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SAFETY VALVE ASSEMBLY FOR PULSE JET BURNERS AND THE LIKE

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FIG. 1

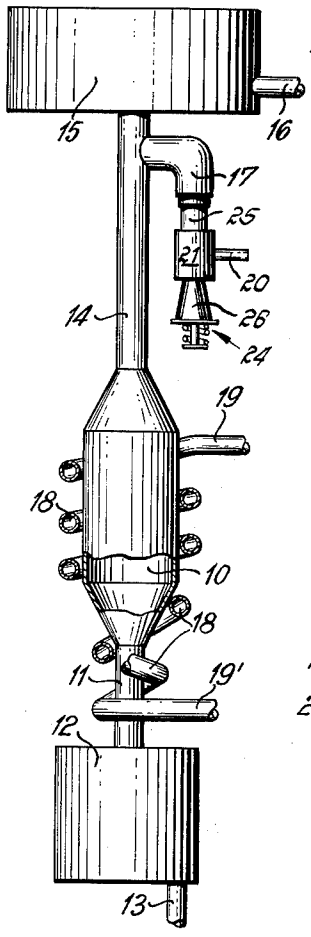


FIG. 1a

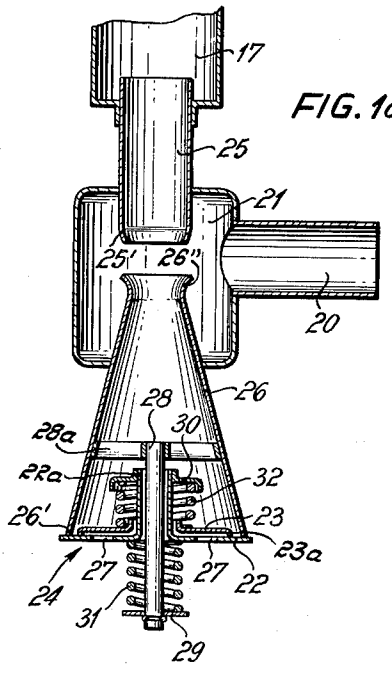


FIG. 2

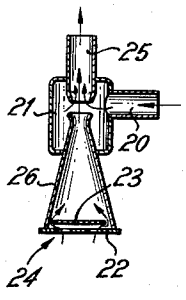


FIG. 3

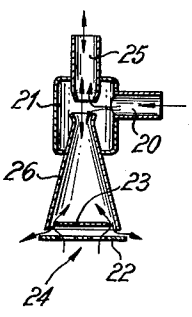
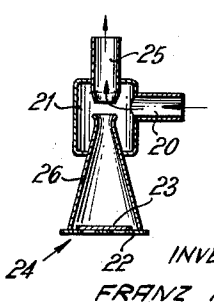


FIG. 4



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SAFETY VALVE ASSEMBLY FOR PULSE JET BURNERS AND THE LIKE

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11 Claims. (Cl. 158—4)

The present invention relates to fuel burning apparatus in general, and more particularly to an improved safety valve assembly which may be used in fuel supply conduits of pulse jet burners and similar fuel burning apparatus wherein the pressure is likely to fluctuate above and below a predetermined permissible pressure range not only at the start but also in another stage of the operation. Still more particularly, the invention relates to a safety valve assembly which serves to prevent excessively high or excessively low pressures from spreading into the main supply conduit which delivers fuel to one or more fuel burning apparatus.

It is well known that a pulse jet burner is likely to misfire during starting whereby a strong pressure wave (immediately followed by a strong suction wave) travels into the supply conduit which delivers fuel to the combustion chamber of the burner. This may become dangerous if the pressure wave or the suction wave is permitted to affect the flow of fuel in the main supply conduit which often delivers fuel to one or more additional apparatus whereby a pressure wave or a suction wave may extinguish the flame of a main burner or a pilot burner in a gas range, water heating boiler or another gas burning apparatus.

Accordingly, it is an important object of our invention to provide a very simple and fully automatic safety valve assembly which prevents excessively high or excessively low pressures from affecting the flow of fuel to one or more gas burning apparatus.

