July 30, 1968 C. JACUZZI 3,394,733

AIRLESS WATER PRESSURE SYSTEM

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Fig. 2.

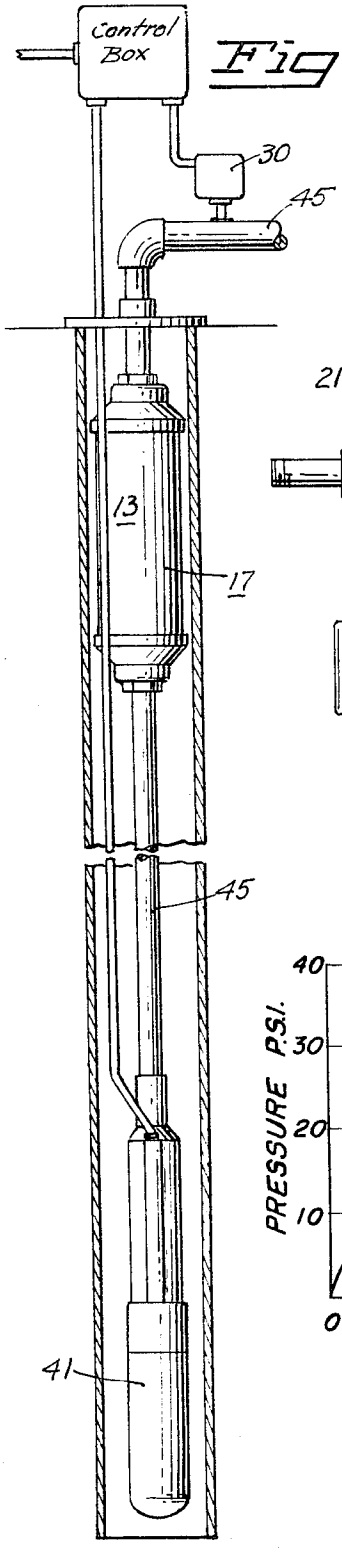


Fig. 1.

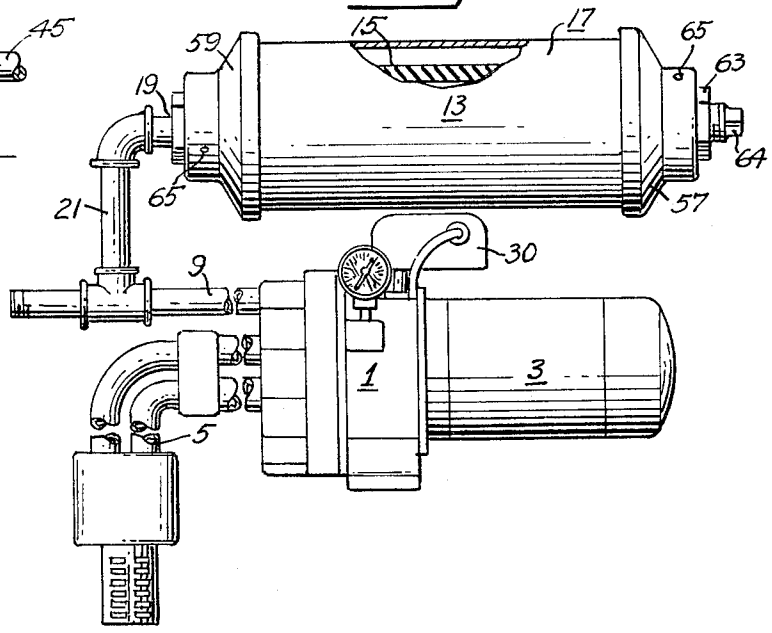
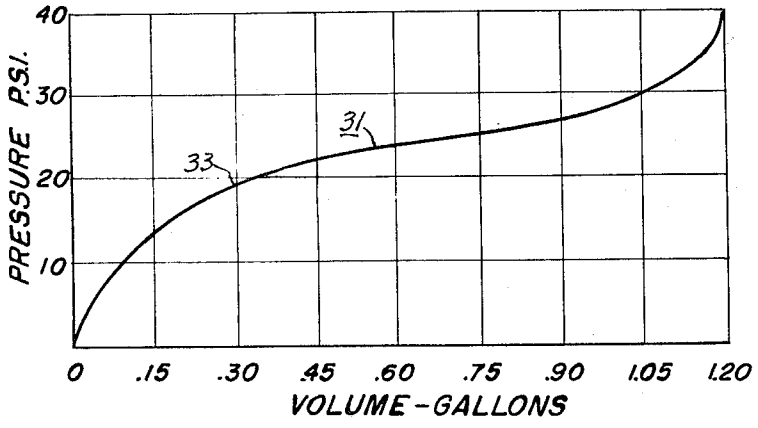


