United States Patent

Weise

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[45] **May 23, 1972**

[54] PILOT VALVE

[72] Inventor: **Irvin B. Weise**, Bellaire, Tex.

[73] Assignee: **Anderson, Greenwood & Co.**, Houston, Tex.

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[21] Appl. No.: **108,906**

Related U.S. Application Data

[62] Division of Ser. No. 796,961, Feb. 6, 1969, Pat. No. 3,568,706.

[52] **U.S. Cl.**.....**137/102**, 137/112, 137/488, 137/492

[51] **Int. Cl.**.....**F16k 17/10**

[58] **Field of Search**.....137/102, 112, 488, 489.5, 496, 137/489, 492

[56] **References Cited**

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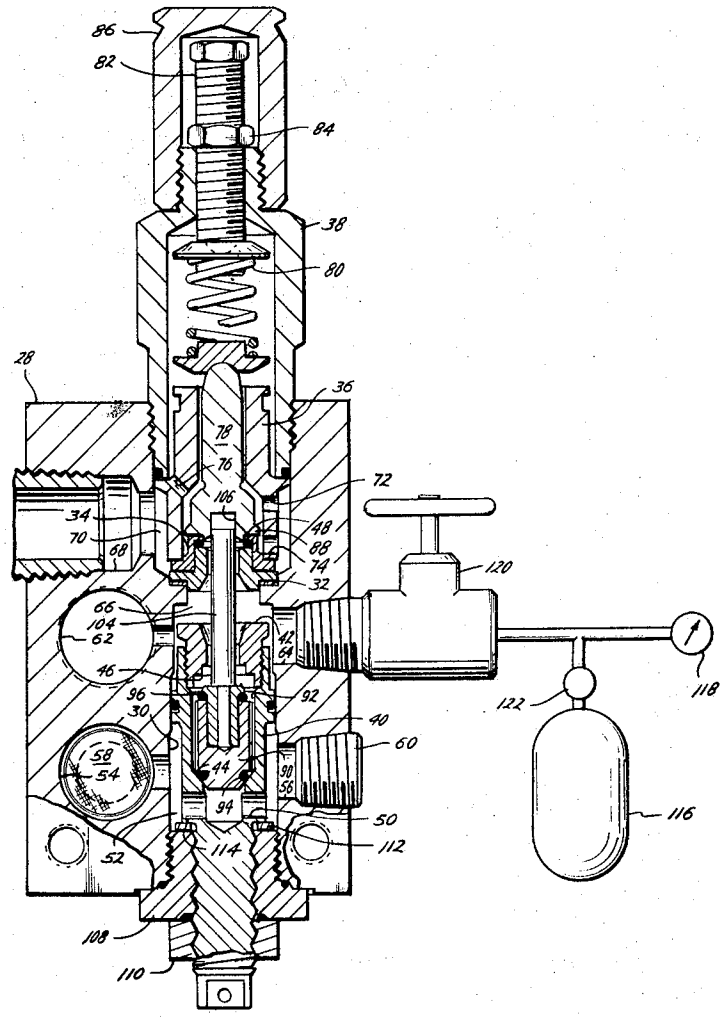
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Primary Examiner—Samuel B. Rothberg
Assistant Examiner—William H. Wright
Attorney—J. Vincent Martin, Joe E. Edwards, M. H. Gay, Alfred H. Evans and Jack R. Springgate

[57] **ABSTRACT**

A pilot valve to be utilized in a pressure relieving system. The pilot valve controls the pressure setting for relief and blowdown through the main valve and assures that there is no reverse flow through the fluid pressure supply line, thereby allowing field testing of the main valve to determine if it is functioning properly while the pilot valve is installed in the system controlling the operation of the main valve.

