July 28, 1959 J. A. BEDE 2,896,862

ACCUMULATOR

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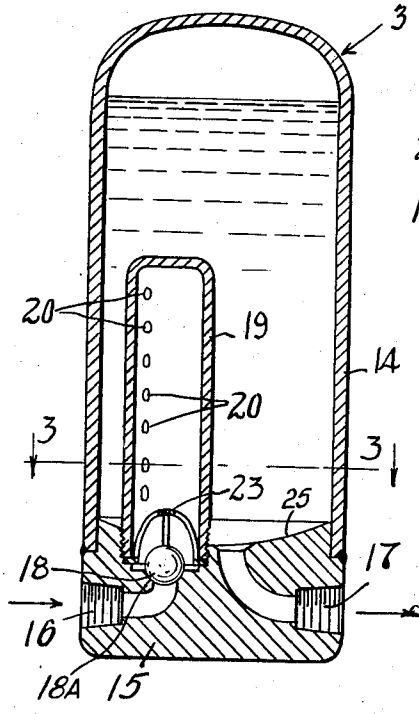


Fig. 2

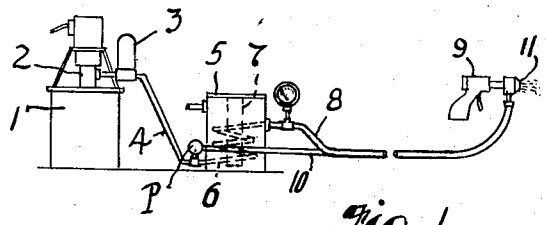


Fig. 1

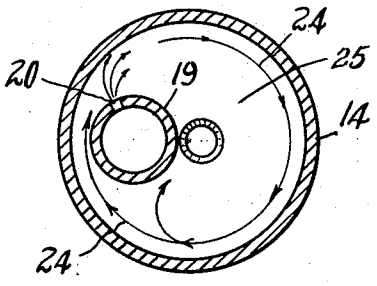


Fig. 3

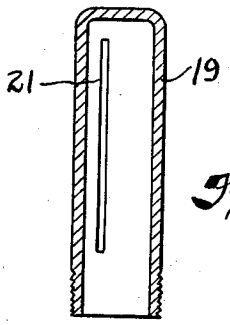


Fig. 4

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# ACCUMULATOR

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4 Claims. (Cl. 239—332)

The present invention relates generally as indicated to an accumulator, and more particularly to an accumulator which is effective to substantially completely diffuse and muffle compression or shock waves in pumped liquids.

Accumulators as such are old and well known in the art and are employed in practically every liquid pressure system. For example, in aircraft hydraulic systems and elsewhere, there are in use spherical accumulators which are divided by flexible diaphragms into hemispherical air and oil chambers, cylindrical accumulators with or without floating pistons which subdivide the space inside the accumulators into separate air and oil chambers. In addition, it is well known to provide air chambers in conjunction with hydraulic rams, force pumps, etc.

A primary function of many accumulators is to provide a reservoir of liquid therein under air pressure so as to enable smooth and rapid actuation of hydraulic cylinders and the like without causing a large pressure drop in the system.

Accumulators are also frequently employed in liquid systems for the purpose of partially smoothing out pressure pulses created in the liquid by the pumps of said systems. However, by reason of the customary connection of the single bottom port of such accumulator to the upwardly extending lateral port of a T-pipe fitting, the shock waves in the liquid cannot be effectively muffled or dissipated. Moreover, even though the liquid may be introduced to such accumulator through a stand pipe having its outlet above the level of a separate accumulator outlet, this expedient alone is ineffective to dampen the shock waves in the liquid in the manner and to the extent achieved by the present invention as is hereinafter described.

Although the present invention is herein described particularly with reference to a liquid system handling liquid coating composition under pressure, it is to be understood that the general principles of the invention may be applied in other liquid pressure systems. I have discovered that efficient spraying of a heavy body liquid coating composition such as paint, enamel, lacquer, varnish, etc. can be accomplished by heating the coating composition to reduce its viscosity to spraying consistency (rather than by added thinner or solvent) and by ejecting the heated composition at relatively high pressure, say 600 p.s.i. for example, through an orifice in the absence of atomizing gas other than that released from the composition itself.