Fig. 6.



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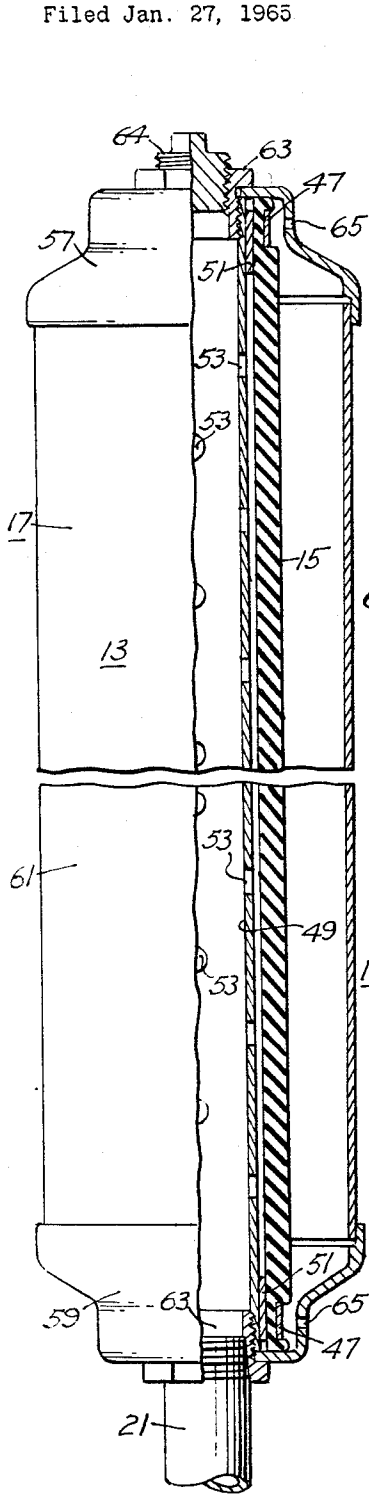

Fig. 3.

