

[54] **AIR CONDITIONING BYPASS CONTROL**
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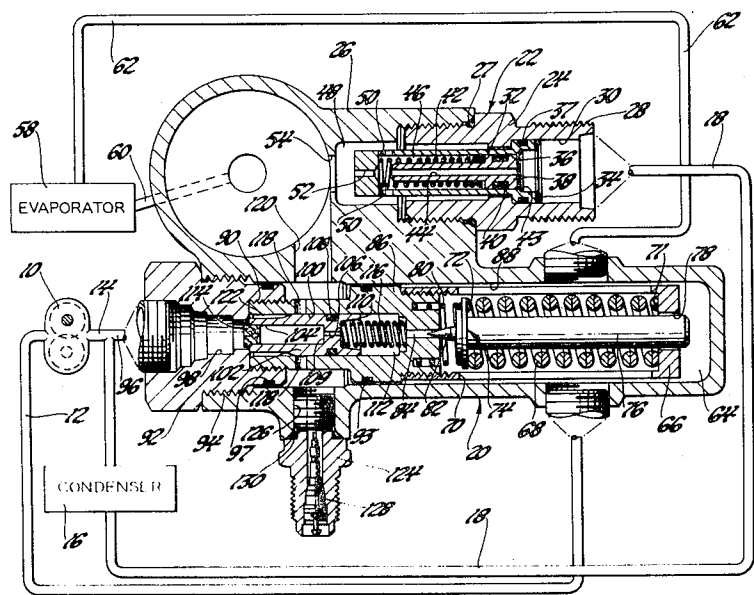
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[57] **ABSTRACT**

A vapor compression air conditioning system including defrost control valve means between the compressor outlet and the evaporator in bypass relationship to the condenser and expansion valve for supplying hot refrigerant directly to the evaporator for defrosting in response to a predetermined low temperature of refrigerant in the evaporator which corresponds to frost accumulation. The control valve includes a piston reciprocal in a housing and having one end of the piston exposed to the compressor outlet pressure and the second end exposed to a refrigerant pressure within a variable volume control chamber between the piston and the housing. A small diameter bleed port extending through the piston equalizes the pressure forces acting on the ends of the piston to normally maintain the piston in a closed position. When a bimetal spring in an adjacent enclosure senses a low refrigerant temperature which corresponds to frost accumulation on the evaporator, a passage between the control chamber and the enclosure is opened for rapidly reducing pressure in the control chamber and causing the piston to move to its open position in which hot refrigerant is directed to the evaporator.

