Oct. 7, 1941. H. F. SMITH 2,258,426

REFRIGERATING APPARATUS

Filed Oct. 26, 1938 3 Sheets-Sheet 1

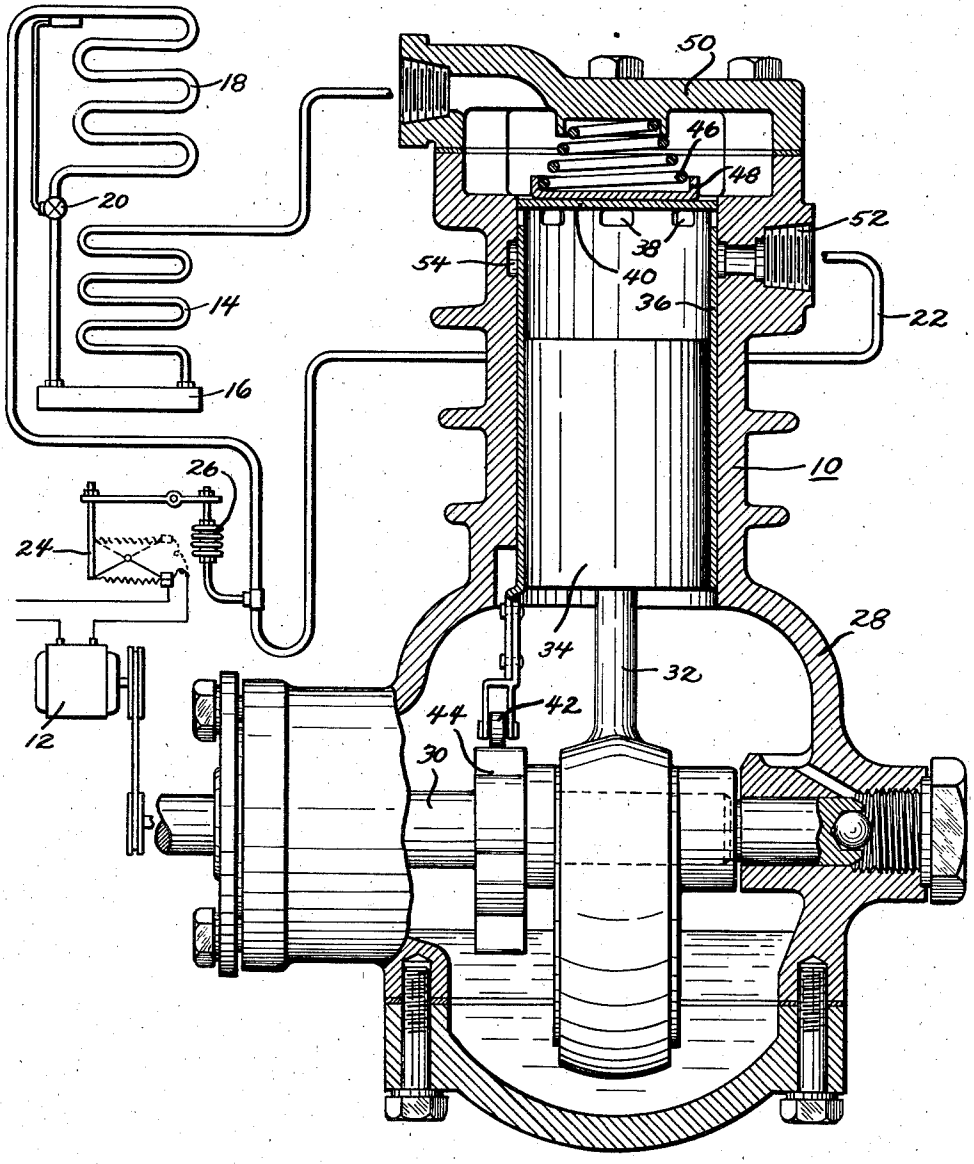


Fig. 1

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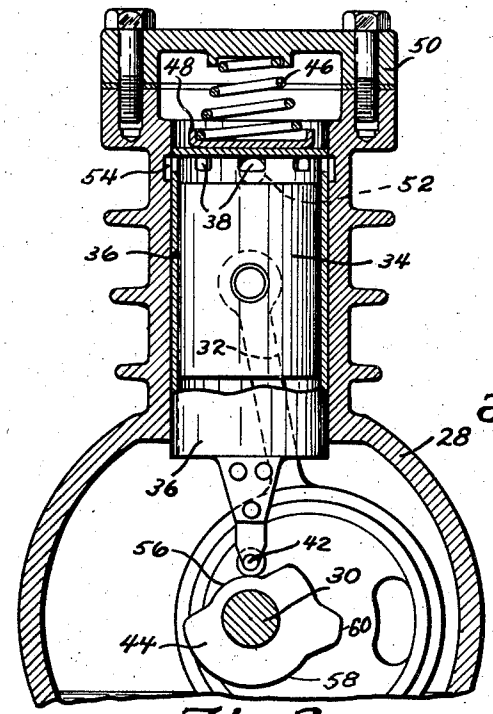