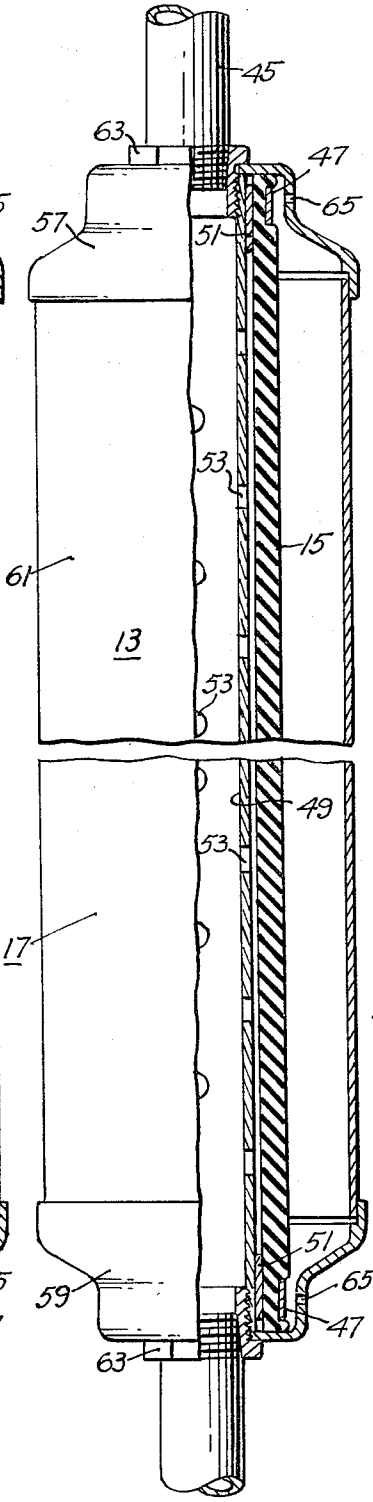

Fig. 4.

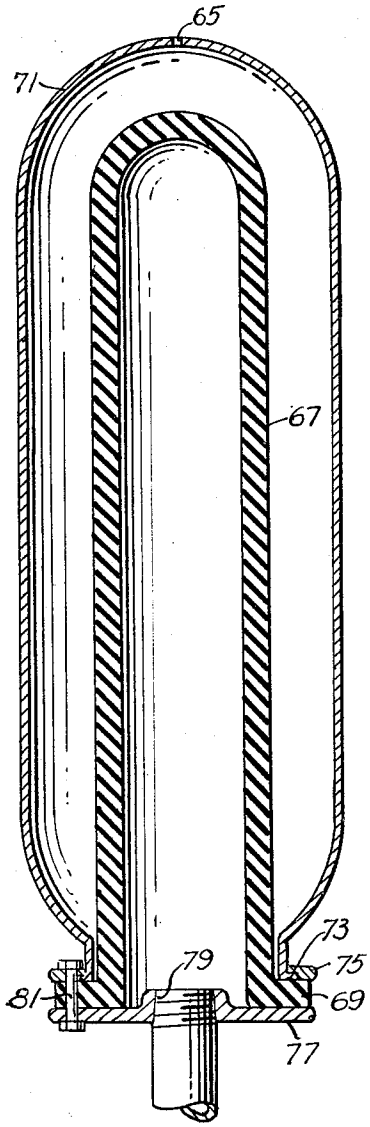

Fig. 5.

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3,394,733

AIRLESS WATER PRESSURE SYSTEM

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Filed Jan. 27, 1965, Ser. No. 428,303
11 Claims. (Cl. 137—568)

My invention relates to pressure systems handling liquid, and more particularly to water pressure systems.

Water pressure systems to which the present invention particularly relates, normally involve a pump having a suction line to a source of water and a discharge line to service. Coupled in the discharge line is a pressure tank for holding a reserve supply of water under pressure of an air cushion.

Tank pressure is maintained between a minimum value and a maximum value by a pressure switch which responds to a drop in pressure to the minimum value and starts the pump to replenish water in the tank and build up the pressure therein to its maximum desired value, when the pressure switch again goes into operation to shut down the pump until the pressure in the tank again drops to its minimum value.

Such pressure tanks pose many problems in the operation of a water pressure system, among which is the problem of replenishing air in the air cushion, which may be lost due to leakage, or absorption by the water in the tank over a period of time.

Also, pressure tanks are normally of substantial size, and consequently are invariably installed above ground, thereby essentially limiting their application in water systems to above ground installations.

Among the objects of the invention are:

(1) To provide a novel and improved water pressure system or the like;

(2) To provide a novel and improved water pressure system or the like employing pressure means capable of being installed above ground or in a small bore well as the case may be;

(3) To provide a novel and improved pressure device for use in a water pressure system or the like;

(4) To provide a novel and improved pressure device for use in a water pressure system or the like, and adapted for operation without an air cushion;

(5) To provide a novel and improved pressure device capable of use in lieu of a conventional type pressure tank in a water pressure system or the like;

(6) To provide a novel and improved airless pressure device to perform the function of a conventional type air cushion pressure tank in a water pressure system or the like, and which is of such relatively small volume as to be capable of installation in a small bore well;

(7) To provide a novel and improved airless pressure device for use in a water pressure system or the like, and capable of being coupled or ganged with other similar pressure devices, to alter the characteristics of the pressure system in which they are installed;

(8) To provide a novel and improved pressure device for a liquid system, which device shall not be conducive to contamination by air or oil.