Another object of the invention is to provide a safety valve assembly of the just outlined characteristics which is especially suited for use in the fuel supply conduit of a pulse jet burner (also called resonance duct burner) but which is equally useful in many other types of gas burning apparatus wherein the pressure prevailing in the combustion chamber might fluctuate within limits which are undesirable in the conduitry serving to deliver fuel to such apparatus.

A further object of the invention is to provide a very compact safety valve assembly which may be readily installed in many types of conventional gas burning apparatus without necessitating expensive alterations of such apparatus, which requires no attention once it is properly installed and adjusted for use in connection with a given type of pulse jet burner or another gas burning apparatus, which may be manufactured at low cost, and which will automatically maintain the pressure in the fuel supply conduit within permissible limits.

A concomitant object of the invention is to provide a safety valve assembly which is particularly suited to damp very strong pressure waves or suction waves which develop on misfiring of a pulse jet burner when the operation of the burner is started.

Still another object of our invention is to provide a safety valve assembly whose cost is well below the cost of conventional devices which are presently being used for the same purpose and whose dimensions are negligible when compared with the dimensions of the apparatus in which the assembly is put to use.

Another object of the invention is to provide a safety valve assembly which may be readily adjusted so as to respond to pressure waves or suction waves of predetermined magnitude.

With the above objects in view, one feature of the invention resides in the provision of a fuel burning apparatus comprising a pulse jet burner or a similar burner which includes a combustion chamber having a resonance duct and a suction duct which latter communicates with the atmosphere or with another source of oxygen, a fuel supply conduit which delivers a stream of preferably gaseous fuel to the suction duct so that the fuel is mixed with oxygen and the resulting mixture enters the combustion chamber to be ignited and to produce spent gases which are evacuated through the resonance duct. Such ignition of fuel in the combustion chamber is often accompanied by pressure waves and suction waves which might travel in the supply conduit and might cause the pressure in this conduit to fluctuate above and below a permissible pressure range. To avoid such excessively high or low pressures from reaching the source of gaseous fuel or from affecting the operation of certain other gas burning apparatus which receive fuel from the same conduit, we provide in the supply conduit a pressure equalizing chamber and a safety valve assembly which includes a pressure relief valve arranged to open in a fully automatic way in response to such pressure in the pressure equalizing chamber which is above the predetermined permissible pressure range and a suction valve which opens automatically when the pressure prevailing in the pressure equalizing chamber drops below the predetermined permissible pressure range so that the pressure in that portion of the fuel supply conduit which delivers fuel to the pressure equalizing chamber always remains within the permissible pressure range. In other words, the pressure equalizing chamber with its safety valve assembly constitutes an effective barrier which prevents excessive fluctuation of pressure in that part of the supply conduit which leads to the pressure equalizing chamber.

We wish to mention here that it is known to damp pressure waves or suction waves with the help of bulky sound absorbing devices which may assume the form of resonators or the like. However, in order to be effective, a resonator must be comparatively large and expensive, especially since the pressure of fuel in a supply conduit is comparatively low. There is hardly any room for a large resonator when a pulse jet burner is used as a room heater or water heater in one- or two-family homes.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved safety valve assembly itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood from the following detailed description of a specific embodiment with reference to the accompanying drawings, in which:

FIG. 1 is a central vertical section through a fluid heating apparatus which includes a pulse jet burner and which embodies the safety valve assembly of our invention, this valve assembly being shown in side elevation;

FIG. 1*a* is an enlarged axial section through the pressure equalizing chamber and the safety valve assembly;

FIG. 2 is a smaller-scale schematic section through the valve assembly with one of the valves in open position;

FIG. 3 illustrates the structure of FIG. 2 with the other valve in open position; and

FIG. 4 illustrates the structure of FIG. 2 or 3 with both valves in closed position.

