United States Patent [19]

Allenbaugh

[11] **3,904,125**

[45] **Sept. 9, 1975**

[54] **CONSTANT PRESSURE NOZZLE DISCHARGE MECHANISM**

[75] Inventor: **George G. Allenbaugh,** Wadsworth, Ohio

[73] Assignee: **Premier Industrial Corporation,** Cleveland, Ohio

[22] Filed: **Mar. 14, 1974**

[21] Appl. No.: **451,017**

[52] **U.S. Cl.** **239/452;** 239/459; 239/541; 239/570

[51] **Int. Cl.²** **B05B 1/32**

[58] **Field of Search** ..... 239/451–453, 239/456, 458, 459, 505, 506, 513, 514, 524, 537, 541, 570, 571, 583; 267/63 R, 153

[56] **References Cited**

UNITED STATES PATENTS

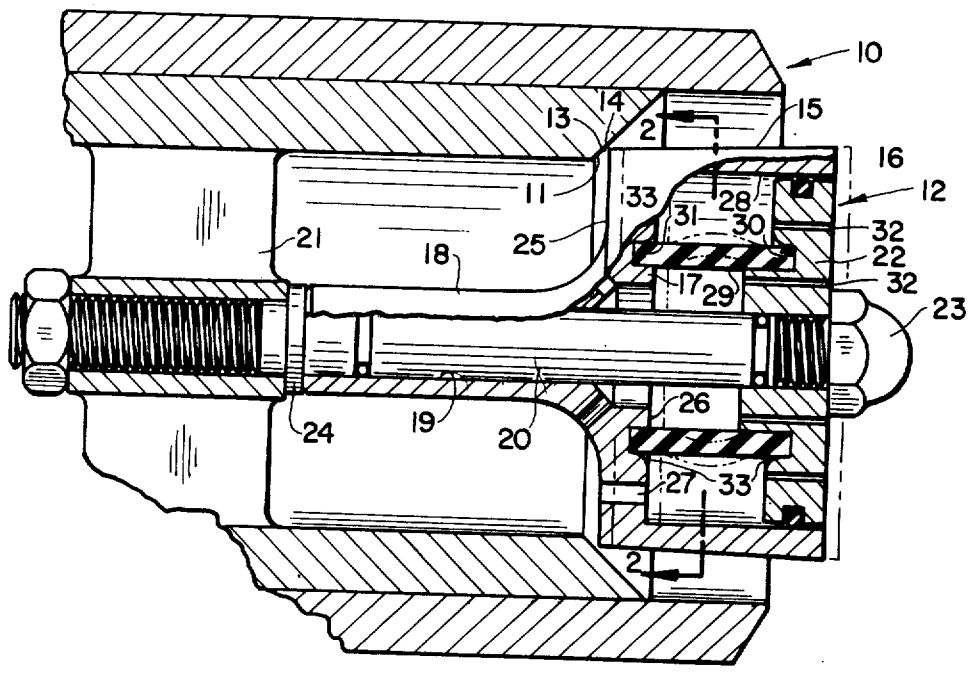
2,568,429	9/1951	Burnam et al.	239/452
2,770,497	11/1956	Filliung et al.	239/452 X
3,109,639	11/1963	Nicolaisen	267/153
3,138,177	6/1964	Cutler	239/452 X
3,191,896	6/1965	Nathan	267/153 X
3,305,227	2/1967	Henley	267/153
3,478,857	11/1969	Linker	267/153 X
3,542,353	11/1970	Hickman	267/153 X
3,684,192	8/1972	McMillan	239/452

Primary Examiner—Lloyd L. King
Assistant Examiner—Andres Kashnikow
Attorney, Agent, or Firm—Isler & Ornstein

[57] **ABSTRACT**

A nozzle having a pressure-responsive movable baffle element displaced by liquid pressure in opposition to a constant-force resilient, deformable reaction element which serves to permit enlargement of the discharge orifice or reduction of the orifice size to establish an equilibrium between the pressure-reaction element and the pressure-induced force acting upon the baffle element.

