

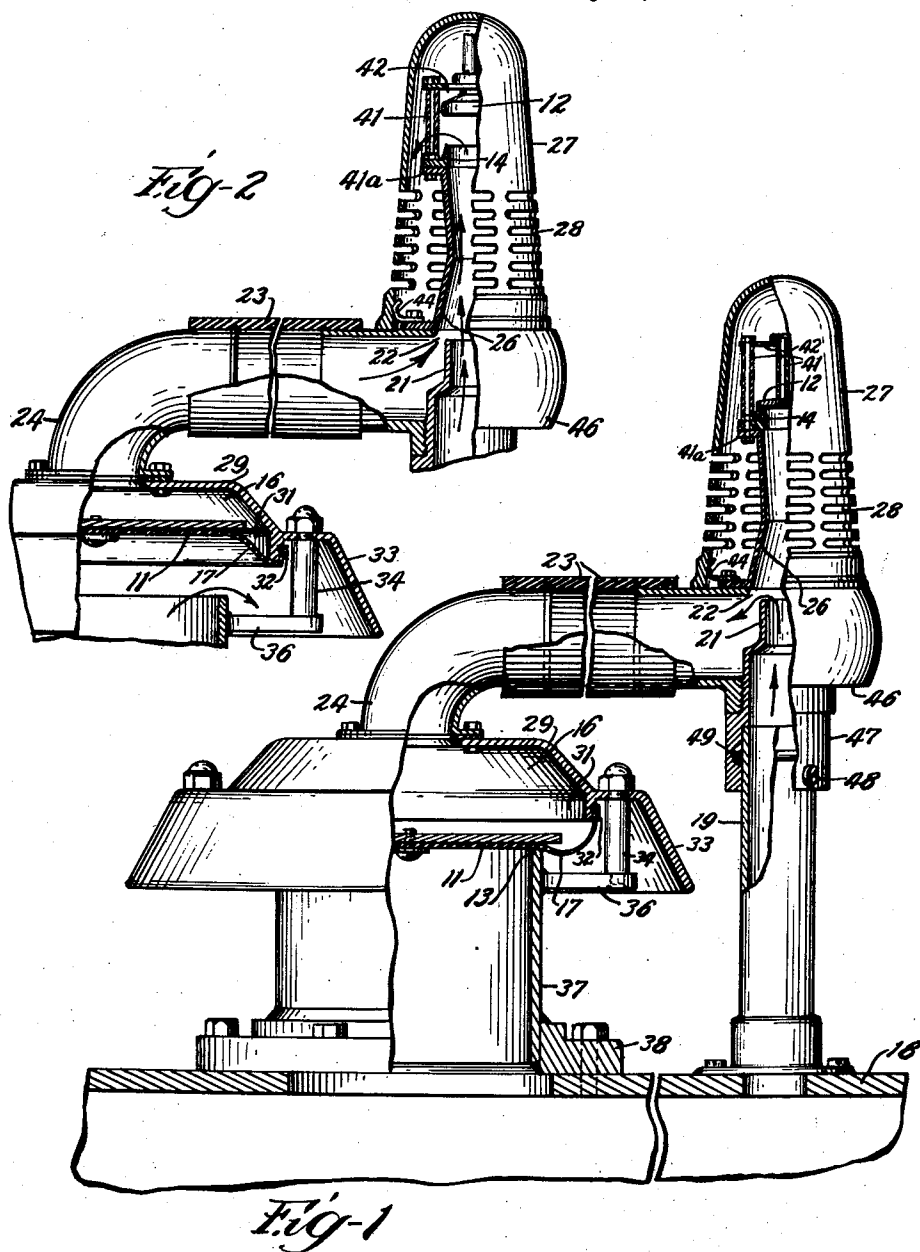
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VENT VALVE WITH PILOT AND INJECTION CONTROL

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## 3,075,544 VENT VALVE WITH PILOT AND INJECTION CONTROL

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In large tanks for storing volatile fuels, such as gasoline, accuracy of pressure regulation is very important. Of course, it is essential not to let the pressure inside the tank build up enough as a result of vaporization of the fuel on a hot day to burst the tank. Likewise, it is essential not to let the pressure fall far enough below atmospheric pressure so that the tank collapses. In large tanks, the areas exposed to the pressure are so great that it is not practical to make the tanks strong enough to resist whatever pressures are likely to be encountered without a relief valve.