Referring to the drawings, and first to FIG. 1, there is shown an apparatus which may be utilized in a house as a room heater or water heater. The heat generating device assumes the form of a pulse jet burner which includes a combustion chamber 10 having a suction duct 14 which delivers to the internal space of the suction cham-

ber a mixture of fuel with oxygen or oxygen-containing air, and a resonance duct 11 which serves to convey from the internal space of the combustion chamber all such spent gases which develop on combustion of the mixture. The burner further comprises a first soundproofing or silencing housing 15 which communicates with the upper end of the suction duct 14 and which is provided with an air-admitting inlet 16, and a second soundproofing or silencing housing 12 which communicates with the discharge end of the resonance duct 11 and which is connected with a take-off pipe 13 for spent gases. In the illustrated embodiment, the pulse jet burner serves to heat a stream of water delivered by a cold water pipe 19 communicating with a heating pipe 18 which is coiled around the combustion chamber 10 so that the water stream exchanges heat with the heated wall of the combustion chamber, and a hot water pipe 19' which communicates with the discharge end of the heating pipe 18. This pulse jet is known in the art and by itself forms no part of our invention. The combustion chamber 10 may be divided into or replaced by two or more combustion chambers each of which is then provided with its own suction duct and resonance duct. Also, and if it is desired to heat water or another fluid to elevated temperature, at least a portion of the heating pipe 18 may extend through the combustion chamber 10 so that this pipe is heated directly by contact with spent gases.

In accordance with the present invention, the suction duct 14 receives a suitable fuel through a composite supply conduit including a main supply conduit 20 and a connecting conduit 17 which latter has a discharge end communicating with the main supply conduit 20 via a pressure equalizing or pressure damping chamber 21 and a cylindrical nipple 25. This nipple has an outer end portion which is connected to the intake end of the conduit 17. The pressure prevailing in the chamber 21 is controlled by a specially constructed safety valve assembly 24, best shown in FIG. 1*a*, which includes a pressure relief valve having an annular disk-shaped valve member 22 and a vacuum valve having an annular disk-shaped valve member 23. These valve members are mounted partially within and in part on a conical diffuser-like mixer nozzle 26 whose outwardly flaring smaller-diameter end portion 26'' extends into the pressure equalizing chamber 21 and whose larger diameter end portion 26' is located externally of this chamber. The nozzle 26 is coaxial with the nipple 25 which latter also extends into the pressure equalizing chamber 21 and is formed with an inwardly bent annular end portion 25' located opposite and at least slightly spaced from the end portion 26''. The other end portion of the nipple 25 extends into the connecting conduit 17. The housing of the chamber 21 constitutes a small but highly effective sound absorbing device.

In addition to the aforementioned disk-shaped valve member 23, the vacuum valve comprises a resilient element 32 here sshown as a helical spring which is arranged to operate between the upper side of the valve member 23 and an annular stop 30 provided on a tubular extension 22*a* of the valve member 22. The extension 22*a* is slidable along a supporting column 28 which is coaxial with the nozzle 26 and which is secured thereto by radial ribs 28*a* connected to an intermediate portion of the nozzle wall. The pressure relief valve comprises a resilient element in the form of a helical spring 31 which operates between the underside of the valve member 22 and a stop 29 provided on the outer portion of the column 28. In the illustrated embodiment, the column 28 extends partially into the interior of and is internally secured to the nozzle 26; however, it is equally possible to connect the outer portion of this column to the exterior of the nozzle 26 or to another stationary part of the apparatus.

The valve member 22 is provided with one or more apertures 27 which may assume the form of circularly arranged round holes and which are overlapped by the valve member 23. The latter comprises a small annular flange 23*a* which is biased against the upper side of the valve member 22 so that the apertures 27 are normally sealed from the interior of the nozzle 26. When the two valves are in closing position, the marginal portion of the valve member 22 is caused to bear against the larger-diameter end portion 26' of the nozzle 26 which constitutes an annular seat for the valve member 22 and the flange 23*a* of the valve member 23 is caused to bear against the upper side of the valve member 22 which latter constitutes an apertured seat for the valve member 23 so that the pressure equalizing chamber 21 then communicates only with the main supply conduit 20 and with the connecting conduit 17.

It will be noted that the axis of the pressure relief valve 22, 31 coincides with the axis of the vacuum valve 23, 32 and that this axis is also the axis of the nozzle 26 and nipple 25. The springs 31, 32 normally tend to maintain the two valves in closed or sealing position so that the interior of the nozzle 26 is sealed from the atmosphere.

