United States Patent [19]

Clay

[11] **3,874,417**

[45] **Apr. 1, 1975**

[54] **PNEUMATIC PUMP SURGE CHAMBER**

[76] Inventor: **Robert B. Clay,** 728 W. 3800 S. Bountiful, Salt Lake City, Utah 84119

[22] Filed: **May 24, 1973**

[21] Appl. No.: **363,684**

[52] **U.S. Cl.** **138/30,** 417/540

[51] **Int. Cl.** **F16i 55/04,** F04b 11/00

[58] **Field of Search** 138/26, 30, 31; 417/540, 417/542

[56] **References Cited**

UNITED STATES PATENTS

2,725,897	12/1955	Crooks	138/31
2,949,932	8/1960	Hewitt	138/30 X
3,473,565	10/1969	Blendermann	138/30 X
3,601,128	8/1971	Hakim	138/30 X
3,741,692	6/1973	Rupp	417/540

FOREIGN PATENTS OR APPLICATIONS

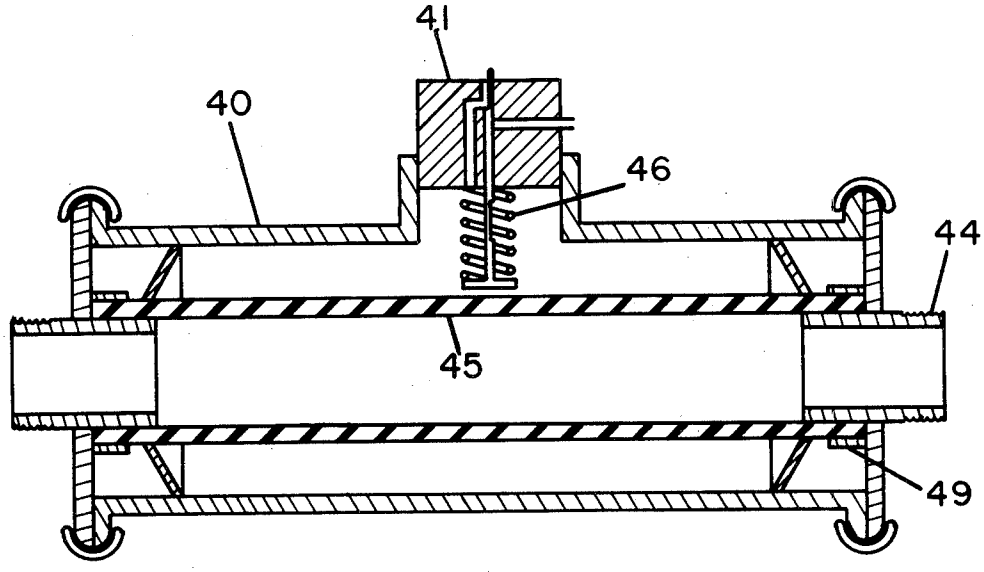
283,878	8/1928	United Kingdom	138/26

Primary Examiner—William L. Freeh
Assistant Examiner—Gregory P. LaPointe
Attorney, Agent, or Firm—Robert A. Bingham

[57] **ABSTRACT**

A pneumatic surge chamber for smoothing high and low pressure surges from pumps is provided which comprises a flexible tube or hose enclosed within a rigid outer air tight chamber of larger diameter than the hose, thereby forming an annular cavity between the hose and chamber. This hose, which contains the flow of the pumped medium, can expand or contract within the containing chamber depending upon surge pulsations from the pump, and the degree of expansion and contraction is automatically controlled within the chamber by a pneumatic valving means which alternately pressurizes and depressurizes the annular cavity to accomodate respective expansion and contraction of the hose.