The need for accuracy is related to the desire to avoid wasting fuel. The pressure regulation is commonly accomplished by a relief valve. When the pressure builds up enough to necessitate discharge of the vapors through a relief valve, the discharging vapors are lost. Accordingly, it is highly desirable to be able to have the valve remain closed until the pressure is very close to the maximum pressure considered safe, and then discharged so rapidly that that maximum pressure considered safe is never exceeded.

Of course, there is no difficulty in constructing a valve which will begin to open at a predetermined pressure. The difficulty lies in getting that valve to open widely enough at very nearly the pressure which begins to open it so that it will discharge at the high rate required for safety. A common expedient to reduce the spread between the pressure at which the valve begins to open and the pressure at which it is fully open is to use a smaller pilot valve which controls the large main valve. In such systems, the main valve is controlled by a diaphragm which forms one wall of an operating chamber into which gas bleeds from the tank. An outlet from this operating chamber to the atmosphere is normally kept closed under control of the pilot valve. When the pilot valve opens, this outlet from the operating chamber to the atmosphere reduces the pressure in the operating chamber so that the main valve opens wide for maximum discharge from the tank. Conventionally, the bleeding connection is quite restricted, so that it will not keep building up the pressure in the operating chamber as the outlet to atmosphere would reduce the pressure. Such a restricted bleeding connection to the operating chamber has the undesirable effect of making the main valve slow to close. When it has discharged enough gas to reduce the pressure in the main tank to a safe level, the pilot valve closes or nearly closes, but the main valve remains open for quite some time. The gas that flows out of the main valve during this time is needlessly lost.

This application is a continuation of Serial Number 523,426, filed July 21, 1955, now abandoned.

According to the present invention, the operating chamber for the main valve communicates with the main tank through a passage that has no constriction—it is not a bleed passage. The operating chamber can be very quickly filled or very quickly emptied under control of the pilot valve by means of an injection nozzle or venturi unit. When the pilot valve is open, gas from the tank flows through the injection unit in such a way that it tends to suck the gas from the operating chamber and not only quickly discharge its excess pressure but actually produce therein a sub-atmospheric pressure. When

the pilot valve closes, the suction action stops and instead the gas from the tank flows in the opposite direction through the suction opening of the injection device and into the operating chamber to close the main valve quickly.

Additional objects of the invention will be apparent from the drawings and from the following description.

### Designation of Figures

FIG. 1 illustrates, somewhat diagrammatically, the form of the invention chosen for illustration applied to a storage tank, some parts being broken away to show cross-sectional detail, the valves being closed.

FIG. 2 is a similar figure, more fragmentary, with the valves open.

### General Description and Operation

The drawing illustrates both the main valve 11 and the pilot valve 12 closed on their seats 13 and 14 respectively. The valve 11 is held against seat 13 with a sufficient pressure for reliable sealing by pressure of gas in operating chamber 16, which is exerted not only against valve plate 11 itself but also against diaphragm 17 surrounding the valve seat 13. The pressure in operating chamber 16 is derived from the tank 18, the gas from tank 18 being free to flow through pipe 19 leading toward the pilot valve 12, through the pre-injection or venturi nozzle 21, back down through annular port 22, through connecting pipe 23 and fitting 24 directly into the operating chamber 16.

When the pressure in tank 18 builds up to a predetermined value, it will raise pilot valve 12 off of its seat 14, down inside of hood 27 and out to atmosphere through the slots 28 in the lower portion of the hood 27. Initially, this relieves the pressure above nozzle 21 so that gas can flow out through annular suction aperture 22, thereby rapidly reducing the gas pressure in operating chamber 16, so that the pressure on the underside of the valve 11 will be enough to raise this valve. Thus is accomplished the opening of the main valve, so that large quantities of gas can escape.

