Dec. 23, 1941. G. H. McMULLEN ET AL 2,267,121

GAS INJECTOR FOR LIQUID SYSTEMS

Filed Sept. 6, 1939 2 Sheets-Sheet 1

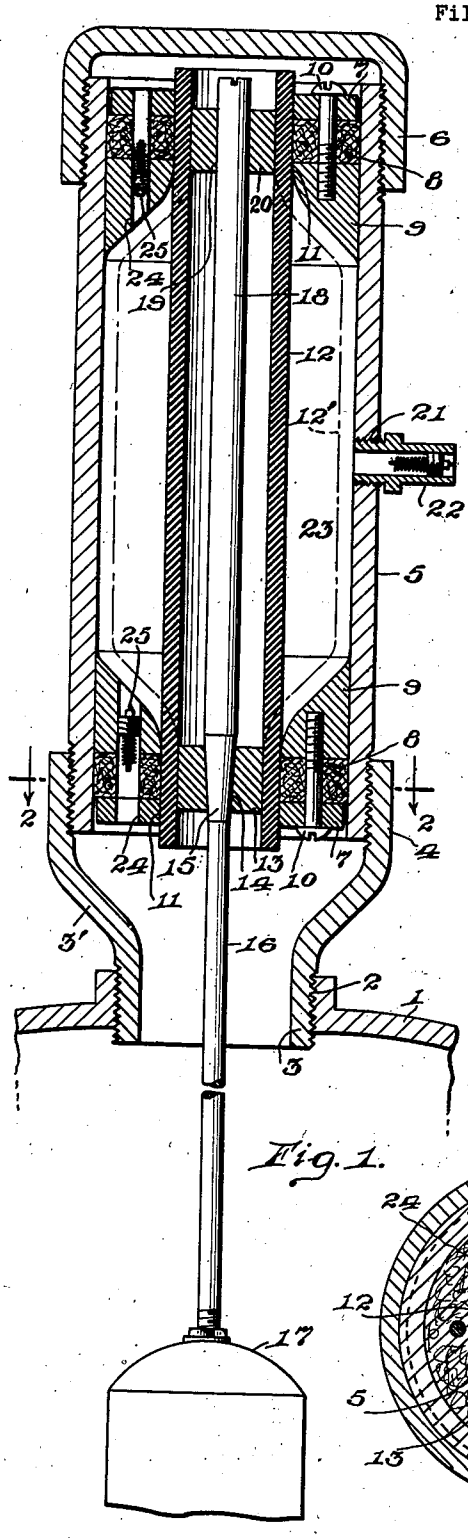

Fig. 1.

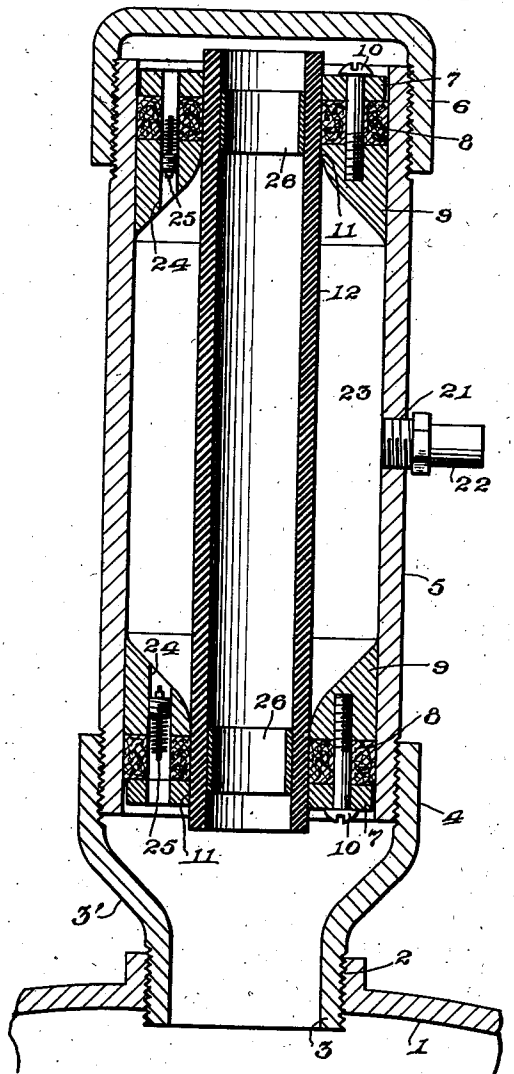

Fig. 3.