Fig. 2

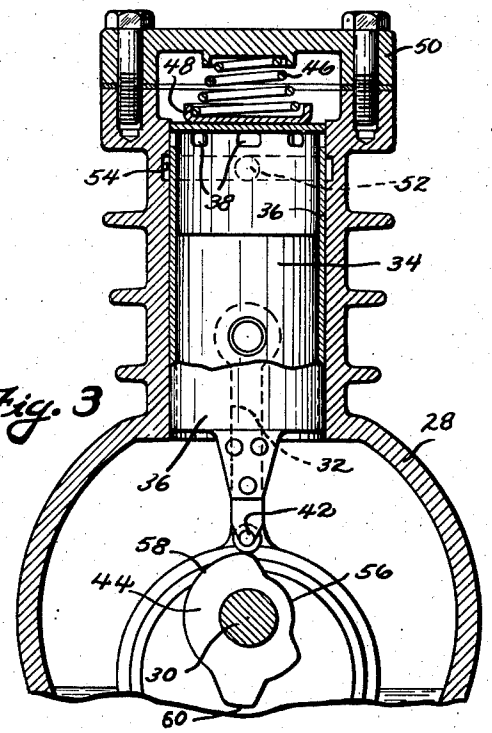


Fig. 3

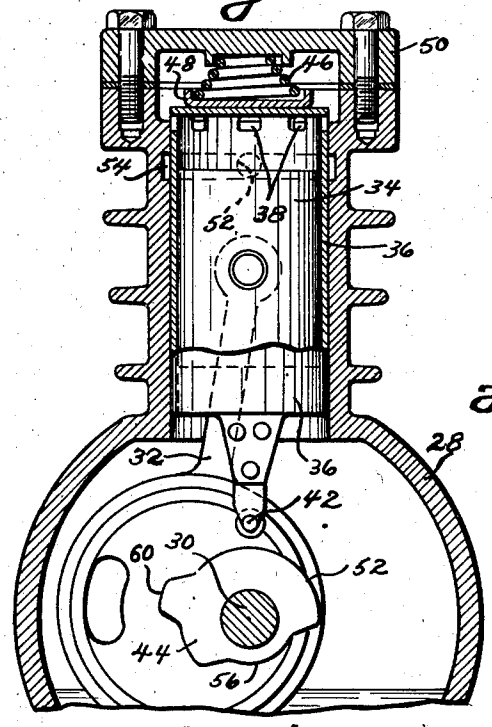


Fig. 4

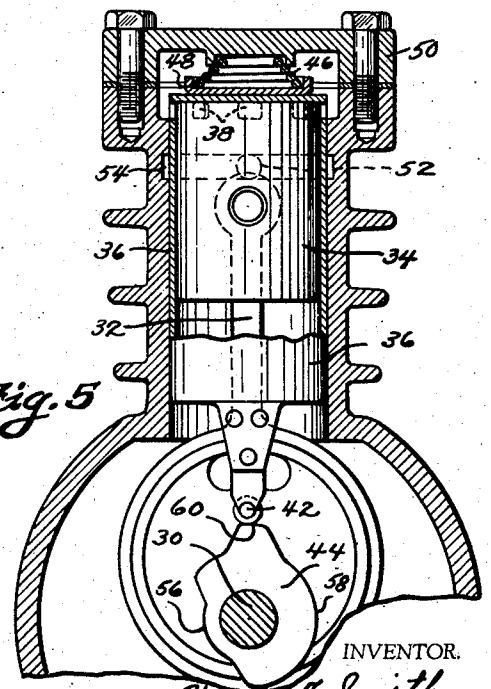


Fig. 5

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Filed Oct. 26, 1938 3 Sheets-Sheet 3

