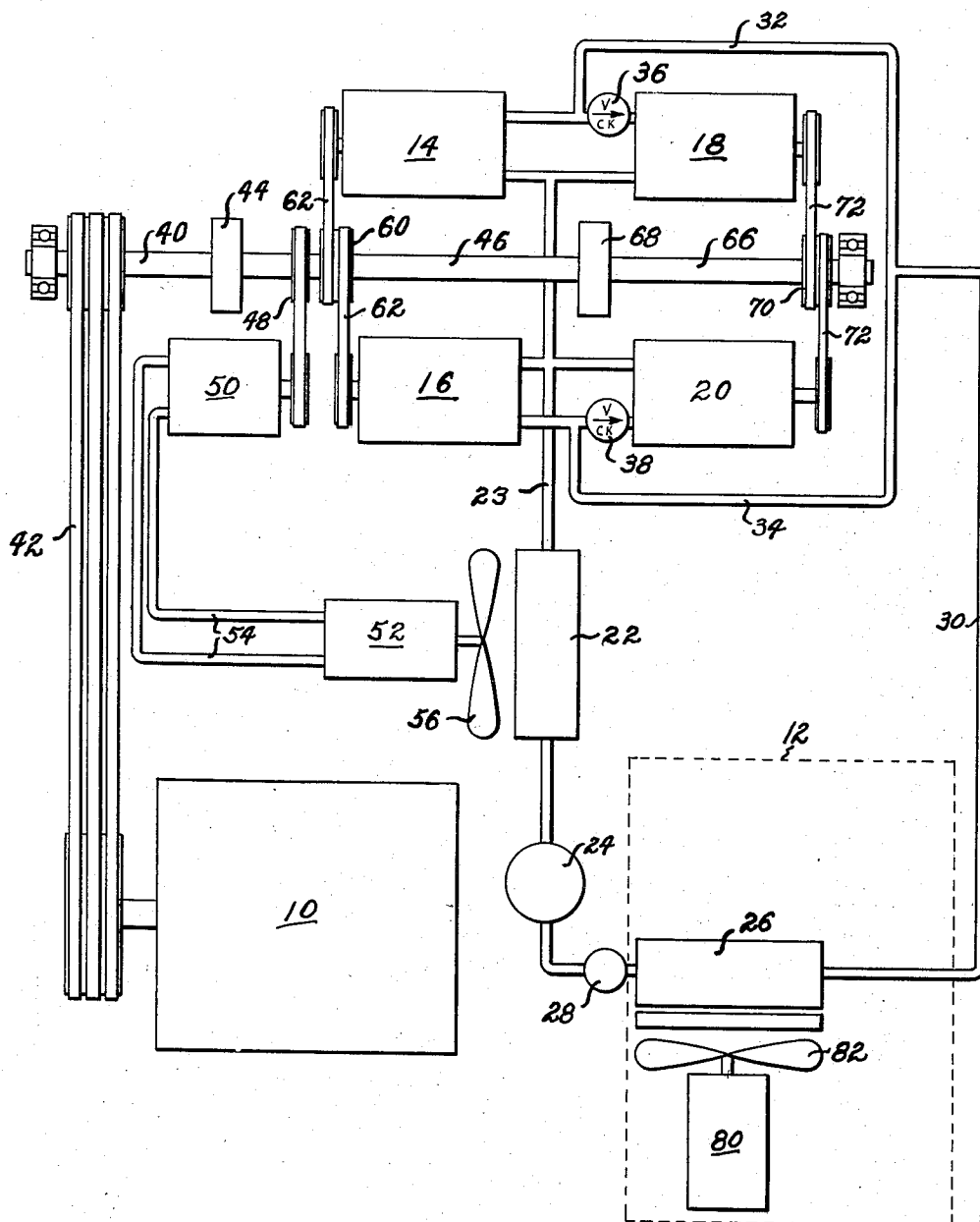


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H. O. SCHJOLIN
REFRIGERATING APPARATUS

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1

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REFRIGERATING APPARATUS

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This invention relates to refrigerating apparatus and more particularly to an arrangement for air conditioning buses and the like.

It is an object of this invention to provide a refrigerating system having an improved arrangement for driving the compressor mechanism and for varying the output of the same.

Another object of this invention is to provide a compressor mechanism which is not only light in weight but also compact and easy to install and repair.

Prior to applicant's invention it was considered impractical if not impossible to provide a satisfactory bus air conditioning system wherein the compressor was directly connected to the main bus engine. One reason for this is that the bus engine speed varies throughout a wide range and any compressor which would have adequate capacity at low engine speeds would, of necessity, have to be so large and complex as well as expensive, that it would be impractical.

It is an object of this invention to provide a compressor arrangement utilizing a plurality of low cost, light weight compressors which are driven directly by the main bus engine through clutch mechanisms whereby it is possible to vary the number of compressors in operation and in that manner compensate for changes in engine speed.

