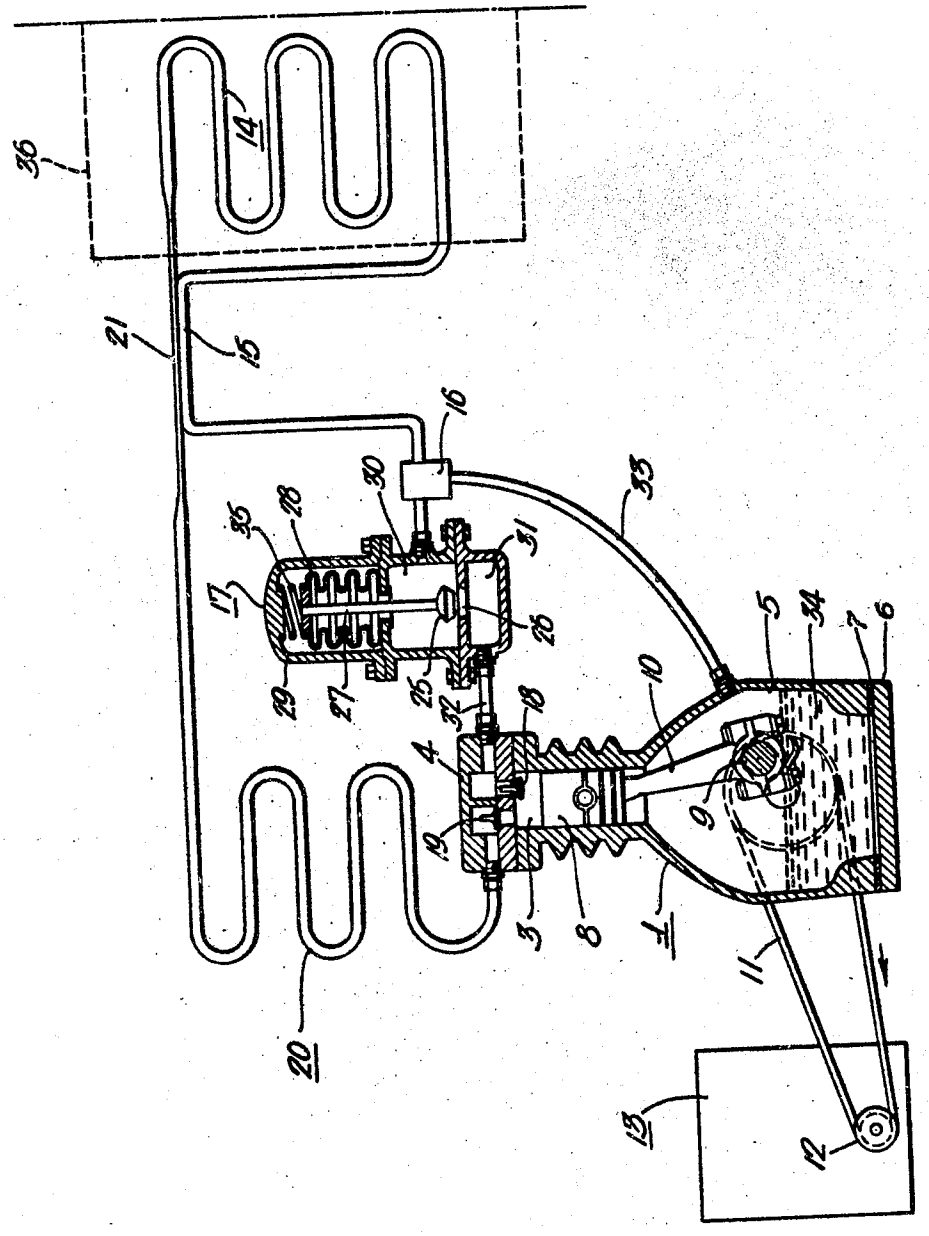
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REFRIGERATING APPARATUS IN WHICH THE PRESSURE IN THE CRANKCASE OF THE COMPRESSOR IS CONTROLLED

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REFRIGERATING APPARATUS IN WHICH THE PRESSURE IN THE CRANKCASE OF THE COMPRESSOR IS CONTROLLED

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This invention relates to refrigerant systems, and more particularly to systems of a character adapted for conditioning air in passenger compartments of automotive vehicles.

