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FLUID DISCHARGE NOZZLE

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2 Sheets-Sheet 1

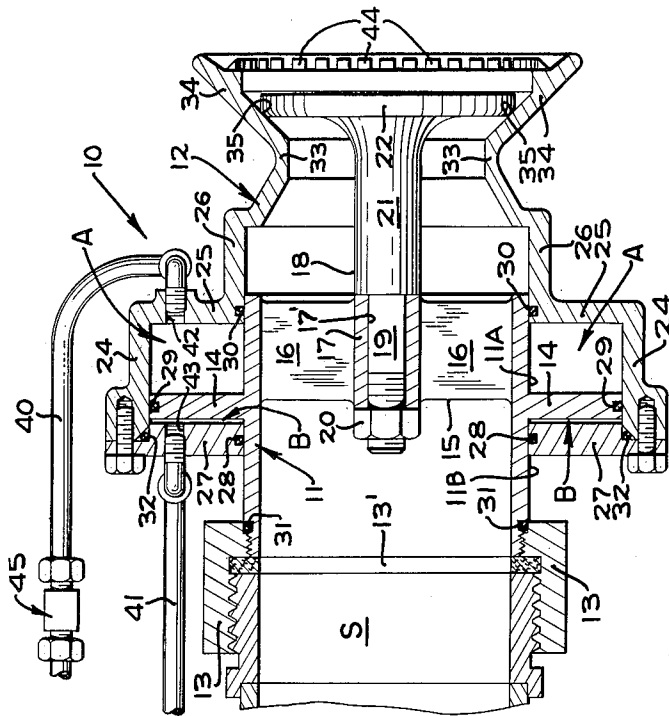


FIG. 1

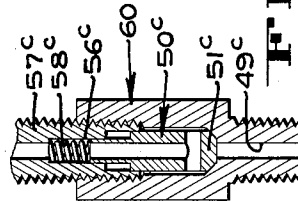


FIG. 2

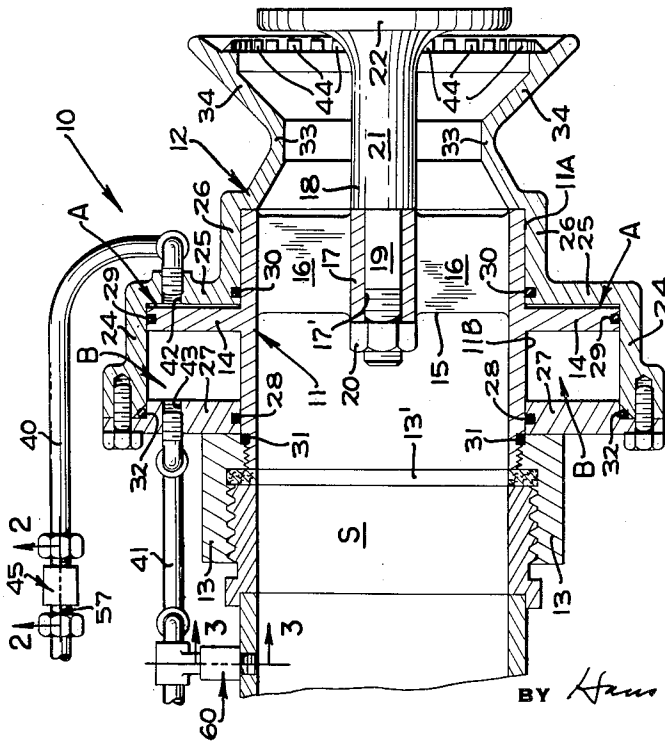


FIG. 3

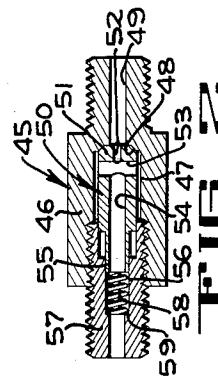


FIG. 4

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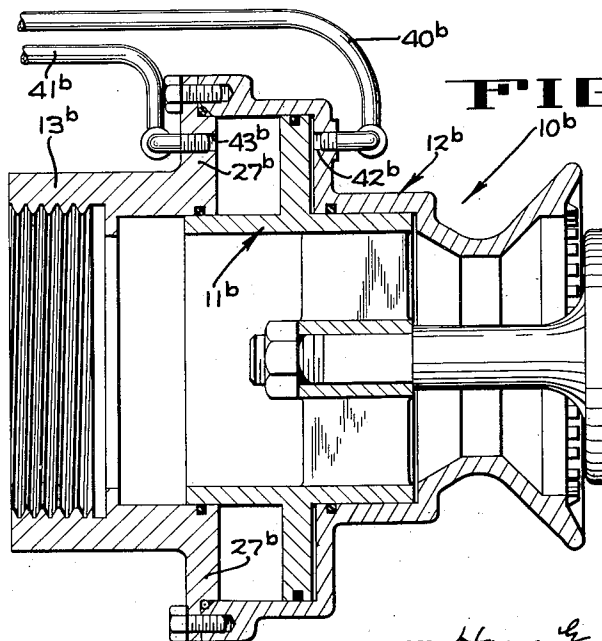
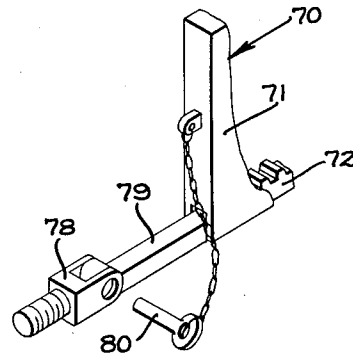
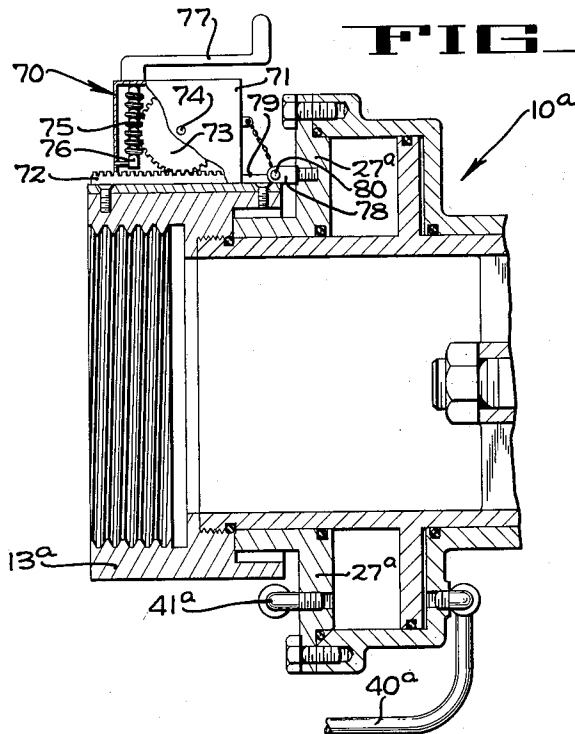
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2 Sheets-Sheet 2



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## FLUID DISCHARGE NOZZLE

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The present invention relates to nozzles for the discharge of fluids from conduits, and more particularly to adjustment mechanisms for controlling the flow of fluid through such nozzles.

Discharge nozzles for fluid conduits have many varied uses. For example, they are employed in fire fighting; for demolition purposes; for debris removal; for decontamination purposes; for smog control; and for earth removal as in hydraulic mining. In these and other uses for such nozzles, it is often desirable that the stream of fluid being discharged be somewhat dispersed, or be broken up into a partial or a true colloidal fog or into a combination of a fog and a straight stream.

Fluid discharge nozzles which have been employed for purposes such as mentioned hereinabove have usually presented a number of disadvantages, related primarily to the manner of operation thereof. Hazards to personnel often result, where direct human operation of the nozzles is required. Although remote control mechanisms have at times been provided, these have often broken down in operation or presented dangers, as a result of the unusual conditions of use. Where electric motors have been employed for control purposes, there has been the problem of maintaining an adequate power supply. In addition, such motors have limitations insofar as variation in speed of operation is concerned. Also, electric motors may become inoperative when wet, especially at extremely low temperatures. Finally, electric control systems are usually quite expensive, from the point of view of both manufacture and maintenance thereof.

It is, therefore, an object of the present invention to provide an improved mechanism for the control of a fluid discharge nozzle.

Another object of the present invention is to provide a mechanism for the control of a fluid discharge nozzle from a remote location.

Another object of the present invention is to provide a fluid discharge nozzle control mechanism that is characterized by positive, dependable operation, and which will operate safely and efficiently throughout a wide temperature range.