10 Claims, 4 Drawing Figures



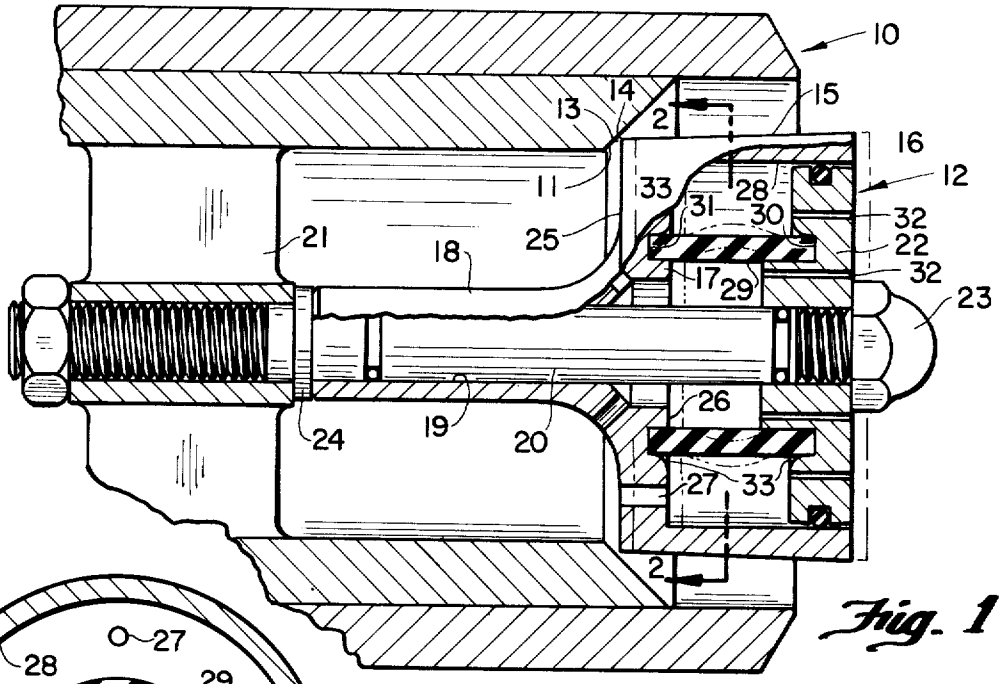


Fig. 1

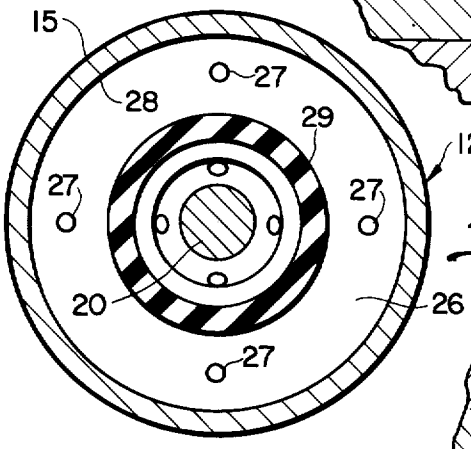


Fig. 2

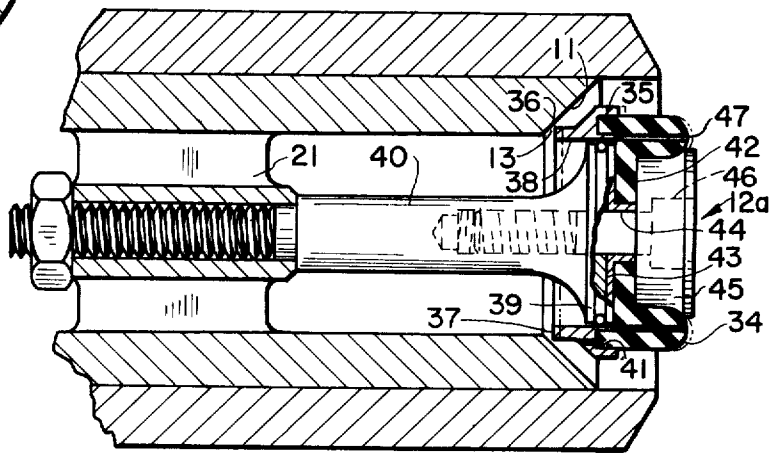


Fig. 3

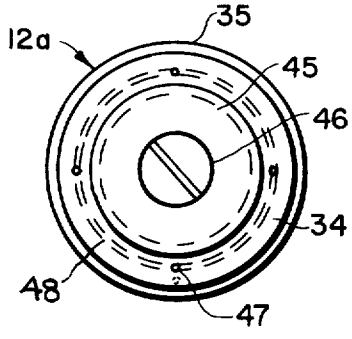


Fig. 4

CONSTANT PRESSURE NOZZLE DISCHARGE MECHANISM

BACKGROUND OF THE INVENTION

The application relates to liquid flow discharge nozzles, particularly of the type used in fire-fighting, where the reach of the discharge stream is of critical importance in properly controlling the fire. In fire-fighting techniques, it is frequently necessary to use a single hose line as soon as possible to initiate the extinguishing of the blaze pending the arrival or connection of additional hose lines as equipment becomes available. The addition of hose lines creates variations in the flow pressure in the hose lines which may lead to a common nozzle through some manifold arrangement. Also, there are variations in pumping pressure which not only affect a nozzle served by multiple hose lines, but also affect the reach of the stream discharged by a single hand line nozzle.

In order to avoid the fluctuations and variations in the reach of the nozzle discharge stream as a result of the above-mentioned factors, as well as other factors, it has been proposed that nozzles be provided with a pressure-responsive baffle which will either diminish or enlarge the discharge orifice of the nozzle in response to fluctuations in line pressure so as to maintain a fairly constant discharge pressure at the nozzle. Examples of such pressure-responsive nozzle structures can be found in U.S. Pat. Nos. 2,568,429; 3,539,112 and 3,684,192. Representative structures of nozzles particularly adapted for firefighting but which do not have any such automatic discharge control feature can be found in U.S. Pat. Nos. 2,936,960; 2,938,673 and 2,991,016.

