# United States Patent [19]

**Siczek et al.**

[11] **3,893,627**

[45] **July 8, 1975**


[54] **ELECTRIC AIRLESS CUP GUN APPARATUS**


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[22] Filed: **Aug. 29, 1974**

[21] Appl. No.: **501,851**

[52] **U.S. Cl.** ..... **239/332**; 222/380; 239/533; 239/574; 239/583

[51] **Int. Cl.** ..... **B05b 9/02**

[58] **Field of Search** ..... 239/101, 331, 332, 351, 239/361, 533, 546, 574, 583, DIG. 14; 222/372, 380, 383; 417/410, 416, 424



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[57] **ABSTRACT**

Apparatus for spraying paint and other liquids under high hydraulic pressure is described, wherein fluid pressure is incrementally developed within a resilient accumulator by controlling fluid passages through the use of pressure-responsive valving, while a reciprocating piston action pumps the fluid into the passages.


**17 Claims, 6 Drawing Figures**

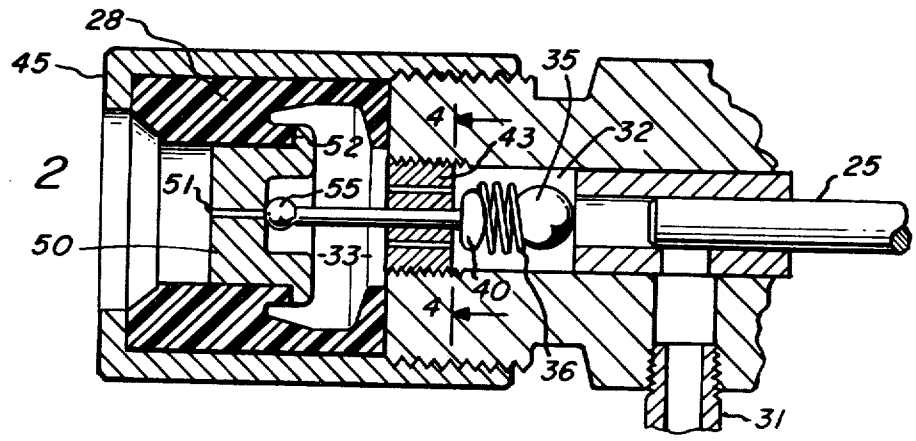


FIG. 4

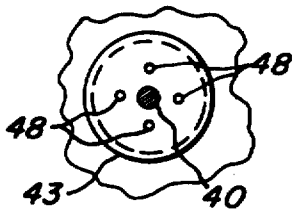



FIG. 1

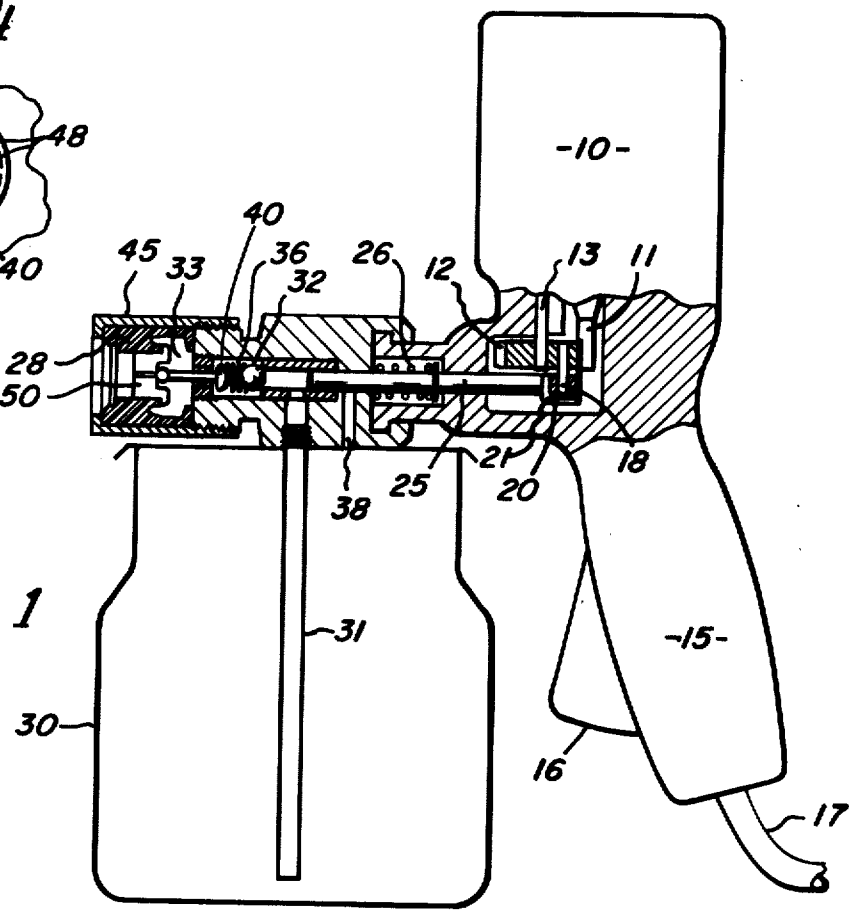



FIG. 2

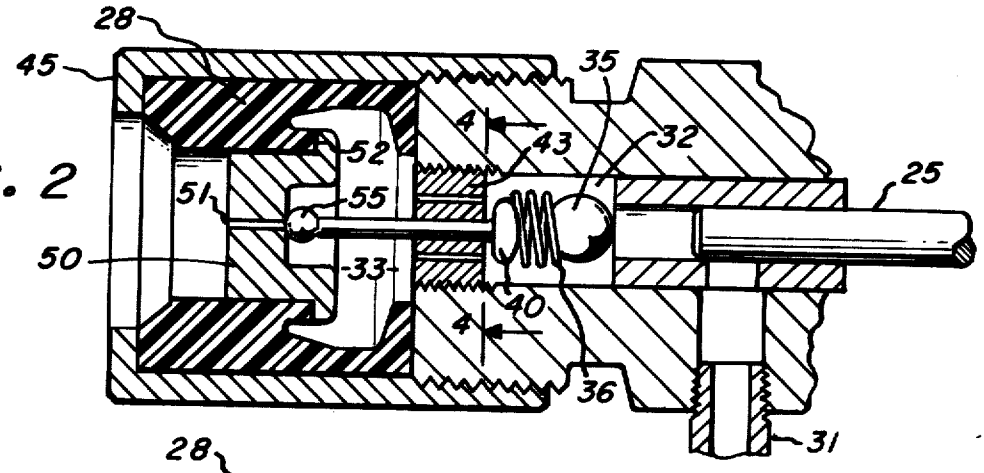



FIG. 3

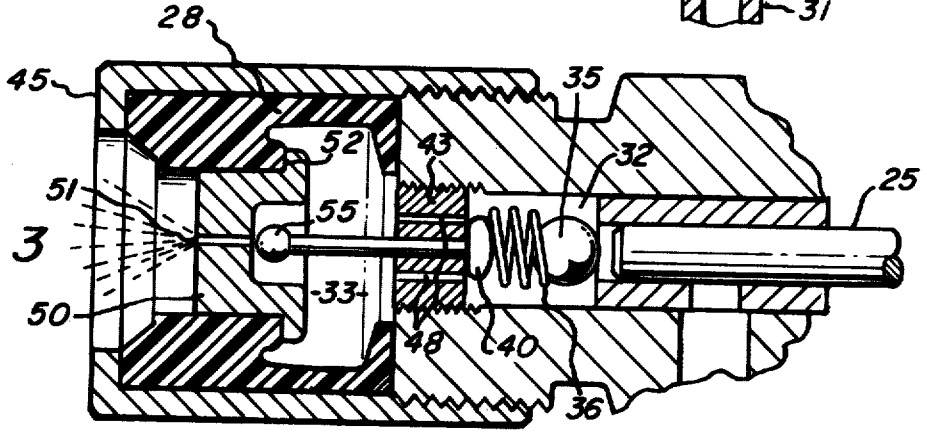


FIG. 5A

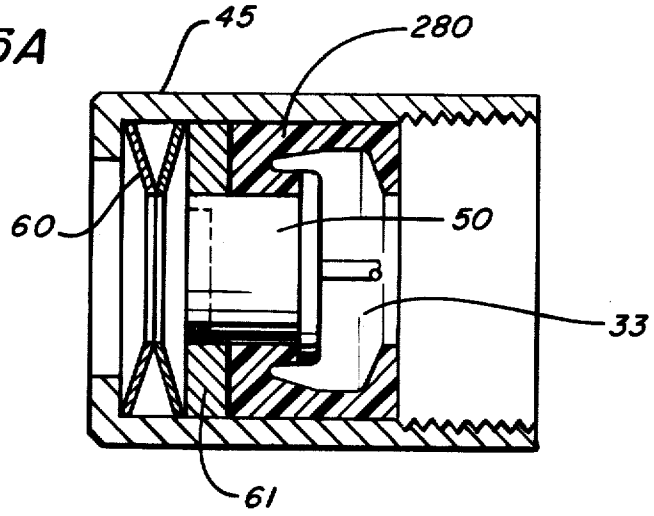
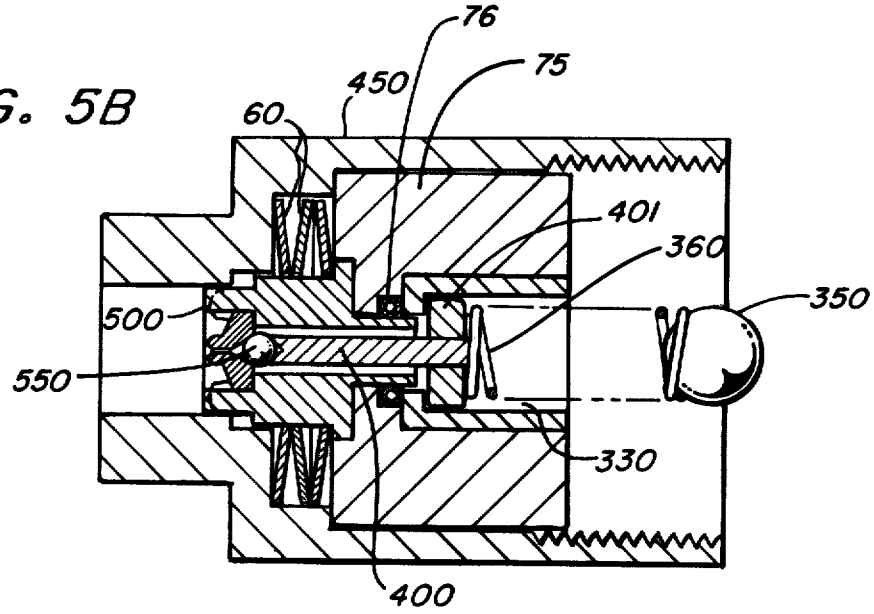



FIG. 5B