In ejecting the heated coating composition as aforesaid, the use of a rotary, positive displacement pump has left much to be desired, because the close-fitting, relatively sliding parts thereof soon wear out with consequent loss of pressure and pumping capacity. For this reason, reciprocating piston pumps have been widely used in the pumping of liquid coating composition; and, while such reciprocating piston pumps are satisfactory from the standpoint of easily obtaining the necessary high pressures and desired volumetrical capacities, they present the serious problem of causing a large pressure variation at the end



of each stroke thereof with the result that the spraying performance is non-uniform.

To my knowledge, such large pressure variation has never been eliminated with any known form of accumulator. Even with the best known form of accumulator, I have found that, with a liquid pressure of 600 p.s.i. at the spray gun during the uniform movement of the reciprocating piston, the pressure drops 100 to 150 p.s.i. at the time that the piston is reversing its direction of movement. This large drop in pressure means that the work pieces are being unevenly sprayed, and should the operator attempt to respray the same, this inevitably must result in overspraying of the areas of the work piece adjoining the inadequately or non-uniformly sprayed areas. Accordingly, uniform spray painting of work pieces cannot be achieved when the pressure of the coating composition drops at intervals from 600 p.s.i. down to 450 to 500 p.s.i.

With the foregoing in mind, it is a primary object of this invention to provide an accumulator which, under the foregoing conditions of operation, is effective to maintain a substantially uniform pressure on the liquid with only a negligible variation, even though the associated pressure creating means is a reciprocating piston pump and without any discernible pressure variation when other types of positive displacement pumps are employed.

It is another object of this invention to provide an accumulator in which the pumped liquid enters the liquid chamber of the accumulator through a diffuser which subdivides or spreads out the pumped liquid for effective dampening of shock waves therein.

It is another object of this invention to provide an accumulator in which the entering liquid has imparted thereto a swirling, wiping motion around the inside of the accumulator body.

Another object of this invention is to provide an accumulator having separate inlet and outlet ports, the latter being disposed at the very bottom of the accumulator chamber so as to preclude settling of the pigment or other constituents of the liquid-coating composition which is adapted to be pumped through the accumulator.

Another object of this invention is to provide an accumulator of the character indicated which includes a check valve therein to prevent back-flow of the liquid pumped during each stroke of the piston pump.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

Fig. 1 somewhat schematically illustrates a paint spraying system in which the present accumulator is employed;

Fig. 2 is a vertical cross-section view of a preferred form of the present accumulator;

Fig. 3 is a transverse horizontal cross-section view taken substantially along the line 3—3, Fig. 2; and

Fig. 4 is a cross-section view of another form of diffuser which may be employed instead of that shown in Figs. 2 and 3.

Referring now more particularly to the drawing and first to Fig. 1 thereof, the reference numeral 1 denotes a paint container in which is immersed a power-driven pump assembly 2, preferably of the double-acting reciprocating piston type.

Connected to the delivery port of said pump assem-

bly is an accumulator 3, the outlet port of which is connected by hose 4 to the inlet end of a paint heater 5. Said paint heater 5 may comprise, for example, a paint passage 6 in a heat-exchange block surrounding an electrical heating element 7, the paint being heated to a desired temperature as it flows under pressure through said paint heater.

The heated paint flows through a hose 8 to the spray gun 9 and, in addition, there is provided at the spray gun, a return hose 10 through which the heated paint is recirculated as by a pump P through the heater 5 when the spray gun 9 is not in use.

When the trigger of the spray gun 9 is actuated, the heated paint is forced through an orifice in the spray nozzle 11, and the finely divided paint particles are directed against the work to be spray painted.

Specific examples of pressures and temperatures which are employed in connection with several different types of liquid-coating compositions will be found in my copending application Serial No. 337,042, filed February 16, 1953, now Patent No. 2,754,228, granted July 10, 1956.

