the valve must be exerted against a spring means tending to close same and against the pressure of the fluid. In other systems in which the pressure of the fluid is not a factor, the valve member is held against the valve seat only by the spring means such that the sealing force, especially when pressures of up to 350 atmospheres are concerned, must be sufficient to counteract the tendency of the fluid pressure to unseat the valve member. Consequently, the spring forces must be relatively considerable and the effort required to operate the valve by a triggering lever is also great. When smaller spring forces are employed, leakage past the valve results. Furthermore, an accurate dispensing of the spray and the high rate of flow thereof are not possible since practical limits are provided to the cross-section of the valved passage because larger cross-sections require still heavier springs whereas smaller cross-sections result in reduction of throughput.

It is the principal object of the present invention, therefore, to provide a spray gun with trigger-operated valve means which can be employed without difficulties and without leakage problems at elevated fluid pressures, and which is yet easily and conveniently operated.

Another object of this invention is to provide an improved spray gun for high-pressure fluids which can be accurately controlled so as to dispense desired quantities of the fluid and which is characterized by a high throughflow capacity.

These objects and others which will become apparent hereinafter are attained, in accordance with the present invention, by a spray gun which comprises a main valve means with a relatively large throughflow cross-section and an auxiliary valve means having a relatively small throughflow cross-section such that the valve member of the main valve means is at least partially displaced by

the force applied thereto by the fluid. According to a specific feature of this invention, the main valve means includes a reciprocal piston-like main valve member exposed to the fluid pressure and normally biased in the direction of the main-valve seat so as to block the flow of the fluid from a main-valve chamber communicating with the source of such fluid; the main valve member forms with an actuating member the auxiliary valve means which is operable by a trigger lever of a piston grip. Thus, the auxiliary valve means can include a valve seat formed on the main valve member which, in turn, is provided with a passage extending from this auxiliary valve seat to the outlet of the spray gun and is adapted to receive fluid from an auxiliary valve chamber surrounding the seat upon withdrawal of the auxiliary valve member by the trigger lever of the piston grip. In accordance with this feature of the invention, the main valve member forms a differential piston exposed to the fluid in both of these chambers so that a reduction in fluid pressure in the auxiliary valve chamber as a consequence of the withdrawal of the auxiliary valve member from its seat will result in the fluid-pressure displacement of the main valve member away from its seat, whereas a blockage of the outflow from the auxiliary valve member will yield a valve-closing displacement of the main valve member and thus a decrease in the throughflow of the main valve means. Thus, the present invention involves a valve or closure system which is at least partly fluid-operated and incorporates a double-valve arrangement in which the movements of a main valve are co-ordinated with that of a controlled valve, the main valve being disposed between the outlet of the spray gun and the connecting means for supplying the high-pressure fluid thereto, while the control valve is disposed between the pistol grip and the connecting means. Furthermore, inasmuch as the differential-piston effect of the main valve member, when the auxiliary valve is closed, is such that an increase in the pressure applied in the valve-closing direction of the main valve member increases with increasing fluid pressure, any pressure increase results in a firmer sealing of the main valve. Automatic opening of the valve because of fluctuation in the pressure of the fluid supply is eliminated. The forces required for operating the valve at the trigger lever are proportionately small and the hydraulic pressure and force upon this lever are minimum. Still further, the release of the trigger lever yields a fluid-powered and automatic return of the main valve member into valve-closing engagement with its seat.

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing whose sole figure is an axial cross-sectional view through a spray gun embodying this invention.

In the drawing, we show a spray gun which comprises a pistol grip 1 having a trigger lever 2 fulcrumed at 2*a* within a downwardly open recess 1*a* of the pistol-grip barrel 1*b*. The lever 2 is designed to actuate a valve system generally designated 3 by means of which the flow of fluid to a spray tube 4 is controlled. The tube 4 carries a nozzle 5 which has an adjustable aperture. A connecting fitting 6 is welded at 6*a* to the tubular body 11 of the main valve means 7 in alignment with a radial port 11*a*. In addition to the main valve means 7, the spray gun is provided with a co-operating control or auxiliary valve means 8 responsive to displacement of the trigger lever 2 for controlling the main valve means 7.

The main valve means 7 comprises, within the tubular body 11, an annular main valve chamber 9 which is charged with the fluid from the connecting means 6 at substantially the full fluid pressure. The chamber 9 thus com-

municates with the radial bore 11*a* and also with a passage 15*a* formed in the main valve seat 15. The latter is a ring held against the shoulder 11*b* of the valve housing 11 by the tube 4 whose male threaded portion 4*a* is screwed into the correspondingly threaded female portion 11*c* at the left-hand end of the housing 11. Annular seals 16*a* and 16*b* are provided respectively between the transverse faces of the male projection 4*a* and the valve seat 15, and between the periphery of this valve seat and the inner wall of the valve housing 11. The passage 15*a* in the valve seat 15 is axially in registry with the passage 4*b* in the tube 4 and supplies the fluid to the outlet nozzle 5. The main-valve housing is subdivided by a partition 17 internally into the pressure chamber 9 and an equalizing chamber 10 axially spaced therefrom but aligned therewith.