If the pressure in tank 18 should continue to build up beyond the value at which the pilot valve cap 12 is first lifted, a very slight increase of pressure will raise the pilot valve 12 high enough so that the gas will be flowing through nozzle 21 at a sufficient rate of speed to create a sub-atmospheric pressure just above it and hence in operating chamber 16, with the result that the valve 11 will be drawn well up into valve housing 29 for maximum discharge of the gases through the main valve.

As soon as enough gas has escaped through the main valve to reduce the pressure in tank 18 below the predetermined value, the cap 12 will again close. The gas flowing through nozzle 21 will then flow copiously through the annular passage 22 and quickly fill the operating chamber 16 with gas at the same pressure as the pressure in the tank 18, closing the main valve 11 as originally indicated.

### Details of Valves

A variety of valves may be used in each of the positions. Those illustrated have been found to be very satisfactory. The valve membrane 17 is preferably neoprene-impregnated nylon fabric which is secured to valve plate 11 only in the central zone so that if there is any irregularity in the plate 11 or seat 13, the gas pressure on the inside or upper side of diaphragm 17 will nevertheless press it into sealing engagement with the seat 13. The periphery of the diaphragm 17 may have a bead formed on the inside thereof to snap into a groove in a pending annular flange 31. Although the diaphragm 17 preferably has to be stretched slightly to snap around

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the flange 31, a ring 32 is preferably slipped over it to be absolutely sure that it does not come loose. Flange 31 is an integral part of the hood 29 which also includes a skirt 33. The hood 29 is supported by a plurality of studs 34, each of which is carried by a finger 36 formed integrally with main discharge pipe 37. The pipe 37 is welded to a flange 38 which may be secured to the tank 18, either by welding or by bolts with a gasket for sealing. The welding of course extends all around so that it forms a complete seal of the welded joint.

The pilot valve cap 12 is preferably of the free floating type, so that it can move up and down with little or no friction. It rides between a ring of guide rods 41 which are carried by a ring 41a at the upper end of the pilot valve nozzle or injection sleeve 26. A top plate 42 limits the upward movement of pilot valve cap 12, guides a rod 43 carried by cap 12, and also insures correct positioning of the upper ends of guide rods 41. Preferably rods 41 and 43 are provided with friction-reducing sleeves, as of Teflon (polymerized tetrafluoro ethylene).

The valve cap 12 may be of any conventional form, although it has been illustrated as including a resilient disk insert engaging a resilient ring seat 14, both preferably of "Teflon". The seat ring may be held in place by a ring clamping it to ring 41a. The pilot valve structure is thoroughly protected from dirt and from the elements by shell 27, which may be held in place by spring fasteners 44. The discharge slots 28 in shell 27 are preferably narrow enough so that they serve the flame arrester purpose.

The nozzle 21 is shaped approximately as shown, according to known principles, to provide a high rate of gas flow with a low back pressure and low turbulence. The shape of injection sleeve 26 illustrated has been found to be very effective in making good use of the suction provided by the gas stream flowing through nozzle 21 when valve 12 is opened.

Injection sleeve 26 is carried by housing 46 which surrounds nozzle 21 and provides annular gap 22 all around the tip of nozzle 21. The housing 46 is threaded on the lower portion or base of nozzle 21, which in turn is secured to pipe 19 by base 47 and set screw 48 therein. Any suitable type of seal may be provided between base 47 and pipe 19, that preferred being an O-ring seal, the rubber O-ring lying in a groove 49 in the base 48. Buna "N" synthetic rubber is satisfactory for the O ring.

In accordance with present practice where pilot valves are used, the outflow pipe 19 toward the pilot valve should be located far enough away from the main discharge pipe 37 so as not to be subject to localized dropping of pressure when the main valve is open. The pipe 23 may conveniently be a flexible connection such as a neoprene hose.