SUMMARY OF THE INVENTION

It is a primary object of the invention to provide an improved constant pressure nozzle discharge mechanism which will eliminate the need for using springs having a relatively high magnitude of force for controlling the automatic adjustment of the size of the discharge orifice. Another object of the invention is to provide a self-adjusting constant pressure discharge mechanism of the character described which will permit the use of a non-metallic, low-cost pressure reaction element having greater sensitivity than metal coil springs and having longer life than such springs due to its non-corrosive characteristic.

Still another object of the invention is to provide a device of the character described which is arranged to be highly compact and to be of smaller physical size than prior art devices intended to accomplish the same function.

A still further object of the invention is to provide a device of the character described which is simple, yet efficient, in operation, that can be manufactured at low cost, and that is readily adaptable to be utilized in the conversion of existing non-pressure responsive nozzles to a self-adjusting constant pressure function.

Other objects and advantages of the invention will appear during the course of the following description and with reference to the annexed drawings in which like parts are designated by like numerals throughout the same.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a view in side elevation of a discharge control mechanism embodying the features of the invention, portions thereof being broken away to show interior detail thereof in section.

FIG. 2 is a cross-sectional view, taken as indicated on line 2—2 of FIG. 1.

FIG. 3 is a view similar to FIG. 1 showing a modified form of the invention.