1 Claim, 3 Drawing Figures



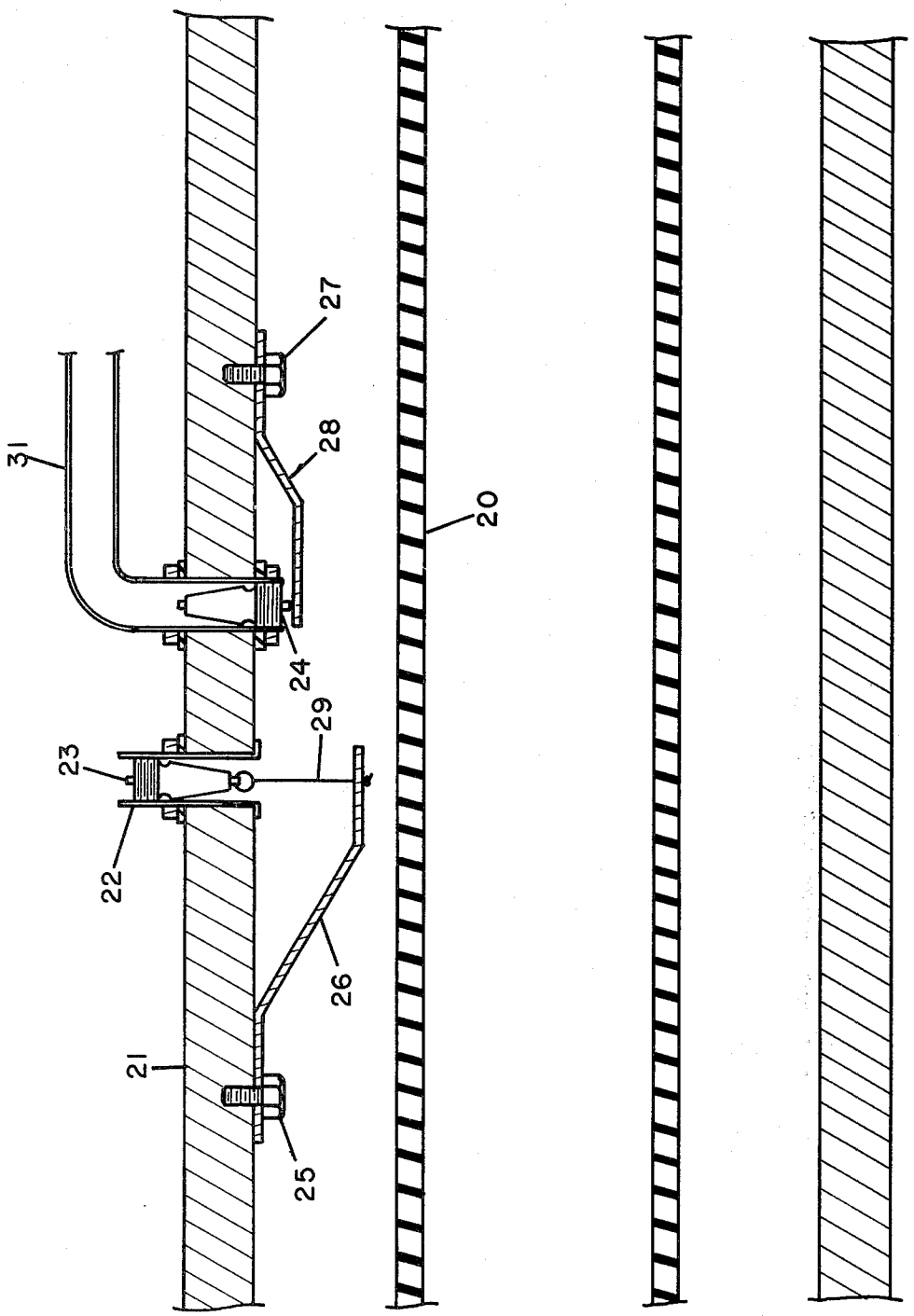


Figure 1

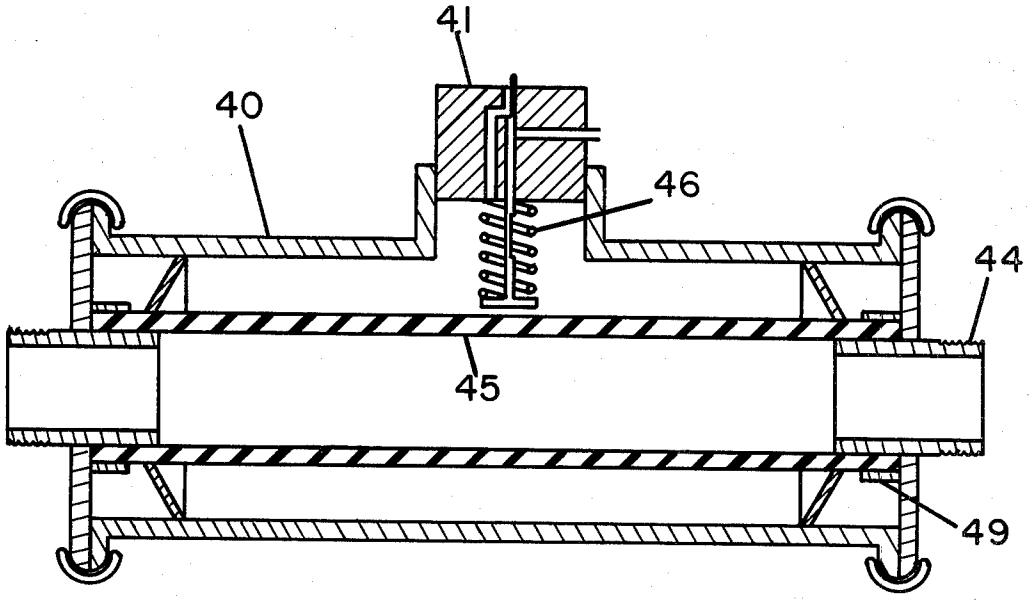


Figure 2

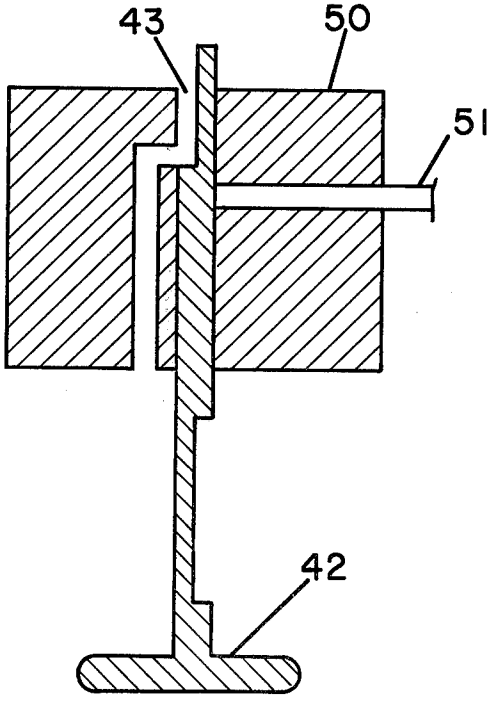


Figure 3

PNEUMATIC PUMP SURGE CHAMBER

BACKGROUND AND PRIOR ART

Peristaltic or diaphragm pumps are well-known in the prior art especially for pumping viscous fluids such as liquid explosive blasting agents or slurries such as described in U.S. Pat. Nos. 3,367,805 3,379,587; 3,453,158; 3,660,181 as well as many others. Such pumps are used for a variety of purposes. In pumping thick or viscous slurries, however, cavitation and other flow hindrance problems arise. A peristaltic pump necessarily depends on successive squeezing and opening of a collapsible tube or channel member to draw in a continuing supply of the material being pumped.