9 Claims, 5 Drawing Figures



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Fig. 1

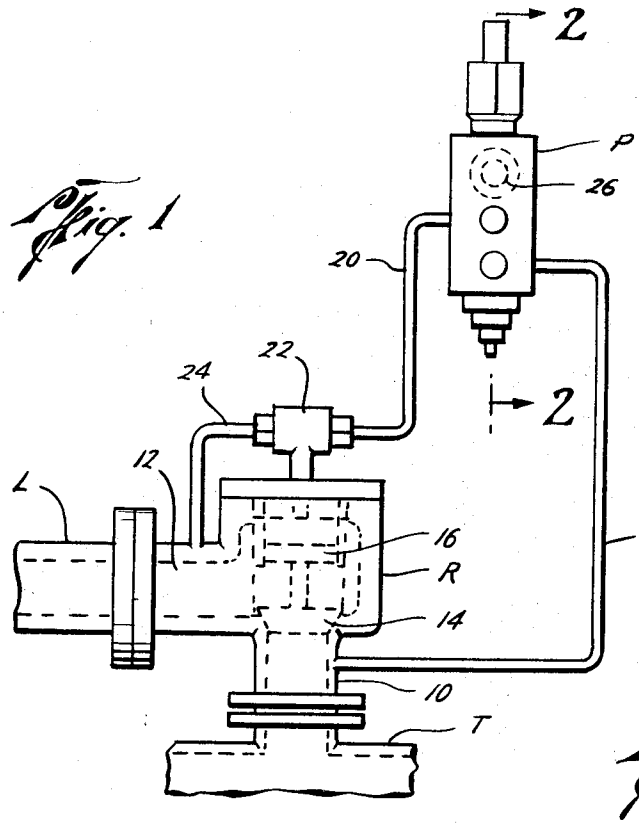


Fig. 5

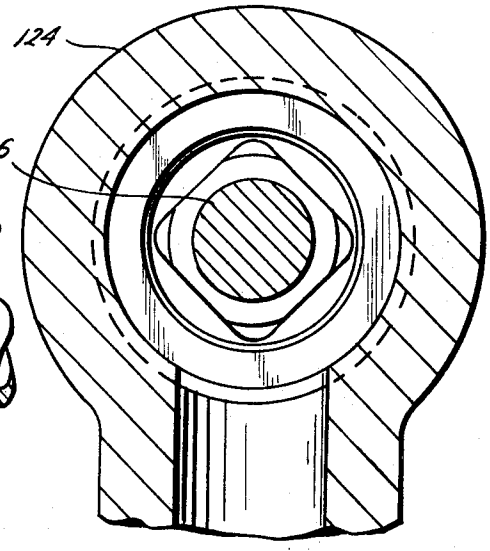
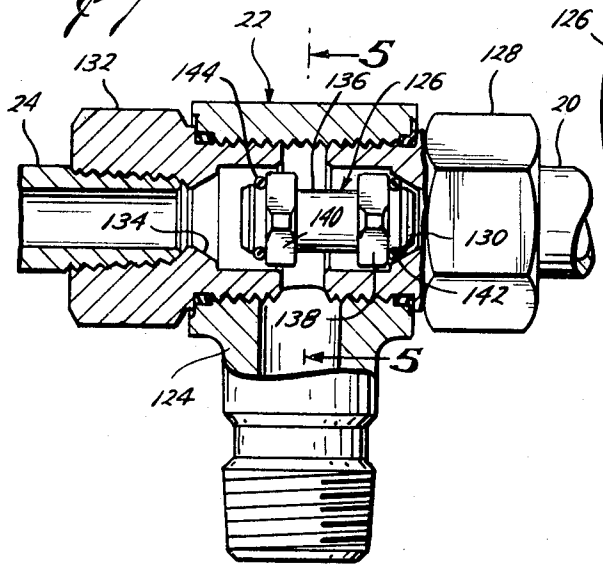


Fig. 4



Irvin B. Weise
INVENTOR.
BY J. Vincent Martin
Joe E. Edwards
Jack L. Spriggs
ATTORNEYS