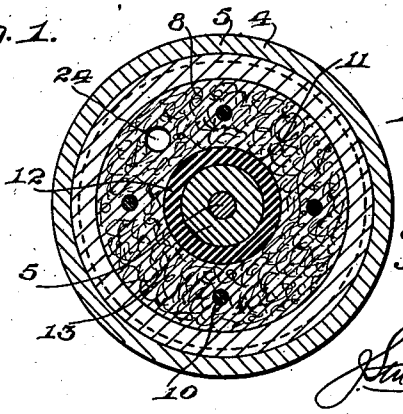

Fig. 2.

George H. McMullen
Josiah M. Haddaway
INVENTORS

BY Stuart Fellman
ATTORNEY

Dec. 23, 1941. G. H. McMULLEN ET AL 2,267,121

GAS INJECTOR FOR LIQUID SYSTEMS

Filed Sept. 6, 1939 2 Sheets-Sheet 2

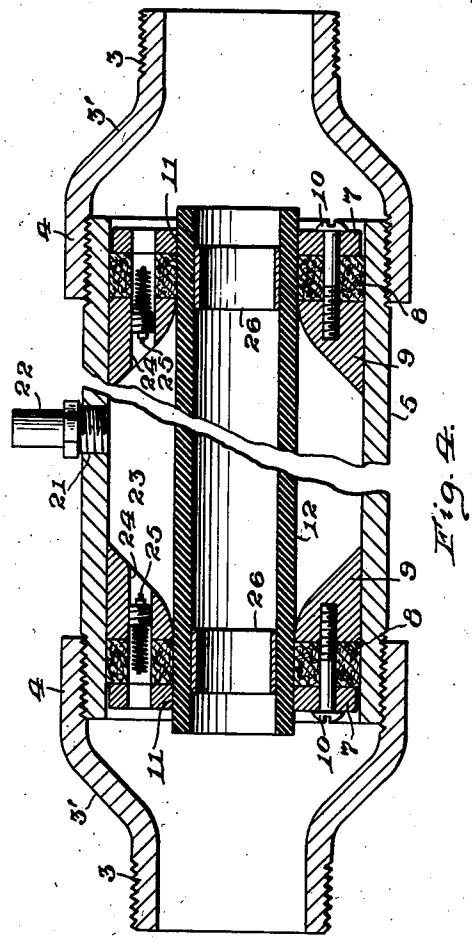

Fig. 4.

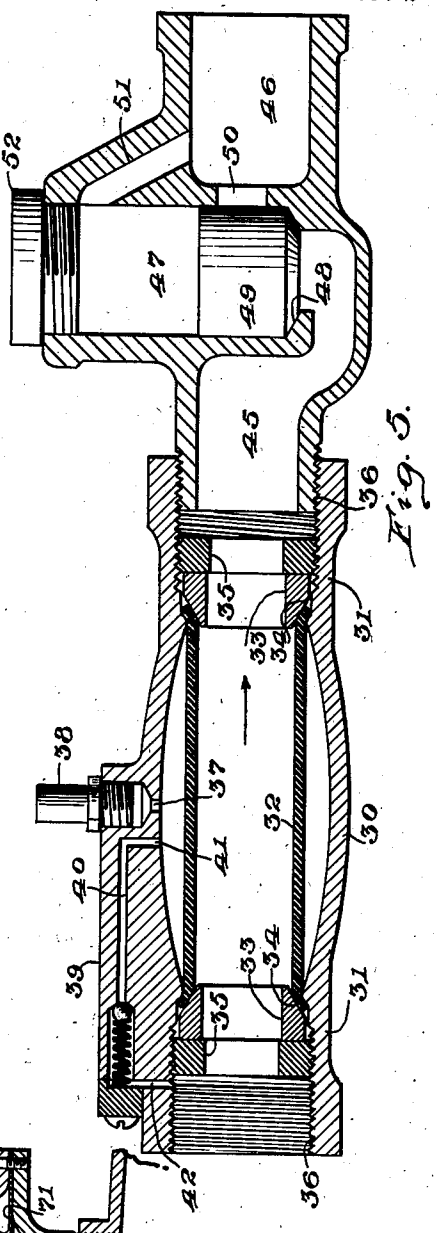

Fig. 5.

