

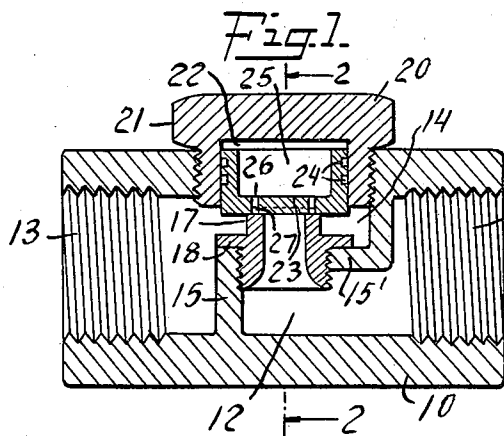
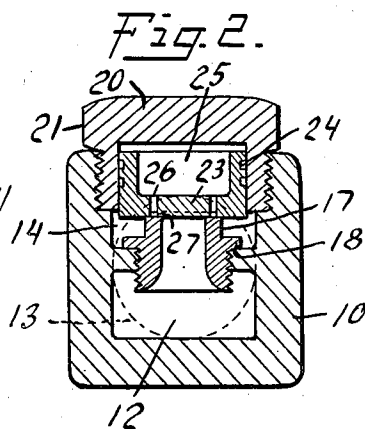
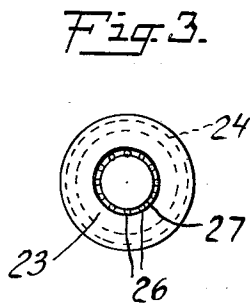
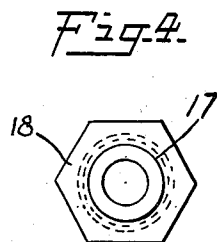
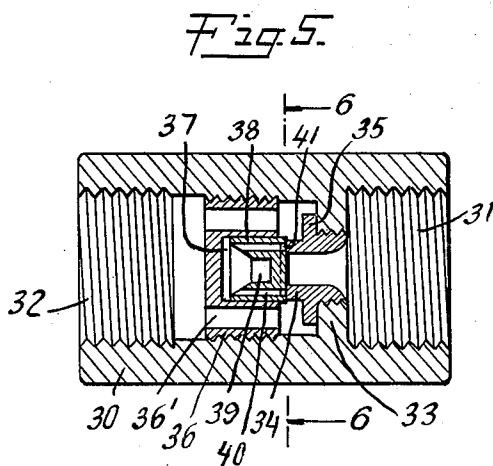
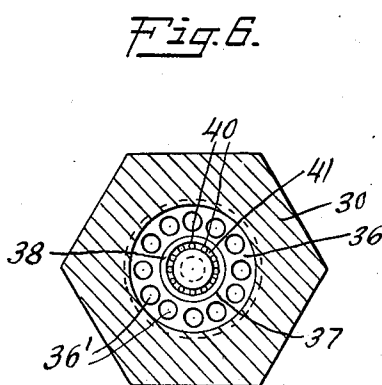
March 11, 1941.

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2,234,387

STEAM TRAP

Filed Aug. 27, 1937



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2,234,387

STEAM TRAP

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Application August 27, 1937, Serial No. 161,187

9 Claims. (Cl. 137—103)

This invention relates to steam traps and has particular reference to a new method for trapping air or condensate or both from a steam system or the like, and to a novel device by which the new method may be practiced. The device of the present invention is of a simple construction adapted for manufacture at low cost and is efficient and reliable in operation.

Steam traps of various forms have been employed heretofore to remove air or condensate from steam systems. One form of steam trap commonly used is the so-called "bucket" type which may employ either an inverted or a straight bucket. In traps of the straight bucket type, steam from the system is passed through a bucket or chamber, and a valve for discharging air and condensate is controlled by the weight of the steam which condenses in the bucket. That is, as the temperature of the steam passing into the bucket decreases, the amount of condensate in the bucket increases, the added weight of the bucket serving to open the valve wider. Steam traps of the inverted bucket type are likewise operated by gravity but differ from the straight bucket type in that the bucket is inverted in a fluid and partially filled with steam from the system. As the steam temperature decreases, steam in the bucket condenses, whereby the bucket loses some of its buoyancy and sinks lower in the fluid so as to open the discharge valve. Steam traps of the bucket type are objectionable in that they employ a relatively large number of moving parts and are operable over only a small range of steam pressures. Also, traps of this type will not pass air from the steam system unless used in conjunction with auxiliary mechanism, such as a thermostat.