Fig. 2

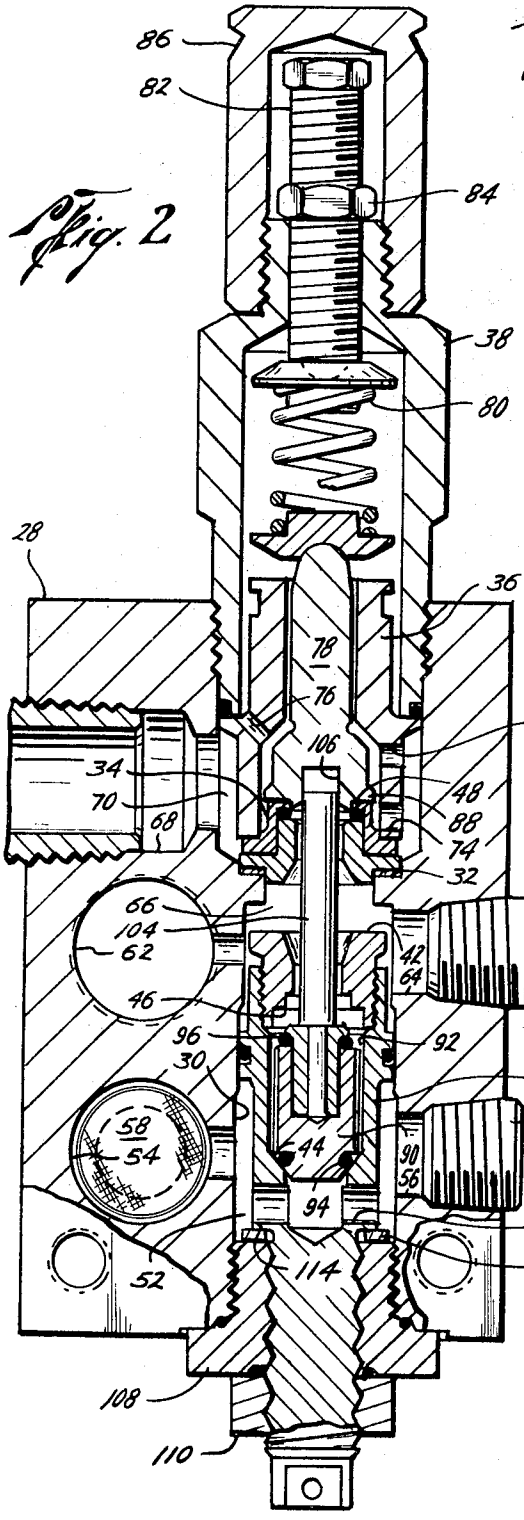
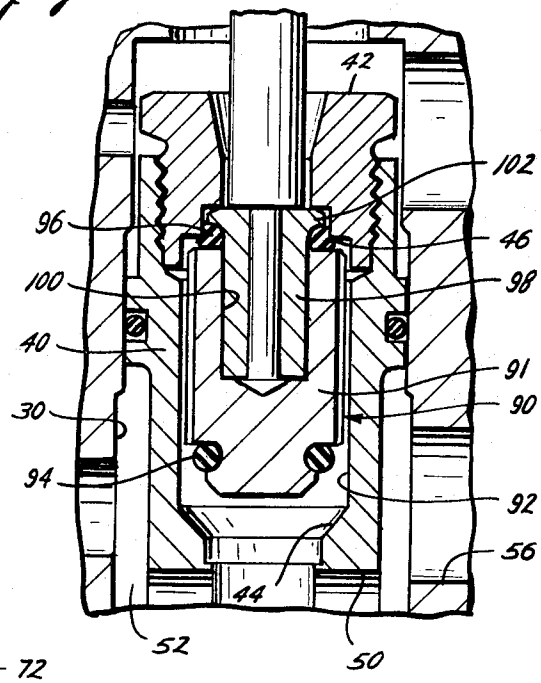


Fig. 3



Irvin B. Weise
INVENTOR.

BY J. Vincent Martin
Joe E. Edwards
Jack R. Springgate
ATTORNEYS

PILOT VALVE

This is a division of application Ser. No. 796,961, filed Feb. 6, 1969 now U.S. Pat. No. 3,568,706. The present invention relates to an improved pilot valve for controlling a relief system. This invention is an improvement on the system and structure disclosed in my prior copending application Ser. No. 711,821 filed Feb. 19, 1968 now U.S. Pat. No. 3,512,560.