Another object of the present invention is to provide control means for a fluid discharge nozzle, which control means is arranged to restrict the speed at which the nozzle can be closed.

Another object of the present invention is to provide mechanism for the control of a fluid discharge nozzle, which is of low cost and does not require more than a minimum of maintenance.

These and other objects of the present invention will become apparent from the following description, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a medial section taken through a nozzle incorporating the present invention and operatively mounted upon a supply conduit.

FIG. 2 is an enlarged fragmentary section along lines 2—2 of FIG. 1.

FIG. 3 is an enlarged fragmentary section along lines 3—3 of FIG. 1.

FIG. 4 is a view similar to FIG. 1, the nozzle being shown in a different operational position.

FIG. 5 is a view similar to FIG. 1, showing a modified form of the invention.

FIG. 6 is a fragmentary perspective, showing a device

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employed in connection with the nozzle of FIG. 5. FIG. 7 is another view similar to FIG. 1, showing a further modified form of the invention.

Referring to the drawings, and particularly to FIG. 1, a fluid discharge nozzle 10 is shown. The nozzle 10 comprises generally an inner hollow cylindrical valve member 11, and an outer housing 12 that is reciprocable in an axial direction, relatively to the member 11. The member 11 threadedly receives at its inlet end an adaptor 13, whereby it is fixedly connected to a suitable fluid supply conduit S. A gasket 13' of resilient material prevents leakage between the member 11 and the conduit S. A flat annular flange 14 extends radially outward from the cylindrical wall of the member 11, a short distance from the outer end thereof.

Positioned within the member 11 adjacent the outer end thereof, is a spider 15 having a plurality of radially extending arms 16 integral at their outer ends with the cylindrical wall of the member 11. The spider 15 is provided with a hub 17 having a bore 17' therethrough concentric with the cylindrical wall of the member 11. A valve stem 18 is secured to the spider 15 and extends axially outwardly therefrom. The inner end 19 of the stem 18 extends through the bore in hub 17, and is threaded to receive a nut 20. The outer end 21 of the stem carries a circular disc-type valve head 22.

The housing 12 is formed at its inner end with an axially extending cylindrical wall portion 24 that slidably engages the outer circumference of the flange 14. The wall portion 24 merges with a radially extending wall portion 25, which in turn merges with an axially extending wall portion 26 that slidably engages the outer cylindrical surface 11A of the member 11. A radially extending annular flange 27 is bolted adjacent its outer periphery to the inner end of the cylindrical wall portion 24, and at its inner periphery slidably engages the outer cylindrical surface 11B of the member 11.

As shown, flange 14 serves as a piston within the member 11 defining a space A with a cylindrical surface 11A of the member 11 and the wall portions 24 and 25 of the housing 12 and an annular space B with the flange 27, wall portion 24 and the outer cylindrical surface 11B of the member 11 therebetween.

Suitable resilient sealing rings 28, 29 and 30 are provided between the flange 27, member 11 and housing 12, being located respectively in a groove formed along the inner annular surface of the flange 27, a groove formed along the outer circumference of the flange 14, and a groove formed along the inner surface of the wall portion 26. A sealing ring 31 is also provided in a groove formed along the outer wall surface of the member 11 adjacent the threaded end thereof. A sealing ring 32 is positioned between the wall portion 24 and the flange 27.

The axially extending wall portion 26 of the member 12 merges into a somewhat narrowed neck portion 33, which in turn merges with a frusto-conical discharge portion 34, providing an annular valve seat for the valve head 22, as shown at 35 (FIG. 4). A plurality of teeth 44 are spaced about the inner periphery of the nozzle discharge portion 34, adjacent the outer end thereof. The teeth 44 serve to break up portions of the stream of fluid being discharged from the nozzle into a fog that is highly efficient both for quenching purposes and as a protective heat screen.

It will be seen that the housing 12 may be axially reciprocated with respect to the member 11, between the position shown in FIG. 1, and that shown in FIG. 4. During reciprocation, the radially inwardly facing surfaces of the housing 12 and of the flange 27 bolted thereto slide along the outwardly facing surface of the member 11 and the outer circumferential surface of the flange

14. Through reciprocation of the housing 12, the position of the valve head 22 with respect to the inner surface of the discharge wall portion 34 can be varied from that shown in FIG. 1, in which the valve head is at its extreme open position, to that shown in FIG. 4, in which the valve head is in its closed position, being seated within and against the wall portion 34. The result of such variation of the position of the valve head is to alter the size of the fluid outlet portion of the nozzle 10 due to the flaring nature of the discharge portion 34.

