

[54] **MOTOR VEHICLE COOLING SYSTEM
WITH BYPASS REGULATED HEAT
EXCHANGER**

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[58] Field of Search 62/196, 197, 198, 513,
62/505

[56] **References Cited**

UNITED STATES PATENTS

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FOREIGN PATENTS OR APPLICATIONS

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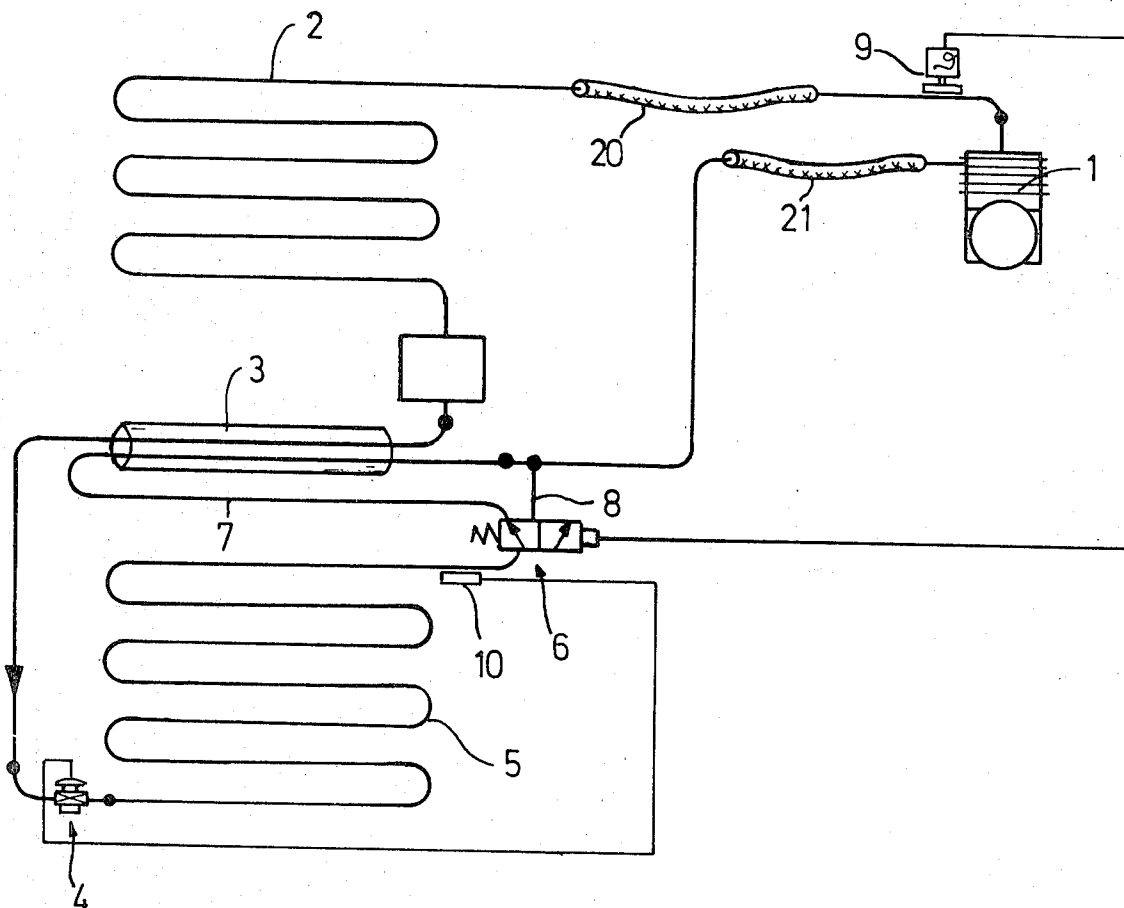
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[57] **ABSTRACT**

Excessive warming of the compressor input by the heat exchanger that supercools the condenser output is prevented by a bypass switched in and out by a thermostatic control at the output of the compressor to prevent the final compression temperature from rising to a value at which damage to lubricating materials and flexible hose materials would result. A branching valve or a second expansion valve may be used according to whether the bypass is just around the heat exchanger or around both the heat exchanger and the evaporator.

