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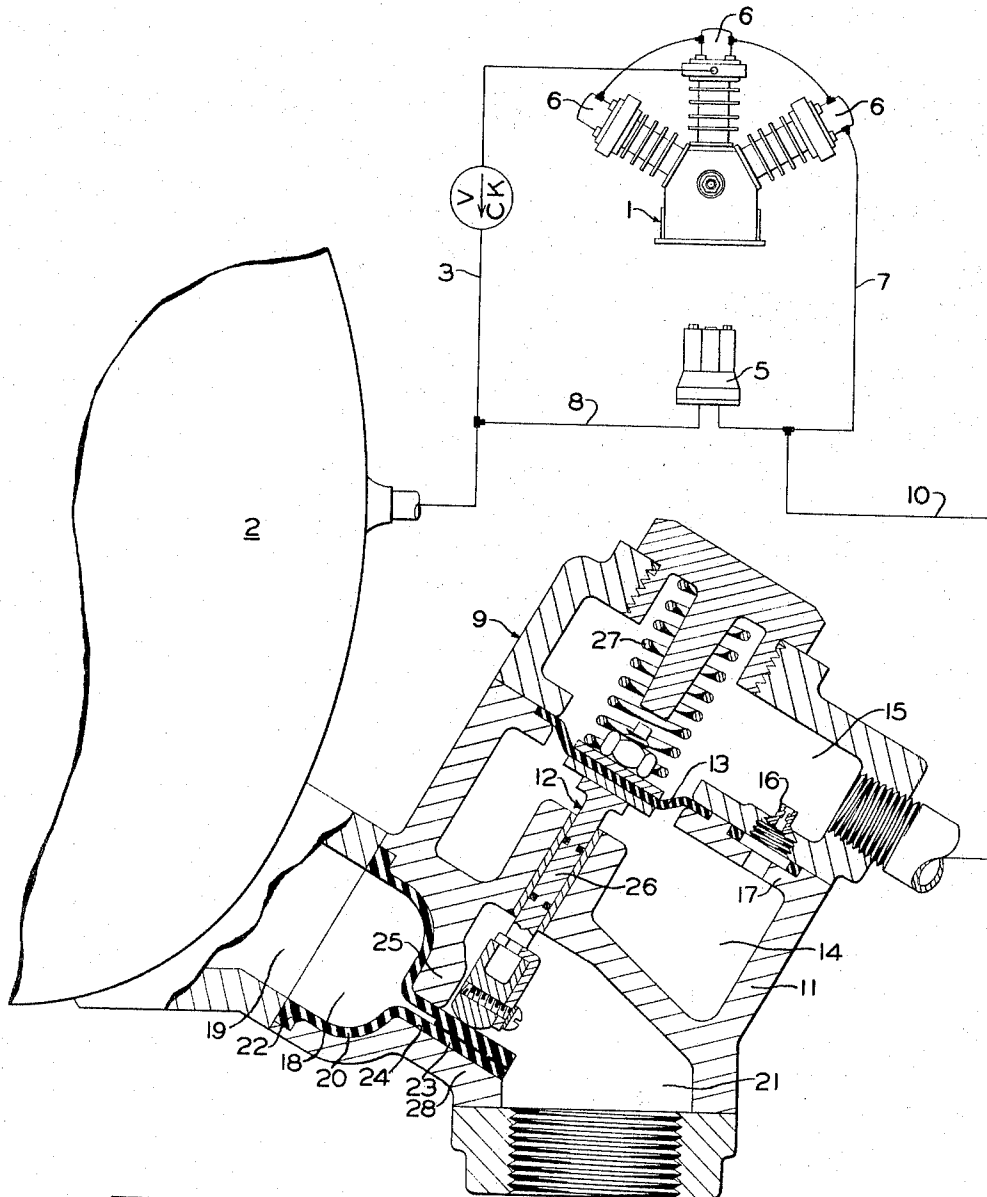
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3,314,593