(9) To provide a novel and improved pressure device which is not critical as to position orientation, and not destroyed by freezing.

Additional objects of my invention will be brought out in the following description of a preferred embodiment of the same, taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a schematic view of a water pressure system or the like embodying the present invention, and depicting an above ground installation including a novel and improved pressure device;

FIGURE 2 is a schematic view of a water pressure system or the like embodying the present invention and depicting a below ground installation of a novel and improved pressure device;

FIGURE 3 is a longitudinal view in section through the form of pressure device depicted in FIGURE 1 as adapted for above ground installation;

FIGURE 4 is a similar view in section through the same pressure device as adapted for the below ground installation depicted in FIGURE 2;

FIGURE 5 is a view in section through a modified version of the pressure device of FIGURE 3.

FIGURE 6 is a graph depicting the general operating characteristics of the pressure device illustrated above.

Referring to the drawings for details of the invention in its preferred form, the system depicted in FIGURE 1 involves a pump **1** driven by a motor **3** and having an intake end and a discharge end, the intake end being connected to a suction line **5** which may, in a water pressure system, extend down into a well, while the discharge end will connect to a discharge line **9**, which may be a pressure line, or a service line which serves one or more outlets controlled by valves or spigots in the conventional manner.

Coupled into the discharge line is an airless pressure device **13** embodying the novel and improved features of the present invention, which, for an above ground installation as depicted in the system of FIGURE 1, will comprise in general, an expansible tube **15** as the principal functioning element, enclosed within a vented housing **17** and having but a single open end **19** functioning both as an inlet and discharge opening. The expansible tube will be connected at such opening by a coupling pipe or fitting **21** leading to the discharge line **9** of the system, which discharge line may be deemed to include the portion of the base casting of the pump, to which the pipe which carries water from the pump, is connected.

A conventional pressure switch **30** coupled into the discharge line or at some other corresponding pressure point in the system, will be exposed to whatever pressure conditions exist therein, and consequently the pressure prevailing at any instant in the pressure device. When set for a certain pressure range, such as a range of 20 to 40 pounds pressure for example, the pressure switch will connect the pump motor in circuit and start the pump when the pressure in the system drops to or falls below the lower value of pressure in such range, and will maintain the pump motor in circuit until water pressure in the pressure device reaches the maximum value of the pressure range, at which time the pressure switch will respond and cut out the motor.

The characteristics of an expansible tube as exemplified by the curve **31** of FIGURE 6, are such that substantial expansion or enlargement thereof does not begin until a certain region **33** of pressure is developed within the tube, following which, expansion will continue almost linearly with increase in pressure until further expansion is precluded by the enclosing housing. The region **33** at which substantial expansion begins, in the characteristic curve **31** of an expansible tube, may be referred to as the knee of the curve.

Of considerable importance to the present invention is the fact that the expansible tube **15** must have a characteristic curve which can be closely related to the pressure range of the system, or in other words, to the pressure range setting of the pressure switch, in that the knee of its characteristic curve should preferably occur at substantially the lower pressure value of the pre-established pressure operating range of the system, as determined by the pressure switch; and the tube must be capable of reaching the maximum value of the pressure range.

Also, as a requirement, the increase in volume or capacity of the tube when functioning throughout the pressure operating range of the system, should be such as to assure an immediate flow of water at pressures within such range, upon opening of a service spigot or corresponding valve, and without too rapid a drop in pressure before the lower pressure of the operating range is reached and the pump started. A capacity of the order of a gallon or gallon and a half will be deemed adequate for the average installation.