The apparatus of FIG. 1 operates as follows:

When the pulse jet burner (including the chamber 10 with the ducts 11, 14 and the soundproofing housings 12, 15 with inlet 16 and take-off pipe 13) is started, it happens quite frequently that very strong suction develops in the connecting conduit 17 so that, and in the absence of the safety valve assembly 24, such suction could produce equally strong suction in the main supply conduit 20. This is highly undesirable, especially if the supply conduit 20 supplies fuel to one or more additional apparatus, for example, to one or more main burners and to one or more pilot burners of a room heater, gas range or the like. If the flames of the main burners and/or pilot burners are extinguished, fuel may escape into the room and can cause an explosion or poisoning.

The vacuum valve 23, 32 of the safety valve assembly 24 opens in a fully automatic way when the pressure prevailing in the interior of the nozzle 26 drops to such a level that atmospheric air flowing through the apertures 27 moves the valve member 23 away from the upper side of the valve member 22 (see the arrows in the lower portion of FIG. 2) and enters the pressure equalizing chamber 21 where it is admixed to the fuel flowing from the main conduit 20 so that the fluid entering the nipple 25 is a mixture of fuel and oxygen-containing air. The fuel flowing in the main conduit 20 is not affected by suction which prevails in the chamber 10 and/or 21 so that any appliances which receive fuel from the main conduit 20 are not affected by the operation of the pulse jet burner.

On the other hand, it also happens that the pulse jet burner misfires, particularly during starting, so that a strong pressure wave travels up the suction duct 14 and into the connecting conduit 17 to raise the pressure which prevails in the pressure equalizing chamber 21. In such instances, the pressure relief valve 22, 31 opens in a fully automatic way because the pressure prevailing in the chamber 21 causes the valve member 22 to move away from the lower end portion 26' of the nozzle 26 and to permit escape of fluid into the atmosphere. Such position of the valve member 22 is illustrated in FIG. 3 and the outwardly directed arrows in the lower portion of this illustration indicate the direction of fluid flow from the nozzle 26. This FIG. 3 further shows the next stage of the operation when, in response to a suction wave (which automatically follows the pressure wave) the valve member 23 again moves away from the valve member 22 to permit inflow of atmospheric air into the chamber 21 where such air is admixed to fuel in the previously described manner. Consequently, the chamber 21 serves as a barrier to prevent excessive pressure or excessive subpressure from affecting the fuel in the main conduit 20 with resultant safety in the operation of all such appliances which might receive fuel from the same source as the pulse jet burner. For example, if the conduit 20 supplies fuel to one or more main burners and

to one or more pilot burners of a gas-heated boiler or gas range, a substantial rise in the pressure of fuel contained in the main conduit 20 could cause some fuel to escape through a fully or nearly fully closed shutoff valve of the range, especially if the sealing member of such shutoff valve is held from its seat by a particle of dust or similar foreign matter. The fuel is then free to escape into the boiler room or a kitchen with resultant danger to the safety and health of the occupants.

The valve members 22, 23 continue to move between their respective open and closed positions until the operation of the pulse jet burner is normalized, whereupon the safety valve 24 assumes the position of FIG. 1*a* or 4 in which each of the valve members, 22, 23 remains closed. In other words, as long as the range of pressures which prevail in the chamber 21 exceeds a predetermined permissible range (for which the two valves are adjusted), the safety valve assembly 24 will allow air to enter the nozzle 26 or fluid to escape from this nozzle in a fully automatic way and without any supervision on the part of an operator. The bias of the springs 31, 32 is selected in such a way that they allow the pressure in the chamber 21 to rise or to drop to such a value which cannot produce any adverse effects in the main fuel conduit 20.

The fuel which is delivered by the main conduit 20 may be a pulverulent, gaseous or diffused liquid substance (e.g., light oil which is vaporized in an apparatus connected to the intake end of the main conduit 20).

It goes without saying that the improved safety valve assembly 24 or an equivalent thereof may be used in many other types of apparatus which need not necessarily include a pulse jet burner, as long as such apparatus operate with substantial fluctuations in pressure which fluctuations should not be transmitted to certain parts of the apparatus or to another apparatus. As a rule, the improved safety valve assembly will find use in many types of appliances which burn a gaseous fuel or a vaporized liquid fuel. The dimensions of the safety valve assembly will be selected in dependency on the intended use and, if desired, the extension 22*a* and the column 28 may be provided with external threads so that the position of the stops 29, 30 may be adjusted in order to vary the bias of the springs 31, 32 with resultant adjustments in the range of pressures at which the two valves will open to connect the internal space of the nozzle 26 with the atmosphere. Such and many other minor modifications of the safety valve assembly will be readily comprehended by men skilled in this art without necessitating additional illustrations.