Another form of steam trap employed heretofore is the thermostatic steam trap in which a valve for discharging air or condensate is controlled by thermoresponsive means, such as a bellows filled with a fluid subjected to the temperature in the steam system. In traps of this type, a considerable change in temperature is necessary to open and close the valve due to the inherent lag in the thermostat, and accordingly the device is not sensitive to conditions in the system. Also, the trap cannot discharge air or condensate until the temperature in the system reaches that for which the thermostat is set to open the valve. Still another form of steam trap in common use is the so-called "orifice" type in which fluid from the steam system flows continuously through an orifice of certain dimensions, the operation of the trap being dependent on the different orifice flow characteristics of condensates

having different temperatures. These traps are objectionable for the reason that the orifice will discharge live steam from the system when the rate of condensation therein is sufficiently low, and if the orifice is made small enough to limit the discharged live steam to a negligible amount, the discharge of air and accumulated condensate from the system will take place too slowly.

Steam traps of the impulse type have also been used to some extent heretofore. These traps as commonly made include a valve seat and a valve member having a projection extending through the seat and provided at its end with an impulse disc. Fluid flowing through the valve impinges on the impulse disc and tends to move the valve member toward its seat against an opposing force. Since live steam impinges on the disc with greater kinetic energy than air or condensate, the valve will pass air or condensate more readily than steam. Steam traps of this type are open to the objection that air or condensate passing through the valve at a rate greater than the normal rate will have sufficient energy to substantially close the valve when the valve should be open its maximum amount. Also, the projection on the valve member which extends through the seat reduces the effective discharge area of the valve.

The present invention is directed to the provision of a novel method for trapping air and condensate from steam systems more expeditiously than has been possible heretofore, and to a new steam trap which overcomes the objections inherent in the prior devices.

In accordance with the present invention, air and condensate are withdrawn from the steam system in a stream along a constricted passage, and the constriction of the passage is varied in accordance with the vapor pressure of the fluid at a selected point in the passage, preferably at a point spaced toward the discharge end of the passage from the region of greatest constriction or pressure therein. When the steam is turned on, air in the system is forced out through the passage and expands after passing through the region of greatest constriction therein. The expanding air creates a reduced pressure at the selected point in the passage, and the reduced pressure acts through suitable control means to reduce the constriction of the passage or maintain the passage open sufficiently wide to permit the air to discharge rapidly. Cold condensate forced through the passage from the system likewise causes a reduced pressure at the selected point in passage beyond the constriction, whereby the condensate may also discharge rapidly.

As the temperature of the discharge increases and approaches that of steam which forces it out, some of the condensate will flash into steam as it discharges through the constriction in the passage, the pressure created by this revaporization being substantially the saturation pressure corresponding to the temperature of the discharging condensate. The flashing of the condensate creates a vapor pressure at the selected point in the passage substantially greater than that which existed during the flow of cold condensate and air, and this increased pressure acts through the control means to increase the constriction of the passage. When the condensate is at substantially steam temperature, the vapor pressure created by its flashing is sufficient to substantially close the passage and thereby prevent any appreciable discharge of live steam.

A steam trap made in accordance with the present invention comprises a body having an inlet chamber communicating with the steam system and an outlet chamber through which fluid from the system may discharge, the two chambers being connected by a constricted passage. The constriction of the passage is variable by means responsive to the vapor pressure of the fluid flowing through the passage at a selected point spaced toward the outlet chamber from the region of greatest constriction in the passage. In its preferred form, the steam trap comprises a nozzle or the like forming part of the passage, and a piston adapted to seat against the discharge end of the nozzle. The piston is movable in a cylinder which communicates with the selected point in the passage, preferably through one or more ports in the piston.

With this construction, fluid flowing through the nozzle strikes the piston and tends to move it away from the discharge end of the nozzle. Movement of the piston away from the nozzle is opposed by the pressure in the cylinder, and when the fluid discharged from the nozzle is at a low temperature it creates a low pressure which is communicated to the cylinder through the ports in the piston, whereby the piston may move inwardly in the cylinder to permit free passage of fluid. Hot condensate, however, will flash into steam as it discharges from the nozzle, and the vapor pressure of the steam will be communicated to the cylinder and act to seat the piston against the discharge end of the nozzle and prevent the escape of live steam.