SUMMARY

An object of the present invention is to provide an improved pressure relieving system in which the outlet of the main valve may be connected into a header with assurance that the main valve will not open to allow reverse flow therethrough when the header pressure exceeds the main valve inlet pressure.

Another object is to provide an improved pilot valve for a pressure relieving system whose setting may be tested with a testing fluid after it has been installed in controlling position on a relief valve without having the testing fluid flow through the pilot fluid supply line.

A further object is to provide an improved pilot valve suitable for use on liquids and gases which includes a check valve to prevent backflow through the fluid supply line and eliminates the possibility of the inlet valve and check valve both closing and being held closed by pressure of fluid trapped therebetween.

Still another object of the present invention is to provide an improved pressure responsive device adapted to be used with a pressure relieving valve to prevent the valve from opening when the valve is subjected to higher pressures at its outlet than at its inlet.

A still further object is to provide an improved pressure relieving system which may be set for a preselected relieving pressure and also for a preselected blowdown independent of the relieving pressure setting.

Another object is to provide as a subcombination in an improved pressure relieving system a pressure responsive device to be used with the pressure relieving system which applies the higher of two fluid pressures to a pressure responsive member in the system.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the present invention are hereinafter set forth and described with reference to the structure of the present invention illustrated in the drawings wherein:

FIG. 1 is a schematic diagram of the improved relieving system of the present invention.

FIG. 2 is a detailed sectional view of the improved pilot valve of the present invention and schematically illustrating the equipment for testing the pilot valve relief setting.

FIG. 3 is an enlarged detailed sectional view of the improved pilot valve showing the inlet valve member in seated position.

FIG. 4 is a partial sectional view of the improved backflow preventer of the present invention.

FIG. 5 is a sectional view taken along line 5—5 in FIG. 4 showing the cross-sectional configuration of the pressure responsive member of the improved backflow preventer of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, the improved pressure relieving system of the present invention is installed to protect tank T from over-pressure conditions. The main relief valve R is connected to have its inlet 10 in communication with the interior of the tank T and has its outlet 12 connected to a suitable disposal line L which may be a manifold or header of outlets from several pressure relieving systems (not shown). The main valve R includes a valve member 14 controlling the flow therethrough responsive to the pressure delivered to the pressure responsive member 16. Main valve R may be of any suitable type which includes a pressure responsive means actuating the valve member to control the flow through the main valve.

With valve R pressure on the pressure responsive member 16 is used to hold valve member 14 in closed position and when the pressure is vented from member 16, the pressure in inlet 10 causes valve member 14 to open.

The improved pilot valve is supplied with fluid under pressure from the tank T by the line 18 which connects from inlet 10 to the pilot valve P. Control pressure is supplied by pilot valve P through the line 20 and the back flow preventer 22 to the pressure responsive member 16 of main valve R. By controlling the pressure supplied to the pressure responsive member 16, the pilot valve P controls the venting of tank T through the main valve R. Also, line 24 connects from outlet 12 to the backflow preventer 22 to cause the main valve R to close or remain closed whenever the pressure in the disposal line L rises to a pressure above the pressure at the inlet 10 to thereby prevent flow of fluids through the main valve R in the reverse direction. The pilot valve P is also provided with a vent port 26 through which fluid pressure in pressure responsive member 16 is vented to allow the main valve to open and relieve pressure within tank T.

The pilot valve P is shown in greater detail in FIGS. 2 and 3. Pilot valve P includes the body 28 in which a central bore 30 is formed with a plurality of ports communicating with bore 30 as hereinafter described. The shoulder 32 projecting into the bore 30 receives the valve seat assembly 34 which is held on shoulder 32 by the cage 36 and the bonnet 38. The cage 40 supports the seat insert 42 within the central bore 30 and is adjustable axially of bore 30 as hereinafter described. Communication through the central bore 30 is first through the back check seat 44 defined within the interior of cage 40, the second seat 46 defined by seat insert 42 and the outlet seat 48 defined by the seat assembly 34. The cage 40 is sealed against the walls of bore 30 and provided with ports 50 communicating from the inlet chamber 52 to the inlet seat 44 so that all flow through the pilot valve P is directed through the inlet seat 44 and the second seat 46. The inlet ports 54 and 56 both communicate with the inlet chamber 52, inlet port 54 being provided with a filter screen 58 and inlet port 56 being an alternate communication into inlet chamber 52 and normally closed by the plug 60. Control ports 62 and 64 both communicate with the intermediate chamber 66 between seats 46 and 48. Port 64 is normally closed but is provided to allow testing of the pilot valve P after it has been installed in position controlling the relief valve R as hereinafter explained. Outlet or vent port 68 communicates with outlet chamber 70. Ports 72 and 74 through cage 36 provide communication between the interior of cage 36 and outlet chamber 70. The port 76 extends through cage 36 to provide communication between the interior of bonnet 38 and the interior of cage 36.