In systems of this type it is common practice to provide a compressor driven either by an auxiliary motor, usually of the electric type, or by a power take-off from some rotating member of the vehicle engine such as the cam shaft. The latter type of drive, because of obvious economical advantages, is preferred. However, it presents certain operational difficulties, perhaps the most important of which arises from fluctuation in compressor operation due to changes in engine speed.

Vehicle air conditioning systems of this type are designed to operate most efficiently at an engine speed calculated to balance the capacity of the driven compressor against the evaporator capacity, and are usually provided with some means to prevent engine speed variations from causing undesirable reduction in evaporator pressure, which reduction, of course, would result in a corresponding undesirable decrease in the temperature of the evaporator. It is also customary to include in such systems a conduit between the inlet side of the compressor and the crankcase to provide open communication therebetween, whereby oil entrained in the circulating refrigerant may be returned to the crankcase.

In such prior systems, even though variations in engine speed are prevented from adversely affecting the evaporator temperature, such variations result nevertheless in substantial fluctuations in compressor crankcase pressure, this because of the varying pressures encountered at the zone where the aforesaid conduit makes connection with the inlet side of the compressor.

In most compressor systems of this type a certain amount of refrigerant is unavoidably present in the body of lubricating oil in the crankcase, and when a sudden decrease in crankcase pressure occurs this refrigerant boils violently, thus agitating the oil and causing a frothy mixture of oil and refrigerant to fill the crankcase and flow through the aforesaid conduit and into the cylinder in quantities detrimental to the efficient operation of the compressor and the system.

Another undesirable feature of such fluctuation in crankcase pressure, is the reversal of pressure differential between the crankcase pressure and atmospheric pressure. In this type of system, and with the refrigerants now in common use, operation of the compressor at the most favorable speed maintains the crankcase pressure at a

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value above atmospheric. Thus the active pressure upon the crankcase sealing means is from the inside of the crankcase, and leakage, if any, is of refrigerant to the atmosphere. It is pointed out that this leakage of refrigerant, while not desirable, is preferable to having moist air leak into the system, because refrigerant may be added to the system at slight cost while purging the system of air and moisture is a costly operation. Operation of the compressor at engine speeds above that at which evaporator capacity is balanced is capable, however, of reducing crankcase pressure below atmospheric, thus reversing the pressure differential. In this connection it is pointed out that frequent reversals of the direction of pressure on the crankcase sealing means, arising from variations in engine speed as described, tends to cause eventual breakdown of the sealing material and thereby promotes leakage.

The present invention has particular reference to these aforesaid conditions and one of its important objects is to provide an improved vehicle air conditioning system in which the compressor crankcase is maintained at a pressure above atmospheric substantially regardless of engine speed.

Another important object of the invention is to provide an air conditioning system in which the flow of any substantial amount of oil from the crankcase into the refrigerant flow conduits is definitely prevented.

A further object of the invention is the provision of such a system wherein evaporator pressure is prevented from falling below a predetermined minimum value, regardless of variations in engine speed.

Further objects and advantages of the invention will become apparent from the following description, in which the features of novelty characterizing the invention will be pointed out with more particularity.

A refrigerant circulating system embodying the invention is illustrated diagrammatically in the attached drawing. Therein, the numeral 1 designates a compressor comprising a cylinder 3, cylinder head 4 and crankcase 5, said crankcase being closed at the bottom by a suitable oil pan 6 with sealing means comprising a gasket 7 interposed between the pan and the adjoining wall of the case. A piston 8 is reciprocated in the cylinder 3 by a crankshaft 9, said shaft being connected to the piston by a rod 10. The crankshaft 9 is journalled in the walls of the case 5 and is driven through a speed-reducing belt drive

11 from a rotating member 12 of a vehicle engine 13.

Reciprocation of piston 8 draws gaseous refrigerant from an evaporator 14 through a suction conduit 15, a chamber or oil trap 16 and a throttle valve 17 into cylinder 3 through a suction inlet valve 18. Within the cylinder the gaseous refrigerant is compressed and discharged through a discharge valve 19 into the condenser 20 from which it returns as a liquid through the usual capillary 21 to the evaporator.