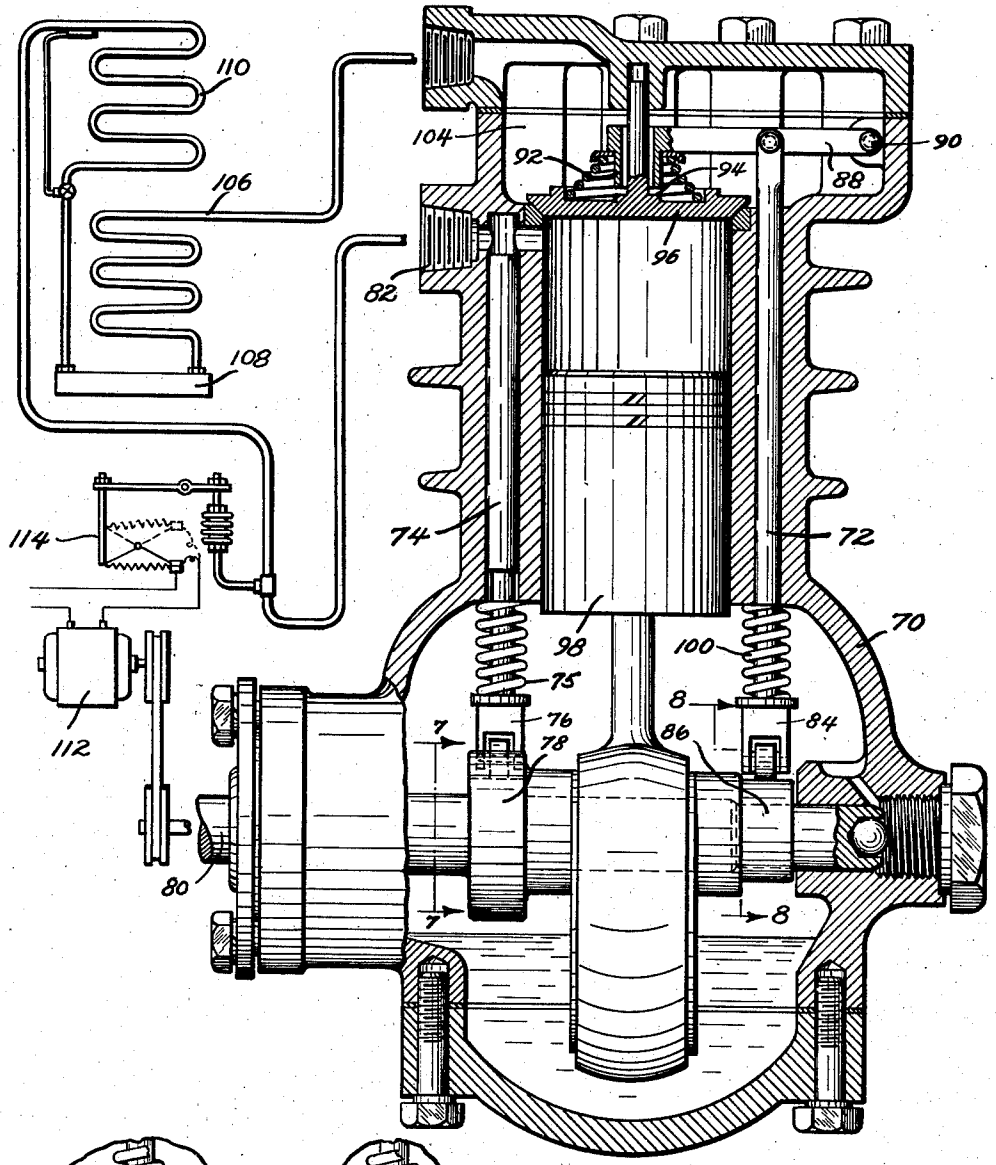


Fig. 6

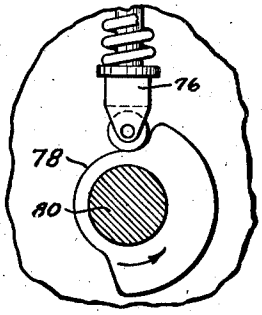


Fig. 7

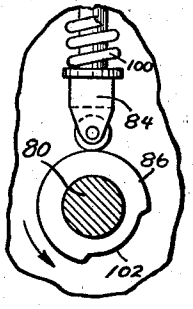


Fig. 8

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Patented Oct. 7, 1941

2,258,426

UNITED STATES PATENT OFFICE

2,258,426

REFRIGERATING APPARATUS

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Application October 26, 1938, Serial No. 237,090

11 Claims. (Cl. 230—222)

This invention relates to refrigeration and more particularly to a novel refrigerant compressor mechanism.

It is an object of this invention to provide a compressor with a valve which is controlled mechanically during a portion of the cycle and operates automatically during another portion of the cycle.

Another object of this invention is to provide a compressor with a special sleeve valve.

In the usual form of compressor employing an outlet valve which is wholly mechanically operated the compressor operates efficiently only at certain limited head pressures and back pressures. While it is possible to provide compressors having mechanically operated valves with means for varying the timing of the valve operation so as to allow for variations in the operating pressures, such timing devices are complicated and add to the cost of construction. Compressors employing valves which are wholly automatically operated, that is, operated in response to pressure, do not operate the most efficiently and are usually noisy in operation. It is an object of this invention, therefore, to provide a compressor with a valve mechanism which incorporates the advantages of the mechanically operated valve as well as the advantages of the automatically operated valve.

Another object of this invention is to provide a valve mechanism which opens automatically in response to pressure and which closes mechanically.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a view partly diagrammatic showing the compressor mechanism in section;

Fig. 2 is a fragmentary sectional view with part of the valve sleeve broken away showing the position of the valve during the intake stroke;

Fig. 3 is a view similar to Fig. 2 showing the position of the valve at the beginning of the compression stroke;

Fig. 4 is a view similar to Figs. 2 and 3 showing the position of the valve during the compression stroke at a time when the pressure within the compression chamber is substantially equal to the head pressure;

Fig. 5 shows the position of the valve sleeve at the end of the compression stroke;

Fig. 6 is a diagrammatic view showing the details of a modified form of valve;

Fig. 7 is a fragmentary sectional view taken on line 7—7 of Fig. 6; and