Factors which enter into the determination of the ultimate or final characteristics of the expansible tube are the nature of the material from which the tube is made, the length of tube, and wall thickness. Such factors offer a number of variables which can be readily adjusted to obtain the characteristics desired in any particular pressure device.

For use in an underground installation, the pressure device will be incorporated into a line carrying water at pump pressure, and such an installation is depicted in the system of FIGURE 2 wherein a submersible pump **41** disposed below the water level in a well **43**, pumps water through a discharge line **45** extending above ground to service. For such type of installation, the expansible tube **15** will be open at each end, for connection in the discharge line.

A basic pressure device adaptable for use in either of the above described types of installations as pictured therein, is depicted in detail in FIGURE 3 as adapted for use in the above ground installation of FIGURE 1, and, in FIGURE 4, as adapted for the underground installation illustrated in FIGURE 2.

Basically, this device comprises an expansible tube **15** clamped at its ends by suitable clamping means such as bands **47**, to a pipe section **49** running longitudinally thereof with its ends internally threaded. A space collar **51** is preferably installed at each end between the tube **15** and the pipe section **49** to initially provide slight spacing between the two.

The pipe section is provided with one or more wall openings or perforations **53** intermediate the ends of the expansible tube, whereby liquid under pressure, entering the pipe section, may gain access to the tube and begin to cause substantial expansion thereof when the pressure reaches the minimum value of the desired pressure operating range for which the pressure device is designed. The accessibility of liquid to the tube provided by the slight spacing attributable to the collars, will assure uniform and efficient functioning of the tube in this connection.

To permit of such expansion and without allowing localized ballooning of the tube or longitudinal stretching thereof, is a prime reason for the housing **17**. Such housing is comprised of a pair of bell end caps, **57, 59,** and an intermediate cylindrical shell **61** snugly fitting into the larger ends of the caps.

At their smaller ends, each cap abuts the proximate ends of the tube **15** and pipe section **49**, and is clamped thereagainst by a flanged bushing **63** passing through a central opening in the cap, to threadedly engage the pipe section. The bushing, as thus installed, is adapted to either threadedly receive a plug **64**, or a pipe connection such as when connected to a discharge line.

Vent holes **65** in the housing, preferably the end cap components thereof, permit free movement of air from and into the housing, in response to expansion and deflation of the expansible tube.

When the pressure device is to be utilized for an above ground installation as illustrated in FIGURE 1, one of the bell end caps **57** will be closed by a plug **64**, while the other **59** will be connected to one end of the coupling pipe **21**, and when the device is to be adapted for use in an underground installation, such as depicted in FIGURE 2, both bell end caps will be open for connection into the line carrying liquid under pump pressure.

In one specific form of the invention, a heavy rubber tube twenty-two inches long and having an inside diameter of two and one-half inches and a thickness of five-eighths inch, was banded at its ends to a pipe section of one and one-half inches inside diameter and an outside diameter of one and seven-eighths inches, with collars of a quarter inch thickness. This assembly was enclosed within a housing having a diameter of seven inches. Such device was found to have a capacity somewhat in excess of a gallon, between operating pressures of 20 to 40 pounds per square inch.

A feature of importance in the present invention is the flexibility of its application, through ganging a plurality of such devices in the same system, to realize increased capacity. For example, two or more of such units may be connected in tandem or in parallel relationship. Through such manipulations, the overall capacity characteristics may be widely varied to meet desired conditions in a particular system.

The pressure device, while illustrated and described in connection with its use in a water pressure system, may be employed in any fluid pressure system where the action of an accumulator is desired.

In the modified form of pressure device illustrated in FIGURE 5, and employable in the manner of that of FIGURE 1, the tube **67** is formed with one end closed, and its other end terminating in a flange **69** provided with uniformly spaced bolt holes. This tube is enclosed in a capsule type housing **71** having an open end bounded by a narrow flange **73** against which the tube flange is adapted to abut. The tube and its housing are clamped at their flanges, between a clamping ring **75** and an end plate **77** having a threaded opening **79** for connection to a coupling pipe, the clamping ring and end plate having bolt holes matching those in the tube flange, for the reception of clamping bolts **81**.