5 Claims, 2 Drawing Figures



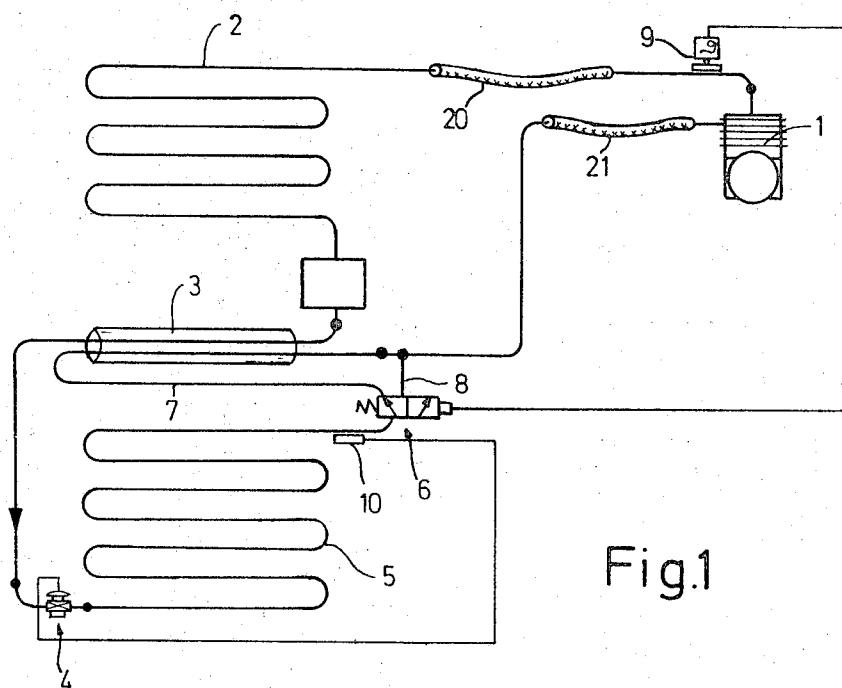


Fig.1

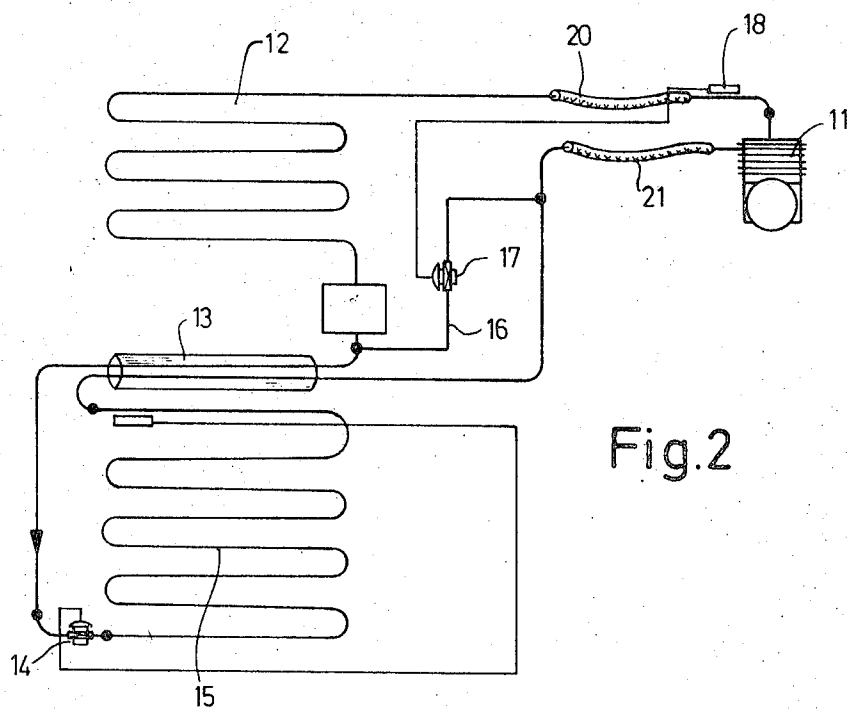


Fig.2

MOTOR VEHICLE COOLING SYSTEM WITH BYPASS REGULATED HEAT EXCHANGER

This invention relates to a cooling system particularly suitable for use in a motor vehicle, of the type that uses a heat exchanger for further cooling of the liquified refrigerant passing from the condenser to the evaporator, which in so doing provides further warming of the cool vapor coming from the evaporator before it is supplied to the input of the compressor.