3 Claims, 2 Drawing Figures



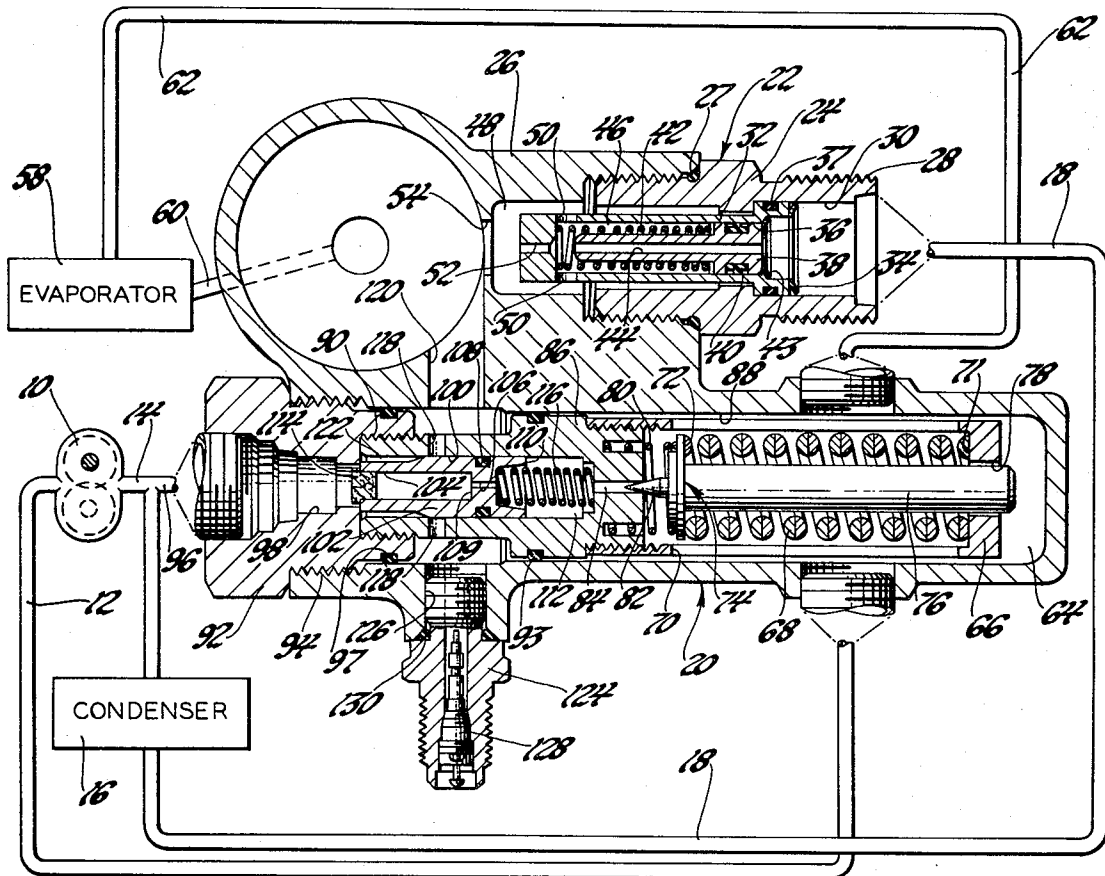


Fig. 1

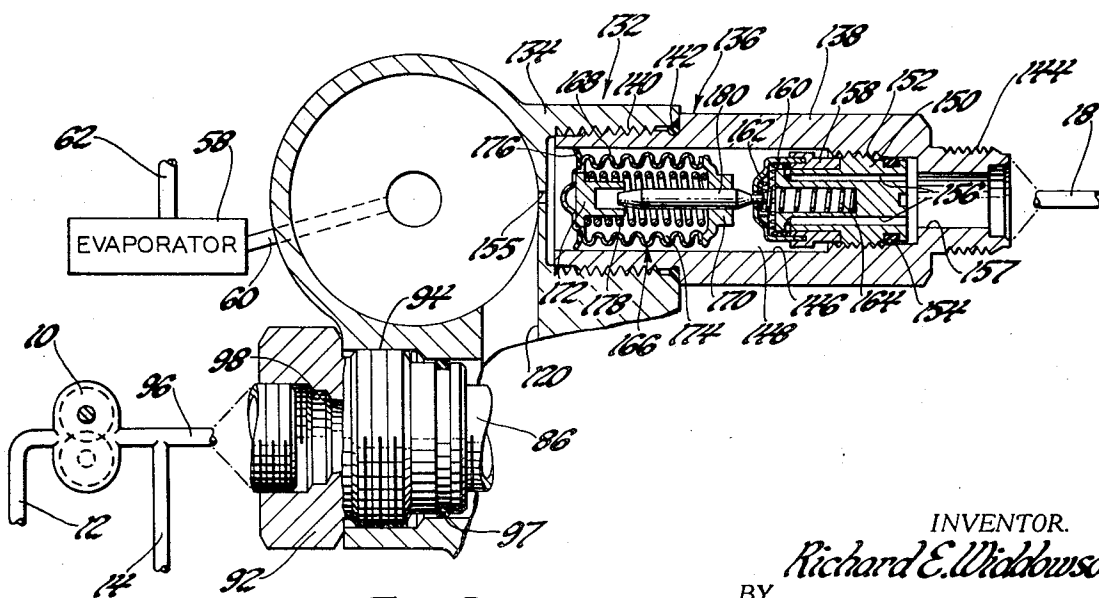


Fig. 2

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AIR CONDITIONING BYPASS CONTROL

This invention relates to vapor compression type air conditioning systems and includes a bypass control valve between the compressor outlet and the evaporator which opens in response to a predetermined low evaporator temperature corresponding to frost accumulation on the evaporator to direct hot refrigerant to the evaporator for defrosting.