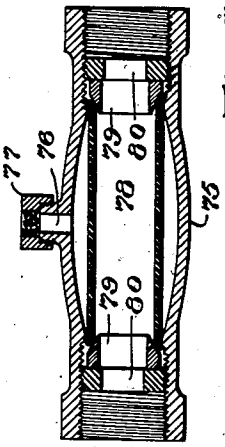

Fig. 7.

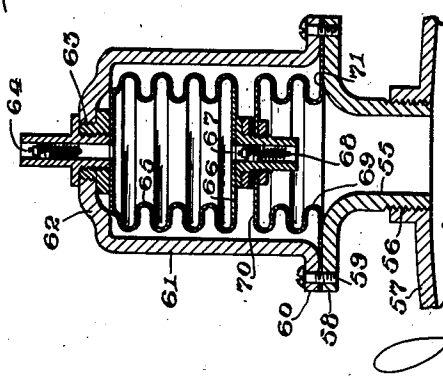

Fig. 6.

George H. McMullen,
Josiah M. Haddaway,
INVENTORS

BY J. Stuart Freeman,
ATTORNEY

Patented Dec. 23, 1941 2,267,121

UNITED STATES PATENT OFFICE

2,267,121

GAS INJECTOR FOR LIQUID SYSTEMS

George H. McMullen and Josiah M. Haddaway,
West Chester, Pa.

Application September 6, 1939, Serial No. 293,572

9 Claims. (Cl. 137—68)

The object of the invention is to provide improvements in gas injectors for liquid systems, but especially one which is adapted for use in devices such as those designed for the injection of air into water systems and into the air chambers thereof, in order to insure regular flow of the water therefrom, even where the water is initially impelled by intermittent or reciprocatory pumping means.

As is well known, in the case of the myriad forms of reciprocatory and many other types of pumps, whether intended for shallow or deep wells, it is desirable that their irregular pumping action shall be transformed into a relatively steady and uniform flow of the water propelled thereby, particularly when the discharge is not made first into a gravity storage tank, but is direct to the faucets, valves, or other forms of discharge outlets. For this purpose these pumps have heretofore been provided with an air chamber separate and distinct from the main line of the system as it leads from the pump, and in order to maintain a substantial quantity of air in such chambers, to replace that which becomes dispersed in and led with the water therefrom, a separate pump has invariably been provided, such pump usually being operated by the regular water pumping mechanism and in parallel therewith.

An object of the present invention, therefore, is to provide an improved type of air pump, which may be interposed directly in the main channel leading from the pump, or may be attached to a laterally directed T or similar form of branch line, or which may be attached to and in communication with the interior of the storage tank, which in such a case is closed at the top, and in such latter case may either be controlled by the level of the water in such tank, as by means of a float, or may be left free to operate entirely independently of such water level.

The broad principle upon which the improved injector operates resides in the provision of a casing, within which is positioned a resilient expansible element, such as an elastic tube, into or through which the water flows from the pump and which is alternately expanded by the intermittent pressure of such water, until it substantially or entirely fills the interior of said casing, the flow of air into the space between said element and the walls of said casing, and from said space and into the main water line or channel, being controlled by suitable automatic valves.

A modification of this construction, but which functions within the scope of the same broad principle, comprises a casing and an expansible bellows or equivalent element therein, the water pressure from the pump in such case being exerted upon the outside of such element (within said casing), while an air inlet valve connects the interior of said element with the outside of said casing, and an air outlet valve connects the interior of said element with the interior of said casing, so that a collapsing and consequent expulsion of air from within said element serves to force such air into the water within the line, and a replacement of such expelled air being effected by an expansion of said element, whereupon fresh air is taken therein from without said casing.

Still another object is to provide in conjunction with the form of injector first referred to (that is, when positioned directly in the water line) an improved check valve, which operates to provide a temporary reverse or back pressure, for the purpose of operating the expansible element, until such check valve has functioned to release and permit the flow of water in the main line therethrough, and by which time said element has been able to force air surrounding it into said water line.

And a still further object is to provide a modified form of the device, by which no air is injected into the system, but which device operates as a shock- or pulsation-absorbing unit, and aside from a protective casing primarily comprises the insertion in the direct water or other liquid line of a radially elastic tube, which alternately expands and contracts with variations in the liquid pressure, resulting from uneven pulsations from the pump in one direction, or from suddenly closing a valve or the like, and thereby in the opposite direction arresting the flow of liquid with equal suddenness, in such latter case the inertia of the flowing liquid being absorbed by the expansible tube, instead of causing the well known pounding or "hammer" against the valve or other arresting means.