AUTOMATICALLY CONTROLLED DRAIN VALVE

Filed Dec. 30, 1964

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

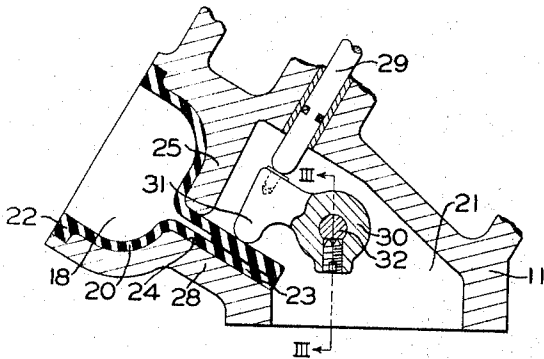


Fig. 2

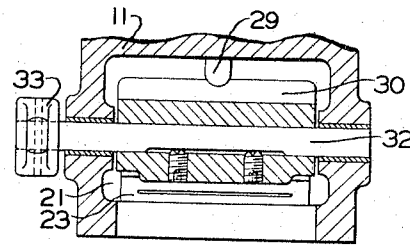


Fig. 3

Fig. 4

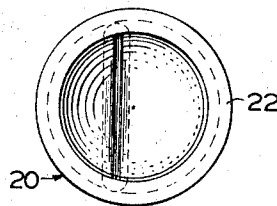
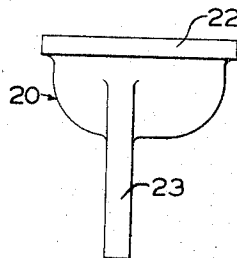


Fig. 5



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AUTOMATICALLY CONTROLLED DRAIN VALVE
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4 Claims. (Cl. 230—1)

This invention relates to drain valves and, more particularly, to an improved automatic drain valve for draining condensate accumulating in a compressed air storage reservoir.

As is well known to those familiar with the art, moisture accumulated by condensation in an air compressing system during the compressing operation may be drained off via an automatically operable drain valve fixed to a sump or drainage chamber in which the condensate accumulates. In some of the presently used drainage arrangements, the drain valve is a self-closing type valve operable responsively to fluid pressure to open and allow the condensate to be forced out by air pressure in the main storage reservoir to which the draining chamber is annexed, the drain valve then closing automatically after a predetermined period of time. In such an arrangement, the air pressure for operating the drain valve to open is usually the air pressure supplied to the compressor unloader for unloading the compressor, and drainage of the condensate, therefore, is effected at the beginning of the period during which the compressor operates unloaded.

It is well known that moisture vapor present in the compressed air condenses due to cooling of such compressed air. Since a greater amount of cooling in the main storage reservoir occurs during the period that the compressor is unloaded, condensation of moisture also occurs mostly during such period. It follows, therefore, that drainage of the condensate would be more effective at the end of the unloaded period during which the compressed air in the storage reservoir has been allowed to cool down to its lowest temperature and the condensation process would thus be as nearly complete as possible. This would insure removal of a maximum amount of moisture from the compressed air stored for usage, thereby allowing a minimum of damaging moisture to reach the device or devices to which the compressed air is supplied.

Moreover, some of the commonly known drain valves presently in use employ metal type valves and valve seats which may result in faulty or inefficient operation of the drain valve should any hard foreign material or dirt become lodged between the valve and seat to prevent effective seating of the valve to thereby cause appreciable leakage therpast.

The object of this invention, therefore, is to provide apparatus including an improved drain valve device automatically operable for effecting drainage of condensate from a drainage chamber of an air compressing system at the end of the unloaded period of the compressor, that is, at the beginning of the period during which the compressor operates loaded, said valve device being characterized by a valve member capable of effecting an airtight seal at the conclusion of the drainage operation irrespective of dirt or other foreign objects which may lodge in said valve member and being further characterized by means manually operable at any time for effecting drainage of the condensate if deemed necessary.