# ELECTRIC AIRLESS CUP GUN APPARATUS

This invention relates to an apparatus for the spraying of paint and other liquids under the influence of high hydraulic pressure. More particularly, the invention in its preferred embodiment is described with reference to a portable, electrically powered, paint sprayer apparatus. The invention is particularly useful in providing a means for incrementally building up and accumulating a high hydraulic pressure for subsequent release through an orifice for the purpose of spraying.

There are essentially two approaches to the spraying of paint and other liquids through an orifice. The first of these involves spraying liquid at relatively low pressure and utilizing an auxiliary gas, usually air, to atomize and assist in the spraying of the liquid. An apparatus which uses this approach will have, in addition to suitable passages and orifices for the flow of the liquid to be sprayed, additional passages for controlling the flow of pressurized air so that the liquid stream and air stream may be merged to create an atomized spray pattern.

A second approach to the art of spraying liquids involves spraying under high hydraulic liquid pressure. An apparatus which sprays according to this approach will have only a single passage for controlling the flow of the liquid, although it will also have means for building up and maintaining a high pressure within the spray passages. Of course, suitable valving mechanisms must be used in either of the aforementioned approaches, but the obvious advantage of spraying under hydraulic pressure is that an auxiliary source of pressurized air is not required. This advantage is somewhat lessened by the fact that means must be provided for developing high hydraulic pressures.

In the field of portable paint and liquid sprayers, the problem of developing high hydraulic pressure is compounded, because equipment capable of doing so is frequently bulky and expensive. However, small motor driven diaphragm and piston arrangements have been devised whereby the hydraulic pressure is incrementally increased with each stroke of the driving piston or diaphragm, and by driving the piston or diaphragm at a high enough rate it becomes possible to develop a high pressure within some confined chamber.

The present invention utilizes the concept of developing high hydraulic pressure through the application of successive pressure strokes on fluid confined in a chamber, although it accomplishes this purpose through a new and novel apparatus.

It is therefore an object of this invention to provide an apparatus for spraying paint and other liquids under high hydraulic pressure.

It is another object of this invention to provide an apparatus for use in a lightweight, portable paint sprayer.

It is yet another object of this invention to provide an economical pressurizing means for paint and other liquids, for the purpose of spraying under the influence of such pressure.