FIG. 4 is an end view in elevation, as viewed from the right-hand side of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring more particularly to FIGS. 1 and 2 of the drawing, there is shown a fragmentary portion of a nozzle body 10 having an inner wall surface 11 defining a substantially conically divergent discharge opening. For a more complete and detailed description of the structure and characteristics of such nozzle bodies, reference is made to the previously mentioned prior art patents. Disposed within the nozzle body 10 is a pressure-responsive baffle mechanism, generally designated 12, which functions to define an adjustable annular discharge orifice 13 between the wall 11 and a circumferential portion 14 of a hollow cylinder 15 which forms part of the baffle mechanism. Due to the angularity or slope of the conical wall surface 11, it will be apparent that longitudinal movement of the cylinder 15 and its portion 14 toward the discharge end of the nozzle will increase the spacing between the portion 14 and the wall 11 thereby increasing the area or size of the discharge orifice 13. Likewise, as the portion 14 is moved longitudinally inwardly in the opposite direction, the spacing between it and the wall is decreased to throttle or diminish the size of the discharge orifice and reduce its flow capability.

The cylinder 15 is provided with an open end 16 and a closed end defined by a transverse wall 17. For purposes of stabilizing the longitudinal movement of the cylinder 15, an axially-extending, rearwardly directed projection 18 is provided on the outer surface of the end wall 17 and is centrally bored as at 19 to permit traverse thereof by an axially extending shaft or rod 20. One end of the rod 20 is suitably secured to the nozzle body as, for example, by threaded engagement with a diametrical spider or web 21 which is customarily provided in the nozzle body.

The other end of the rod 20 traverses a piston 22 which is mounted in the open end of the cylinder 15 in sealing engagement therewith. Although the piston 22 could be fixedly secured to the end of the rod 20, the reaction forces involved in the operation of the baffle mechanism are such as to urge the piston outwardly of the rod 20, so that no such fixed securement is required, but it is sufficient to provide a retainer nut 23 on the end of the rod to limit the outward movement of the piston. Similarly, a retaining collar 24 is provided near the other end of the rod to act as a stop to limit inward movement of the cylinder relatively to the rod and thereby position the surface or portion 14 of the cylinder in a minimum spaced relationship to the nozzle wall 11, if circumstances dictate that complete closure of the discharge orifice is not desired. The minimum size of the discharge orifice can be adjusted either by providing threaded adjustment of the retaining collar 24 on the rod 20 or by adjustment of the threaded engagement of the end of the rod in the web 21 of the nozzle.

It will be noted that the surface **25** of the end wall **17** of the cylinder is exposed to the line pressure of the water or other liquid being furnished under pressure to the nozzle. This hydraulic pressure on the surface **25** exerts an axially-directed force on the cylinder to the extent that there is a differential in pressure or in surface area between the outer surface **25** and the interior surface **26** of the wall **17.** In order to reduce the magnitude of the forces involved in establishing and maintaining equilibrium of the forces involved in the operation of the baffle mechanism, a plurality of apertures **27** are provided traversing the wall **17** so as to equalize the hydraulic pressure on the surfaces **25** and **26** of the end wall **17.** However, it will be noted that the projected or effective surface area of the surface **25** is greater than the area of the surface **26** to the extent of the area of the diametrical surface of the wall **28** of the cylinder. Inasmuch as the pressures on opposite sides of the wall **17** are equal, the described differential in surface area results in an effective pressure-responsive surface on the surface **25** which exerts a displacing force on the cylinder **15** urging it to move away from the wall **11** of the nozzle and thus enlarge the discharge orifice. Such line pressure-induced displacement of the cylinder is yieldably opposed by a pressure-reaction element **29** which is interposed in slightly stressed condition between the cylinder and the piston. In the particular form shown, the element **29** is a hollow cylinder made of a resilient deformable elastomer, such as selected rubber having a predetermined durometer value of hardness and a predetermined wall thickness which will provide it with the necessary operational force characteristic for which the baffle mechanism is designed. An annular recess **30** in the face of the piston and a corresponding annular recess **31** in the surface **26** of the cylinder serve to accomodate and retain the ends of the cylindrical element **29** against displacement. The length of the element **29** is preselected to be slightly greater than the spacing between the opposed recesses **30** and **31,** so that there will be a slight initial preloading or prestressing of the element **29** in its assembled relationship.