Another object of this invention is to provide an improved arrangement for transmitting power from a bus engine to the various auxiliary devices used in air conditioning the bus.

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 drawing:

The sole figure of the drawing somewhat schematically shows a bus air conditioning system constructed in accordance with the invention.

Referring now to the drawing, wherein a preferred embodiment of the invention has been shown, reference numeral 10 generally designates the main bus engine which is used for propelling the bus through suitable transmission mechanism not shown. The refrigerating apparatus for use in air conditioning the passenger compartment 12 comprises a bank of four compressors, designated by the reference numerals 14, 16, 18 and 20, a condenser 22 which is connected to the outlet of the compressors by means of the conduit means 23 and an evaporator 26. A reservoir 24 is provided in the line which leads from the condenser 22 to the evaporator 26. The flow of refrigerant to the evaporator 26 is controlled by means of a conventional pressure regulating means 28. Any suitable pressure regulating means such as an automatic expansion valve, a thermostatic expansion valve or a fixed restrictor could be used for this purpose. The vaporized refrigerant leaves the evaporator 26 through suction line 30 which communicates with two branch lines 32 and 34, as shown. Each of the branch lines, in turn,

2

have branches leading to the inlets of two of the compressors. Check valves 36 and 38 are provided in the lines leading to the compressors 18 and 20, respectively, as shown, and permit free flow of refrigerant vapor to the inlets of the adjacent compressors 18 and 20 but prevent evacuation of these compressors when they are declutched and the compressors 14 and 16 continue to operate.

A jack shaft is provided as shown and this shaft has three sections designated by reference numerals 40, 46 and 66. Section 40 is directly connected to the main bus engine 10 through the drive belts 42 so as to operate at all times whenever the engine 10 operates. A manually operable clutch 44 is arranged as shown, for declutching the shaft sections 46 and 66 from the shaft section 40 so as to render the refrigeration equipment inoperative whenever air conditioning is unnecessary. The shaft section 46 is provided with a first pulley 48 which is keyed to the shaft 46 so as to drive a hydraulic pump 50. The pump 50 is adapted to supply fluid under pressure to a constant speed hydraulic motor 52 through the lines 54. The motor 52 drives a condenser cooling fan 56 as shown. The hydraulic drive for the condenser fan makes it possible to mount the condenser and the fan 56 on the roof of the bus or at any other suitable point remote from the main bus engine.

A second pulley means 60 is keyed to the shaft section 46 and serves to drive the compressors 14 and 16 through belts 62 at all times that the shaft 46 operates.

At low engine speeds it is desirable to operate all of the compressors whereas at high engine speeds this would result in excess compressor capacity. Accordingly a speed responsive clutch 68 is provided, as shown, between the shaft section 46 and the shaft section 66 for the purpose of declutching the shaft section 66 at shaft speeds above 1500 r.p.m. so as to prevent operation of the compressors 18 and 20 at higher engine speeds. As shown in the drawing, the shaft section 66 has secured thereto pulley means 70 which cooperate with belts 72 which transmit power from the shaft section 66 to the compressors 18 and 20.

By virtue of the above-described arrangement it is possible to utilize light weight, inexpensive compressor means which can be conveniently arranged to be driven directly from the bus engine in such a manner that all four of the compressors operate at low engine speeds and only two or a lesser number of compressors operate at higher engine speeds.

For purposes of illustration, four compressors have been shown whereas it is within the purview of this invention to utilize any other number of compressors, depending upon such matters as the refrigeration load and the compressor design.

The evaporator fan 82 which circulates air to be conditioned in thermal exchange with the evaporator 26 is driven by an electric motor 80, as shown. The evaporator 26 may be located directly in the passenger compartment, as schematically shown, or it can be mounted in an air duct located in any convenient place such as below or above the passenger compartment.

The compressors 14, 16, 18 and 20 are preferably of the axial type disclosed in U.S. patent application, Serial No. 398,319 filed December 15, 1953. The check valves 36 and 38 may be of any conventional design and serve to prevent reverse flow of refrigerant and/or lubricant through the section lines leading to the compressors 18 and 20 when the compressors 18 and 20 are declutched and the compressors 14 and 16 continue to operate.

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, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. In combination, an engine, a refrigerant evaporator, a condenser, a plurality of compressors, refrigerant flow means connecting said compressors in parallel refrigerant flow relationship with each other and in series with said condenser and said evaporator, a hydraulic pump, fan means for circulating air in thermal exchange relationship with said condenser, a hydraulic motor for driving said fan means, means whereby operation of said hydraulic pump causes operation of said hydraulic motor, torque transmitting means between said engine, said pump, and said compressors, said torque transmitting means including a first clutch for disengaging all of said compressors and said pump from said engine and a second clutch for disengaging only a portion of said compressors from said engine without disengaging said pump.