Fig. 8 is a fragmentary sectional view taken on line 8—8 of Fig. 6.

As shown in Fig. 1 the compressor 10 is driven by a motor 12. The compressed refrigerant discharges into the condenser 14 wherein it is condensed. The condensed refrigerant collects in the usual sump 16 from which it is fed to the evaporator 18 in the usual manner. The flow of refrigerant into the evaporator 18 is controlled by means of the thermostatic expansion valve 20. The vaporized refrigerant returns to the compressor via the vapor line 22. The motor 12 is controlled by the switch 24 which in turn is controlled by the back pressure by means of the bellows arrangement 26 which is of standard construction and therefore needs no further description.

The compressor 10 is of the reciprocating type and comprises the usual casing 28 in which the crankshaft 30 is journaled. The crankshaft 30 imparts reciprocation to the piston rod 32 in the usual and well-known manner. The main piston 34 reciprocates within a valve sleeve 36. The valve sleeve 36 is provided with a plurality of ports or openings 38, the purpose of which will be described hereinafter. An end plate 40 is provided which is integral with the side walls of the sleeve 36. The sleeve 36 is cam operated and has secured to it the cam follower mechanism 42 which cooperates with a cam 44 provided on the main crankshaft. The sleeve 36 is biased downwardly by means of a compression spring 46 which is mounted between the cylinder head 50 and the cup 48 which rests on the upper end 49 of the sleeve 36. For purposes of illustration the sleeve 36 has been shown as completely surrounding the piston. However, a short sleeve confined to the upper end of the cylinder could be used. The uncompressed gas enters the compression chamber through the inlet 52 which communicates with the recess 54 surrounding the sleeve 36. During the intake stroke the sleeve 36 is in the position shown in Fig. 2 in which position the ports 38 are in registry with the recess 54. As the piston moves downwardly from the position shown in Fig. 2 the uncompressed gas is drawn into the compression chamber. After the compression chamber has been filled with the low pressure gas the cam 44 moves into the position shown in Fig. 3 whereby the valve sleeve 36 is moved to a position in which the ports 38 are

out of registry with the intake 54. For convenience in description, that portion of the cam surface with which the cam follower 42 is in engagement in Fig. 2 has been designated by the reference character 56, and that surface with which the cam follower is in engagement in Fig. 3 has been designated by the reference character 58.