With the objects thus broadly stated, the invention comprises further details of construction and operation, which are hereinafter fully brought out in the following description, when read in conjunction with the accompanying drawings, in which Fig. 1 is a transverse longitudinal section of an injector showing one embodiment of the invention in its float-operated form; Fig. 2 is a transverse section on the line 2—2 of Fig. 1; Fig. 3 is a similar section of a slightly modified form minus the float of Fig. 1;

Fig. 4 is a similar section of a still further but only slightly modified form of the device shown in Fig. 3, connected directly in the water line leading from a pump, or in an equivalent position in which water flows through it; Fig. 5 is a vertically longitudinal section through substantially the same form of injector as that shown in Fig. 4, but connected in this instance to an improved type of check valve; Fig. 6 is a similar section of a different form of injector, but which also embodies substantially the same principles of operation; and Fig. 7 is a longitudinal section through a modification of the invention, in which the device is not intended to inject air into the system, but operates directly to absorb pump and similar pulsations, and the so-called "water hammer" when a valve is closed suddenly.

Referring to Figs. 1, 2 and 3, a small portion 1 of the upper wall of a tank adapted to hold water or other liquid, is shown as being provided with a threaded aperture 2. This tank, in addition to serving as a reservoir, also is intended to contain a variable quantity of air in its upper portion in order to thereby function as an air dome or equivalent for insuring a uniform flow of water from such tank, when and as may be desired under the control of faucets, valves, or other types of controlling means.

Into the aperture 2 is secured the similarly threaded reduced end portion 3 of a coupling 3', the relatively larger internally threaded opposite end portion 4 of which receives in threaded engagement a cylindrical body member 5, having its opposite end closed by means of an imperforate cap or other suitable form of closure 6, also in threaded engagement therewith. The body portion 5, together with the attached members 3' and 6, cooperate to form a casing which is here disclosed as being made in probably the most economical form, but which instead may be cast as, for instance, in the form shown in Fig. 5, and hereinafter described.

Within the opposite end portions of the body member 5 are secured similarly constructed partition units which are, therefore, interchangeable. Each of these units comprises an outwardly positioned rigid gasket 7, formed of metal or other suitable material and of a diameter slightly smaller than that of the interior of said body member. Adjacent to each of these gaskets is positioned a rubber or other form of elastic gasket 8, while upon the opposite or inner face of each of these elastic gaskets is positioned a metallic ring 9, the adjacent surfaces of which are in cross section represented by reverse or O-G curves, and the several parts of each partition unit being secured together in binding relation by means of circumferentially spaced screws or bolts 10.

Each of these partition units is provided with an axially positioned bore 11, through which extend the opposite end portions of a radially resilient rubber or equivalent tube 12. Within the lower portion of this tube, in the form of the device shown in Figs. 1 and 2, there is positioned an annular ferrule 13, having an axial downwardly tapering bore 14, forming a valve seat for a correspondingly tapered portion 15 of a rod 16, the lower end of which rod extends downwardly through and freely from the restricted portion 3 of the member 3', and carries a float 17 positioned within the upper portion of the tank 1. The upper portion 18 of the rod 16 extends freely (with sufficient clearance to pass air) through an axial bore 19 in an annular ferrule 20, which is positioned in the upper end portion of the tube 12. These ferrules 13 and 20, being in the same planes as the respective gaskets 8, also serve to prevent a collapse of the adjacent portions of said tube 12, as it is compressed radially inwardly, and which is thus secured in position by a radially inward contraction of the gaskets 8, as they are compressed by the screws 10 between the gaskets 7 and the rings 9, when at the same time said gaskets 8 also tend to expand radially outwardly in binding cooperation with the inner surface of the casing member 5. The functional result of this construction permits the adjustable positioning of the respective partition units readily in any desired positions within the casing member 5, and similarly permits them to be withdrawn therefrom for repair or replacement whenever the same may be desired. Also, a distinct advantage of such a unit resides in the fact that it forms such a positive seal, that it is adapted for use in many other ways, as for instance in the connection of two pipes, tubes, bars and tubes, et cetera.