Many positive displacement pumps move fluids by relatively small, discrete volumes. These intermittent volumes of fluid, moved against a head or through a pressurized pipe, produce pressure variations or pulses in the pressurized pipe due to the inertia of the fluid in the pipe system. A series of synchronized positive displacement pumps can be connected in parallel so that the peak outputs of each can be timed to produce a relatively pulseless high pressure output. However, with only a single or double acting pump, pressure surges greater than the maximum pressure and more than twice the average pressure are commonly encountered. To reduce the stresses, noise and motion associated with such pressure surges, devices have been made which absorb part of the energy during the rapid movement of fluid from the pump and then liberate it while the pump is confining the next discrete volume preparatory to expelling it into the pressurized system.

Pressure pulsations result in large energy losses and may interfere with manipulations of a delivery hose used, for example, when blasting slurry is pumped into boreholes. In some cases pulsations are severe enough to damage the pumping apparatus and even to burst the delivery hose which can involve serious dangers to operating personnel. For these reasons as well as others, it is important that such pressure surges be minimized and eliminated as far as possible.

Surge chambers known in the prior art include elastic drums, tubes, or cylinders which can yield and thus expand or contract to accommodate variations in flow velocity and pressure. Various types of pneumatically pressured surge chambers are also known, such as an enclosed air-tight chamber which allows influx of the pumped medium during surges. Such prior art surge chambers generally allow accumulations of pumped medium during surges. In some operations, however, it is most undesirable to have surged material accumulate in substantial volumes. For example, when an operator is filling a borehole with explosive slurry, it is important for him to be able to start and stop the flow quickly; e.g., to avoid spillage or overflow. An expansive surge chamber, where a substantial volume of slurry can accululate, makes close control more difficult. It is therefore highly desirable to be able to smooth low or high pressure surges without accumulating relatively large masses of the viscous liquid in a surge chamber. Furthermore, fluids such as slurry or aqueous explosive compositions may contain thickening and crosslinking components which act to increase the composition's viscosity with time. When handling these viscosity-increasing compositions, it is imperative that high pressure surges be accomodated without accumulation of large masses of composition which may become highly viscous in the matter of a few seconds and thereafter impede or clot the surge chamber. Thus, surge chambers for these latter fluids must not accumulate liquid mass to any appreciable extent, and whatever mass is accumulated by an expanding chamber due to a high pressure surge must be immediately expelled. This latter requirement in the operation of the surge chamber is hereinafter referred to as a "first in/first out " operation.

While various surge chambers have been developed to minimize the normally large pressure variations from a positive displacement pump, however, none of the prior art devices effectively incorporate both (a) first in/first out operation and (b) effective surge control, regardless of average pumping pressure. Commonly owned U.S. Pat. No. 3,649,138 describes a surge chamber which meets these requirements to a degree; however, that surge chamber is dependent upon elasticity and resiliency of a flexible hose to accomodate pressure surges and is therefore effective only to a definable upper pressure limit, especially since the hose must also work effectively at relatively lower pressures. In contrast, the surge chamber of the present invention operates effectively at both low and high pressures, is not restricted to an upper pressure limit, and yet combines the desirable features of first in/first out operation with effective surge control regardless of average pumping pressure.

It is therefore the object of this invention to provide a surge chamber that will smooth low or high pressure surges without accumulating relatively large masses of viscous fluid while preventing substantial pressure variations in the pump output or delivery hose.

While the surge chamber of the present invention is particularly suitable for a peristaltic or hose diaphragm pump, it is also suitable for use with reciprocating and other types of pumps even where the pulse volume is large in comparison with the average pumping rate. The surge chamber of the present invention is designed to absorb pressure surges at low average pressure and to similarly absorb larger surges in pressure at high average pressure with relatively little further volume expansion.