2. Air conditioning apparatus comprising in combination, an engine operable at widely varying speeds irrespective of air conditioning requirements, evaporator means arranged in thermal exchange relationship with air to be conditioned, condenser means dissipating heat removed from said air, a plurality of compressors arranged in refrigerant flow relationship with said evaporator means and said condenser means, torque transmitting means between said engine and said compressors, said torque transmitting means comprising a first clutch responsive to changes in speed of said engine for disengaging certain of said compressors at engine speeds above a predetermined value and a second clutch for disengaging other of said compressors from said engine.

3. Air conditioning apparatus comprising in combination, an engine operable at widely varying speeds irrespective of air conditioning requirements, evaporator means arranged in thermal exchange relationship with air to be conditioned, condenser means for dissipating heat removed from said air by said evaporator, a plurality of compressors arranged in refrigerant flow relationship with said evaporator means and said condenser means so as to withdraw refrigerant vapor from said evaporator means and to discharge the same into said condenser means, a multiple section power transmitting shaft, means transmitting power from said engine to a first section of said shaft, a first clutch between said first section of said shaft and a second section of said shaft, means for transmitting power from said second section of said shaft to at least one of said compressors, a speed responsive clutch connecting said second section of said shaft to a third section of said shaft, and means for transmitting power from said third section of said shaft to at least one of said compressors.

4. Air conditioning apparatus comprising in combination, an engine operable at widely varying speeds irrespective of air conditioning requirements, evaporator means arranged in thermal exchange relationship with air to be conditioned, condenser means for dissipating heat removed from said air by said evaporator, a plurality of compressors arranged in refrigerant flow relationship with said evaporator means and said condenser means so as to withdraw refrigerant vapor from said evaporator means and to discharge the same into said condenser means, a multiple section power transmitting shaft, means transmitting power from said engine to a first section of said shaft, a first clutch between said first section of said shaft and a second section of said shaft, means for transmitting power from said second section of said shaft to at least one of said compressors, a speed responsive clutch connecting said second section of said shaft to a third section of said shaft, means for transmitting power from said third section of said shaft to at least one of said compressors, a hydraulic pump driven by said second section of said shaft, a hydraulic motor, fluid connections between said pump and said motor whereby operation of said pump causes operation of said motor, and fan means operated by said motor and arranged to circulate condenser cooling air in thermal exchange with said condenser means.

5. Air conditioning apparatus comprising in combination, an engine operable at widely varying speeds irrespective of air conditioning requirements, evaporator means arranged in thermal exchange relationship with air to be conditioned, condenser means, a plurality of compressors arranged in parallel refrigerant flow relationship to one another and in series with said evaporator means and said condenser means, a multiple section drive shaft, means transmitting power from said engine to a first section of said shaft, a first clutch between said first section of said shaft and a second section of said shaft, means for transmitting power from said second section of said drive shaft to at least one of said compressors, a speed responsive clutch connecting said second section of said shaft to a third section of said shaft, means for transmitting power from said third section of said shaft to at least one of said compressors, each of said compressors having a separate inlet for receiving refrigerant vapor from said evaporator means, and a check valve preventing reverse flow of refrigerant through the inlet of said last named compressor when said last named compressor is inoperative.

6. Air conditioning apparatus comprising in combination, an engine operable at widely varying speeds irrespective of air conditioning requirements, evaporator means arranged in thermal exchange relationship with air to be conditioned, condenser means, a plurality of compressors arranged in parallel refrigerant flow relationship to one another and in series with said evaporator means and said condenser means, a multiple section drive shaft, means transmitting power from said engine to a first section of said shaft, a first clutch between said first section of said shaft and a second section of said shaft, means for transmitting power from said second section of said drive shaft to at least one of said compressors, a speed responsive clutch connecting said second section of said shaft to a third section of said shaft, means for transmitting power from said third section of said shaft to at least one of said compressors, each of said compressors having a separate inlet for receiving refrigerant vapor from said evaporator means, a check valve preventing reverse flow of refrigerant through the inlet of said last named compressor when said last named compressor is inoperative, said plurality of compressors comprising a first pair of compressors disposed on opposite sides of said second section of said shaft and drivingly connected thereto by means of belts and a second pair of compressors disposed on opposite sides of said third section of said shaft and drivingly connected thereto by means of belts.

7. In combination, an engine, refrigerating apparatus including compressor means, a condensing means, and an evaporator connected in refrigerant flow relationship, said compressor means comprising a plurality of compressors having separate suction and discharge lines, torque transmitting means drivingly connecting said engine to said compressors, said torque transmitting means including means responsive to the speed of said engine for disengaging a portion only of said compressors at engine speeds above a predetermined value, and valve means for preventing the flow of refrigerant from an inoperative compressor into the suction line of an operative compressor.

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