A main valve member 12 is axially shiftable within the housing 11 and constitutes a differential piston, as will become apparent hereinafter. The valve piston 12 is of tubular configuration and thus has an axially extending bore 13, the piston 12 having a relatively small-diameter portion 12*a* exposed to fluid pressure within the chamber 9 and a head 12*b* exposed to fluid pressure within the chamber 10. Thus, in the region of the pressure chamber 9, the cross-section of the main valve member 12 is smaller than the cross-section of the member in the region of the equalizing chamber 10, in which the piston-cross-section corresponds to the cross-section of the equalizing chamber.

The valve body 11 is provided with an axially extending channel 14 communicating between a compartment 10*a* of the equalizing chamber on the right-hand side of the valve piston 12 and the pressure chamber 9. The compartment 10*a* thus forms the auxiliary valve chamber, as will become apparent hereinafter. More particularly, the channel 14 opens into a circumferential groove 28 of the forwardly projecting portion 23*a* of a controlled valve housing 23, this portion 23*a* being received within the tubular rearward end 11*d* of the valve housing 11. The annular groove 28 is sealed off from leakage out of the spray gun and from the compartment 10*a* by a pair of O-ring seals 23*b* axially spaced on opposite sides of the groove 28 and seated in respective recesses of the forward portion 23*a* of the control-valve housing 23. From the radial throttle bore 27, communicating with the groove 28, the fluid can pass through an annular clearance between the wall of bore 26 and the controlled-valve member 25 slidable therein. The throttle bore ensures that, in an unblocked condition of aperture 22, the pressure in compartment 10*a* will be less than that in chamber 9. The bore 26 opens into the compartment 10*a* around the member 25.

Thus fluid under pressure is supplied to the compartment 10*a* at the right-hand end of the valve member 12 and its head 12*b* to urge the forward portion 12*a* of the valve member into engagement with the seat 15 when the pressure within the compartment 10*a* is equal to that within the chamber 9. The valve is then closed so that fluid cannot flow through the passage 4*b* to the nozzle 5.

The head 12*b* of the valve member 12 is provided with an annular shoulder 12*c* of substantially identical diameter as that of the equalizing chamber 10 and flanked by a pair of annular double-lift sealing glands 19 adapted to be spread apart by the fluid under pressure to ensure a proper sealing engagement between the piston-like valve member 12 and the inner wall of chamber 10. On the left-hand side of the head 12*b* of member 12, a radial bore 20 is provided between the internal passage 13 and the chamber 10. Any fluid within this left-hand portion of chamber 10 readily passes through the bore 13 to the nozzle 5 when the valve member 12 is shifted to the left and the development of a vacuum is prevented by the induction of fluid into the left-hand side of chamber 10 when the valve member 12 is displaced to the right.

A sealing engagement between the chambers 9 and 10 is ensured by a further annular sealing gland 18 of the double-lip which bears upon the small-diameter portion 12*a* of the member 12 and the wall of chamber 9. The glands 18 and 19 are retained in respective grooves of the wall of chamber 9 and head of 12*b* of member 12, respectively, so that undesirable axial movement of member 18 with respect to the housing 11 or of seals 19 with respect to the member 12 will be prevented.

The right-hand end of the main valve member 12 is provided with the auxiliary or control valve seat 21 whose aperture 22 has a substantially smaller cross-section than that of bore 13 and co-operates within conically shaped tip 25*a* of the axially shiftable auxiliary valve member 25 to form the auxiliary valve means. The smaller diameter of aperture 22 ensures that the effective area of the piston 12, exposed to fluid pressure at compartment 10*a* and with an effective force to the left member greater than the force effective upon the valve member 12 to the right, is a consequence of fluid pressure within chamber 9 or even fluid-pressure backup at the left-hand side of the head 12*b* in chamber 10. The forward end 12*d* of valve member 12 is beveled to cooperate within valve seat 15 in a conical fashion, as will be evident from the drawing.

The control-valve housing 23 is locked within the housing 12 by a threaded cap 31 which is screwed onto the right-hand end portion 11*d* of the housing and clamps the shoulder 23*b* thereagainst. The control-valve housing 23 forms a coupling member for the pistol grip 1 and the housing 11 and is thus provided at 23*c* with a threaded male formation locked into the forward end of the barrel 1*b* of the grip. This formation 23*c* threadedly receives a guide bushing 24 within which the valve member 25 is shiftable, the bushing 24 forming a seat for a double-lip seal 30 surrounding the valve member 25.