While we have illustrated and described the expansible tube as being of rubber, it may be of any other suitable material, or may even take the form of a bellows or a piston operating against a spring resistance. The expression "expansible tube" is intended to apply to any such forms.

It will be apparent from the foregoing, that our invention fulfills all the objects attributed thereto, and while we have illustrated and described the same in its preferred form, the invention is subject to alteration and modification without departing from the underlying principles involved, and we accordingly do not desire to be limited in our protection to the specific details illustrated and described except as may be necessitated by the appended claims.

I claim:

1. A pressure system comprising

a pump having an intake end and a discharge end,

a discharge line extending from said pump at its discharge end,

pressure range determining means responsive to pressure in said system for determining operating periods of said pump to establish a pressure operating range for said system,

a device for holding liquid under pressure for use during quiescent periods of said pump, said liquid holding device being flow coupled in said discharge line and comprising

an expansible tube having an expansion characteristic adapting it to begin substantial expansion at internal pressure corresponding to substantially the lower operating pressure of said pressure range and capable of reaching the maximum value of said pressure range, following a substantial increase in capacity,

and means for restricting storage of energy in said liquid holding device, to said expansible tube.

2. A pressure system comprising

a pump having an intake end and a discharge end,

a discharge line extending from said pump at its discharge end,

pressure range determining means responsive to pressure in said system for determining operating periods of said pump to establish a pressure operating range for said system,

a device for holding liquid under pressure for use during quiescent periods of said pump, said liquid holding device being flow coupled in said discharge line and comprising

an expansible tube having expansion characteristics adapting it to begin substantial expansion at internal pressure corresponding to substantially the lower operating pressure of said pressure range,

tube expansion limiting means for physically limiting expansion of said tube at substantially the upper pressure of said pressure range and following an increase in capacity of the order of a gallon or more,

and means for restricting storage of energy in said liquid holding device, to said expansible tube.

3. A pressure system comprising

a pump having an intake end and a discharge end,

a discharge line extending from said pump at its discharge end,

pressure range determining means responsive to pressure in said system for determining operating periods of said pump to establish a pressure operating range for said system,

a device for holding liquid under pressure for use during quiescent periods of said pump, said liquid holding device being flow coupled in said discharge line and comprising

an expansible tube having an expansion characteristic adapting it to begin substantial expansion at internal pressure corresponding to substantially the lower operating pressure of said pressure range,

tube expansion limiting means involving a housing enclosing said tube, in sufficient spaced relationship to said tube to physically limit expansion of said tube at substantially the upper pressure of said pressure range,

and means for restricting storage of energy in said liquid holding device, to said expansible tube.

4. A pressure system comprising

a pump having an intake end and a discharge end,

a discharge line extending from said pump at its discharge end,

a pressure range determining means responsive to pressure in said system for determining operating periods of said pump to establish a pressure operating range for said system,

a device for holding liquid under pressure for use during quiescent periods of said pump, said liquid holding device being flow coupled in said discharge line and comprising

an expansible tube having an expansion characteristic adapting it to begin substantial expansion at substantially the lower operating pressure of said pressure range and capable of reaching the maximum value of said pressure range, with an increase in capacity of the order of a gallon or more,

a pipe section running longitudinally internally of said tube,

means sealing said expansible tube at each end to said pipe section,

said pipe section having at least one opening therein between the ends of said expansible tube,

means at at least one end of said pipe section for coupling same to said discharge line,

and means for restricting storage of energy in said liquid holding device, to said expansible tube.