The safety valve assembly of our invention is equally effective when a pressure wave precedes a suction wave or vice versa, i.e., it is of no consequence if, at the time the pulse jet burner is started, the valve member 22 opens prior to opening of the valve member 23 or the other way around. It is of particular importance that the valve assembly 24 should damp the very large initial pressure wave which develops when a pulse jet burner misfires during starting and which is often strong enough to affect the flow of fuel from the main conduit 20 to one or more gas ranges or other appliances which receive fuel from the same source.

The entire safety valve assembly constitutes a very small, compact structure which may be readily installed in or on many types of existing fuel burning apparatus wherein the pressure in the fuel supply conduit might flluctuate during starting or in another stage of the operation.

The feature that the two valves of the safety valve assembly may be mounted on a common supporting column is of importance in apparatus wherein the safety valve assembly must be accommodated in a small space. The two valves actually constitute a dual valve wherein certain elements of one valve cooperate with and serve as supports or abutments for certain elements of the other valve.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a fuel burning apparatus, in combination, a pulse jet burner comprising a combustion chamber having a resonance duct and an air admitting suction duct; fuel supply conduit means for delivering fuel into said suction duct so that the fuel is mixed with air entering through said suction duct and the resulting mixture is then sucked into said combustion chamber where burning thereof during operation of the pulse jet burner will result in pressure waves and suction waves which will cause the pressure in said suction duct and in said conduit means to fluctuate above and below a permissible pressure range; pressure equalizing duct means communicating at one end with said fuel supply conduit means and at the other end with the atmosphere; and means for controlling the magnitude of pressure waves and suction waves reaching said fuel supply conduit means comprising pressure relief valve means arranged in said pressure equalizing duct means and arranged to open automatically in response to a pressure in said conduit means which is above said permissible pressure range, and vacuum valve means arranged also in said pressure equalizing duct means and arranged to open automatically when the pressure prevailing in said conduit means drops below said permissible pressure range whereby the pressure in said conduit means remains within said permissible pressure range.

2. In a fuel burning apparatus, in combination, a pulse jet burner comprising a combustion chamber having a resonance duct and an air admitting suction duct; fuel supply conduit means for delivering fuel into said suction duct so that the fuel is mixed with air entering through said suction duct and the resulting mixture is then sucked into said combustion chamber where burning thereof during operation of the pulse jet burner will result in pressure waves and suction waves which will cause the pressure in said suction duct and in said conduit means to fluctuate above and below a permissible presssure range; and means for controlling the magnitude of pressure waves and suction waves reaching said fuel supply conduit means comprising a pressure equalizing chamber provided in said supply conduit means so that fuel flowing through said conduit means passes through said pressure equalizing chamber on its way to said suction duct, pressure equalizing duct means communicating at one end with the interior of said pressure equalizing chamber and at the other end with the atmosphere, and a safety valve assembly comprising a pressure relief valve arranged in said pressure equalizing duct means and arranged to open automatically in response to a pressure in said pressure equalizing chamber which is above said permissible pressure range, and a vacuum valve arranged also in said pressure equalizing duct means and arranged to open automatically when the pressure prevailing in said pressure equalizing chamber drops below said permissible pressure range whereby the pressure in that portion of said conduit means which delivers fuel to said pressure equalizing chamber remains within said permissible pressure range, each of said valves comprising a reciprocable valve member and said valve members having a common axis.