In air conditioning systems, there is an undesirable tendency for frost to accumulate on the evaporator under some conditions. It is a known practice to provide a throttling valve in air conditioning systems to restrict refrigerant flow through the compressor's inlet line which maintains refrigerant pressure in the evaporator above a predetermined pressure level corresponding to an evaporator fin temperature of more than 32° F. Although this prevents frost accumulation on the evaporator, it has the disadvantage of reducing refrigerant flow and thus decreases the evaporator's capacity to cool the passenger compartment of the automobile. The efficiency of the system is also decreased.

The present defrost control valve for the refrigerating system uses hot refrigerant directly from the compressor for defrosting purposes. It includes a bimetal spring which moves in response to evaporator refrigerant temperature to cause a piston valve to open a passage which bypasses the condenser and expansion valve to supply hot refrigerant directly to the evaporator for defrosting.

The elimination of a throttling valve and the substitution of the defrost control valve reduces the pressure differential between the evaporator or low side of the system and the compressor outlet or the high side of the system under some operating conditions. This reduction increases the efficiency of the system since less work input is needed to drive the compressor for a given amount of cooling.

When the air conditioning system is first activated in warm ambient temperatures, the present defrost control valve is closed since the refrigerant temperature from the evaporator is relatively high due to the amount of heat absorbed from the passenger compartment. The absence of a flow restriction in the suction line decreases the time necessary to pull down the temperature of the passenger compartment to a comfortable level.

Another advantage of the present defrost control valve is the prevention of subatmospheric pressures within the refrigerating system which may be caused by restricting the suction line. Subatmospheric pressures can induce air to leak into the system which is very undesirable. The refrigerant pressure in the present defrost control valve is above atmospheric pressure.

Therefore, it is an object of this invention to provide a defrost control valve assembly responsive to a low refrigerant temperature to direct hot refrigerant from the compressor outlet directly to the evaporator for defrosting.

It is a further object of this invention to provide a defrost control valve assembly including a bimetal type spring to sense a predetermined low refrigerant temperature from the evaporator and cause a passage to open which directs hot refrigerant from the compressor outlet to the evaporator for defrosting.

It is a still further object of the invention to provide a defrost control valve assembly including a housing with expansion valve portion and a defrost control valve portion in which a piston is reciprocated between closed and open positions for directing hot refrigerant to the evaporator in response to movement of a thermally responsive member which senses a predetermined low refrigerant temperature downstream from the evaporator corresponding to frost accumulation on the evaporator.

Further objects and advantages of the present invention will be apparent from the following detailed description, reference being had to the accompanying drawings in which preferred embodiments of the invention are clearly shown.

IN THE DRAWINGS:

FIG. 1 is a diagrammatic view of an air conditioning system including a sectional view of a combination expansion valve and defrost control valve assembly; and

FIG. 2 is a diagrammatic view of a portion of an air conditioning system including a fragmentary sectional view of another embodiment of the expansion valve portion of the assembly shown in FIG. 1.

Referring now to FIG. 1, there is illustrated an air conditioning system which includes a compressor 10 adapted to be driven by an automobile engine (not shown). The compressor 10 draws refrigerant through a suction or intake conduit 12 and passes compressed refrigerant through a discharge conduit 14 into an air cooled condenser 16, which is normally located in front of an automobile radiator.

The compressed refrigerant is cooled and liquefied in condenser 16 from which it flows through a conduit 18 to the present combination expansion valve and defrost control valve assembly 20. An expansion valve portion 22 of assembly 20 includes a housing 24 which is threadably supported within the main housing 26 of assembly 20. An O-ring type seal 27 between members 24 and 26 prevents leakage therebetween. The conduit 18 is threadably connected at 28 to the housing member 24. A central bore 30 in housing 24 encircles a stationary expansion valve member 32 which is secured by an annular expansion member 34.

An O-ring seal 37 between members 24 and 32 prevents leakage therebetween. Stationary valve member 32 has a central bore 36 which supports a movable valve member 38 having an annular seal 40. A compression spring 42 normally maintains the member 38 in the position against retainer 43 shown in FIG. 1. A passage 44 extends axially through member 38 and connects the conduit 18 with interior 46 of housing member 32. After flowing through the passage 44 the refrigerant enters a cavity 48 through ports 50. A second passage 52 which is centrally located in the end of the member 32 is aligned with passage 44. An outlet 54 in housing 26 permits refrigerant to flow from cavity 48 to an evaporator 58 through a conduit 60.