The valve member 78 which is slidably mounted within cage 36 controls the flow through valve seat 48 responsive to the pressure forces exerted thereon and the force of the adjustable biasing means (spring 80). Spring 80 is adjustable by the threading of screw 82 through bonnet 38. Lock nut 84 is provided to retain screw 82 in its preselected position and cap 86 engages bonnet 36 and covers the outer end of screw 82 and lock nut 84. When valve member 78 is open allowing flow through valve seat 48 a portion of this flow flows through each of port 74 and port 72. The flow to port 72 is restricted by the flange 88 extending outwardly from valve member 78 and terminating in close spaced relationship to the interior of cage 36. This restricts the flow to cause the valve member 78 to snap to full open position when it first opens by exposing the entire lower side of valve member 78 to the fluid pressure from the intermediate chamber 66.

Flow from the inlet chamber 52 to the intermediate chamber 66 is controlled by valve member 90 which is slidably mounted within bore 92 of cage 40 and movable between seats 44 and 46 responsive to the pressure differential across valve member 90. Valve member 90 is preferably closely spaced with respect to the wall of bore 92 to provide a restriction to the flow of fluid through bore 92 around valve member 90. It has been found that if valve member 90 has a polygonal

cross-sectional shape such as a hexagon, the points of the polygon engage the walls of bore **92** to guide the movement of valve member **90** in the bore **92** and the restricted flow area is provided between the flats of the hexagon and the wall of the bore **92**.

The valve member **90** includes the body **91**, the sealing ring **94** which is adapted to engage seat **44** when valve member **90** is in its lower position and the sealing ring **96** held in place by the tubular retainer **98** which sealing ring **96** is adapted to engage the seat **46** as best shown in FIG. **3** when valve member **90** is in its upper position. When valve member **90** is not required to function as a check valve then seal ring **94** may be omitted so that valve member **90** does not seal on seat **44**. Tubular retainer **98** is positioned within the bore **100** defined in body **91**, includes the annular flange **102** which projects radially outwardly and is adapted to engage the sealing ring **96** to support it in position for sealing engagement with valve seat **46**. This support configuration for sealing ring **96** allows pressure to be equalized across ring **96** through tubular retainer **98** and the space around retainer **98** within the bore **100** in body **91**. By equalizing pressure on opposite sides of ring **96** it remains in position to engage seat **46** at all times and is not extruded or pulled out of its support position because of pressure differentials to which it might be exposed resulting from the flow of fluids through seat **46**. Valve member **90** thus is the inlet valve when seated on seat **46** and the back check valve when seated on seat **44**. Valve member **90** when seated on seat **46** is held by pressure differential to assure that it also cannot engage seat **44**. When lower pressures are encountered, the two piece construction of valve member **90** may be eliminated in favor of a single piece and a relatively firm O-ring **96** which would not require pressure equalization during flow.

In order to insure that valve member **90** is disengaged from seat **46** when valve member **78** is in engagement with seat **48** and that valve member **78** is open when valve member **90** is in engagement with seat **46**, the spacer rod **104** is positioned between the two valve members **78** and **90**. Rod **104** extends through both valve seats **46** and **48** and is closely spaced with respect to the valve seats to provide a flow restriction to the fluids flowing through these two annular passages. The engagement of spacer rod **104** with valve member **78** is within the bore **106** defined in member **78** to allow some relative movement between the valve members **78** and **90** while assuring that both valve members are not seated at the same time. The length of rod **104** is preselected with respect to the distance between the seated position of valve member **78** on seat **48** and the seated position of valve member **90** on seat **46** to assure that both are not closed at the same time.