These and other objects and advantages will become apparent upon a reading of the following specification and claims, and with reference to the attached drawings, in which:

FIG. 1 illustrates the invention in side view in partial cross section;

FIG. 2 is an expanded cross sectional view of an essential part of the invention;



FIG. 3 is a cross sectional side view of the same part, showing a second operating position;

FIG. 4 illustrates the passages between chambers;

FIG. 5A illustrates an alternative embodiment of the novel chamber of this invention; and

FIG. 5B illustrates another embodiment of the novel chamber of this invention.

Referring first to FIG. 1, the inventive apparatus is shown in side view, with pertinent features illustrated in cross section. A portable paint spraying apparatus is held by handle **15** and is actuated by means of trigger **16**, which permits electrical energy to flow from wire **17** to drive motor **10**. Motor **10** has a drive shaft gear **11** which drives a second gear **12**. Gear **12** is mounted with a suitable bearing on spindle **13** and rotates freely about spindle **13**. An eccentric shaft **18** is securely attached to gear **12** in a position displaced from the axis of gear **12**, projecting downwardly and having a rotatable wheel **20** attached at its lower end. Wheel **20** rests within a yoke **21** which forms the end of piston rod **25**. Therefore, as motor drive shaft gear **11** rotates it causes gear **12** to similarly rotate further causing eccentric shaft **18** to impart a reciprocating motion to the end of piston rod **25**, which may be biased rearwardly by spring **26**. This motion causes piston rod **25** to move back and forth within its cylinder. Any other form of reciprocating drive apparatus would be suitable for use with this invention, the apparatus described with reference to motor **10** being a representative and preferred embodiment for use with the invention. It has been found that a ⅓ — horsepower electric motor operating at **12,000** r.p.m. provides an effective power source for this invention.

As piston rod **25** reciprocates within its cylinder, it draws paint from paint container **30** upwardly through suction tube **31** during each reverse stroke, and forces this paint into chamber **32** during each forward stroke. Paint is forced into chamber **32** by pressure exerted against ball valve **35**, causing ball **35** to move away from its seat against the spring force of spring **36**. Ball **35** may return to its seated position during each rearward stroke of piston rod **25**, thereby allowing the upward suction of additional paint via suction tube **31**. A drain passage **38** is provided for allowing excess accumulated paint to drain back into container **30**, if such paint travels between piston rod **25** and its cylinder. Suitable packing material (not shown) may be used to provide a seal for piston rod **25** rearward of drain passage **38** and to thereby prevent paint from leaking to the exterior of the apparatus.

Chamber **32** is connected to chamber **33** by means of passages **48** (see FIG. **4**). Therefore, paint which is forced into chamber **32** flows into chamber **33** through passages **48**. Chamber **33** is formed as an interior chamber within an accumulator **28**. Accumulator **28** is formed from a resilient, flexible material such as rubber for purposes which will be hereinafter described. A spray tip **50**, of conventional design known in the art and typically manufactured of carbide steel, is seated within accumulator **28**, and the assembly consisting of spray tip **50** and accumulator **28** is clamped onto the spray gun body by means of threaded tip retainer **45**.

FIG. 2 illustrates in expanded view the novel portion of the inventive apparatus. Further, it illustrates the relative positions of the operational components during the forward stroke of piston rod **25**. The fluid drawn into the cylinder of piston rod **25** during its reversed

stroke is forced forwardly, opening ball valve **35** to allow this fluid to enter chamber **32.** The fluid also escapes through threaded valve guide **43** via passages **48** into chamber **33.** The fluid is prevented from leaving via the spray tip **50** orifice **51** because valve **55** remains seated against its seat in the rear of spray tip **50.** Thus, the fluid forced into chambers **32** and **33** by piston rod **25** is accumulated therein during each successive forward stroke of piston rod **25,** building up fluid pressure within these chambers during each of these strokes. During each successive reverse stroke of piston rod **25,** ball valve **35** may become seated to prevent leakage of the fluid backward into the piston rod cylinder, and a new quantity of fluid is drawn into the piston rod **25** cylinder.