When presently available accumulators are used in the system shown in Fig. 1, there is relatively large pressure variation from say, 600 p.s.i. down to 450 to 500 p.s.i. at the end of each stroke of the piston in the pump assembly 2.

In contradistinction, when the present accumulator 3 is used, such pressure variation at the end of each stroke of the piston in said pump 2 will be only a negligible amount such as 10 to 20 p.s.i. at the operating pressure of 600 p.s.i., whereby the spraying performance will be uniform.

The accumulator 3 herein comprises a cylindrical body shell 14 which is closed at its upper end and which has its open lower end secured by any suitable expedient such as welding, brazing, threading, etc. to a ported body 15 formed with an inlet port 16 and an outlet port 17.

The inlet port 16 terminates in an upwardly facing seat 18A for a ball check valve 18 and screwed or otherwise secured to the body 15 in register with port 16 is the lower open end of a diffuser tube 19, said tube being closed at its upper end and being formed with a series of lateral openings 20 (or a slit 21, Fig. 4) longitudinally along the side wall thereof.

A check valve stop and guide member 23 is clamped between said diffuser tube 19 and said body 15. The holes 20 (or slit 21) face generally toward the inside wall of the accumulator body shell 14 so as to induce a circular, swirling motion in the liquid issuing therefrom as shown by the arrows 24 in Fig. 3.

The upper end surface 25 of said body 15 is dish-shaped as shown, and the outlet port 17 is preferably at or near the center of said dish-shaped surface 25 so that pigment or other constituents of the liquid coating composition will not have an opportunity to settle out or be trapped in any pocket in the accumulator. The swirling motion imparted to the paint also lengthens the path of flow of the paint through the accumulator 3 whereby to afford opportunity for better pulse elimination therein.

Moreover, the circular motion effects a wiping action around the inner wall of the accumulator shell 14 and this is desirable especially in coating composition systems when changing from one composition to another or changing colors.

Accordingly, with the present accumulator 3, it is unnecessary to take the accumulator apart in order to clean the same, but, instead, a quantity of solvent is pumped through the system, and the resulting wiping and swirling motion thoroughly cleans the inside wall of the accumulator chamber. In addition, because the accumulator outlet 17 is at the bottom, it is a simple matter to drain out all of the solvent whereupon the different color or different composition may be pumped therethrough.



As a specific example of the present invention, the accumulator shell 14 including the body 15 was of about 10" length and of 4" diameter, and the diffuser tube was of about 5" length and of 1½" inside diameter such that its volumetric capacity was at least as great as the displacement of the piston in the pump 2 during one stroke thereof. Ordinarily, the piston displacement per stroke is about 2–3 ounces, but on occasion is 6 ounces or more in systems wherein several spray guns 9 are simultaneously operated from a single supply source. In any event, the volumetric capacity of the diffuser tube 19 is preferably sufficient to absorb the full volume of liquid displaced during one stroke of the piston pump 2.

The diffuser 19 may be provided with a series of six to eight ⅜" diameter holes 20 (or a 3/16" x 4" slit 21) such that the aggregate flow area of the holes 20 (or flow area of the slit 21) is preferably about twice as great as the flow area of the intake pipe or port 16. It has been found that, by pumping the liquid into the diffuser 19, the shock waves therein are muffled and diffused by the provision of the series of relatively small holes 20 or the longitudinally extending slit 21. The diffuser 19 should not constitute a restriction to the uniform rate of flow of liquid therethrough.

As can be seen, the air chamber in the accumulator 3 functions in the same way as the filter condenser block in the B+ supply of an A.C. power supply in a radio, that is, the air chamber is charged to absorb peaks of liquid pressure and then discharges during the lull between peaks. This is as far as presently available accumulators go in the stabilizing of pressure pulses; and, as aforesaid, the air chamber alone permits a 100 to 150 p.s.i. pressure fluctuation in a 600 p.s.i. pressure system.