The effective areas of valve members **78** and **90** are each larger than the area of valve seat **46**. The cross-sectional area of rod **106** is significantly smaller than the area of either seat **46** or seat **48** so that it is ineffective as a force developing member.

In addition, the position of valve seat **46** is adjustable with respect to valve seat **48** to provide a blowdown control adjustment. This adjustment is provided by the threaded engagement of the lower or projecting end of cage **40** in bushing **108**. Lock nut **110** is provided to secure the cage **40** in its preselected position. Also, shim **112** is positioned between the shoulder **114** on cage **40** and the inner end of bushing **108**. The thickness of the shim **112** is preselected to assure that seats **46** and **48** are not spaced apart a sufficient distance so that both may be closed at the same time. For convenience in adjusting, the outer end of cage **40** is provided with flats to allow cage **40** to be turned with a wrench or a suitable handle.

The testing system shown in FIG. **2** includes a test pressure source or tank **116** and a pressure gage **118**. Valve **120** connects into alternate port **64** and flow lines connect between valve **120** and pressure gauge **118** and also through valve **122** to tank **116** as shown. With the testing system connected as shown, valve **120** is opened first and valve **122** is then opened gradually to pressurize intermediate chamber **66**. This pressure is registered on gage **118**. By increasing the pressure until valve member **78** lifts off valve seat **48** to vent chamber **66**, the opening setting of pilot valve P may be checked and reset if needed. During the time that the pressure in intermediate chamber **66** exceeds the pressure in inlet chamber **52**, valve member **90** is held in seated position on seat **44** to prevent test fluid from flowing back into the supply system. This allows air to be used in testing even though it could not be tolerated in tank T. The pressure fluid delivered to intermediate chamber **66** only leaves the system through valve seat **48** and vent port **68** and is not conducted to the tank T or the disposal line L. As previously mentioned, the seal ring **94** may be omitted if this testing system is not to be used. With the testing system valve **120** remains connected in port **64** and when the testing system is not to be used, a plug may be used to close port **64** in place of valve **120**.

The control pressure maintained in intermediate chamber **66** is delivered through port **62**, line **20** to backflow preventer **22**. If this control pressure is greater than the pressure in outlet **12**, it is conducted through backflow preventer **22** into the main valve R where it is exerted against the pressure responsive member **16** to control the position of valve member **14**. Thus, backflow preventer **22** functions as a switching valve to direct the greater of the two fluid pressures to the pressure responsive means **16**. Backflow preventer **22** has a tee-shaped body **124** and includes a double-acting valve member **126**. The branch leg of body **124** is threaded for connection into main valve R.

Connection of line **20** to backflow preventer **22** is provided into one of the aligned legs of body **124** by the bushing **128** which also defines the inwardly facing valve seat **130**. Line **24** is connected into the other of the aligned legs of body **124** by bushing **132** which defines inwardly facing seat **134**. As shown, valve member **126** is positioned within body **124**, responsive to the pressures exerted on opposite ends thereof and coacts with seats **130** and **134** to provide communication to main valve R from line **20** or line **24** whichever has the higher pressure.

The valve member **126** includes a cylindrical body **136** with heads **138** and **140** at each end of body **136**. Head **138** supports the seal ring **142** which in one position of member **126** engages seat **130** to seal off flow from line **20**. Head **140** supports seal ring **144** which in the other position of valve member **126** engages seat **134**. Heads **138** and **140** are preferred to be generally polygonal shaped in cross-section. As shown, the heads **138** and **140** are square shaped with rounded corners and terminate in a frusto-conical portion supporting the seal rings **142** and **144**. As best seen in FIG. **5**, the rounded corners of the heads guide the valve member **126** in its axial movement by engagement with the walls of the bores in bushings **128** and **132**. Further, the heads provide sufficient restriction to flow of fluids through the spaces between the head flats and the walls of the bushing bores to cause movement of the valve member **126** to the other seat responsive to changes in the pressures delivered to bushings **128** and **132**. Thus, the backflow preventer **22** functions to assure that the pressure responsive member **16** in main valve R is exposed to the fluid pressure in line **20** or line **24** whichever is higher.