FIG. **4** illustrates an end view of valve guide **43.** A plurality of passages **48** may be provided therein for allowing the passage of fluid into chamber **33,** and these passages remain open regardless of the position of valve rod **40.**

As piston rod **25** reciprocates, the fluid pressure within chamber **33** incrementally increases with each stroke. Because chamber **33** is formed from a resilient flexible material comprised of accumulator **28** the pressure build up causes some deformity to the interior shape of chamber **33.** In particular, the pressure build up causes spray tip **50** to exert a forward force against shoulders **52,** which are formed within accumulator **28.** Shoulders **52** move incrementally forward with each stroke of piston rod **25,** allowing spray tip **50** to also move forward At some point the rounded head of valve rod **40** abuts against valve guide **43** and thereby prevents further forward movement of valve **55,** and valve **55** is released from its seat against the rear of spray tip **50** and a fluid passage to the spray tip orifice **51** is created. When this passage opens fluid is ejected out through orifice **51** as illustrated in FIG. **3,** to relieve the pressure within chamber **33.** As the pressure drops within chamber **33** the interior shape of accumulator **28** returns to normal and the rear seat of spray tip **50** again becomes seated against valve **55.** This causes valve rod **40** to again lift from its seat against valve guide **43.** The cycle then repeats itself as described hereinbefore.

Because piston rod **25** is reciprocated at a relatively high rate of speed, typically **2,000** to **3,000** strokes per minute, the spray output from orifice **51** appears as a continuous spray. Pulsations or surges in this spray output tend to be damped by the resiliency of accumulator **28.** If piston **25** supplies enough fluid volume under high pressure valve **55** may remain open to allow a constant escape of fluid from orifice **51.** If piston **25** doesn't supply enough fluid volume, valve **55** may open and close at the same rate as piston **25** reciprocates. In either case, the operative result is a high pressure spray pattern which provides an effective spray for the purposes intended.

The apparatus may be initially set up and adjusted by means of the threaded fittings illustrated in the figures. For example, the compression of spring **36,** holding ball valve **35** onto its seat, may be adjusted initially by the threaded depth of valve guide **43.** This valve guide **43** may be threaded into the spray gun body, using a special wrench adapted to fit passages **48,** until the spring force of spring **36** exerts the desired force against ball valve **35** for the pressure ranges desired. Similarly, the position of valve rod **40,** as well as the pressure required in chamber **33** to unseat valve **55,** may be adjusted by tightening tip retainer **45** against **45** against the spray gun body. As tip retainer **45** is threaded onto the spray gun body it increases the gap between the selectively head of valve rod **40** and valve guide **43,** and thereby increases the internal pressure within chamber **33** which must build up before sufficient deformity of accumulator **28** occurs to release valve **55.** Thus the spray gun may be adjusted to operate selectively over different fluid pressure ranges, which adjustment may be necessary depending upon the viscosity and other characteristics of the paint or fluid to be sprayed. If desired, an additional adjustment may be provided by varying the length of valve rod **40.** Adjustment of this valve rod length may be provided by threading one end of the valve rod and controlling the depth which it is inserted into the ball valve **55,** or into the rounded head of valve rod **40.**

FIG. **5A** illustrates an alternative embodiment of the accumulator chamber of this invention. In this embodiment, the resiliency of the accumulator is accomplished by the combination of a resilient member **280,** which functions similarly to accumulator **28** described hereinbefore, and a plurality of spring washers **60.** Spring washers **60** may be stacked as illustrated in FIG. **5A** to provide an additional resilient force acting against spray tip **50** in the manner already described. It may be necessary to utilize a flat washer **61** between the end surface of member **280** and the stack of spring washers **60.**

FIG. **5B** illustrates yet another embodiment of the spray tip assembly. Tip retainer **450** secures the assembly onto the body of the spray gun as before. A plurality of spring washers **60** are clamped by tip retainer **450** against spray tip **500,** and spray tip **500** is clamped securely against member **75.** Member **75** may be a non-resilient metallic member, and a suitable O-ring **76** seal is provided to prevent fluid leakage around the spray tip **500** edges. A valve rod **400** is engaged between ball valve **550** and valve rod end **401,** and a spring **360** is engaged between end **401** and ball valve **350.** The overall operation of this embodiment is similar to that described hereinbefore, except the resiliency of the accumulator is entirely accomplished through the use of the plurality of spring washers **600.** The spray tip **500** slides forward and backward in response to pressures within chamber **330,** and such sliding action is sealably accomplished through O-ring **76.** The adjustments for control of pressure and fluid spray characteristics can be accomplished in a manner similar to that already described for other embodiments of the invention.

The invention as herein described has produced an excellent paint spray application using water-base latex paint, and a spray tip orifice of **0.013** inch in effective area. The piston stroke rate for effective operation was found to be in the range of from **2,000** to **3,000** strokes per minute, and this produced a peak hydraulic pressure of **2,000** – 2,500 p.s.i. Other paint types have been used in the embodiment described herein with equally satisfactory results.