It will be apparent that the new steam trap requires only one moving part, such as a piston, and will operate without adjustment at any pressure in the system, its operation being independent of the system pressure. The constriction of the discharge passage is controlled automatically in accordance with the temperature of the discharge fluid without the use of a thermostat. The device is adapted to discharge low temperature condensate and air at any temperature below that of steam and by reason of its simple construction the device has a high discharge capacity for a given size.

For a better understanding of the invention reference may be had to the accompanying drawing illustrating two forms of a steam trap constructed and operating in accordance with the principles of the invention. In the drawing

Fig. 1 is a longitudinal section through one form of the new steam trap;

Fig. 2 is a section on the line 2—2 in Fig. 1;

Figs. 3 and 4 are detail views of one end of

the piston and the top of the nozzle, respectively, shown in Figs. 1 and 2;

Fig. 5 is a longitudinal section through a modified form of the new steam trap, and

Fig. 6 is a section on the line 6—6 in Fig. 5.

The devices illustrated will be described in detail in connection with a steam system, such as a common steam heating system, although it will be understood that they may be employed in connection with other fluid systems as well.

The device shown in Figs. 1 to 3, inclusive, comprises an elongated valve body or housing 10 which is substantially square in cross section. The housing 10 is provided with a threaded opening 11 at one end adapted to receive the threaded end of a pipe (not shown) connected to the steam system. Inwardly from the opening 11 and communicating therewith is an inlet chamber 12. At its opposite end, the housing 10 is provided with a threaded opening 13 for receiving the threaded end of a discharge pipe (not shown) leading to the atmosphere or other discharge space in which there is a pressure somewhat lower than the normal working pressure in the steam system. The opening 13 extends inwardly in the housing to an outlet chamber 14, the two chambers 12 and 14 being separated by a partition 15 which includes a horizontal portion 15'.

A nozzle 17 is threaded through the horizontal portion 15' of the partition, the lower part of the nozzle passage being flared outwardly toward the inlet chamber 12 to increase the discharge coefficient of the nozzle. The nozzle extends upwardly from the partition into the outlet chamber 14 and is formed with an hexagonal shoulder 18 to which a spanner may be applied to screw the nozzle in place, as will be more fully described hereinafter. The shoulder 18 is spaced below the upper end of the nozzle and engages the top of the horizontal part of the partition 15 when the nozzle is threaded tightly in the partition.

The top of the housing 10 above outlet chamber 14 is provided with an opening therethrough in which is threaded a bonnet 20 substantially coaxial with the nozzle 17. At its upper end, the bonnet is formed with an hexagonal portion 21, whereby a spanner may be applied to the bonnet to screw it tightly in the top of the housing. A cylindrical recess 22 is formed in the lower end of the bonnet 20 constituting a cylinder in which a piston 23 is disposed. As shown particularly in Figs. 1 and 2, the cylinder 22 is coaxial with the nozzle 17 and is considerably greater in diameter than the discharge end of the nozzle passage. The piston 23 fits closely in the cylinder 22 and has circumferential grooves 24 in its cylindrical surface which serve to prevent or reduce fluid leakage between the piston and cylinder wall. At its upper end, the piston 23 is formed with a cylindrical recess 25 which is likewise considerably greater in diameter than the discharge end of the nozzle passage.

The piston 23 is adapted to be raised and lowered in the cylinder 22, and when the piston is raised in the cylinder, the cylinder is in communication with the space between the piston and the upper end of the nozzle 17 through a plurality of small orifices 26 in the lower end of the piston. The orifices 26 are arranged in a circular series which is concentric with the nozzle passage but spaced radially outwardly from the discharge end thereof. At its lower end, the

piston is provided with an annular groove 27 which interconnects the orifices 26.