5. A device for holding liquid under pressure for use during quiescent periods of a pump, in a pressure system having a pre-established pressure operating range, comprising

an expansible tube adapted, in response to internal pressure, to begin substantial expansion at substantially the lower operating pressure of said pressure range, said tube being of a size and thickness of material enabling same to reach the maximum value of said pressure range, with an increase in capacity of the order of a gallon or more,

and means for flow coupling same into such pressure system.

6. A device for holding liquid under pressure for use during quiescent periods of a pump, in a pressure system having a pre-established pressure operating range, comprising

an expansible tube exposed exteriorly to normal atmosphere and adapted to begin substantial expansion at substantially the lower operating pressure of said pressure range,

means inhibiting further expansion of said tube at pressures substantially beyond the maximum of said pressure range with said tube still exposed to normal atmosphere,

and means for flow coupling said liquid holding device into such pressure system.

7. A device for holding liquid under pressure for use during quiescent periods of a pump, in a pressure system having a pre-established pressure operating range, comprising

an expansible tube having an expansion characteristic adapting it to begin substantial expansion at internal pressure corresponding to substantially the lower operating pressure of said pressure range,

tube expansion limiting means involving a vented substantially non-expansible housing enclosing said tube and permitting unrestricted expansion to said housing, said housing being spaced from said tube sufficient to enable said tube to reach the upper pressure limit of said pressure operating range before engaging said housing,

and means for flow coupling said expansible tube into such pressure system.

8. A device for holding liquid under pressure during quiescent periods of a pump, in a pressure system having a pre-established operating pressure range, comprising

an expansible tube having an expansion characteristic adapting it to begin substantial expansion at internal pressure corresponding to substantially the lower operating pressure of said pressure range,

a pipe section running longitudinally internally of said tube,

means sealing said expansible tube at each end to said pipe section,

said pipe section having perforations therein between the ends of said expansible tube,

vented tube expansion limiting means for physically limiting expansion of said tube at substantially the upper pressure of said pressure range,

and means at at least one end of said pipe section for flow coupling said expansible tube into a pressure system.

9. A device for holding liquid under pressure during quiescent periods of a pump, in a pressure system having a pre-established pressure operating range, comprising

an expansible tube adapted to begin substantial expansion at internal pressure corresponding to substantially the lower operating pressure of said pressure range,

a pipe section running longitudinally internally of said tube,

means sealing said expansible tube at each end to said pipe section,

said pipe section including end collars to slightly space said expansible tube from said pipe section, and further having perforations therein between the ends of said expansible tube,

tube expansion limiting means involving a vented non-expansible housing enclosing said tube and permitting unrestricted expansion to said housing, said housing

being spaced from said tube sufficient to enable said tube to reach the upper pressure limit of said pressure range before engaging said housing,

said housing including a bell end at each end of said pipe section, and a cylindrical shell extending between said bell ends,

and means at at least one end of said pipe section for flow coupling said expansible tube into a pressure system.

10. A device for holding liquid under pressure during quiescent periods of a pump, in a pressure system comprising

an expansible tube,

a pipe section running longitudinally internally of said tube,

means sealing said expansible tube at each end to said pipe section,

said pipe section having perforations therein between the ends of said expansible tube,

tube expansion limiting means for physically limiting expansion of said tube longitudinally, said means including a non-expansible housing enclosing said tube and having ends substantially abutting the ends of said tube and clamping rings about the ends of said tube spaced slightly from said housing ends,

and means at at least one end of said pipe section for flow coupling said expansible tube into a pressure system.

11. A device for holding liquid under pressure during quiescent periods of a pump, in a pressure system comprising

an expansible tube,

a pipe section running longitudinally internally of said tube,

means sealing said expansible tube at each end to said pipe section,

said pipe section including end collars to slightly space said expansible tube from said pipe section, and further having perforations therein between the ends of said expansible tube,

tube expansion limiting means involving a vented non-expansible housing enclosing said tube and having ends substantially abutting the ends of said tube for physically limiting both radially and longitudinally expansion of said tube,

and means at at least one end of said pipe section for flow coupling said expansible tube into a pressure system.

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