In operation, the pressure fluid from inlet **10** is supplied to inlet port **54** and inlet chamber **52** of pilot valve P. When the valve member **90** is disengaged from both seats **44** and **46** fluid flows around valve member **90** into intermediate chamber **66**. Port **62** and line **20** communicate from chamber **66** to backflow preventer **22** and supply fluid to the pressure responsive member **16** of valve R to hold valve member **14** in closed position. Member **16** has a greater effective pressure area than valve member **14** to assure that valve R is closed when inlet pressure is delivered through pilot valve P and backflow preventer **22** to pressure responsive member **16**.

The fluid pressure in intermediate chamber **66** is exerted on the exposed portion of valve member **78** through seat **48**. The force exerted by spring **80** is adjusted to allow valve member **78** to lift off seat **48** at the maximum pressure which is desired in tank T. As previously explained when valve member **78**

cracks open, it snaps to its full open position because of the increased area of valve member exposed to the pressure in intermediate chamber **66** and the flow through valve seat **48** causes a flow past valve member **90** to urge valve member **90** toward closed position and exert a force on valve member **78** by the connection of rod **106** urging valve member **78** toward full open position. When valve member **78** is fully open, valve member **90** engages seat **46** to shut off the inlet supply of fluid. The pressure control fluid in valve R is vented through valve seat **48** and out vent port **68**. With the reduced control, pressure valve member **14** opens to relieve the pressure in tank T.

Control of blowdown or closing pressure is controlled by the adjustment of the position of seat **46** in relation to seat **48**. The effectiveness of such control is explained in my aforementioned patent application Ser. No. 711,821. Such control is accomplished by loosening lock nut **110** and rotating cage **40** within housing **108**. Thus, as cage **40** is threaded inwardly, seat **46** is moved closer to seat **48** providing a greater lift of valve member **78** to cause valve member **90** to engage seat **46** thereby compressing spring **80** so that the force exerted by spring **80** toward closing is greater. With valve seats **46** and **48** closer together, the closing pressure of valve member **78** is higher than the closing pressure when valve seats **46** and **48** are spaced farther apart. The closing pressure of valve member **78** is preselected to provide the desired blowdown of tank T before valve R closes. This adjusting of blowdown has no effect on the opening setting of pilot valve P since the force exerted by spring **80** on valve member **78** when valve member **78** is seated remains the same regardless of the position of seat **46**.

The closing of seat **48** and the opening of flow through seat **46** is responsive to the pressure force on valve member **90** and the spring force exerted by spring **80**. The restriction to flow in the areas around rod **106** through the seats **46** and **48** creates a restriction to flow which causes valve **90** to snap away from seat **46** once it cracks open and also causes valve member **78** to snap to closed position on seat **48**. This restriction creates a slight increase in back pressure on valve member **90** as it first opens to provide some additional opening force which is sufficient to snap valve member **90** open.

The restriction between valve **90** and bore **92** is particularly important to the operation of pilot valve P when it is set to handle gas and liquid is supplied through line **18**. Such conditions can occur in propane or butane systems and it is important that the pilot valve P function properly to cause the system to be relieved at the preselected relieving pressure when exposed to either gas or liquid. With liquid in pilot valve P, as valve member **78** cracks open, flow around valve member **90** creates a small pressure drop to produce an added force lifting valve member **78** to snap it to full open position.