In the present case, I have provided a diffuser 19 which further smooths out pulses in the liquid flow in a manner comparable to the way that a filter choke retards changes in electrical current in the A.C. power supply of a radio. The series of relatively small holes 20 or the relatively narrow slit 21 in the diffuser 19 serve to effectively retard and dissipate rapid changes in the rate of flow of liquid therethrough while uniform flow of liquid therethrough is not appreciably retarded.

In other words, in the normal operation of the Fig. 1 system, the pressure drop through the accumulator 3 is negligible by reason of free, uniform flow of liquid through the diffuser 19 and accumulator body 14. However, at the time of piston reversal in the pump 2, both the air chamber and diffuser become effective to smooth out or practically eliminate pressure pulses (condenser action to stabilize voltage) and rapid flow-change pulses (filter choke action to retard changes in electrical current).

Referring further to the electrical analogy of the diffuser 19, it is evident that, as the frequency of the pulses in the liquid increases, the retarding effect of the diffuser likewise increases, as does the retarding effect of the radio filter choke.

The example given above is to be regarded as merely exemplary in that the diameter of and the number of holes 20 or the dimensions of the slit 21 may be varied over a fairly wide range just so the liquid is subdivided or spread out into a relatively small or thin stream form as compared with the inlet stream. Also, by making the volumetric capacity of the diffuser at least equal to the pump displacement between successive pulses, the shock wave, insofar as rate of flow change is concerned, is effectively dampened in said diffuser.

The accumulator 3 herein may, of course, be employed, with equal efficacy, with any type of pump and especially with reciprocating pumps of the piston, diaphragm or like type which produce severe pulsations in the liquid during reversals of movement of the pump elements

thereof. Likewise, as already mentioned, the accumulator 3 herein may be employed in any liquid system involving the use of through pumps which tend to pulsate.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims, or the equivalent of such, be employed.

I therefore particularly point out and distinctly claim as my invention:

1. The combination with a paint pressure system having a pump therein whose delivery has pulsations therein, of an accumulator providing an upright generally cylindrical chamber for air and paint under pressure and having separate inlet and outlet ports leading thereinto from the bottom, a conduit connected to the delivery port of said pump and to such inlet port for flow of paint under pressure delivered by said pump into and out of said chamber, an upwardly extending tubular diffuser in said accumulator having an inlet at its lower end in communication with said inlet port and a lateral diffusing outlet below the paint level in said chamber and effective to substantially eliminate pulsation in the paint emerging from such outlet port, another conduit connected to such outlet port, and a spray gun connected to said another conduit through which the pulsationless paint under pressure from said accumulator outlet is discharged in finely subdivided form, such diffusing outlet being of relatively narrow circumferential extent in relation to the diameter of such inlet port and being directed non-radially toward the side wall of said chamber to effect swirling, wiping motion of the paint circumferentially around said chamber to increase the path of travel of the paint from such inlet port to such outlet port and to facilitate cleaning of said accumulator when changing from a paint of one color or composition to another.



2. The combination of claim 1 wherein such diffusing outlet is of axial extent such that the cross-section area of such diffusing outlet is at least as great as that of such inlet port.

3. An accumulator comprising a generally cylindrical, hollow body closed at its upper end and formed with separate inlet and outlet ports entering said body from the lower end thereof, and a tubular diffuser in said body extending upwardly from such inlet port for flow of liquid under pressure thereinto, and provided with a laterally disposed diffusing outlet effective to substantially eliminate pulsation in liquid which is adapted to flow into said body through such inlet port and diffuser and out of said body through such outlet port, such diffusing outlet being directed non-radially toward the cylindrical side wall of said body to induce a swirling motion in the liquid circumferentially around said side wall as it flows through said body, said diffusing outlet being of relatively narrow circumferential extent in relation to the cross-section diameter of said inlet port but being of axial extent such that the cross-section area of said diffusing outlet is at least as great as that of said inlet port.

4. The accumulator of claim 3 wherein the bottom wall of the chamber defined by said body is dish-shaped, and wherein said outlet port enters said body at approximately the lowest point of such bottom wall.

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