The body member 5 is provided preferably substantially centrally with an aperture 21, within which is secured any suitable form of air (or other gas) inlet valve 22, whereby a gas can enter the space 23 between the tube 12 (during its collapse) and the surrounding casing member 5. The several elements of the said partition units are provided with aligned apertures which, together, form bores 24 in which are positioned air outlet valves 25 of any suitable type, the same for convenience preferably being valves which are interchangeable with the air inlet valve 22.

In the form of the device shown in Figs. 1 and 2, as the water level rises within the tank 1 and the float 17 is thereby raised, the valve 15 is similarly raised and accordingly opens the passageway through the lower ferrule 13. Each subsequent pulsation of a supply pump conducting additional water into said tank thereupon forces air into and radially expands the tube 12, substantially or completely into the dot-and-dash position 12' shown in Fig. 1, with the obvious result that the air previously trapped within the space 23 is forced outwardly through the valves 25 and into the upper portion of the tank 1. Air passing the upper valve 25 flows radially inwardly beneath the casing closure 6, thence through the bore 19 in the upper ferrule 20 and downwardly through the tube 12 into the tank, while air passing the lower valve 25 flows directly into said tank. With the release of the temporary excess pressure by opening a valve or other outlet controlling means, the resilient characteristics of the tube 12 cause it to return to its normal collapsed position shown in Fig. 1, thereby drawing air into the casing member 5 through the inlet valve 22. This cycle of operation is thereupon continued until the proper volume of air is restored within the tank and the pressure of such air prevents the further operation of the tube 12, until such pressure is again relieved by and upon drawing water from said tank, without its being replenished at the same rate by the pump or other liquid impelling means.

Referring to Fig. 3, since there is no valve stem or float present in this instance, the ferrules 13 and 20 of Fig. 1 are replaced by simple, uniformly bored ferrules 26. However, while the simple cylindrical ferrules 26 would obviously be supplied in new valves in which there is no intention to use a float and valve stem, the device shown in Fig. 1 may be used as shown in Fig. 3

without alteration or substitution for the ferrules 13 and 20 other than the mere elimination of the said valve stem and float. When using the form shown in Fig. 3, this valve operates in the same manner as that hereinbefore described, but is not restricted to functioning only after the liquid level within the tank reaches a given predetermined height in order to thereby raise the float and release the valve 15. Accordingly, this slightly simplified form of the device begins to operate as soon as the air above the liquid level within the tank reaches sufficient pressure to cause the tube 12 to expand sufficiently to compress air in the space 23 and thereafter upon collapsing forcing such air into the tank.

Referring to Fig. 4, the horizontally disposed valve here shown is given the same numerals as are applied to the device as illustrated in Fig. 3. However, it will be noted that in this instance the reduction fitting 3' is duplicated upon both ends of the body member 5. As a consequence of this construction, and by connecting this simple form of air pump directly in the pipe line leading from the liquid pump, the intermittent positive pressure exerted by such pump against the back pressure of the liquid beyond the improved air pump, will result in causing correspondingly intermittent radial expansion of the elastic tube 12 with intervening contractions of said tube, thereby alternately forcing air from the space 23 in opposite directions through the two air outlet valves 25, directly into the water line and causing replacement air to be drawn into the space 23 by way of the air inlet valve 22.

Referring to Fig. 5, a cast form of the improved injector is here shown as comprising a centrally bellied body portion 30, within and between the opposite relatively restricted ends 31 of which are secured the opposite end portions of a radially elastic tube 32 by means of hollow annular ferrules 33, having conical faces 34 in contact with the ends of said tube, said ferrules being forced into operative position by means of hollow annular nuts 35, which are removably positioned within the internally threaded end portions 36 of the device. The central portion 30 is provided substantially centrally with an air inlet aperture 37 controlled by a valve 38, while one side of the device is provided with a radial enlargement 39 through which extends longitudinally a bore 40 opening through apertures 41 and 42, respectively, into the air space surrounding the tube 32 and into the water line, preferably beyond one or other of the two ferrule-sealing nuts 35, and the flow of air through this channel being restricted to one direction only by means of a second valve 43 of any desired type, but preferably interchangeable with the valve 38.