A guide block 29 is axially shiftable within the recess 1*a* in the barrel 1*b* of the pistol grip 1 and is formed with a slot 32 through which the trigger lever 2 passes. The lever 2 is provided with a camming protuberance 33 which bears upon the rear wall of the slot 32 to cam the block 29 to the right when the lever 2 is rotated in the counterclockwise sense. The block 29 further is affixed to the auxiliary valve member 25, which is received within a bore 29*a* of this block, by a setscrew 29*b*. Furthermore, a spring means 34, advantageously formed by dished spring disks of the type generally known as "Belleville washers," is received within an internally threaded bore 1*c* in the rearward portion of the barrel and bears upon the block 29 to urge it to the left, i.e. into valve-closing direction with respect to the auxiliary valve means 28. A guide rod 35 threaded at 35*a* into the block 29, passes axially through the area of spring disks 34 and is shiftable within a bushing 36 threaded into the bore 1*c* and forming a seat for the spring means 34. The bushing 36 thus constitutes a pressure screw for prestressing the spring means 34. To permit adjustment of the preload pressure, the right-hand end of screw 36 can extend from the barrel 1*b* and can be provided with a screwdriver slot 36*a*. A cap 39 can be threaded onto this free end of the screw to serve as a locking means preventing undesired rotation thereof. The nozzle 5, according to a specific feature of this invention, comprises a threaded reduced-diameter portion 4*c* of the spray tube 4 onto which can be screwed a cap 40 which clamps the annular shoulder of a replaceable calibrated-bore body 38 against a sealing ring 39. When it is desired to change the spray aperture, substitute bodies 38 may be clamped in place by the cap 40.

Operation

When hydraulic fluid is supplied via the connecting tube 6 to the pressure chamber 9, a corresponding pressure is delivered via the chamber 14, the groove 28, the throttle bore 27 and the clearance 26 surrounding member 25, to the compartment 10*a* of the equalizing chamber 10 to the right-hand side of the head 12*b* of

member **12**. Thus, in a static condition of the system, the same pressure appears in compartment **10***a* as is supplied to chamber **9** and, since the effective surface area of the piston head **12***b* in terms of the force applied to the piston **12** in the valve-closing direction (i.e. to the left in the drawing) is substantially larger than the counterpressure applied in the opposite direction by the force of fluid upon the exposed area of the narrow portion **12***a* of this member. Thus, the effective force in the valve-closing, assuming the absence of back pressure in the tube **4***b*, is equal to the product of the pressure P and the difference between the net surface areas A_1 and A_2 effective in the valve-closing and valve-opening directions, respectively. The area A_1 is, of course, proportional to the difference between the overall diameter α of the piston head **12***b* and the diameter β of the aperture **22** of valve seat **21**. Similarly, the effective area A_2 in the opposite direction is proportional to the difference between the outer dimeter δ of the member **12***a* and the diameter ϵ of the bore **4***b* and of the valve seat **15***a*. Thus, the force holding the piston **12** against its valve seat **15** and blocking the flow of liquid through the bore **4***b* is proportional to the pressure supplied in the connecting pipe **6**.

Concurrently, a force is applied via the valve member **25** to the spring disk **34**. The net force to the right is equal to the product of the effective area A_3 and this pressure P, where the area A_3 is proportional to the difference between the diameter γ of the bore **22**. This force is dimensioned by tightening the screw **36** to be less than the spring force applied to the body **29** and thus serves to reduce the effective resisting force of the spring. When lever **2** is then drawn inwardly (counterclockwise) against the force of spring means **34**, the aperture **22** is unblocked and the pressure compartment **10***a* is relieved as the fluid flows therefrom through the bore **13** and the passage **4***b*. The pressure in chamber **9** remains effective while the pressure in compartment **10***a* falls substantially to zero so that a net force equal to the product of the pressure P and the area A_2 is applied to the valve member **12** to shift it to the right, away from the valve seat **15**. The fluid supplied via duct **6** can then flow past the seat **15** into the passage **4***b* and thence is dispensed through the nozzle **5**. Additional fluid passes via the channel **14**, the annular groove **28**, the throttle bore **27** and the guide bore **26** into the compartment **10***a* of equalizing chamber **10**. From this chamber the flow of fluid proceeds via the aperture **22** of auxiliary valve seat **21** and the bore **13** to the passage **4***b* and nozzle **5**. The throttle bore **27** is so dimensioned that there is a pressure drop between the pressure in the chambers **9** and **10***a* during the flow of fluid past the valve seat **15**. The effect of this throttle bore is augmented by the aspiration of fluid through the bore **13** as a consequence of its high rate of flow past the conical tip **12***d* at the narrow gap between the valve member **12** and the seat **15**. This ensures that the pressure-resisting reseating of the valve member **25** will be minimal.