The operation of the device is as follows: When the steam system is not in use, the piston 23 rests on the upper end of the nozzle 17 so as to close the passage therein (Figs. 1 and 2). However, when the steam is turned on in the system, it forces the air and cold condensate into the inlet opening 11 and inlet chamber 12 and through the nozzle 17. The low temperature fluid passing through the nozzle strikes the part of the piston immediately above the nozzle passage at a high velocity, and the pressure thus derived from the kinetic energy of the fluid tends to raise the piston against the pressure in the cylinder 22. Since the air in the cylinder is at a relatively low temperature, substantially the temperature of the surrounding atmosphere, the pressure in the cylinder is correspondingly low, so that the total force tending to depress the piston is less than that tending to raise it. That is, the relatively high pressure acting on the piston through the nozzle multiplied by the small piston area immediately above the nozzle passage is sufficient to raise the piston against the opposing force of the low pressure in the cylinder multiplied by the entire working area of the piston. The piston will therefore rise in the cylinder and permit the air and cold condensate to flow radially outwardly between the piston and the upper end of the nozzle.

The distance which the piston 23 may move away from the nozzle is preferably limited by the upper end of the cylinder, so that when the piston is at the top of the cylinder the clearance between the lower end of the piston and the top of the nozzle multiplied by the circumference of the discharge end of the nozzle passage is substantially equal to or slightly less than the area of the nozzle passage at its discharge end. Accordingly, the low temperature fluid discharging through the nozzle will not lose any substantial pressure until it commences to flow radially outwardly between the piston and nozzle.

It will be observed that the discharging fluid may flow radially outwardly from the top of the nozzle in all directions, since the outlet chamber 14 completely surrounds the top of the nozzle. The area of the discharge passage between the piston and the top of the nozzle will therefore increase rapidly as the fluid flows outwardly from the end of the nozzle passage, regardless of the position of the piston. The discharging fluid will thus flow at high velocity between the piston and nozzle at a rapidly decreasing pressure as it progresses outwardly, so that when the fluid reaches the small orifices 26 in the piston it will be at a relatively low pressure. Since the orifices 26 are in communication with the cylinder 22, the pressure in the cylinder will now be a mean of the pressure at the orifice edges nearest the axis of the nozzle passage and the pressure at the orifice edges most distant from the axis of the nozzle passage. These pressures being relatively low under the conditions set forth, the pressure in the cylinder multiplied by the piston area will result in a force of such small magnitude that it cannot move the piston toward the nozzle against the upward force exerted on the piston by the discharge from the nozzle passage. The piston will accordingly remain in an elevated position and permit air and cold condensate to discharge rapidly from the steam system.

As the discharge continues through the nozzle

17, the temperature of the discharging condensate gradually increases due to the fact that the steam which forces the condensate out of the system heats the condensate near the steam. The discharging condensate will finally reach a temperature such that at the low pressure existing at the orifices 26, at least part of the condensate passing by the orifices will flash into steam, the pressure created by this flashing or revaporization of the condensate being equal to the saturation pressure corresponding to the temperature of the condensate at the orifices. The vapor pressure thus created is communicated through the orifices 26 to the cylinder and increases the pressure in the cylinder to such an extent that when multiplied by the piston area the resultant force is sufficient to overcome the force of the discharging fluid tending to raise the piston, whereby the piston will be depressed so as to decrease the rate of flow through nozzle 17. However, as the piston approaches the top of the nozzle, the force tending to raise the piston will increase due to the additional back pressure in the nozzle incident to decreasing the rate of flow therethrough. Accordingly, the piston will move downwardly a short distance until the opposing forces acting thereon are balanced.

A further increase in the temperature of the discharging condensate at the orifices 26 results in a corresponding increase in the vapor pressure created by flashing of the condensate at the orifices. The increased vapor pressure is transmitted through the orifices to the cylinder 22 and acts to further depress the piston, until the condensate passing the orifices is at substantially the temperature of the steam. When this condition prevails, the pressure in the cylinder is sufficient to hold the piston in a position wherein it is nearly seated against the top of the nozzle, so that the flow of hot condensate between the piston and the top of the nozzle is just sufficient to maintain the pressure in the cylinder necessary to hold the piston down against the pressure acting through the nozzle. Thereafter, any increase in the temperature of the condensate causes a further increase in the pressure in the cylinder and consequently a further decrease in the rate of flow through the nozzle, and any decrease in the temperature of the condensate causes a corresponding drop in the pressure in the cylinder so that the piston rises and permits a more rapid discharge from the system.