Invention is claimed as follows:

1. Pressure relief apparatus of the automatic pilot controlled main relief valve type, main and supplemental conduits having open terminal portions spaced apart for communication at spaced points with a container to be regulated, a valve seat communicating with the main conduit, a diaphragm, a main valve carried by the diaphragm and adapted to close said seat externally, the diaphragm being sealed to a main valve housing to form with it an operating chamber and being exposed to the atmosphere in areas surrounding the main valve; a pilot valve seat, a pilot valve cap of light construction adapted to close said seat by gravity alone except when a predetermined pressure raises it from the seat, a pre-injection nozzle communicating with the supplemental conduit and directed to discharge through said seat toward the cap, to blow gas at high speed through the pilot seat when pressure is above said pre-determined pressure, said cap being raised solely by gas which has passed through said nozzle and having a downwardly extending flange surrounding the pilot seat to ensure substantial lift at low pressure, the flow area beyond the seat being other-

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wise substantially unrestricted, and an injection ring spaced around the nozzle outlet to form an injection opening and through which gas flows from said nozzle to and through said pilot seat, said injection opening communicating with the operating chamber whereby gas is sucked by injection action at said injection ring from said operating chamber when said pilot valve is open and is blown into said operating chamber through said injection opening when the pilot valve is closed, the diaphragm being substantially larger in diameter than the valve seat and the valve and parts moving with it being of light construction and said valve being actuated by gravity and gas pressure alone.

2. Pressure relief apparatus of the automatic pilot controlled main relief valve type, including main and supplemental conduits having open terminal portions spaced apart for communication at spaced points with a container to be regulated, a valve seat communicating with the main conduit, a diaphragm, a main valve carried by the diaphragm and adapted to close said seat externally, the diaphragm being sealed to a main valve housing to form with it an operating chamber and being exposed to the atmosphere in areas surrounding the main valve; a pilot valve seat, a pilot valve cap adapted to close said seat by gravity pressure alone except when a predetermined pressure raises it from the seat, a pre-injection nozzle communicating with the supplemental conduit and directed to discharge through said seat toward the cap, to blow gas at high speed through the pilot seat when pressure is above said pre-determined pressure, said cap being raised solely by gas which has passed through said nozzle and having a downwardly extending flange surrounding the pilot seat to ensure substantial lift at low pressure, the flow area beyond the seat being otherwise substantially unrestricted, and an injection ring spaced around the nozzle outlet to form an injection opening and through which gas flows from said nozzle to and through said pilot seat, said injection opening communicating with the operating chamber whereby gas is sucked by injection action at said injection ring from said operating chamber through said injection opening when the pilot valve is closed, the diaphragm being substantially larger in diameter than the valve seat and the valve parts moving with it being of light construction and said valve being actuated by gravity and gas pressure alone.

3. Pressure relief apparatus of the automatic pilot controlled main relief valve type, including main and supplemental conduits having open terminal portions spaced apart for communication at spaced points with a container to be regulated, a valve seat communicating with the main conduit, a diaphragm, a main valve carried by the diaphragm and adapted to close said seat externally, the diaphragm being sealed to a main valve housing to form with it an operating chamber, a pilot valve seat, a pilot valve cap adapted to close said seat by gravity pressure alone except when a predetermined pressure raises it from the seat, a pre-injection nozzle communicating with the supplemental conduit and directed to discharge through said seat toward the cap, to blow gas at high speed through the pilot seat when the pressure is above said pre-determined pressure, said cap being raised solely by gas which has passed through said nozzle, and being directly aligned with said nozzle to ensure substantial lift at low pressure, the flow area beyond the seat being otherwise substantially unrestricted, and an injection passage opening into the nozzle outlet to form an injection opening past which gas flows from said nozzle to and through said pilot seat, said injection passage communicating with the operating chamber whereby gas is sucked by injection action at said injection passage from said operating chamber when said pilot valve is open and is blown into said operating chamber through said injection opening when the pilot valve is closed, the diaphragm being substantially larger in diameter than the valve seat and the valve parts moving with it being

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of light construction and said valve being actuated by gravity and gas pressure alone.

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