When the lever **2** is released, the spring **34**, as a consequence of its precompression via adjusting screw **36** and the relieving of the hydraulic counterpressure applied to member **25**, shifts the body **29** to the left and causes the member **25** to close the aperture **22** and the bore **13**. The pressure within compartment **10***a* rapidly builds up to equal that within chamber **9** so that the differential force is again applied to member **12** to displace it to the left into valve-closing engagement within seat **15**. Any fluid compressed in the compartment of chamber **10** at the left-hand side of the head **10***b* escapes via the bore **20**.

The invention described and illustrated is believed to admit many modifications within the ability of persons skilled in the art, all such modifications being considered within the spirt and scope of the appended claims.

We claim:

1. A high-pressure spray gun for the controlled dispensing of high-pressure fluid, comprising a pistol grip having a flow-control lever; tubular discharge means connected with said pistol grip for dispensing said fluid; main valve means rearwardly of said discharge tube and connectable with a source of said fluid for controlledly supplying same to said tube, said main valve means having a movable main valve member for controlling the flow of fluid through said main valve means; auxiliary valve means operable by said lever for fluid biasing of said main valve member to displace same at least partially under the fluid bias as regulated by said auxiliary valve means; housing means for said main and auxiliary valve means between said grip and said discharging means, said main valve means and said auxiliary valve means being axially aligned between said discharge means and said grip within said housing means, said main valve means comprising a main valve seat coaxial with said main valve member and engageable thereby upon axial movement of said main valve member in a valve-closing direction; said main valve member being constituted as an axially extending piston, said main valve means further comprising a pressure chamber in the region of said main valve seat and a further chamber axially spaced therefrom in valve-opening direction of movement of said main valve member, said main valve member having a relatively small effective piston surface exposed to the fluid pressure within said pressure chamber and a relatively large effective surface exposed to fluid pressure within said further chamber, said housing means being provided with a channel interconnecting said chambers and with duct means for supplying said fluid under pressure to said pressure chamber whereby a pressure balance between said chamber results in an axial force upon said main valve member holding same in valve-closing direction against said main valve seat, said valve member being provided with an axially extending bore interconnecting said chambers, said auxiliary valve means including an auxiliary valve member axially shiftable in said housing means and engaging with said main valve member for selectively blocking the axially extending bore thereof, said main valve member having a relatively large head within said further chamber and a relatively small-diameter portion extending forwardly from said head toward said main valve seat, said auxiliary valve means including an auxiliary valve seat in said head engageable by said auxiliary valve member, said housing means being provided with a partition closely surrounding said small-diameter portion and separating said chambers from one another, said main valve member being provided with a port communicating between the portion of said other chamber forwardly of said head and said axially extending bore; and sealing means at said partition between said housing means and small-diameter portion for preventing the flow of fluid past the outer surface of said small-diameter portion between said chambers.

2. A spray gun as defined in claim **1** wherein said head is provided with sealing means engageable with a wall of said other chamber for preventing the passage of fluid between portions of said other chamber on opposite sides of said head, said auxiliary valve seat defining a valve aperture of a cross-section less than that of said axially extending bore.

3. A spray gun as defined in claim **2** wherein said channel between said chambers is formed with throttle means for ensuring that the fluid pressure within said other chamber remains below that of said pressure chamber in an open condition of said main valve means.

4. A spray gun as defined in claim **3** wherein said auxiliary valve member is an axially extending rod guided in said housing means and passing into said grip, said rod having a conical forward portion insertable into said aperture, said main valve member having a conical forward portion engageable with said main valve seat, said

pistol grip being provided with an axially shiftable body engaging said rod, said lever being cammingly engageable with said body, said spray gun further comprising spring means in said pistol grip acting upon said body for urging said rod into engagement with said auxiliary valve seat, and sealing means between said rod and said housing means rearwardly of said other chamber for preventing the escape of fluid therefrom.

5. A spray gun as defined in claim 4 wherein said housing means is formed with a guide bushing for said rod and with a guide bore receiving said rod with annular clearance and opening into said other chamber, said throttle means communicating with said clearance.

6. A spray gun as defined in claim 4 wherein said spring means includes a stack of annular spring disks axially aligned with said valve means and disposed in said grip rearwardly of said body, said body having a rod slidably passing through said disks, said grip being provided with an adjusting screw for axially precompressing said spring means.

7. A spray gun as defined in claim 6, further comprising changeable-bore nozzle means on said tube forwardly of said valve means.

8. A spray gun as defined in claim 7 wherein said nozzle means is threadedly mounted on said tube, said tube is threadedly secured to said housing means, said housing means further comprising threaded coupling means connecting same with said grip.

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