In conjunction with the form of the injector last described, and through which liquid is intended to flow in the direction of the arrow, there is preferably connected to the discharge end of said injector a check valve of any suitable type, but for which purpose there is here illustrated a simple form which is characterized by high efficiency, as well as economy in construction. This valve primarily comprises an inlet channel 45 and an outlet channel 46, between and separating which is a vertical channel 47, said last-mentioned channel terminating downwardly in an annular tapered valve seat 48 through which communication is had with the inlet channel 45. A gravity actuated valve 49 is adapted to rest upon said valve seat, while the wall of the central channel 47 is provided with an aperture 50 in direct communication with the outlet channel 46, the lower side of the aperture 50 being spaced above said valve seat, and consequently above the lower surface of said valve when in its lowermost position. The upper portion of the central channel 47 is also connected with the outlet channel 46 by means of a by-pass 51, both for the purpose of relieving pressure upon the upper surface of the valve as it rises, and also for the purpose of positively seating said valve between positive pulsations of the pump connected to the opposite end of the injector.

The positive seating of the valve 49 is effected by reason of the differential of the areas of its upper and lower surfaces, while access to this valve may be had by and upon removing a plug or equivalent closure 52 for the upper portion of the central channel 47. In the operation of the composite structure shown in Fig. 5, pressure originating with the pump (not shown) will build up within and cause expansion of the flexible tube 32, until the valve 49 has raised sufficiently to permit such pressure to be relieved by exit of the temporarily confined liquid through the aperture 50 into the discharge channel 46 of said check valve. Thereupon, as soon as the temporary pump pressure has been released, the weight of the valve 49, combined with the back pressure of the water or other liquid upon the upper surface of this valve, will cause it to drop into its lower position and thereby block any reverse flow of water through the injector.

Referring now to Fig. 6, a modified form of air injector is here shown as comprising a lower tubular portion 55, which is normally secured within an aperture 56 in the upper wall 57 of a tank. The member 55 also comprises a flange 58, to which is secured by screws 59 the flanged portion 60 of a preferably tubular casing 61, the upper portion of which is closed by a wall 62, except for a central aperture 63, in which is secured an air inlet valve 64 by any suitable means. Positioned within the upper portion of said casing and with its interior in communication with the valve 64 is a metal bellows 65, the lower wall 66 of which is apertured at 67 and communicates through an air outlet valve 68 with the under side of a corrugated metal diaphragm 69, the upper wall 70 of which diaphragm is suitably secured so as to move in unison with the lower wall 66 of said bellows. The lower portion of said diaphragm is thereupon provided with a radially outwardly extending annular flange 71, which is tightly held between the flanges 58 and 60 of the surrounding casing. In the operation of this form of the device, pulsations from a pump supplying water to the tank 57 cause the upper wall of the diaphragm to alternately rise and fall, thereby causing a corresponding rise and fall of the lower wall 66 of said bellows, with the obvious result that air is alternately drawn past the valve 64 into and expelled past the valve 68 into the upper portion of said tank.

Referring to Fig. 7, the modified form of the device here shown comprises a preferably bellied or equivalently shaped casing 75, having a laterally directed opening 76, spanned by a perforated or at least porous cover 77, by which foreign particles and dust are prevented from entering the space between said casing and an axially positioned, radially elastic tube 78 positioned therein. Said tube is secured in operative position by means of annular ferrules and nuts 79 and 80, while said casing is adapted to be connected directly in the main line of the system by

means of threaded end portions, or equivalent means. Thus, except for the injection principle, the modification shown in Fig. 7 is structurally similar in the details mentioned to that shown in Fig. 5, and pulsations in the body of liquid caused by the pump are absorbed by the radial expansion of said tube, while in a similar manner the inertia of flowing liquid, as when the device is placed in a line between a tank or other supply and a valve, is absorbed by said tube upon suddenly closing such valve, and thereby eliminating the so-called "hammer" effect. Instead of the porous cover 77, the opening 76 may be closed by a valve which normally permits a free flow of air in both directions, while contact of a liquid with such valve, as when the tube may leak, operates to positively close the valve and prevent escape of liquid from the system.

The broad idea underlying the principles embodied in the present invention, and defined by the appended claims, is to be understood as anticipating the many changes in details of construction which may be made in the several forms of the injector hereinbefore described, while still operating to function in accordance with the principles herein set forth.

Having thus described our invention, what we claim as new and desire to protect by Letters Patent of the United States is:

1. A gas injector pump for liquid systems, comprising a casing, a distortable member within and spaced from said casing, adapted to be distorted by positive pressure within the system to occupy the space between said casing and said member, adjustable distortable sealing means to connect said casing with said member, a gas inlet valve extending through said casing and connecting the space between said casing and said member with the exterior of said casing, and a gas outlet valve extending through said sealing means and connecting the said space with the system.