Because of the restriction of passage 44, the refrigerant pressure within the evaporator 58 and resultant pressure within the interior 46 is normally lower than the pressure within conduit 18. This causes high pressure in conduit 18 to move valve member 38 to the left in FIG. 1 and the left-hand end of member 38 to contact the end of member 32. The combined restriction to refrigerant flow through the passages 44

and 52 usually provides desirable refrigerant quantities for the evaporator 58.

When the heat load on the evaporator 58 is great, refrigerant pressure in the evaporator may increase due to superheating of refrigerant. Superheating of refrigerant is the temperature of refrigerant above its boiling point at a given pressure. The resultant pressure in the evaporator is transmitted to cavity 48 and interior 46 and acts to force the valve member 38 to the right into the position shown in FIG. 1 thus separating the passages 44 and 52. This movement reduces the flow restriction through the expansion valve and increases the quantity of refrigerant passed into the evaporator. The increased flow to the evaporator decreases superheating and evaporator pressure. Refrigerant flows through the evaporator 58 and conduit 62 into a chamber or enclosure 64 within housing 26. After flowing through enclosure 64, refrigerant is conducted by suction line 12 to the intake of compressor 10 to complete the cycle.

Within the enclosure 64 a cup-shaped member 66 supports a bimetallic coil spring 68 whose coils are composed of two different metals with differing thermal coefficients of expansion. The bimetal coil spring expands and contracts axially in response to refrigerant temperature changes in the enclosure 64. Elongated slots 70 in the side of member 66 pass refrigerant to the spring 68 and increase the heat transfer. One end of the bimetal spring 68 rests against the end 71 of member 66 and the other end of the spring contacts an enlarged portion 72 of a needle valve members 74. The valve 74 includes an elongated body portion 76 extending centrally through the center of spring 68 and bore 78 in the member 66. A lighter spring 80 engages the other side of the enlarged portion 72 of needle valve 74 in opposition to the force produced by the bimetal spring 68.

The coaction of springs 68 and 80 upon the enlarged portion 72 of needle valve 74 locates the pointed end 82 of the valve 74 with respect to a passage 84. A valve housing 86 is supported within a bore 88 of housing 26 and is threadably connected at 90 to an inlet fitting 92. An O-ring seal 93 prevents refrigerant leakage therebetween. The fitting 92 threadably engages housing 26 at 94 and is fluidly connected to a conduit 96 which extends to the outlet of compressor 10. An O-ring seal 97 prevents fluid leakage therebetween. An inlet opening 98 extends centrally through the fitting 92 into a cylindrical bore 100 in the valve housing 86. A piston type valve 102 is supported for movement within bore 100. A central passage 104 extends partially through the piston 102 and a small diameter bleed passage 106 extends the remainder of the distance through the piston 102. An O-ring seal 108 prevents fluid leakage between the piston valve 102 and the housing 86.

The left end 109 of the piston valve 102 is exposed to refrigerant pressure from the compressor outlet through conduit 96 and inlet passage 98. The right end 110 of the piston 102 forms a wall of a variable volume chamber 112 within member 86. The passage 84 extends from enclosure 64 to the control chamber 112. The chamber 112 also communicates with inlet 98 by bore 104 and bleed port 106. When the passage 84 is closed by the needle valve 82, pressure from the inlet 98 is transmitted through a filter 114, bore 104 and

bleed passage 106 into the chamber 112. This equalizes the pressure in chamber 112 and in the inlet 98 and a light coil spring 116 maintains the piston 102 in the closed position in FIG. 1. In the closed position, ports 118 are blocked by the piston to prevent refrigerant flow through the bypass 120 to the evaporator.

When frost accumulates on the evaporator, heat transfer to air passing through is lessened which causes refrigerant flowing through the conduit 62 to decrease in temperature. The bimetal spring 68 senses the temperature decrease and contracts to move the needle valve 82 away from passage 84. The opening of passage 84 quickly reduces refrigerant pressure within the control chamber 112 which causes the piston 102 to move to the right in FIG. 1 which align ports 118 with grooves 122 in the valve. Hot refrigerant then flows from the compressor outlet through the conduit 96, inlet passage 98, grooves 122, ports 118, bypass 120 and conduit 60 into the evaporator 58. This raises the temperature of the evaporator for melting frost.