In order to control the movement of the housing 12 with respect to the member 11, and to thus vary the size of the opening between the valve head 22 and the wall portion 34, two flexible hydraulic fluid supply tubes 40 and 41 are connected, respectively, with ports 42 and 43, located respectively in the wall portion 25 of the housing 12 and the flange 27. Hydraulic fluid is supplied from a suitable source of fluid under pressure to the tube 40 or tube 41 by a conventional control valve (remotely positioned and not shown).

If the hydraulic fluid is supplied under pressure to the tube 40, said fluid will enter the annular space A defined by the flange 14, the outer cylindrical surface 11a of the member 11, and the wall portions 24 and 25 of the housing 12, forcing wall portion 25 to move to the right from the position thereof shown in FIG. 1, moving with it the discharge portion 34 of the housing 12. On the other hand, if fluid is supplied under pressure to the tube 41, it will enter the annular space B defined by the flange 27, the flange 14, the outer cylindrical surface 11b of the member 11 therebetween, and the wall portion 24 of the housing 12, forcing flange 27 to move to the left from the position thereof shown in FIG. 4, moving with it the discharge portion 34 of the housing 12. Each of the tubes 40 and 41 is looped to permit the described movements of the housing 12.

It will be realized that when hydraulic fluid is supplied by either the tube 40 or the tube 41 to the respectively associated aforementioned annular space A or B, and movement of the housing 12 results, hydraulic fluid present in the other of the said spaces will be forced therefrom through the port associated therewith. Through proper operation of the control valve, the housing 12 can be moved to and positively held in any desired position between the extreme open position shown in FIG. 1 and the extreme closed position shown in FIG. 4.

In order to prevent hydraulic surges in the fluid supply conduit S which might result, for example, from a too rapid closing of the nozzle 10, a metering valve 45 is connected into the supply tube 40. The valve 45 (FIG. 2) comprises a body portion 46 having a cylindrical valve chamber 47 therewithin. The chamber 47 terminates at its right-hand end, as viewed in FIG. 2, in a frusto-conical valve seat 48, which communicates with a passageway 49 extending through the adjacent end portion of the valve body 46 and into communication with the bore of the tube 40 at the right hand end (FIGS. 1 and 2) of the metering valve 45. A cylindrical valve element 50 axially movable within the chamber 47 is of smaller diameter than the chamber 47 and at its head 51 normally engages the seat 48. A metering orifice 52 extends axially through the head 51, establishing communication between the passageway 49 and a passageway 53 extending transversely through the valve element 50. A passage 54 extends axially through the valve element 50, and is in communication with the transverse passageway 53. The end portion 55 of the valve element 50, opposite the head 51, is of reduced diameter, and is slidably received in a cylindrical bore 56 in a sleeve 57. The valve body 46 threadably receives the sleeve 57 through the open end of the chamber 47. A spring 58 is seated within the bore 56, bearing at its inner end against the end portion 55 of the valve element 50, and at its outer end against a shoulder 59 in the bore 56 of the sleeve 57. The sleeve's bore 56 communicates with the bore of the tube

40 at the left hand end (FIGS. 1 and 2) of the metering valve 45.

When fluid enters the metering valve 45 through the sleeve 57, it flows freely through the passage 54 and the passageway 53 and into the unoccupied portion of the chamber 47. Since both the spring 58 and the fluid pressure tend to maintain the valve element head 51 in engagement with its seat 48, the fluid must flow through the metering orifice 52 before being discharged from the valve 45 through the passageway 49. Since the orifice 52 is of restricted diameter, it will limit fluid flow out through the passageway 49. As a result, the rate at which fluid flows through the tube 40 and into the port 42 cannot exceed a certain limit, and a too rapid closing of the nozzle 10 is thus prevented.

When fluid enters the metering valve 45 through the passageway 49, the pressure thereof forces the valve element head 51 out of engagement with its seat 48, against the urging of the spring 58. Fluid is then free to flow not only through the orifice 52, but around the head 51 into the passageway 53 thus by-passing the orifice 52. It then proceeds through the passageway 54 and through the sleeve 57. The valve 45 thus offers relatively little resistance to flow of fluid along the last defined course, and consequently will allow the nozzle 10 to be opened relatively rapidly.