Although the pressure of the liquid flowing to the discharge nozzle may be on the order of 100–200 psi and thus capable of being translated into forces of relatively great magnitude acting on the baffle element **15,** the reduction and deliberate limitation of the effective surface area of the cylinder **15** which is exposed to this liquid pressure, results in a displacing force of relatively small magnitude on the cylinder. Accordingly, the pressure reaction element **29** which serves to oppose this pressure-induced displacement of the cylinder can likewise have an operational force of relatively low magnitude, which may be on the order of 5–15 pounds.

When a proper operational value of force for the element **29** has been determined, this value of force becomes the operational standard or yardstick for establishing an equilibrium of mechanical and hydraulic forces for attaining substantially constant discharge flow pressure at the orifice **13.** When the pressurized flow of liquid to the nozzle is initiated, the cylinder **15** is either in sealing abutment with the wall **11** or is spaced therefrom to provide a minimum discharge orifice opening, depending upon the adjusted positional relationship desired between the baffle mechanism **12** and the wall **11** of the nozzle. As the liquid pressure is impressed upon the surface **25** of the end wall **17** and communicates through apertures **27** with the interior of the cylinder **15,** the pressure-responsive area or surface represented by the differential in area between the surfaces **25** and **26** becomes effective to impress or exert a force urging the cylinder toward the piston and acting to displace the cylinder in that direction if this pressure-induced force is of a value greater than the opposing operational force of the element **29.** Thus, as line pressure increases, displacement of the cylinder will occur moving it axially away from the wall **11** to increase the size of the discharge orifice **13** and thus permit a greater volume of water or other liquid to be discharged through the orifice. As the orifice size increases and volume of discharge also increases, there is a decrease in the discharge pressure at the orifice and on the end wall **17** of the cylinder which is translated into a lower magnitude of displacing force on the cylinder until this force and the counter-force of the element **29** are equal or in equilibrium. At this point, forward displacement of the cylinder will cease and no further orifice-changing movement of the cylinder will occur until there is some fluctuation in the liquid pressure, either higher or lower, which distrubs the previously described balance or equilibrium of forces. If the pressure increases, the cylinder is further displaced by the hydraulic pressure to further enlarge the orifice opening and reduce the discharge pressure until equilibrium is attained. If the liquid pressure decreases, the pressure reaction element **29** displaces the cylinder toward the wall **11** to decrease the size of the discharge orifice and increase the discharge pressure until equilibrium is obtained between the forces. By maintaining a constant pressure at the discharge orifice by means of the self-adjustment of the baffle mechanism **12** in response to liquid pressure fluctuations, a substantially uniform reach of the discharge stream is maintained.

During the forward or orifice-enlarging displacement of the cylinder, the pressure reaction element **29** is subjected to a compressive stress between the piston and the cylinder, but due to its non-compressive characteristic, the element **29** will buckle or deform radially in response to such stress, rather than compressing. This characteristic of the element **29** results in a very favorable load-deflection curve having a substantially constant load characteristic throughout the operational range of its axial deflection. The buckled or radially-deformed condition of the pressure-reaction element is indicated in phantom outline in FIG. **1.**

One or more vent openings or weep holes **32** are provided in the piston **22** to permit atmospheric venting of the interior of the cylinder **15** in response to variations in the volume thereof resulting from the relative displacing movement in one direction or the other. The vents **32** are provided for communication both interiorly and exteriorly of the element **29,** so that the element **29** is free of any direct fluid pressure forces which would modify or interfere with its function in being responsive only to the hydraulic force acting on the pressure-responsive surface of the end wall **17.**

From the foregoing description, it will be apparent that the baffle mechanism **12** provides a simple, relatively low-cost combination of parts having a pressure-reaction element **29** of relatively low force magnitude which permits ready assembly without the use of costly fixtures and which also provides quick and sensitive response to the pressure fluctuations or variations in the discharge nozzle. The relatively long projection **18** in

which the rod **20** is slidably received provides an adequate length of guide area and bearing surface to assure precise axial travel of the cylinder **15** relatively to the nozzle wall **11.** It will also be noted that the outboard walls of the annular recesses **30** and **31** are provided with a arcuate guide surface **33** to accomodate to radial deflection of the element **29** outwardly and minimize the possibility of undue wear on the element by the outer edge of the grooves. The simplicity of the baffle mechanism **12** also lends itself to use as a conversion unit in existing non-pressure response nozzles to convert them to self-adjusting operation. The element **29** is not subject to corrosion and requires far less cost and precision in manufacture than a metal coil spring to accomplish a comparable function.