When the bimetal spring 68 senses the warmer temperature output from the evaporator the needle valve 82 blocks passage 84 and the piston moves to the left to block ports 118.

In automotive air conditioning systems, operation of the compressor 10 during cool ambient temperatures may produce a low refrigerant pressure within the evaporator corresponding to reduced temperatures. At evaporator pressures below approximately 30 psig, the temperature may fall below 32° F. and frost may form. The present defrost control valve will open under these temperature conditions to flood the evaporator with sufficient hot refrigerant to raise the evaporator temperature above 32° F. Once the temperature of refrigerant in the evaporator is above 32° F. and sensed by the bimetal operator, the supply of hot refrigerant is cut off. Subsequently, if the evaporator temperature again falls below 32° F. the valve may open again.

The housing 26 is provided with a fitting 124 which threadably engages bore 126 and includes a check valve 128. Fitting 124 is utilized to initially fill the air conditioning system with refrigerant and may be used to recharge the system as needed. An O-ring seal 130 prevents refrigerant leakage between the fitting 124 and housing 26.

In FIG. 2, another embodiment of the combination expansion valve and defrost control valve assembly 132 is illustrated. The assembly 132 includes a housing 134 similar to housing 24 in FIG. 1. Assembly 132 is identical to that shown in FIG. 1 except for the expansion valve portion 136 illustrated in the fragmentary view. The expansion valve includes a housing 138 threadably secured to the member 134 at 140 and is sealed by an O-ring 142. Conduit 18 is connected to the housing 138 by a threaded fitting (not shown) at 144. Member 138 includes a central bore 146 which forms a cavity or a chamber 148. A stationary valve member 150 is fixedly supported within the cavity 148 at 152. An O-ring 154 prevents fluid leakage around the valve member 150. Passages 156 extend from the inlet opening 157 to cavity 148 through the side of the valve member 150. A sleeve type valve member 158 encircles the stationary valve member 150 and is movable axially along it. The movement of the valve member 158 controls refrigerant flow through the passages 156. A cup-

shaped member 160 surrounding the end of member 150 is perforated by a plurality of ports 162 for refrigerant flow from the passages 156 into cavity 148. A coil spring 164 between the member 162 and the stationary member 150 normally maintains the sleeve valve 158 in a position blocking the passages 156.

The sleeve valve 158 and member 160 are axially moved with respect to stationary member 150 by contraction and expansion of a sealed casing 166 with a bellows like configuration. The casing 166 includes a tubular thin-walled metal member 168 with corrugations formed in its side surface. End members 170 and 172 seal the casing interior 174. The end 172 is fixedly supported within the bore 146 by an expansion ring member 176 which has cut out portions around its periphery to permit refrigerant flow from passages 156 to an outlet port 155. The interior 174 of the casing 166 is evacuated so as to expand and contract in response to pressure changes within interior 148. A coil spring 178 extends between end members 170, 172 to normally maintain the casing 166 in an extended position. A valve pin 180 is molded in the end member 170 and extends toward the end member 172 which limit the contraction which the casing can experience. The other end of the valve pin 180 extends through a central portion of the cup-shaped member 160 to move the member 160 and sleeve valve 158 axially over the stationary valve member 150 as the sealed casing 166 expands. The casing 166 expands when the refrigerant pressure within the cavity 148 decreases and contracts when the pressure increases. This permits spring 164 to move the sleeve valve 158 to close passages 156.

While the embodiments of the present invention as herein described constitute preferred forms, it is to be understood that other forms might be adapted.