During the upward stroke of the piston the cam follower 42 rides along the cam surface 58 until such time when the pressure within the compression chamber exceeds the head pressure, at which time the cam follower 42 is free to leave the cam surface 58 as shown in Fig. 4. The spring 46 tends to move the sleeve in one direction and movement of the piston tends to move the sleeve in the opposite direction. It is apparent, therefore, that the piston 34 never operates against a pressure which exceeds the head pressure by any appreciable amount. By virtue of this arrangement the starting torque required is not excessive since the compression pressure never exceeds the head pressure by any appreciable amount.

Fig. 5 shows both the piston 34 and the valve sleeve 36 in the uppermost position. It will be noted that in this position the piston covers the ports 38. As the piston moves downwardly from the position shown in Fig. 5, the piston and the valve move together until the port 38 comes into registry with the intake 54. At this point the cam follower engages the cam surface 56 and stops further downward movement of the valve sleeve 36. The piston, however, continues its movement and travels to the end of the suction stroke. By virtue of the above described construction it will be observed that the piston and the valve sleeve 36 move upwardly together when the pressure in the compression chamber is substantially equal to the discharge pressure. It will also be noted that the valve sleeve 36 and piston 34 move downwardly together from the position shown in Fig. 5 until the inlet ports 38 are in registry with the inlet 54. Referring to Fig. 5 it will be noted that the cam 44 has a cam surface 60 which serves to move the valve sleeve 63 into the uppermost position in which the ports 38 are wholly uncovered. By virtue of this valve arrangement, there is no need for any change in the timing of the valve operating mechanism, and the valve mechanism operates without any valve slap which is common in the ordinary type of pressure-operated automatic valve.

In Fig. 6 I have shown a modified valve arrangement in which the valve opens automatically and is closed mechanically. In this modification the compressor casing 70 has a pair of slide rods 72 and 74 slidably supported in the side walls of the compression chamber. The slide rod 74 carries at its lower end a cam follower 76 which cooperates with a cam 78 mounted on the main compressor shaft 80. The upper end of the slide rod 74 serves as a valve for opening and closing the inlet port 82. The spring 75 holds the cam follower 76 in engagement with the cam 78. The arrangement of the cam 78 is such as to properly time the opening and closing of the inlet port. The slide rod 72 carries a cam follower 84 which cooperates with a cam 86 provided on the main shaft 80. The rod 72 has a pivotal connection with a lever 88 which is mounted to swing about a stationary pivot 90. The free end of the lever 88 is provided with a valve operating extension 92 which engages the shoulder 94 on the main valve 96. In the position shown in Fig. 6 the slide rod 72 is in its uppermost position and the valve 96 is shown in the fully closed position. The piston 98 is shown in its lowermost position. At the beginning of the compression stroke the slide rod 74 is cammed into its uppermost position by means of the cam 78. As the piston 98 moves upwardly the pressure within the compression chamber gradually increases until it becomes equal to the discharge pressure at which time a further increase in the compression pressure serves to unseat the valve 96. The slide rod 72 is biased into its lowermost position by means of a spring 100 whenever the low portion 102 of the cam 86 is opposite the follower 84. The spring 100 serves to pull the slide rod 72 down, and this downward movement causes the extension 92 on the lever 88 to positively close the valve 96. By virtue of this arrangement the valve 96 opens automatically when the compression pressure is sufficiently high to unseat the valve and is mechanically closed at the proper time.