The valve 17 includes a plug element 25 which controls a port 26, and means is provided for actuating the plug to throttle the port in response to a decrease in the evaporator pressure below a desired minimum. The plug 25 is suspended through the medium of a rod 27 from the upper end of an expansible bellows 28 within a casing 29. A chamber 30 within the casing 29 is in open communication with the evaporator through the suction conduit 15 and chamber 16, and with the cylinder 3 through port 26, a lower chamber 31 in the casing 29, a conduit 32, and the suction inlet valve 18.

The trap 16 is interposed in conduit 15 between the evaporator and valve 17 and is in open communication with crankcase 5 through a conduit 33. The crankcase normally contains a quantity of lubricating oil 34.

The valve 17 is designed so that pressures in the suction conduit 15 above a predetermined minimum will maintain the bellows expanded against the pressure of a spring 35, thereby to hold the plug 25 clear of the port 26 and permit gaseous refrigerant to flow into the cylinder 3 as described. When the engine is running at the speed calculated to balance evaporator capacity, and the evaporator has been reduced to the desired temperature, the pressure of gaseous refrigerant in conduit 15 will be just sufficient to maintain the plug 25 in its open position relative to port 26 for unrestricted passage of refrigerant into cylinder 3. Operation of the compressor at increased speed will tend to reduce the pressure in conduit 15, and reduction of pressure to the aforesaid minimum will permit the spring 35 to compress the bellows and will move the plug 25 into the port 26 so as to throttle the flow of refrigerant into the compressor. By this throttling action the evaporator pressure will be prevented from falling below the said required minimum although the pressure in the conduit 32 and cylinder 3 may be considerably lower.

In operation of the apparatus described above, let it be assumed that the engine 10 is running at a rate sufficient to operate compressor 1 at a speed maintaining the desired evaporator pressure, say for example forty pounds per square inch, for cooling the air within the passenger compartment of the motor vehicle to a comfortable degree, said compartment being indicated by broken lines 36. During such operation it will be obvious that the pressure will be equalized throughout the low side of the system, including the crankcase. It should be particularly noted that in accordance with the invention, the open communication between the conduit 15, chamber 16, and crankcase 5 insures that the latter will always remain at the same pressure as that in the suction conduit and evaporator regardless of the condition, open or closed, of valve 17. Consequently control of the evaporator pressure entails an automatic control of the crankcase pressure.

While the engine continues to operate at this speed the pressures remain balanced with evaporator capacity, but if the speed is increased the evaporator pressure will immediately tend to decrease below the 40 pounds per square inch and the valve 17 will move toward the closed position, thereby throttling the flow of refrigerant from the evaporator into cylinder 3, as described above. By this means the evaporator is regulated to a minimum pressure adequate to maintain the passenger compartment at a comfortable temperature and sufficiently high to prevent frostation of the evaporator. Also the crankcase is maintained at a pressure greater than atmospheric and at a value precluding formation of an excessive amount of the aforesaid frothy mixture of refrigerant and oil in the crankcase. Similarly, by maintaining the crankcase pressure continuously at a point in excess of atmospheric the aforedescribed deleterious action of a fluctuating pressure on the gasket 7 is avoided.

During the operation of this system and, in fact, all volatile liquid compression systems, a certain amount of the lubricant in the crankcase 5 will unavoidably enter the cylinder of the compressor, but since in the present instance the crankcase pressure is maintained substantially constant, the amount of lubricant thus entering the cylinder remains at a minimum. The small quantity which does enter the cylinder is entrained with the refrigerant and is discharged into the condenser to find its way to the evaporator and thence through suction conduit 15 into chamber 16. The major part of the lubricant which thus enters chamber 16 with the vaporized refrigerant is separated in the chamber and flows through conduit 33 to the crankcase.

I claim:

1. In a refrigerant circulating system for compressing, condensing and evaporating a refrigerant, the combination with a compressor comprising a crankcase and suction and discharge ports, of variable-speed drive means for said compressor, a condenser connected to said discharge port, an evaporator connected to said condenser for reception from the latter of the condensed refrigerant, means for regulating flow of the refrigerant from the condenser to the evaporator, means for conducting refrigerant from the evaporator to the suction port of said compressor, and means responsive to evaporator pressure for preventing the pressure in said crankcase from falling below a predetermined minimum irrespective of the speed of operation of said compressor.