A check valve 60 (FIG. 3) is connected between the tube 41 and the fluid supply conduit S, for the purpose of preventing the build-up of too great a pressure in the conduit, and also for the purpose of aiding the metering valve 45 in preventing too rapid closing of the nozzle. The structure of the check valve 60 is identical to that of the metering valve 45, with the exception that the check valve has no orifice in its valve element head corresponding to the metering orifice 52 in the metering valve. Therefore, parts of the check valve 60 that correspond to parts of the metering valve 45 will be identified by the same reference numeral with the suffix "c" added, and the structure of the check valve 60 will not be described herein further detail. When the pressure of fluid in the conduit S reaches a predetermined level, the pressure will be communicated to fluid present in the passageway 49c; the head 51c of the valve element 50c will be unseated against the urging of the spring 58c; and fluid will flow through the check valve 60 and the sleeve 57c into the control line 41. Therefore, the passageway 49c and the bore 56c of the sleeve 57c constitute the inlet and outlet passageways, respectively, of the check valve 60.

Thus it may be seen that when pressure within the supply conduit rises to a dangerous or otherwise undesirable level, the housing 12 will be moved toward open position, and fluid will be discharged from the nozzle until the pressure has dropped to a permissible level. Fluid obviously cannot flow through the valve 60 in the opposite direction.

If the pressure build-up in the fluid supply conduit S is the result of a too rapid closing of the nozzle 10, fluid will flow through the check valve 60, the supply tube 41 and port 43, and will serve to retard the rate of closing of the nozzle. The check valve 60 in this way will aid the operation of the metering valve 45.

When the above described form of the nozzle of the invention is closed, as illustrated in FIG. 4, the valve head 22 is in engagement with its seat 35, and therefore prevents fluid from escaping from the nozzle. Upon introduction of fluid under pressure to the space B and relief of pressure within the space A, the wall portion 34 is withdrawn from the valve head 22, the latter thus being unseated. This permits a jet of fluid to issue in a concentrated, high velocity stream through the outlet between the wall portion 34 and the valve head 22. As the space between the wall portion 34 and the valve head 22 is increased, the quantity of fluid discharged increases accordingly, until a point is reached at which the jet begins

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to take the form of a cone. At this point, the stream is partially dispersed by the teeth 44 into a fog. Still further opening of the nozzle produces corresponding increase in the size of the cone angle, and in the extent of dispersion of the fluid.

In closing the nozzle 10, an operation the reverse of that just described takes place. Here, the nozzle is open to begin with, and may be in the extreme open position shown in FIG. 1. If fluid is introduced into the chamber A and pressure is relieved within the chamber B, the wall portion 34 will be moved toward the valve head 22, and if this adjustment of the nozzle is continued until the position shown in FIG. 4 is reached, the jet will change progressively from a conical, highly dispersed fog back to a concentrated, high velocity jet stream and flow will cease when the valve head 22 seats against the conical wall portion 34.

Referring to FIG. 5, a nozzle 10a is shown which is similar in every respect to the nozzle 10 of FIGS. 1 to 4, except that it is provided with an auxiliary manual control unit 70 that can be used alternatively to the hydraulic control means for opening and closing the nozzle. Hydraulic fluid supply tubes 40a and 41a are connected to the nozzle 10a in the same manner as the corresponding tubes 40 and 41. Opposite the tubes 40a and 41a, and bolted to the adaptor 13a, is a box-like housing 71. Positioned at the bottom of the housing is a rack 72, which extends axially of the nozzle. A pinion wheel 73 is rotatably mounted on a transversely extending shaft 74 supported within the housing 71, which wheel engages the rack 72 in the usual manner. The rack and pinion wheel are operated by means of a worm gear 75 mounted on a shaft 76 supported within the housing 71, said worm gear being in engagement with the teeth of the pinion wheel 73. A crank arm 77 exteriorly of the housing 71 is adapted to rotate the shaft 76 in either direction. A yoke 78 (FIG. 6) is bolted to the flange 27a, and extends outwardly therefrom. An extension portion 79 of the rack 72 projects between the ends of the yoke 78. The said yoke ends and the rack extension 79 are apertured to receive a pin 80, whereby they are coupled together. The pin 80 can, if desired, be chained to the housing 71 as shown.