The compressed refrigerant passing through the valve 96 flows into the cylinder head 104 from whence it flows into the condenser 106. The condensed refrigerant collects in the sump 108 from whence it flows into the evaporator 110 prior to its return to the compressor intake 82. The compressor is operated by means of the motor 112 which is controlled by switch mechanism 114 which operates in the same manner as the switch mechanism 24 described hereinabove.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a refrigerant compressor, means forming a pumping chamber, a piston within said chamber, inlet and outlet ports for said chamber, a sleeve valve surrounding said piston and controlling the opening and closing of said ports, a crankshaft for operating said piston, cam means on said shaft for operating said sleeve valve, and means whereby said sleeve valve moves to uncover said outlet port when the compression pressure exceeds the discharge pressure.

2. In a compressor for a refrigerating system, the combination with reciprocating piston and a cylinder cooperating therewith and provided with an exhaust port and an intake port, of a sleeve surrounding said piston and provided with means for covering and uncovering said ports, cam means for reciprocating said sleeve in one direction, and resilient means opposing movement of said sleeve by said cam.

3. In a compressor for a refrigerating system, the combination with a piston and cylinder cooperating therewith and provided with an exhaust port and an intake port, of valve means in direct sliding engagement with said piston for opening and closing said ports, cam operated means for operating said valve during one portion of its cycle of operation, and pressure means for operating said valve the remainder of said cycle.

4. In a gas compressor, a cylinder, inlet and outlet ports for said cylinder, a piston operating within said cylinder, a sleeve valve having a closed end forming one wall of the compression chamber, mechanical means for operating said valve, and means whereby said valve and said piston move in unison when the compression

pressure is substantially equal to the discharge pressure.

5. In a compressor, a cylinder, a piston operable therein and forming with said cylinder a compression chamber, an intake port, an outlet port, a pressure operated valve for said outlet port, valve means for said inlet port, resilient means biasing said outlet valve into closed position, and means in addition to said resilient means for moving said outlet valve to closed position and positively holding said valve closed until the start of the suction stroke.

6. In a compressor, a cylinder, a sleeve slidable within said cylinder, an opening in said sleeve, a piston slidable within said sleeve, an inlet port in said cylinder, an outlet port in said cylinder, and means for first moving said sleeve to a position in which said opening is in registry with said inlet port and thereafter moving said sleeve into a position in which said opening is in registry with said outlet port.

7. In a compressor, a cylinder, a sleeve slidable within said cylinder, an opening in said sleeve, a piston slidable within said sleeve, an inlet port in said cylinder, an outlet port in said cylinder, and means for first moving said sleeve to a position in which said opening is in registry with said inlet port and thereafter moving said sleeve into a position in which said opening is in registry with said outlet port, said sleeve and piston being so constructed and arranged that said piston covers said opening at the end of the compression stroke and the first portion of the return stroke.

8. In a compressor, a compression chamber, a piston movable therein, means for introducing low pressure gas into said chamber, an outlet in said chamber for compressed gas, a pressure operated valve for said outlet, spring means biasing said valve to closed position, and mechanical means in addition to said spring means for positively closing said valve at the end of the compression stroke and for positively holding said valve closed until the start of the suction stroke.

9. In a compressor, means forming a pumping chamber, a pumping element movable in said chamber, means for conveying gas to be compressed to said chamber, an outlet port through which the compressed gas is discharged, valve means for said outlet port, said valve means being so constructed and arranged as to open when the pressure within said chamber exceeds the discharge pressure, a rotary shaft, means whereby rotation of said shaft imparts a pumping movement to said pumping element, and mechanical means operated by said shaft for positively actuating said valve means to closed position once during each pumping cycle and for positively holding said valve closed substantially at the end of each compression stroke.

10. In a compressor for a refrigerating system, the combination with a piston and cylinder cooperating therewith and provided with an exhaust port and an intake port, of valve means in direct sliding engagement with said piston for opening and closing one of said ports, mechanically operated means for operating said valve during one portion of its cycle of operation, and pressure means for operating said valve the remainder of said cycle.

11. In a compressor, means forming a valve port, a valve member cooperating with said valve port, an abutment on said valve member, means for operating said valve member to closed position, an abutment on said valve operating means, resilient means between said valve member, and said valve operating means biasing said valve member to closed position, said abutments being so constructed and arranged as to positively actuate said valve member to the fully closed position at the end of the valve closing movement.

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