It will also be noted that a characteristic of the sleeve **29** is that relatively small changes can be made in the length of the sleeve prior to assembly to calibrate the sleeve to a desired value of constant pressure counterforce and thereby provide meaningful adjustments in the operation characteristics of the baffle mechanism by either shortening the existing sleeve **29** or replacing it with a slightly longer sleeve, without the necessity of replacing or modifying any other components of the baffle mechanism. Such changes in the length of the sleeve can accomplish adjustment within a limited range. If more extensive changes in the operating characteristics of the sleeve are required, then such changes are accomplished by changes in the durometer hardness value of the material of which the sleeve is formed or by changes in the wall thickness of the sleeve or by a combination of both.

In FIGS. **3** and **4** of the drawing, there is shown a modified form of the invention which is characterized by its compactness. This compactness is achieved by utilizing a cylindrical pressure-reaction element **34** which is molded so as to be bent back upon itself and thereby permits the modified baffle mechanism **12***a* to be considerably shorter in overall length than the embodiment illustrated in FIGS. **1** and **2.**

The baffle mechanism **12***a* includes a hollow cylinder **35** having an exterior edge portion **36** which is axially displaceable toward and away from the wall **11** of the nozzle to define the adjustable discharge orifice **13.** The diametrical annular end surface **37** defines a pressure-responsive area determined by the thickness of the wall **38** of the cylinder.

A piston **39** is mounted within the cylinder **35** in sealing engagement therewith. A piston rod **40** extends rearwardly from the piston for threaded securement to the spider or web **21** of the nozzle. The piston and its associated piston rod define the piston assembly.

An annular recess **41** is provided in the opposite end face of the cylinder **35** to receive and retain one end of the sleeve element **34.** The opposite end of the sleeve element is provided with a diametrically extending flange portion **42** which is molded or otherwise fixedly secured to a metallic backing plate **43** having a central opening **44** therein. A retainer element **45** snugly engages a portion of the wall of the sleeve **34** and seats on the flange **42.** A screw **46** traverses the retainer element and is threadedly secured in the piston rod **40** centrally thereof to secure the retainer element and the underlying flange **42** and backing plate **43** snugly against the face of the piston **39.** This serves to anchor the flanged end of the element **34.** As previously indicated, the remainder of the sleeve extends back upon itself and retained in the recess **41** which serves to stress the sleeve. This slight pre-loading or pre-stressing of the sleeve serves to urge the cylinder **35** rearwardly toward the wall **11** and normally bring the edge **36** into abutment with the wall. It will be noted however that if the piston rod is partially unthreaded with respect to the web **21,** the entire baffle mechanism **12***a* can be displaced forwardly to a position where a minimum discharge orifice opening **13** is provided to the extent desired.

With the edge **36** of the cylinder in abutment with the wall **11,** it will be apparent that the end surface **37** is exposed to the liquid pressure within the nozzle. This pressure is translated into a cylinder-displacing force which causes forward displacement of the cylinder away from the wall **11** as soon as the magnitude of that force overcomes or exceeds the counterforce of the resilient yieldable pressure reaction member **34.** At that position of the cylinder, an equilibrium will be attained between the hydraulically induced force and the mechanical counterforce of the element **34** to provide a constant discharge pressure at the orifice **13.** During the forward displacement of the cylinder, the walls of the sleeve **34** roll over and move in telescopic fashion relatively to each other as the sleeve is deformed by the axial compressive thrust of force exerted thereon by the displacing movement of the cylinder. Vents or weep holes **47** are provided at the rolled edge **48** of the element **34** to relieve any water pressure that might exist between the adjacent walls of the sleeve as a result of possible leakage of the water or other fluid past the piston **39.**