When it is desired to operate the nozzle 10a by means of the hydraulic control mechanism, the rack extension 79 is uncoupled from the yoke 78 by removal of the pin 80. Conversely, when it is desired to utilize the manual control unit 70, the rack extension and the yoke are coupled together. It will be noted that the worm-driven rack and pinion provide an irreversible drive. While the crank arm 77 may be turned in either direction for opening or closing the nozzle 10a, once the housing has been moved to a desired position and the crank arm released, it will remain in such position, unaffected by forces exerted by the fluid passing through the nozzle.

In FIG. 7, a modified nozzle construction 10b is shown. Here, an axial tubular extension 13b of the flange 27b is provided, which extension is internally threaded at its inner end for connection to the threaded outer end of a fluid supply conduit. The valve member 11b positioned within the housing 12b is reciprocable with respect to the latter. The structures of the member 11b and the housing 12b are otherwise similar to those of the corresponding parts in the nozzle 10, and will therefore not be here further described. The nozzle 10b is operated by hydraulic fluid supplied by tubes 40b and 41b in the same manner as the nozzle 10. However, when the nozzle is in an open position such as shown in FIG. 7, and fluid is introduced from the tube 40b into the housing 12b through the port 42b, the valve member 11b is caused to move toward the left as viewed in FIG. 7 and to thus close the nozzle. Conversely, when the nozzle is in closed position, introduction of fluid from the tube 41b into the housing 12b through the port 43b will cause the valve member 11b

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to move toward the right, thereby opening the nozzle.

While two particular embodiments of the present invention have been shown and described, it will be understood that the fluid discharge nozzle is capable of further modification without departing from the principles of the invention and that the scope of the invention should be limited only by the scope and proper interpretation of the claims appended hereto.

The invention having thus been described, what is believed to be new and desired to be protected by Letters Patent is:

1. A fluid discharge nozzle comprising a housing having a fluid inlet port adapted for connection to a fluid source of pressure and a fluid outlet port, means operable within said housing and responsive to said pressure for varying the effective size of said fluid outlet port, means responsive to said pressure and connected to said varying means for limiting the rate of operation of said varying means when decreasing the size of said fluid outlet port, and means responsive to said pressure and connected to said varying means for automatically actuating said varying means to increase the size of the fluid outlet port when a predetermined increase in the fluid pressure occurs in the housing.

2. A fluid discharge nozzle comprising a housing having a fluid inlet port adapted for connection to a fluid source of pressure and a fluid outlet port, a valve member within said housing, means responsive to said pressure for effecting relative movement between said housing and said valve member for varying the effective size of said fluid outlet port, and means responsive to said pressure at said fluid inlet port and connected into said movement effecting means for controlling the rate of relative movement between said housing and valve member tending to decrease the size of said fluid outlet port.

3. A fluid discharge nozzle comprising a housing having a fluid inlet port adapted for connection to a conduit containing fluid under pressure and a fluid outlet port, a valve member within said housing, said housing being relatively movable with respect to said valve member for varying the effective size of said fluid outlet port, and means responsive to pressure surges of said fluid and operatively connected with said housing for automatically controlling the rate of movement of said housing tending to decrease the size of said fluid outlet port.

4. A fluid discharge nozzle comprising a housing having an inlet port adapted for connection to a fluid source under pressure and a fluid outlet port, a valve member within said housing, hydraulic means connected to said fluid source and operable to effect relative movement between said housing and said valve member for decreasing the size of the fluid outlet port and operable to effect relative movement between said housing and said valve member for increasing the size of the fluid outlet port, and means connected into said fluid source and connected into said hydraulic means for automatically limiting the rate of port-closing relative movement between said housing and said valve member to prevent undesirable surges in pressure of said fluid sources.

5. A fluid discharge nozzle comprising a housing having a fluid inlet and a fluid outlet port, a valve member within said housing, hydraulic means operable to effect relative movement between said housing and said valve member for increasing and decreasing the size of the fluid outlet port, and a check valve having an inlet passageway in communication with said fluid inlet and an outlet passageway in communication with said hydraulic means, said check valve being adapted to conduct fluid from said fluid inlet to said hydraulic means to initiate port size increasing operation of said hydraulic means when a predetermined fluid pressure level has been reached in the nozzle.

6. A fluid discharge nozzle according to claim 5, in which said check valve comprises a hollow valve body defining a valve seat at the inner end of said inlet passageway

way, a movable valve element within said valve body, and resilient means urging said valve element against said seat, said valve body and said valve element being adapted to conduct fluid from said inlet passageway to said outlet passageway when said valve element is unseated.