Briefly, the improved automatic drain valve device included in the apparatus embodying the invention comprises a rubber cup-like valve member having a smaller neck portion via which condensate from the drainage reservoir may drain when the neck portion is permitted to open. Opening and closing of the neck portion of the valve member is effected through the end of a piston stem bearing thereon, said piston stem being controlled by a

piston subjected directly on one side and through choke means on the other side to air pressure from the delivery side of the compressor governor and operable to maintain the valve member closed during such time that the compressor governor delivers control air at storage reservoir pressure to the compressor unloader for unloading the compressor. Upon reduction of air pressure in the storage reservoir to a minimum degree and therefore operation of the governor to relieve the compressor unloader of control air for again loading the compressor, the one side of the piston in the drain valve device is immediately relieved of such pressure while relief of such pressure on the other side is delayed by the choke means to establish a differential pressure effective for causing movement of the piston stem and thereby opening of the neck portion of the valve member momentarily to allow drainage of the condensate. After a predetermined period, a spring returns the piston and piston stem to the valve-closing position. An optional arrangement, along with automatic operation, includes a handle whereby opening of the valve member may be effected manually at any time it is deemed necessary.

In the drawings, FIG. 1 shows a schematic arrangement of an air compressing system embodying the invention, including an automatic drain valve device, shown in section;

FIG. 2 is a sectional view of the drain valve device modified to include manually operable means;

FIG. 3 is a sectional view taken along line III—III of FIG. 2 as viewed in the direction indicated by the arrows;

FIG. 4 is a horizontal view, in outline, of one of the components of the drain valve device; and

FIG. 5 is an elevational view, in outline, of the component shown in FIG. 4.

Description and operation

As shown in FIG. 1, an air compressing system, in which the drain valve device embodying the invention may be used, comprises an air compressor 1, a storage reservoir 2 (only a portion being shown) in which compressed air from the compressor is stored via a conduit 3, a check valve device 4 interposed in said conduit for preventing back flow therethrough, a compressor governor 5 for controlling a plurality of compressor unloader devices 6 associated respectively with each cylinder of the compressor, said compressor governor being connected on the delivery side via a conduit 7 to said compressor unloaders and on the inlet side to said storage reservoir via a conduit 8 and conduit 3, and a drain valve device 9 affixed to said storage reservoir and connected to conduit 7 via a conduit 10.

The drain valve device 9 comprises a casing 11 affixed by suitable means (not shown) to the bottom of the storage reservoir 2. A piston assemblage 12 operably disposed in casing 11 comprises a diaphragm type piston 13 which cooperates with said casing to define therein and on opposite sides of said piston, an equalizing chamber 14 and a pressure chamber 15 to which the conduit 10 connects. A choke element 16 disposed in an intervening wall 17 between the equalizing chamber 14 and the pressure chamber 15 provides restrictive communication between said chambers.

The casing 11 is also provided with a drainage chamber 18 which is in direct communication with the storage reservoir 2 via a port 19 formed in said reservoir. A cup-like valve element 20 made of a resilient material such as rubber, for example, and disposed in the drainage chamber 18 for controlling communication between said drainage chamber and an atmospheric chamber 21 is provided with a peripheral flange 22 at one end which is sealingly clamped between the casing 11 and the reservoir 2, said

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cup-like valve element being of such contour as to conform to the inner surface contour of said drainage chamber and form, in effect, a lining therefor. See FIGS. 4 and 5. The other end or base of the cup-like valve element 20 has a neck-shaped drain valve 23 extending through an opening 24 formed in an internal segment 25 of casing 11 for separating the drainage chamber 18 from the atmospheric chamber 21 and through which drain valve, when open, condensate may be drained from said drainage chamber to atmosphere via said atmospheric chamber in a manner to be hereinafter described.

The piston assemblage 12 further comprises a piston stem 26 extending coaxially from the side of piston 13 adjacent equalizing chamber 14 with the free end of said piston stem bearing externally and perpendicularly against one side of the neck-shaped drain valve 23. A spring 27 disposed in pressure chamber 15 urges the piston assemblage 12 toward a valve-closing position in which the free end of valve stem 26 is caused to exert pressure on the neck-like drain valve 23 and thereby pinch said drain valve between said free end of the valve stem and a flat wall portion 28 of casing 11 to thereby close the drain valve and cut off communication between drainage chamber 18 and atmospheric chamber 21.