A cooling system of this type is described, for example, in the *Handbuch der Kältetechnik*, by R. Plank (Vol. III, Heidelberg, 1959, Page 34 f.). In this cooling system the cool vapor is not sucked into the compressor in its original concentration, but only after it has been preheated in a heat exchanger which serves to provide supercooling of the liquid refrigerant. This supercooling of the refrigerant before it reaches the expansion valve increases the cooling capability of the evaporator of the cooling system. Increasing the preheating of the cooled vapor on its way to the compressor, however, also raises the final temperature at the output of the compressor. The latter must not, however, exceed a certain value in the neighborhood of 150°C. If the final compression temperature should exceed that limit, the lubricating oil of the compressor partly dissolved in the refrigerant would be charred. The lubricant would lose its lubricating qualities and the compressor would soon fail in consequence. Furthermore, if the cooling system is installed in a motor vehicle, as shown, for example, in U.S. Pat. No. 2,893,700, the piping for the refrigerant must be provided in part by flexible hoses. If the compression temperature exceeds the above-mentioned limit, then, the flexible hoses are likely to be attacked to an extent that will eventually cause them to break.

It is accordingly an object of the invention to provide a cooling system of the type described above, which permits the use of ordinary lubricants and also that of flexible hoses of rubber or synthetic materials as conduits for the refrigerant.

SUBJECT MATTER OF THE PRESENT INVENTION

Briefly, a thermostatically controlled bypass is provided to reduce the temperature of the vapor input to the compressor. A thermostatic control responds to the temperature of the compressor output and controls the bypass so as to prevent that temperature from rising to a value where it would be damaging to lubricant or hose materials. It is particularly advantageous to provide the bypass around the vapor side of the heat exchanger and to have it controlled by a branching valve which can direct the vapor to the heat exchanger or to the bypass, according to the control provided by the thermosensor that provides the thermostatic action. On the other hand, it is also very advantageous to provide the bypass as a bypass around the evaporator, controlled by a second expansion valve that responds to the thermosensor providing the thermostatic action. In either case the best location for the thermosensor is in the refrigerant circulation path directly behind the compressor, that is, at or near its output connection.

The invention will be described by way of example with reference to the accompanying drawing, wherein:

FIG. 1 is a diagram of a first embodiment of the invention in a cooling system, and

FIG. 2 is a diagram of a second embodiment of the invention in a cooling system.

The cooling system shown in FIG. 1 constitutes a circulation path for the refrigerant contained in the system. In its cycle the refrigerant passes through a compressor 1, the output of which is connected to a condenser 2. The output of the condenser 2 is in turn connected through an internal heat exchanger 3 and an expansion valve 4 to an evaporator 5. At the output of the evaporator 5 is a branching valve 6 of three-sort two-position type. The valve 6 in one position connects the output of the evaporator 5 with a pressure line 7 leading to the internal heat exchanger 3, while in the other position connects the output of the evaporator 5 with a bypass pressure line 8 that bypasses the internal heat exchanger 3. Both the bypass pressure line 8 and the pressure line passing through the internal heat exchanger 3 lead to the input suction line of the compressor 1.

Temperature sensor 9 is provided in the refrigerant circulation path directly behind the compressor 1, i.e. in the pressure line leading from the compressor 1 to the condenser 2. The sensor 9 controls the branching valve 6. The expansion valve 4 is connected with a temperature sensor 10, which is provided at the output of the evaporator 5. Hoses of synthetic material appear, for example, at 20 and 21, forming part of the pressure lines in the refrigerant circulation system.