What is claimed is as follows:

1. An air conditioning system comprising: an evaporator for cooling air in a passenger compartment; a compressor for pressurizing refrigerant discharged from said evaporator; a condenser for cooling refrigerant discharged from said compressor; valve means for expanding refrigerant discharged from said condenser to a low pressure condition prior to its introduction into said evaporator; a defrost control valve assembly fluidly connected between said compressor and said evaporator and opened in response to a predetermined evaporator refrigerant temperature to direct hot refrigerant from said compressor directly into said evaporator for defrosting; said defrost control valve including a housing with a cylinder and a piston valve within said cylinder reciprocal between closed and open positions; one end of said piston valve being exposed to refrigerant pressure from said compressor outlet which exerts an opening force upon said piston valve; the other end of said piston valve forming a variable volume control chamber with said housing; said piston having a small diameter bleed port extending between said ends to said control chamber to transmit refrigerant pressure from the compressor outlet to said control chamber thus equalizing the pressure forces acting on the ends of the piston which normally maintains said piston in its closed position; said housing forming an enclosure connected to said control chamber by a passage and having an inlet and an outlet fluidly connected respectively to said evaporator and

the inlet of said compressor; valve means for blocking said passage when in a closed position; bimetal spring means within said enclosure and connected to said valve member for moving said valve member into an open position in response to a predetermined evaporator refrigerant temperature corresponding to frost accumulation on said evaporator whereby said open passage decreases refrigerant pressure in said control chamber to permit a pressure force on said first end of said piston to move it into an open position permitting hot refrigerant to pass directly to said evaporator for defrosting.

2. An air conditioning system comprising: an evaporator for cooling passenger compartment air; a compressor for pressurizing refrigerant discharged from said evaporator; a condenser for cooling refrigerant discharged from said evaporator; a combination expansion valve and defrost control valve assembly including a housing with an expansion valve portion fluidly extending between said condenser and said evaporator for expanding refrigerant to a lower pressure condition; said housing further having a defrost control valve portion opening in response to a low refrigerant temperature corresponding to frost accumulation on said evaporator to direct hot refrigerant from said compressor directly into said evaporator for defrosting purposes; said defrost control valve portion having a cylinder and a piston valve within said cylinder reciprocal between closed and open positions; one end of said piston valve being exposed to refrigerant pressure from said compressor outlet to exert a fluid force upon said piston valve; the second end of said piston valve forming a variable volume control chamber with said housing; said piston having a small diameter bleed port therethrough extending between said first and second piston ends for transmitting refrigerant pressure from the compressor outlet to said control chamber thereby equalizing refrigerant pressures acting against said first and second ends; said housing forming an enclosure connected by a passage to said control chamber and having an inlet and an outlet fluidly connected respectively to said evaporator and said compressor; a needle valve member adapted to move between open and closed positions with respect to said passage; bimetal spring means within said enclosure operatively connected to said needle valve member for movement between open and closed positions in response to changes in refrigerant temperature of said evaporator corresponding to frost accumulation on said evaporator whereby said bimetal spring means moves in response to a predetermined low refrigerant temperature to open said passage and change the refrigerant pressure within said control chamber to move said piston into an open position for directing hot refrigerant to said evaporator.

3. In an air conditioning system including an evaporator for cooling air, a refrigerant compressor, a condenser, and an expansion valve in refrigerant flow relation; a defrost control valve assembly for melting frost on said evaporator comprising: a valve housing with an inlet fluidly connected to said compressor, an outlet fluidly connected to said evaporator and a cylindrical bore between said inlet and outlet; a piston valve axially movable within said cylindrical bore between closed and open positions to regulate a flow of hot

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refrigerant from said compressor outlet to said evaporator for defrosting; one end of said piston valve exposed to refrigerant pressure from the compressor outlet; a second end of said piston valve providing a movable wall of a variable volume control chamber in said cylinder bore; said piston valve having a small diameter bleed port extending therethrough between said control chamber and said inlet for transmitting refrigerant pressure to said control chamber thus equalizing pressure forces on said piston valve; said housing forming an enclosure with an inlet and an outlet fluidly connected respectively to said evaporator and said compressor inlet for refrigerant flow through said enclosure; said housing also having a passage between said control chamber and said enclosure for transmitting refrigerant pressure corresponding to said

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evaporator to said control chamber; a needle valve member movable with respect to said housing for opening and closing said passage; a bimetal coil spring within said enclosure in heat transfer relationship to refrigerant from said evaporator and axially movable with the temperature changes to cause said needle valve member to open said passage in response to a predetermined low refrigerant temperature whereby said predetermined low refrigerant temperature corresponds to frost accumulation on said evaporator and the opening of said passage rapidly changes the control chamber pressure which produces movement of said piston valve in said cylindrical bore for directing hot refrigerant to said evaporator.

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