In considering and understanding the operation of the improved automatic drain valve device embodying the invention, a brief description regarding the operation of the air-compressing system with which said drain valve device is illustratively associated will be considered. As is well known to those skilled in the art, the governor device 5 functions to control operation of the air compressor 1 through the compressor unloader devices 6 to maintain pressure in the storage reservoir 2 within a predetermined operating range between minimum and maximum pressure values or settings. That is, when pressure in the storage reservoir 2 has attained the maximum pressure setting due to compressing operation of the compressor 1, the governor device 5 operates responsively to such maximum pressure to open communication between conduits 7 and 6 to allow air at said maximum pressure to flow to the compressor unloader devices 6 which, in turn, operate responsively to such maximum pressure to unload the compressor for cutting off further flow of compressed air from the compressor to storage reservoir and at the same time, if desired, cause the compressor driving motor (not shown) to run at idling speed. Upon reduction of pressure in the storage reservoir 2 to the minimum pressure settings, such as through use of air stored in the reservoir, the governor device 5 operates to close communication between conduits 8 and 7 and thereby cut off flow of pressurized air to the compressor unloader devices 6 which, in turn, operate to load the compressor 1 and restore the speed of the compressor driving motor to a normal operating rate for compressing air and recharging the storage reservoir with pressurized air until the maximum setting is reached once more.

When the governor device 5 operates responsively to the maximum pressure setting for communicating conduit 8 to conduit 7 for unloading the air compressor 1, as above noted, air at said maximum pressure is also supplied via conduit 10 to pressure chamber 15 of the drain valve device 9, which pressure, along with spring 27 maintains piston assemblage 12 in its valve-closing position to keep drain valve 23 closed. Since, as was previously mentioned, the drain valve 23 is made of a flexible resilient material, it will still make an effective seal when closed notwithstanding any foreign object or dirt which may become lodged in the neck of said valve.

With pressure chamber 15 charged with pressurized air, such pressurized air also flows via choke 16 to equalizing chamber 14 until the pressures in both chambers are eventually equalized. The spring 27, however, will be effective to maintain the piston assemblage 12 in its valve-closing position as long as the respective pressures in pressure chamber 15 and equalizing chamber 14 are

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equal or, at least, as long as the force of said spring acting in one direction exceeds the force of any pressure differential between chambers 14 and 15 acting in the opposite direction.

During the time that the compressor 1 is unloaded, no compressed air, of course, is being supplied to the storage reservoir 2 while, at the same time, the pressure therein is gradually reduced through usage so that the temperature of the compressed air therein gradually reduces accordingly to cause any water vapor therein to condense to a liquid state which accumulates in the drainage chamber 18. When the pressure in storage reservoir 2 is reduced to the minimum pressure setting, the governor device 5, as above observed, operates to relieve the unloader devices 6 of air pressure via conduit 7 and an atmospheric vent port (not shown) in said governor device, which unloader devices, in turn, operate to cut in or restore the compressor 1 to normal compressing operation for recharging the depleted compressed air in said storage reservoir. At the same time air pressure is relieved from pressure chamber 15 of the drain valve device 9 via conduit 10 and the vent port in the governor device 5.

The choke 16 is so calibrated as to delay venting of control chamber 14 sufficiently to cause a differential pressure to be established between the two sides of diaphragm 13 with the higher pressure momentarily retained on the side adjacent control chamber 14 being effective for moving the piston assemblage 12 to a valve-opening position in which the free end of piston stem 26 is moved away from drain valve 23 and thereby relieves said drain valve of valve-closing pressure. With the drain valve 23 relieved of piston stem pressure, air pressure in drainage chamber 18 behind said drain valve forces the neck portion thereof to dilate or open and causes any condensate present in said drainage chamber to be blown out or expelled to atmosphere via atmospheric chamber 21. The length of time that piston assemblage 12 remains in its valve-opening position and that drain valve 23 remains open, therefore, depends on the calibration of choke 16 which determines dissipation of air pressure in control chamber 14 to a degree at which spring 27 becomes effective for restoring piston assemblage 12 to its valve-closing position to reclose the drain valve.

Of course, when air pressure in storage reservoir 2 has been restored to its maximum value, the governor device 5 again operates, in the manner above described, to unload the compressor 1 and re-establish air pressure in control chamber 15 and pressure chamber 14 to maintain drain valve 23 closed until such time as the compressor 1 is loaded again when pressure in said storage reservoir is reduced to the minimum value.