2. In a refrigerant circulating system for compressing, condensing and evaporating a refrigerant, the combination with a compressor comprising a crankcase and suction and discharge ports, of variable-speed drive means for said compressor, a condenser connected to said discharge port, an evaporator connected to said condenser for reception from the latter of the condensed refrigerant, means for regulating flow of the refrigerant from the condenser to the evaporator, means for conducting refrigerant from the evaporator to the suction port of said compressor, means for preventing the pressure in said evaporator from falling below a predetermined minimum value irrespective of the speed of operation of the compressor, and means for maintaining the said crankcase at substantially the same pressure as said evaporator.

3. In a refrigerant circulating system for compressing, condensing and evaporating a refrigerant, the combination of a compressor com-

prising a crankcase and suction and discharge ports, of variable-speed drive means for said compressor, a condenser connected to said discharge port, an evaporator connected to said condenser for reception from the latter of the refrigerant, means for regulating flow of the refrigerant from the condenser to the evaporator, a conduit for conducting refrigerant from the evaporator to the suction port of the compressor, throttling means in said conduit automatically operative to prevent the pressure in the evaporator from falling below a predetermined minimum irrespective of the operating speed of the compressor, and means for maintaining the crankcase at substantially the same internal pressure as said evaporator, said last-named means including a conduit establishing communication between the crankcase at a point in said system intermediate the said throttling means and the evaporator.

4. In a refrigerant circulating system for compressing, condensing and evaporating a refrigerant, the combination of a compressor comprising a crankcase and suction and discharge ports, of variable-speed drive means for said compressor, a condenser connected to said discharge port, an evaporator connected to said condenser for reception from the latter of the refrigerant, means for regulating flow of the refrigerant from the condenser to the evaporator, a conduit for conducting refrigerant from the evaporator to the suction port of the compressor, throttling means in said conduit automatically operative to prevent the pressure in the evaporator from falling below a predetermined minimum irrespective of the operating speed of the compressor, an oil separating chamber in said conduit intermediate the throttling means and the evaporator, and a conduit extending from the separating chamber to the crankcase and operative to equalize the crankcase and evaporator pressures.

5. In a refrigerating system including a compressor, condenser and evaporator in series flow circuit, said compressor having a crankcase normally containing a mixture of lubricant and refrigerant, variable speed drive means for said compressor, and means including a communicating connection between the said circuit and the crankcase for preventing the pressure in said crankcase from falling below a predetermined minimum.

6. In a refrigerating system including a compressor, condenser and evaporator in series flow circuit, said compressor having a crankcase normally containing a mixture of lubricant and refrigerant, variable speed drive means for said compressor, means for preventing undesirable reduction of the pressure within said evaporator arising from variations in the speed of the said compressor drive means, and a conduit connecting and adapted to maintain substantially equalized pressures within said crankcase and evaporator.

7. In a refrigerating system including a compressor, condenser and evaporator in series flow circuit, said compressor having a crankcase normally containing a mixture of lubricant and refrigerant, variable-speed drive means for said compressor, means interposed between the evaporator and the compressor for preventing undesirable reduction of the pressure within said evaporator and for maintaining said evaporator at a pressure in excess of one atmosphere irrespective of variations in the operating speed of said compressor, and means providing communication between the crankcase and a portion of said refrigerant flow circuit intermediate the said interposed means and the evaporator.

8. In a refrigerating system including a compressor, condenser and evaporator in series flow circuit, said compressor having a crankcase normally containing a mixture of lubricant and refrigerant, variable-speed drive means for said compressor, throttling means for preventing the pressure in said evaporator from falling below a predetermined minimum irrespective of variations in the operating speed of said compressor, said throttling means being located in the refrigerant flow circuit between the evaporator and the compressor, and a conduit providing communication between the crankcase and a portion of said refrigerant flow circuit which is located between said throttling means and the evaporator.

9. In a refrigerating system including a compressor, condenser and evaporator in series flow circuit, said compressor having a crankcase normally containing a mixture of lubricant and refrigerant, variable-speed drive means for said compressor, throttling means for preventing the pressure in said evaporator from falling below a predetermined minimum irrespective of variations in the operating speed of said compressor, said throttling means being responsive to evaporator pressure and being located in the refrigerant flow circuit between the evaporator and the compressor, and a conduit providing communication between the crankcase and a portion of said refrigerant flow circuit which is located between said throttling means and the evaporator.

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