From the foregoing, it can be seen that the improved pressure relieving system is responsive to pressure in the pressure vessel and in the discharge line so that the system vents the pressure vessel to the discharge line when the pressure in the vessel reaches a preselected pressure but the system functions to assure that there is no communication between the vessel and the discharge line when the pressure in the discharge line increases to a level above the pressure in the vessel. Also, the improved pilot valve may be tested after it is installed in a pressure relieving system without danger of the testing fluid leaking back into the pressure system. The pressure relieving system of the present invention is adaptable for relieving pressure of a gas or liquid in a pressure vessel.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A pilot valve comprising,
a body having three ports in communication with a bore through said body and three valve seats defined within the bore of said body,
the first of said ports communicating with said bore on the first side of the first of said valve seats,
the second of said ports communicating with said bore between the second and third of said valve seats,
the third of said ports communicating with said bore on the opposite side of said third valve seat from said second port,
a first valve member movably mounted within said bore and adapted to engage said first and second valve seats,
said first valve member engaging only one of said valve seats at a time,
a second valve member movably mounted to engage the third valve seat,
means urging said second valve member toward engagement with said third valve seat, and
a rod extending between said first valve member and said second valve member,
said rod being sufficiently long so that when said first valve member is seated on said second valve seat, said second valve member is held out of engagement with said third valve seat and when said second valve member is seated, said first valve member is held out of engagement with said second valve seat.

2. A pilot valve according to claim **1**, including
means for adjusting the relative position of said second valve seat within said bore with respect to said third valve seat.

3. A pilot valve according to claim **1**, including
stop means coacting with said position adjusting means to prevent moving said valve seats sufficiently far apart with respect to said rod to allow both of said second and said third valve seats to be closed at one time.

4. A pilot valve according to claim **1**, including
a valve body having an axial bore,
a tubular retainer positioned in said axial bore and having an outwardly extending annular flange, and
a sealing ring mounted around said tubular retainer between said flange and said valve body whereby said retainer equalizes pressures across said sealing ring,
said sealing ring adapted to engage said second valve seat.

5. A pilot valve according to claim **1**, including
a second sealing ring mounted on the opposite end of said body from said first sealing ring,
said second sealing ring adapted to engage said first valve seat.

6. A pilot valve according to claim **1**, including
said second valve member includes a radially extending flange,
said flange coacts with said body to restrict the flow of fluid to said third port after said second valve member initially disengages from said third valve seat to exert additional pressure force on said second valve member to snap it to full open position.

7. A pilot valve according to claim **1**, including
a fluid pressure source, and
means connecting said fluid pressure source to said pilot valve between said first and third valve seats whereby the opening setting of said second valve member may be tested.

8. A pilot valve according to claim **1**, including
said first valve member is free to move to and from seated engagement with said first valve seat responsive to pressure differentials exerted thereacross when said second valve member is in seated engagement with said third valve seat.

9. A pilot valve comprising,
a body with a bore therein,
means defining a first valve member chamber, a control chamber, and a second valve member chamber within said bore,
an inlet port,
said inlet port being in communication with said first valve member chamber through a first valve seat, said first valve member chamber in turn being in communication

with said control chamber through a second valve seat, and said control chamber in turn being in communication with said second valve member chamber through a third valve seat,

a control port in communication with said control chamber, and an outlet port in communication with said second valve member chamber,

a first valve member movably mounted in said first valve member chamber and adapted to engage said first and second valve seats to control flow from said inlet port through said first valve member chamber to said control chamber, said first valve member engaging only one of said first and second valve seats at a time,

a second valve member movably mounted in said second valve member chamber and adapted to engage said third valve seat to control flow from said control chamber to said outlet chamber,

a rod extending between said first valve member and said second valve member, said rod being sufficiently long so that when said first valve member is seated on said second valve seat, said second valve member is held out of engagement with said third valve seat and when said second valve member is seated on said third valve seat, said first valve member is held out of engagement with said second valve seat, and

means urging said second valve member toward engagement with said third valve seat,

said first valve member opening in response to the pressure of the fluid in said inlet port,

said second valve member opening in response to pressure from fluid flowing from said inlet port through said first valve member chamber to said control chamber,

said first valve member seating on said second valve seat in response to flow from said inlet port through said control chamber to said second valve member chamber upon opening of said second valve member and thereby shutting off flow from said inlet port to said control chamber,

said second valve member seating on said third valve seat and said first valve member moving out of engagement with said second valve seat when the force of said urging means overcomes the pressure of the fluid in the first valve member chamber.

* * * * *