7. A fluid discharge nozzle comprising a housing having an inlet port adapted for connection to a source of fluid under pressure and a fluid outlet port, a valve member mounted within said housing for relative movement between the housing and the valve member, first hydraulic means connected to said fluid source and operable to effect relative movement between said housing and said valve member for decreasing the size of the fluid outlet port, and second hydraulic means connected to said fluid source and operable to effect relative movement between said housing and said valve member for increasing the size of the fluid outlet port, said first hydraulic means including a metering valve separately connected with said fluid source for automatically limiting the rate of relative movement between said housing and said valve member to prevent undesirable pressure surges within said housing.

8. A fluid discharge nozzle according to claim 7, in which said metering valve comprises a hollow valve body, means defining a first passageway for said valve body in communication with a supply of hydraulic fluid, means defining a second passageway for said valve body in communication with said housing, said valve body being formed with a valve seat at the inner end of said second passageway, a movable valve element within said valve body having a metering orifice, and resilient means urging said valve element against said seat, said valve body and said valve element being adapted when said valve element is seated to conduct fluid from said first passageway through said metering orifice and to said second passageway, said valve body and said valve element being adapted when said valve element is unseated to conduct fluid from said second passageway to said first passageway along a course by-passing said metering orifice.

9. A fluid discharge nozzle comprising: a housing having a fluid inlet port adapted to be connected to a source of pressurized fluid and a fluid outlet port, a valve mounted for relative movement with the housing to open and close the fluid outlet port, a first hydraulic system connected so as to effect relative movement between the valve and housing to open said outlet port in response to said fluid, and a second hydraulic system connected to effect relative movement between the valve and housing to close said outlet port in response to said fluid, and control means connected to automatically control the operation of said second hydraulic system responsive to pressure surges of said fluid.

10. A fluid discharge nozzle comprising: a housing having a fluid inlet port adapted to be connected to a source of pressurized fluid and a fluid outlet port, a

valve mounted for relative movement with the housing to open and close the fluid outlet port, a first hydraulic system operated by said fluid source connected to effect relative movement between the valve and housing to open said outlet port, a second hydraulic system operated by said fluid source connected to effect relative movement between said valve and housing to close said outlet port, and means connected to said fluid source and connected into said second hydraulic system for controlling the rate of operation thereof in a manner preventing surges of fluid pressure within said housing.

11. A fluid discharge nozzle comprising: a housing having a fluid inlet port connected to a source of pressurized fluid and a fluid outlet port, a valve mounted for relative movement with the housing to open and close the fluid outlet port, a first hydraulic system connected with said fluid source to effect relative movement between the valve and housing to open said outlet port, a second hydraulic system connected with said fluid source to effect relative movement between said valve and housing to close said outlet port, and means connected between said source of pressurized fluid and said first hydraulic system for controlling said first hydraulic system in response to pressure fluctuations at said source.

12. A fluid discharge nozzle comprising: a housing connected to a source of fluid under pressure and having a fluid outlet port; a valve member mounted for relative movement with said housing for adjusting the nozzle from a closed condition to an open condition; and means for positively controlling such adjustment, including; an annular flange on said valve member and a first annular wall on said housing forming a first annular chamber therebetween, a second annular wall on said housing cooperating with said annular flange to form therebetween a second annular chamber, a first hydraulic system connected with said fluid source and to said first annular chamber for effecting relative movement between said valve member and said housing, and a second hydraulic system connected with said fluid source and to said second annular chamber for effecting relative movement between said valve member and said housing in the direction opposite that which is effected by said first hydraulic system.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |                     |               |
|-----------|---------------------|---------------|
| 2,498,482 | Cadman et al. ----- | Feb. 21, 1950 |
| 2,538,364 | James et al. -----  | Jan. 16, 1951 |
| 2,590,466 | Rued -----          | Mar. 25, 1952 |
| 2,593,921 | Robinson -----      | Apr. 22, 1952 |
| 2,711,929 | Nielsen -----       | June 28, 1955 |
| 2,747,939 | Caird -----         | May 29, 1956  |
| 2,808,293 | Schenk -----        | Oct. 1, 1957  |
| 2,834,416 | Becker -----        | May 13, 1958  |
| 2,889,821 | Maki -----          | June 9, 1959  |