It will be apparent that the new steam trap is of a compact construction made up of a small number of simple parts, only one of which is movable. The device may be readily assembled by inserting the nozzle 17 through the opening for the bonnet 20, screwing the nozzle in place with the aid of a spanner applied to the shoulder 18 thereon, and screwing the bonnet in the top of the housing. The device will operate without adjustment at any pressure in the system consistent with the strength of the parts, and will discharge both air and condensate at any temperature below that of steam. By properly proportioning the area of the piston and the area of the nozzle passage, the piston may be made to substantially close the nozzle at any desired condensate temperature below that of steam for a given pressure in the system. That is, increasing the piston area will cause the piston to shut down the nozzle discharge at a lower condensate temperature, and increasing the area of

the nozzle passage will require a higher condensate temperature to shut down the nozzle discharge the same amount. Also, the action of the trap may be varied as desired by proper positioning of the orifices 26 with respect to the top edge of the nozzle passage, as will be readily apparent.

It will also be apparent that the device of the present invention is ready for operation whenever the steam system is turned on and is automatically adjusted in accordance with the condensate temperature to pass the condensate at the rate it is formed in the system. In the event that no condensate forms in the system for a period of time during its operation, the high temperature of the steam passing between the piston and nozzle will further increase the pressure in the cylinder so that the piston 23, which acts as a valve member, will permit only a negligible amount of steam to escape. The escaped steam will cool and condense as it expands into the outlet chamber 14.

While I have shown the piston 23 in close engagement with the side wall of the cylinder, the amount of clearance between the piston and cylinder is not critical. The piston may fit loosely in the cylinder, in which case the grooves 24 cause the condensate leakage between the cylinder and outlet chamber to vaporize and thus impede further leakage. Also, while I have shown the piston in such a position that the action of gravity thereon tends to seat it against the nozzle, the operation of the device is not dependent on the action of gravity. If desired, the device could be turned upside down and the piston normally held against the nozzle by a spring or the like, or the spring could be eliminated and the piston normally retained by gravity in spaced relation to the discharge end of the nozzle.

A modified form of the new steam trap is shown in Figs. 5 and 6 of the drawing. As there shown, the steam trap comprises an elongated valve body or housing 30, of hexagonal cross-section. The housing 30 has an inlet chamber 31 at one end thereof which is threaded to receive the end of a pipe (not shown) connected to the steam system, and an outlet chamber 32 at the opposite end which is likewise threaded to receive the end of a discharge pipe (not shown). The two chambers 31 and 32 are separated by a vertical partition 33, the partition having a central opening therethrough in which a nozzle 34 is threaded. At its inlet end, the passage of the nozzle 34 communicates with the inlet chamber 31 and is rounded or flared outwardly toward the inlet chamber to increase the discharge capacity of the nozzle. The nozzle projects into the outlet chamber 32 from the partition 33 and is formed with an hexagonal shoulder 35 spaced outwardly from the discharge end of the nozzle, the shoulder 35 engaging the outlet side of the partition when the nozzle is screwed in position.

Threaded in the outlet chamber 32 near the discharge end of the nozzle is a member 36 which is recessed to form a cylinder 37 communicating with the space between the member and the partition 33. A plurality of passages 36' extend through the member 36, the passages being spaced radially outwardly from the cylinder 37 and having a total cross-sectional area considerably greater than the area of the nozzle passage. The cylinder 37 is substantially greater in diameter than the discharge end of the nozzle passage and is coaxial with the nozzle. A piston

38 is slidable in the cylinder 37, the piston being in close engagement with the side wall of the cylinder so as to prevent any substantial fluid leakage between the piston and cylinder. The piston 38 is formed at its inner end with a recess 39 and has a plurality of small orifices 40 leading from the recess to the outer end of the piston. The orifices 40 are arranged in a circular series which is concentric with the nozzle 34 but spaced radially outwardly from the passage therein. A groove 41 formed in the outer end of the piston interconnects the orifices 40.