SUMMARY

Briefly, the pneumatic surge chamber of the present invention comprises a pipe containing an expandable hose. The pipe contains an atmospheric air exhaust valve which will remain open as long as the hose is not substantially expanded or dilated, i.e., when not experiencing a pressure surge superimposed on the average pressure; and which will close when a surge does occur. The pipe also contains a high pressure inlet valve which works conjunctively opposite to that of the exhaust valve in that when a surge, and thus an expansion of the hose, occurs, the high pressure inlet valve will open pressurizing the chamber surrounding the hose and enclosed by the pipe, thereby inhibiting or dampening by pressurized air further expansion of the hose.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a cutaway side view of a preferred embodiment of the invention showing an air-dampened surge chamber, the air outlet exhaust valve and high pressure inlet valve both attached to the chamber pipe, and the enclosed hose.

FIG. 2 is a cross-sectional view of another surge chamber showing an enclosed hose and a three-way valve arrangement attached to the outer pipe.

FIG. 3 is an enlarged cross-sectional view of the three-way valve arrangement shown in FIG. 2.

DESCRIPTION OF PREFERRED EMBODIMENT

The present invention can be better understood by reference to the accompanying drawings. FIG. 1 shows a surge chamber of the present invention. Basically the surge chamber comprises a tubular member or hose **20**; a pipe **21** which encloses and circumferences the hose, air inlet and exhaust valves and stems **24** and **31** and **23** and **22**, respectively, which are attached to the pipe wall **21**; and springs **26** and **28** for contacting or actuating valves **23** and **24**.

The operation of the pneumatic surge chamber of the present invention is as follows. Referring to FIG. **1**, as a fluid is pumped into the tubular member or hose **20**, the hose will expand outwardly to an extent dependent upon the pressure of the surge. As the hose expands it contacts and depresses the flat spring **26** which is connected to the pipe **21** by a screw **25**. The end of the spring **26** opposite its secured end is attached by means of a nylon line **29** to an outlet exhaust valve **23** which is secured to the pipe wall **21** by means of a valve stem **22**. As the spring is depressed, the nylon line **29** moves up allowing the outlet valve **23** to close, thereby forming an air-tight seal within the pipe chamber.

Further expansion of the hose **20** will contact and depress spring **28** which is secured to the pipe wall **21** by a screw **27** or similar means. Depression of the spring **28** will open the high pressure inlet valve **24** which is secured to the pipe wall **21** by means of a valve stem **31**. As a result, pressurized air from a pressurized tank or similar source (not shown) will be allowed to enter the pipe chamber thereby inhibiting and controlling further expansion of the hose **20**. In this manner the volumetric expansion range of the hose will be limited regardless of the amount of surge pressure produced by the pump as long as the inlet air source is of sufficiently high pressure. Generally then, this surge chamber is air-tight and the higher pumping pressures automatically introduce corresponding air pressures into the chamber volume between the hose **20** and the outer pipe **21**, providing a variable matched air cushion to backup the surging of the hose **20**. Strategic placement of springs **26** and **28** will allow pressurization and depressurization of the chamber and respective expansion and subsequent contraction of the hose **20** to be controlled to a predetermined degree.

Between surges the fluid pressure within the hose **20** is reduced and the hose **20** will contract from its expanded form to a size depending upon ambient fluid pressure between surges, whereupon valve **24** will close and valve **23** will open venting the pressurized air within the chamber to the atmosphere.

Therefore, in the manner described above the volume of the surge produced by the pump is automatically controlled.