After an equilibrium of the forces has been achieved, the discharge pressure at the nozzle will remain constant and further self-adjustment of the baffle mechanism **12***a* will occur only in response to fluctuations or variations in the pressure supplied to the nozzle. If such liquid pressure decreases, the pressure reaction element will displace the cylinder rearwardly toward the wall **11** of the nozzle to throttle the discharge orifice and thereby reduce volume flow therethrough and build up the discharge pressure to a value which will achieve equilibrium with the constant force exerted by the element **34.** If the fluctuation in line pressure results in a higher line pressure, the cylinder will be displaced forwardly by this increased pressure producing a higher force on the pressure responsive surface **37,** thereby causing enlargement of the discharge orifice **13** and increased liquid flow therethrough which will cause a decrease in discharge pressure until an equilibrium of the forces is again achieved.

As in the case of the previously described pressure reaction element **29,** the pressure reaction element **34** is a resilient, non-compressible elastomeric element having a constant load-deflection characteristic which permits the forces employed to be of relatively low magnitude, as previously indicated with respect to the element **29.** The fact that the element **34** deforms telescopically rather than radially as in the previously described embodiment, results in the compactness and shorter length previously mentioned. The modified form of the invention therefore lends itself more readily to use in smaller discharge nozzles than would be practical with the embodiment shown in FIGS. **1** and **2.**

It is to be understood that the forms of my invention, herewith shown and described, are to be taken as preferred examples of the same, and that various changes

in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of my invention, or the scope of the subjoined claims.

Having thus described my invention, I claim:

1. In a pressure-control baffle for a liquid discharge nozzle, the combination of a hollow baffle cylinder disposed in the path of pressurized liquid flow and defining an adjustable discharge orifice, a piston assembly operatively mounted in said cylinder and secured to the nozzle to support said cylinder for discharge-control movement relatively thereto, said piston assembly sealing said cylinder against discharge of fluid therethrough, an effective pressure-responsive area defined by the diametrical surface of the wall of said cylinder and exerting a variable pressure-induced force thereon to displace said cylinder into orifice-enlarging position, a tubular, resilient pressure-reaction element stressed between said cylinder and said piston assembly and transversely deformable to yieldably oppose said displacement with a substantially uniform counter-force of predetermined value for regulating the position of said cylinder and the size of said discharge orifice to establish equilibrium between said force and said counter-force, and means for maintaining an equalized hydraulic pressure on opposite sides of the tubular wall of said pressure-reaction element whereby said element is energized solely in response to displacement of said cylinder.

2. A combination as defined in claim **1**, wherein said piston assembly includes a piston rod having a piston mounted thereon, said piston rod having one end thereof threaded for securement to the nozzle, and means carried by said piston rod for limiting movement of said cylinder relatively to said piston.

3. A combination as defined in claim **1**, wherein said pressure-reaction element is a resilient deformable sleeve of elastomeric material.

4. A combination as defined in claim **3**, wherein said sleeve is of cylindrical configuration.

5. A combination as defined in claim **3**, wherein said sleeve is stressed by axially-induced deformation thereof.

6. A combination as defined in claim **5**, wherein said axially-induced stress is compressive and said sleeve deforms radially.

7. A combination as defined in claim **5**, wherein said axially-induced stress is compressive and said sleeve deforms telescopically.

8. A combination as defined in claim **5**, wherein one end of said sleeve bears against said cylinder interiorly thereof, and the other end of said sleeve bears against said piston assembly.

9. A combination as defined in claim **5**, wherein one end of said sleeve bears against said cylinder exteriorly thereof, and the other end of said sleeve bears against said piston assembly.

10. A combination as defined in claim **5**, wherein one end of said sleeve bears against said cylinder, the other end of said sleeve bears against said piston assembly, and said sleeve is formed to be bent upon itself between said ends.

* * * * *