The piston 38 is adapted to seat against the discharge end of the nozzle (Fig. 5) and acts as a valve member to control the rate of discharge through the nozzle. Movement of the piston away from the nozzle is preferably limited by the end of the cylinder so that the maximum clearance between the piston and nozzle multiplied by the circumference of the discharge end of the nozzle passage is equal to or less than the area of the nozzle passage at its discharge end. Accordingly, the fluid discharging through the nozzle from the system will not lose any substantial pressure until it commences to flow outwardly between the end of the nozzle and the piston. The fluid may flow outwardly from the nozzle in all directions into the space between member 36 and the partition, and from the latter space the fluid may flow through the passages 36' and the outlet chamber 32.

The operation of the device shown in Figs. 5 and 6 will be apparent from the description given in connection with the operation of the device shown in Figs. 1 to 4, inclusive. The device shown in Figs. 5 and 6 may be readily assembled by screwing the nozzle in the partition 33 from the outlet chamber with the aid of a spanner applied to the hexagonal shoulder 35, and then screwing the member 36 in position with the aid of a spanner projecting into the openings 36'.

I claim:

1. A valve comprising a body having inlet and outlet openings therein and a constricted, main passage between the inlet and outlet openings, a cylinder independent of said passage, a piston in the cylinder dividing the cylinder from the passage and closely engaging the side wall of the cylinder to prevent fluid leakage between the piston and said wall, the piston being operable to control the constriction of said passage, and a duct independent of said passage and forming a branch passage for conducting fluid to the cylinder from a part of the first passage located toward the outlet opening from the region of greatest constriction in the first passage.

2. A valve comprising a body having inlet and outlet chambers, a port between the inlet and outlet chambers from which fluid from the inlet chamber may discharge radially outwardly into the outlet chamber, a cylinder, a piston in the cylinder adapted to seat against the discharge end of the port, and means for conducting vapor to the cylinder from a point between the piston and discharge end of the port and spaced radially outwardly from said discharge end of the port.

3. A valve comprising a housing, a seat in the housing having an opening through which fluid may discharge, a cylinder, and a piston movable in the cylinder and adapted to engage the discharge end of the seat and substantially close said opening, the piston having an opening therethrough communicating with the cylinder from a point spaced radially outwardly from the discharge end of said opening in the seat.

4. A valve comprising a housing, a seat in the housing having an opening through which fluid may discharge, a cylinder, and a piston movable in the cylinder and adapted to engage the discharge end of the seat and substantially close said opening, the piston having a plurality of spaced openings therethrough leading to the cylinder and arranged in substantially circular series radially outwardly from the discharge end of said opening in the seat.

5. A valve comprising a housing, a seat in the housing having an opening through which fluid may discharge, a cylinder, and a piston in the cylinder engageable at one end with the discharge end of the seat and having a recess in the opposite end thereof, the piston having an opening therethrough leading to said recess from a point between the piston and seat spaced radially outwardly from the discharge end of said opening in the seat.

6. A valve comprising a housing, a valve seat in the housing, a passage in the housing leading through the valve seat, a member removably mounted in a wall of the housing having a recess leading to the passage, valve means coacting with said seat including a piston slidably mounted in the recess between said member and the passage, and means for conducting vapor to said recess from a point spaced toward the outlet end of the passage from the discharge end of the seat.

7. A valve comprising a housing having inlet and outlet chambers, a partition between said chambers, a valve seat removably mounted in the partition and having a passage connecting said chambers, a member removably mounted in

a wall of housing and having a recess substantially coaxial with said passage, a piston slidably mounted in the recess coacting with the seat and adapted to substantially close the discharge end of said passage, and means for conducting vapor to said recess from a point spaced toward the outlet chamber from said discharge end of the passage.

8. A valve comprising a housing having inlet and outlet openings and a passage connecting said openings, a recessed member mounted in the passage having an opening therethrough, a valve seat mounted in the passage having an opening therethrough substantially coaxial with said recess, a piston slidable in the recess and adapted to substantially close the discharge end of said opening in the seat, and means for conducting vapor to the recess from a point spaced toward the outlet opening from the discharge end of said opening in the seat.

9. A valve comprising a housing having inlet and outlet openings and a passage connecting said openings, a recessed member removably mounted in the passage and having an opening therethrough, a valve seat removably mounted in the passage having an opening therethrough substantially coaxial with said recess, and a piston slidable in the recess and adapted to substantially close the discharge end of said opening in the seat, the piston having a passage therethrough leading to the recess from a point between the piston and valve seat spaced outwardly from the discharge end of said opening in the seat.

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