What is claimed is:

**1.** Apparatus for accumulating incremental fluid pulses and for developing an elevated fluid pressure therein for subsequent release to the exterior, comprising

a. means for receiving said fluid pulses, including a check valve for admitting said fluid and preventing reverse flow therefrom;

b. an accumulator chamber connected to said means for receiving, said accumulator chamber having a pressure-deformable member therein;

c. a housing having a fluid release passage therethrough, said housing seated against said deformable member, with said fluid release passage connecting the interior of said accumulator chamber with the exterior;

d. valve means for opening said fluid release passage, sealably seated in said fluid release passage and operatively connected to move from its sealably seated position under conditions of elevated pressure in said accumulator chamber;

**2.** The apparatus of claim **1** wherein said valve means further comprises

i. a ball valve seated against said housing in blocking relationship to said fluid release passage;

ii. a valve rod interposed between said ball valve and said means for receiving said fluid pulses, said valve rod having thereon a means for limiting its movement; and

iii. a shoulder fixedly located relative to said means for limiting movement and in operative contact under predetermined conditions of elevated pressure in said accumulator chamber.

**3.** The apparatus of claim **2** wherein the position of said valve rod means for limiting movement relative to said shoulder is greater than required for seating the ball valve under unelevated pressure conditions internal said accumulator chamber.

**4.** The apparatus of claim **3,** further comprising a retainer clamp means for compressing said accumulator chamber and said housing against said means for receiving said fluid pulses.

**5.** The apparatus of claim **4** wherein said housing further comprises a spray tip having an orifice therein for forming a spray.

**6.** The apparatus of claim **5** wherein said valve rod is coupled to said receiving means check valve by a compression spring.

**7.** The apparatus of claim **6** wherein said retainer clamp is threaded and is adjustable in compression force against said means for receiving said fluid pulses.

**8.** An apparatus for developing an elevated fluid pressure in a chamber after withdrawing the fluid from a container into the chamber, and subsequently spraying the fluid, comprising

a. a fluid passage connecting said container to a cylinder;

b. a piston reciprocable within said cylinder, and a fluid outlet extending from said cylinder;

c. a chamber connected to said cylinder fluid outlet, said chamber having therein a resilient wall portion;

d. a spray conduit connected to said chamber resilient wall portion;

e. valve means for closing said spray conduit, said valve means closing said spray conduit when the fluid pressure in said chamber is not elevated, and said valve means opening said spray conduit when the fluid pressure in said chamber is elevated; and

f. valve means for closing said chamber from said cylinder during a reciprocable piston stroke.

**9.** The apparatus as claimed in claim **8,** wherein said chamber resilient wall portion further comprises a raised shoulder formed from said resilient material of said wall portion, and said spray conduit is seated against said raised shoulder.

**10.** The apparatus of claim **9** wherein said valve means for closing said chamber from said cylinder is connected by a compression spring to said valve means for closing said spray conduit.

**11.** The apparatus of claim **10** wherein said valve means for closing said spray conduit is a ball valve and said valve means for closing said passage connecting said chamber to said cylinder is a ball valve.

**12.** The apparatus of claim **11** further comprising a threaded retainer clamp grasping the exterior of said chamber and holding said chamber resilient wall portion in adjustable compression against said passage connecting said chamber to said cylinder.

**13.** The apparatus of claim **12** wherein said spray conduit further comprises an orifice for developing a spray.

**14.** A spray apparatus for accumulating incremental fluid pulses in a housing and for developing an elevated fluid pressure therein for subsequent release to the exterior, comprising:

a. means for receiving said fluid pulses, including a chamber and a check valve for admitting said fluid into said chamber and preventing reverse flow therefrom;

b. a movable wall portion forming a part of said chamber and movable relative to said housing;

c. a spray tip located in said movable wall portion and having a passage passing therethrough to the exterior;

d. a resilient member connected between said movable wall portion and said housing in compressible relationship to said chamber; and

e. valve means for opening and closing said spray tip passage, seated against said spray tip and connected in limited movement relationship to said housing.

**15.** The apparatus of claim **14** wherein said resilient member further comprises at least one spring washer.

**16.** The apparatus of claim **15** wherein said valve means further comprises

i. a valve seated in said spray tip passage;

ii. a shoulder attached to said housing;

iii. a valve rod interposed against said valve and in sliding relationship to said shoulder, said valve rod having a stop thereon for contacting said shoulder under predetermined conditions of elevated pressure in said chamber.

**17.** The apparatus of claim **16,** further comprising means for adjusting the compression force of said resilient member against said chamber, said means being threadably attached to said housing.

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