The cooling system of FIG. 1 operates as follows. The compressor 1 is driven by a motor not shown in the drawing. In a motor vehicle the compressor could be driven by the crankshaft of the motor, by a belt drive for example. The compressor 1 sucks in relatively cool vapor, compresses it and thereby warms it. The warm refrigerant is cooled in the condenser and thereby liquified. Now the liquid refrigerant flows through the internal heat exchanger 3 and may be supercooled there, according to the position of the branching valve 6. The liquid refrigerant then flows to the expansion valve 4 where it is relieved of the condenser pressure, down to the lower evaporator pressure. Under the lower pressure it enters the evaporator and there evaporates, while it absorbs heat from its surroundings. This heat absorption upon evaporation provides the cooling capacity of the cooling system.

The refrigerant is sucked out of the evaporator by the compressor 1, and according to the position of the branching valve 6 it is led through the internal heat exchanger 3 or through a bypass to be described presently. In the heat exchanger 3 a heat transfer occurs in the direction that causes the cool vapor drawn through by the compressor to be preheated. The supercooling of the liquid refrigerant in the internal heat exchanger requires a considerable preheating of the refrigerant vapor applied to the input of the compressor 1, as the result of which the compression temperature naturally also rises. If it rises above the value for which the temperature sensor 9 is set, however, the sensor 9 then operates the branching valve 6 in the necessary direction to divert the cool vapor coming from the evaporator to the bypass pressure line 8 that bypasses the internal heat exchanger 3. Now that the cool vapor no longer passes through the heat exchanger 3, the temperature of the vapor drawn in by the compressor drops. As a result final compression temperature falls below the

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value for which the temperature sensor 9 is set, so that the cool vapor coming from the evaporator 5 can again be led through the internal heat exchanger 3, so that the cooling capacity of the cooling system can again be raised.

The cooling system shown in FIG. 2 likewise has a compressor 11, a condenser 12, a heat exchanger 13, an expansion valve 14 and an evaporator 15. Between the condenser 12 and the heat exchanger 13 there branches off a bypass 16 around the evaporator 15, and in this bypass 16 a second thermostatic expansion valve 17 is interposed. This expansion valve 17 is connected with a temperature sensor 18, which again is situated in the refrigerant line directly behind the compressor 11 leading to the condenser 12.

The operation of this second embodiment of the invention in a cooling system corresponds substantially to the operation of the embodiment first described. If as a result of excessive preheating of the cool vapor drawn in by the compressor 11 the final compression temperature exceeds the value for which the temperature sensor 18 is set, the latter operates the second expansion valve 17 to spray additional refrigerant into the low pressure input line to the compressor, thereby reducing excessively high preheat temperatures at the compressor input. In consequence, the final compressor temperature will eventually fall back below the value for which the temperature sensor 18 is set.

I claim:

1. A cooling system particularly suitable for a motor vehicle, comprising a compressor, a condenser, a heat exchanger for further cooling of the liquidified refrigerant, an expansion valve and an evaporator arranged for

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continuously cycling the refrigerant, wherein:

said heat exchanger is arranged to cool said liquid refrigerant by warming cooled vapor from said evaporator before it is supplied to said compressor, and

automatically regulated bypass means are provided for reducing the temperature of the vapor provided to said compressor in response to thermostatic means responsive to the temperature of the refrigerant output of said compressor, and thereby to prevent the output of said compressor from reaching a temperature damaging to organic compounds exposed to the refrigerant of the system.

2. A cooling system as defined in claim 1, in which said bypass means is a bypass around the vapor side (7) of said heat exchanger (3) controlled by a branching valve (6) for cutting said heat exchanger into and out of operation.

3. A cooling system as defined in claim 2, in which said thermostatic means (9) is a temperature sensor in the refrigerant circulation path directly behind said compressor (1).

4. A cooling system as defined in claim 1, in which said bypass means is a bypass around said evaporator (15) controlled by a second expansion valve (17) in response to thermostatic means (18) responsive to the temperature of the refrigerant output of said compressor (11).

5. A cooling system as defined in claim 4, in which said thermostatic means (18) is a thermosensor in the refrigerant circulation path directly behind said compressor (11).

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