An equivalent and alternate means of controlling pump surges by cashioning or dampening with pressurized air is shown in FIGS. **2** and **3**. FIG. **2** shows a surge chamber of the present invention which comprises basically a hose **45** contained within and surrounded by a pipe **40**, a valve plunger **42** (FIG. **3**), a three-way valve **41**, a plunger spring **46**, a house inlet **44** and a hose clamp **49**. FIG. **3** shows an enlarged view of the three-way valve shown in FIG. **2** absent plunger spring **46** and which comprises a valve plunger **42**, a valve exhaust and inlet **43** and **51**, respectively, and a valve block **50**. This surge chamber performs in a manner similar to the one described above and shown in FIG. **1**. Fluid is pumped into hose **45** which is clamped over inlet **44** by a clamp **49**. As the hose **45** expands corresponding to a pressure surge from a pump, it will depress the valve plunger **42** held open by a spring **46** of the three-way valve **41** and thereby close the valve **43** opening to the atomosphere. Further depression of the valve would open the high pressurized air inlet **51** to the enclosed annular chamber. The chamber will then pressurize thereby cushioning or inhibiting further expansion of the hose **45**. As the pressure surge passes, the hose **45** will contract and the valve plunger will return by means of the spring **46** to its original position venting the pressurized air within the chamber. FIG. **3** is a blownup cross-sectional view of the three-way valve arrangement shown in FIG. **2**. Strategic placement of openings on plunger **42** and on the valve block **50** will provide for predeterminable control of hose oscillation.

The air-cushioned surge chamber described in FIGS. **1** and **2** are more versatile than the surge chamber described in U.S. Pat. No. **3,649,128** since not only can they be used in instances of high pressure surging, but also they are useful in circumstances of mild surging such as when a peristaltic pump is used. Another advantage of using the air-cushioned surge chamber shown in FIGS. **1** and **2** is that it lowers the range of maximum and minimum output pressures of pumped fluid from the pump over the range obtainable by the surge chamber described in U.S. Pat. No. 3,649,138. For example, comparative tests were run using a peristaltic pump and the two types of surge chambers shown in U.S. Pat. No. 3,649,138 and FIG. **1**. Water was pumped at a nominal rate. Using the surge chamber and pump of U.S. Pat. No. 3,649,138, the outlet pressure from the pump varied from 100 psi maximum to 60 psi minimum. Passing the outlet through the air-cushioned surge chamber of FIG. **1** improved the respective average pressure readings to 100 psi and 93 psi. This reduced pressure range resulted in a corresponding decrease in delivery hose and pump pulsations.

The relative sizes of the various components of the surge chamber of the present invention shown in FIGS. **1–3** are not critical and can be varied as desired depending upon rate and quantity of flow to be accomodated. Preferably, the hose of the surge chamber should approximate in size the conduit being used for transporting the pumped material. A typical surge chamber for use in pumping aqueous explosive compositions through pumps such as shown in U.S. Pat. No. 3,649,138 would comprise a hose of about 2-inch diameter contained within a pipe of about 4-inch internal diameter. An example of materials for the pipe and hose components of the surge chamber are a standard metal pipe and a gum rubber hose.

The invention described above offers outstanding advantages in smooth, uniform flow. This is desirable and frequently is very important in delivering blasting slurry into boreholes. It is desirable, of course, to be able to control the flow with reasonable precision, and it is im-

portant to minimize pump vibrations, whipping of the hose, and pressure surges.

It will be obvious that modifications mentioned above and others not mentioned may be made by those skilled in the art without departing from the spirit and purpose of the invention. It is intended to cover the invention and obvious variations and modifications as broadly as the prior are permits.

What is claimed is:

1. A surge chamber of limited volume expansion for accomodating pressure surges of wide ranges and relatively high pressure surges incident to pumping fluids on a first in/first out basis so that no accumulation of the pumped fluid occurs comprising, in combination, an elastic expandable tube adapted to be connected to a delivery flow line and adapted to receive a mass of said fluid from a pump or variable pressure source; a rigid gas-tight chamber circumscribing said tube and spaced from said tube; a pressurized gas source for supplying gas under pressure to said chamber; and a three-way valve connecting said gas source and said chamber directly activated by expansion and subsequent elastic contraction of said tube to respectively allow the pressurized gas to enter and leave and thus respectively pressurize and depressurize said chamber thereby dampening expansions of said tube as caused by pressure surges of a pumped fluid within said tube.

* * * * *