2. A gas injector for liquid systems, comprising a casing having an enlarged portion, a radially expansible tube secured at spaced regions to the inner walls of said casing upon the opposite sides of said central portion to provide a space therebetween, an inlet valve connecting said space with the exterior of said casing, a second valve connecting said space with said system, said casing being connected to the upper air chamber of a liquid containing tank, and the interior of said tube being in communication with said air chamber.

3. A gas injector for liquid systems, comprising a casing having an enlarged portion, a radially expansible tube within said casing, partition units sealing the space between said tube and said casing adjacent to each end of said tube, an inlet valve connecting said space to the exterior of said casing, the interior of said casing being connected to the upper gas chamber of a liquid containing tank, and an outlet valve extending through one of said partitions and connecting said space with said gas chamber.

4. A gas injector for liquid systems, comprising a casing having an enlarged portion, a radially expansible tube within said casing, partition units sealing the space between said tube and said casing adjacent to each end of said tube, an inlet valve connecting said space to the exterior of said casing, said casing being connected to the upper gas chamber of a liquid containing tank, and outlet valves extending through said partitions, one valve leading from said space directly into said gas chamber, and the other valve leading into said gas chamber by way of said tube.

5. A gas injector for liquid systems, comprising a casing having an enlarged portion, a radially expansible tube within said casing, partition units sealing the space between said tube and said casing adjacent to each end of said tube, an inlet valve connecting said space to the exterior of said casing, the interior of said casing being connected to the upper gas chamber of a liquid containing tank, an outlet valve extending through one of said partitions and connecting said space with said gas chamber, a ferrule having a valve seat and distending the normal lower portion of said tube, a valve for said seat, and a float depending from and adapted to raise said valve from said seat upon liquid in said tank reaching a predetermined level, whereby when said valve is raised said tube functions in accordance with variations in pressure upon the liquid by extraneous impelling means.

6. A gas injector for liquid systems, comprising a casing having an enlarged portion, a radially expansible tube within said casing, partition units sealing the space between said tube and said casing adjacent to each end of said tube, an inlet valve connecting said space to the exterior of said casing, the interior of said casing being connected to the upper gas chamber of a liquid containing tank, an outlet valve extending through one of said partitions and connecting said space with said gas chamber, a ferrule having a valve seat and distending the normal lower portion of said tube, a valve for said seat, a float depending from and adapted to raise said valve from said seat upon liquid in said tank reaching a predetermined level, whereby when said valve is raised said tube functions in accordance with variations in pressure upon the liquid by extraneous impelling means, a stem rising from said valve, and a ferrule in the normal upper portion of and distending said tube, and through which said valve stem passes loosely as a guide.

7. A gas injector for liquid systems, comprising a casing having an enlarged portion, a radially expansible tube within said casing, partition units sealing the space between said tube and said casing adjacent to each end of said tube, an inlet valve connecting said space to the exterior of said casing, said casing being connected to the upper gas chamber of a liquid containing tank, outlet valves extending through said partitions, one valve leading from said space directly into said gas chamber, and the other valve leading into said gas chamber by way of said tube, a ferrule having a valve seat and distorting the normal lower portion of said tube, a valve for said seat, and a float depending from and adapted to raise said valve from said seat upon liquid in said tank reaching a predetermined level, whereby when said valve is raised said tube functions in accordance with variations in pressure upon the liquid by extraneous impelling means.

8. A gas injector for liquid systems, comprising a casing, a bellows attached to and closed upon one side by said casing, an inlet valve extending through said casing into said bellows, an axially yieldable diaphragm spanning said casing beneath and operative to actuate said bellows, an outlet valve connecting the interior of said bellows with the lower side of said diaphragm, and means to secure said casing to and in communication with an air chamber in a liquid system.

9. A gas injector for liquid systems, comprising

a casing, a bellows within and having one side fixed with respect to a wall of said casing, an inlet valve extending through said casing into said bellows, a diaphragm spanning said casing upon the opposite side of said bellows, and connected to said bellows so as to alternately collapse and distend the same, an outlet valve connecting the interior of said bellows with the opposite side of said diaphragm, and means to secure said casing to and in communication with a gas chamber in a liquid system.

GEORGE H. McMULLEN.
JOSIAH M. HADDAWAY.