3. In a fuel burning apparatus, in combination, a pulse jet burner comprising a combustion chamber having a resonance duct and an air admitting suchion duct; fuel supply conduit means for delivering fuel into said suction duct so that the fuel is mixed with air entering through said suction duct and the resulting mixture is then sucked

into said combustion chamber where burninig thereof during operation of the pulse jet burner will result in pressure waves and suction waves which will cause the pressure in said suction duct and in said conduit means to fluctuate above and below a permissible pressure range; a pressure equalizing chamber provided in said supply conduit means, said fuel supply conduit means comprising a main conduit arranged to deliver fuel to said pressure equalizing chamber, a connecting conduit having an intake end and a discharge end communicating with said suction duct, and a nipple extending into said pressure equalizing chamber and having a portion connected with said intake end so that fuel delivered by said main conduit flows through said pressure equalizing chamber and through said nipple prior to entering said connecting conduit; pressure equalizing duct means communicating at one end with the interior of said pressure equalizing chamber and at the other end with the atmosphere; and a safety valve assembly comprising a pressure relief valve arranged in said pressure equalizing duct means and arranged to open automatically in response to a pressure in said pressure equalizing chamber which is above said permissible pressure range, and a vacuum valve arranged also in said pressure equalizing duct means and arranged to open automatically when the pressure prevaling in said pressure equalizing chamber drops below said permissible pressure range whereby the pressure in that portion of said conduit means which delivers fuel to said pressure equalizing chamber remains within said permissible pressure range, each of said valves comprising a reciprocable valve member and said valve members and said nipple having a common axis.

4. A combination as set forth in claim 3, wherein said nipple comprises an inwardly bent annular end portion located in said pressure equalizing chamber.

5. A combination as set forth in claim 3, wherein said pressure equalizing duct means comprises a diffuser nozzle having a smaller-diameter end portion located in the interior of said pressure equalizing chamber opposite said nipple and a larger-diameter end portion located externally of said pressure equalizing chamber and normally sealed from the atmosphere by said safety valve assembly, said nozzle being coaxial with said nipple.

6. A combination as set forth in claim 5, wherein the valve member of said pressure relief valve is a first disk having an aperture and normally abutting against the larger-diameter end portion of said nozzle and wherein the valve member of said vacuum valve is a second disk located in said nozzle and normally abutting against said first disk to seal said aperture from said pressure equalizing chamber.

7. A combination as set forth in claim 6, wherein each of said valves comprises a resilient element, the resilient element of said pressure relief valve being arranged to bias said first disk against the larger-diameter end portion of said nozzle and the resilient element of said vacuum valve being arranged to bias said second disk against said first disk.

8. A combination as set forth in claim 7, further comprising a supporting column for said disks, said column being coaxially secured to and extending into said nozzle.

9. A combination as set forth in claim 8, wherein said resilient elements are helical springs and further comprising a pair of stops for said springs, one of said stops being secured to said column and said first disk comprising a tubular extension supporting the other stop.

10. In a fuel burning apparatus, particularly in a pulse jet burner, in combination, a pressure equalizing chamber; first conduit means for delivering fuel into said chamber; a nipple having a first and a second end portion respectively located in and externally of said chamber; second conduit means connected with the second end portion of said nipple so that fuel delivered by said first conduit means and passing through said chamber enters said second conduit means via said nipple; a diffusor nozzle having a smaller-diameter end portion located in said chamber opposite the first end portion of said nipple and communicating with the interior thereof and a larger-diameter second end portion located externally of said chamber and communicating with the atmosphere, said nozzle being coaxial with said nipple; a supporting column extending into and coaxially supported by said nozzle; a pressure relief valve comprising a first annular disk-shaped valve member slidably mounted on said column and outwardly adjacent to the second end portion of said nozzle, said valve member comprising at least one aperture located within the outlines of said nozzle, and a first spring arranged to bias said valve member against the second end portion of said nozzle so that said valve member moves away from said nozzle only when the pressure prevailing in said nozzle and in said chamber rises to a predetermined value; and a vacuum valve comprising a second annular disk-shaped valve member slidably mounted on said column and located in said nozzle so as to overlap said aperture, and a second spring arranged to bias said second valve member against said first valve member so that said aperture is sealed from said chamber, the bias of said second spring being such that the second valve member moves away from said first valve member to permit entry of atmospheric air into said chamber via said aperture when the pressure in said nozzle and in said chamber drops below a predetermined value.

11. A combination as set forth in claim 10, wherein said column comprises an outer portion extending outwardly and beyond said first valve member and wherein said first valve member comprises a tubular extension surrounded by said second valve member and extending into said nozzle, and further comprising a first stop provided on said outer portion of said column and a second stop provided on said extension, said first spring being a helix which operates between said first stop and said first valve member and said second spring being a helix which operates between said second stop and said second valve member.

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