If so desired, as shown in FIGS. 2 and 3, the automatic drain valve device 9 may be modified so as to be operated manually as well as automatically by providing a modified piston stem 29 somewhat shorter than piston stem 26. The free end of modified piston stem 29 bears on a valve-controlling cam member 30 operably interposed between said free end of said modified piston stem and drain valve 23 in atmospheric chamber 21, said cam member having an extension 31 thereon for contacting and thereby controlling opening and closing of said drain valve. The valve-controlling cam member 30 is keyed to a manually rotatable shaft 32 for rotation therewith, said shaft being rotatably supported in casing 11 and having one end projecting exteriorly of said casing with a knob 33 affixed to said one end for manual manipulation of the shaft and, therefore, the valve-controlling cam member 30.

Manual operation of the modified version of the drain valve device, as shown in FIGS. 2 and 3, for effecting drainage of condensate accumulated in drainage chamber 18 simply consists of turning the knob 33 so as to rotate the shaft 32 and the valve-controlling cam member 30 in a clockwise direction, as viewed in FIG. 2. Since the respective pressures prevailing in pressure chamber 15 and equalizing chamber 14 and, therefore, acting on the

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respective adjacent and opposite sides of piston 13, are normally equalized, the only opposition normally offered against manual rotation of shaft 32 is the biasing effect of spring 27, the calibration of which is such as to render said shaft readily rotatable by the knob 33. The cam member 30 thereby forces the piston stem 29 upwardly, as viewed in the drawing, while the extension 31 is rotated away from the drain valve 23 thus relieving the pressure exerted on said drain valve by the valve stem 29 through said valve-controlling cam member. Upon relief of pressure bearing on drain valve 23, air pressure behind said drain valve in storage reservoir 2 and in drainage chamber 18, similarly to automatic operation, forces the condensate through the neck portion of the valve to atmosphere via atmospheric chamber 21. Closing of drain valve 23, of course, simply requires releasing the knob 33 so that biasing force exerted on valve-controlling cam member 30 by spring 27, acting through piston stem 29, will effect reclosing of said drain valve. It should be understood that even with the drain valve device 9 modified to include manually operable means as above described, said drain valve device will also operate automatically in response to the maximum and minimum pressure settings, as above described.

Having now described the invention, what we claim as new and desire to secure by Letters Patent, is:

1. For use in a compressed air system wherein a compressor supplying air under pressure to a reservoir is loaded and unloaded responsively to variations of pressure in the reservoir, an automatic drain valve apparatus comprising, in combination:

- (a) a valve member consisting of:
 - (i) a cup-like portion open at one end to the reservoir for receiving and accumulating condensed moisture from the reservoir, and
 - (ii) a flexible neck-like portion fixed to the other end of said cup-like portion and being inherently stressed to a closed condition in which said cup-like portion is cut off from atmosphere,
 - (iii) said flexible neck-like portion being yieldingly dilatable by pressure in the reservoir to an open condition for opening said cup-like portion to atmosphere and causing the condensed moisture therein to be drained to atmosphere through said neck-like portion,
- (b) resilient biasing means effective for exerting a first force on said neck-like portion effective for maintaining it in said closed condition against the pressure in the reservoir, and
- (c) fluid pressure responsive means effective when the compressor is loaded for exerting a second force in opposition to and for overcoming said first force for rendering the pressure in the reservoir effective for dilating said neck-like portion to its said open condition.

2. The combination defined in claim 1, further characterized by timing means for limiting the time during which said fluid pressure responsive means is effective to exert a force, in opposition to said first force exerted by the resilient biasing means, to a pre-determined interval following the instant the compressor is loaded.

3. For use in an air compressing system having a compressor, a storage reservoir in which air compressed by the compressor is stored, an unloader device for unloading said compressor responsively to supply of air under pressure thereto and for loading said compressor upon venting of air pressure therefrom, and a governor device responsive to an increase in pressure in the reservoir to a certain maximum value for supplying air under pressure to the unloader device and responsive to reduction of pressure in the reservoir to a certain minimum value for venting air under pressure from the unloader device, the combination of:

- (a) a casing,

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- (b) a valve member operably disposed in said casing and consisting of:

- (i) a cup-like portion open at one end to the reservoir for receiving and accumulating condensed moisture from the reservoir, and
 - (ii) a flexible neck-like portion fixed to the other end of said cup-like portion and being inherently stressed to a closed condition in which said cup-like portion is cut off from atmosphere,
 - (iii) said flexible neck-like portion being yieldingly dilatable by pressure in the reservoir to an open condition for opening said cup-like portion to atmosphere and causing the condensed moisture therein to be drained to atmosphere through said neck-like portion,
- (c) piston means in said casing adapted to be subjected in opposing relation to air pressure in respective chambers on opposite sides thereof,
 - (d) biasing means in one of said chambers for exerting a force, through said piston means on said neck-like portion for maintaining it in its said closed condition against the pressure in the reservoir,
 - (e) choke means providing restricted communication between said chambers, and
 - (f) conduit means via which air under pressure supplied by the governor device to the unloader device to unload the compressor is communicated to said one chamber to exert a differential force on said piston means in assistance of said biasing means for retaining said flexible neck-like portion in its said closed condition, the pressure in said chambers becoming equalized via said choke means after a pre-determined period of time, and via which conduit means air pressure is vented from said one chamber upon venting of the unloader device by the governor device to load the compressor to establish a differential force acting on said piston means in opposition to and effective for a certain length of time for overcoming the force exerted on said neck-like portion by said biasing means until the pressure in said other chamber substantially equalizes via said choke means with that in said one chamber, thereby enabling the air pressure in the reservoir to effect dilation of said neck-like portion to its said open condition for causing the condensed moisture to be drained to atmosphere therethrough.

4. An automatic drain valve device for draining condensate from a pressurized air reservoir, said drain valve device comprising, in combination:

- (a) a casing having therein:
 - (i) a drainage chamber having an opening thereto through which the chamber may be charged with prevailing air pressure in the reservoir and condensate from the reservoir may flow into the chamber,
 - (ii) a pressure chamber into and from which pressurized air may be supplied and released, and
 - (iii) an equalizing chamber,
- (b) choke means carried in said casing and interposed between said pressure chamber and said equalizing chamber for providing restricted communication therebetween,
- (c) a cup-like valve member disposed in said drainage chamber for controlling communication between said drainage chamber and atmosphere,
- (d) said valve member having at the base thereof a flexible neck-like portion disposed adjacent a flat wall portion of said casing and operable to a closed position, when pinched shut against said wall portion by an externally applied force thereon, for closing said drainage chamber to atmosphere and operative to an open position, upon release of such externally applied force, for opening said drainage chamber to atmosphere,

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- (e) a piston operably disposed in said casing with one side subjectable to air pressure in said pressure chamber and the opposite side subjectable to air pressure in said equalizing chamber,
- (f) a piston stem extending from said opposite side 5 of said piston with the free end engageable with said neck-like portion of said valve member, and
- (g) a biasing spring disposed in said pressure chamber and cooperating with the air pressure prevailing therein for urging said piston and said piston stem in one direction to a valve-closing position 10 for exerting said externally applied force on said neck-like portion of said valve member,
- (h) said piston and piston stem being operable in a direction opposite to said one direction, upon re- 15 lease of air pressure in said pressure chamber and consequent occurrence of a pressure differential between the opposite sides of said piston acting in opposition to and exceeding the combined effect of said biasing spring and existing pressure in said pressure chamber, for releasing said externally applied force on said neck-like portion of said valve member and thereby rendering the air pressure prevailing in said drainage chamber effective for dilating

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- said flexible neck-like portion of the valve member and operating said valve member to its open position for a predetermined time interval,
- (j) the duration of said time interval being determined by the size of said choke means in reestablishing equalization of the respective pressure in said pressure and equalizing chambers subsequent to release of air pressure from said pressure chamber, whereupon said biasing spring becomes effective for restoring said piston and piston stem to the valve-closing position.

References Cited by the Examiner

UNITED STATES PATENTS

2,177,510	10/1939	Aikman	137—204
2,509,879	5/1950	Pelton	230—1
2,509,880	5/1950	Pelton	137—204
2,571,420	10/1951	Churchman	230—2
2,602,462	7/1952	Barrett	230—1
2,674,435	4/1954	Angell	251—7
3,004,549	10/1961	Temple	137—204
3,232,486	2/1966	Ofner	251—7

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