May 19, 1964 M. V. GRIFFIN 3,133,429

COMPRESSOR CRANKCASE HEATING DEVICE

Filed Nov. 1, 1957

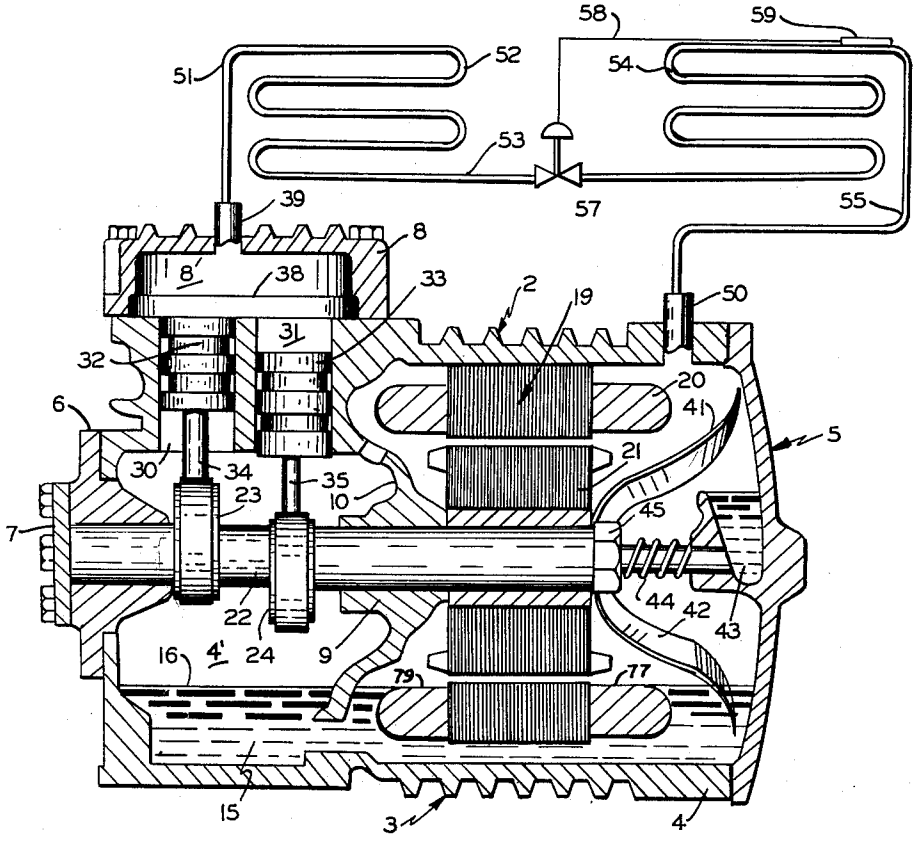


FIG. 1

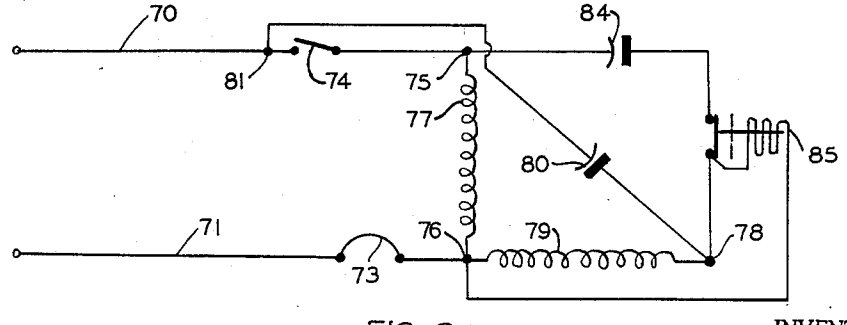


FIG. 2

INVENTOR.
MAURICE V. GRIFFIN

BY Herman Seid

ATTORNEY

United States Patent Office 3,133,429
Patented May 19, 1964

3,133,429

COMPRESSOR CRANKCASE HEATING DEVICE

Maurice V. Griffin, Syracuse, N.Y., assignor to Carrier Corporation, Syracuse, N.Y., a corporation of Delaware

Filed Nov. 1, 1957, Ser. No. 693,830
5 Claims. (Cl. 62—469)

This invention relates to crankcase heating devices for compressors and especially to crankcase heating devices for hermetic compressors.

It is well known that under certain conditions, some refrigerants and oil are freely miscible in all proportions. During normal operation of the refrigerant circuit, because of operating pressures and temperatures, the oil in the sump of a compressor will be substantially free of refrigerant. However, on shutdown when the system reaches ambient temperature and the pressure equalizes within the refrigeration circuit, the refrigerant vapor and oil in the sump of the compressor will mix to form a substantially homogenous solution. If the ambient temperature is especially low with certain refrigerants, phase separation may result with the separation of the crankcase solution into two layers—the lower layer being refrigerant-rich solution and the upper layer being oil-rich solution.

This phenomenon is not localized, and it is possible that the entire liquid refrigerant charge within the circuit may be absorbed by the oil charge in the sump. This absorption of refrigerant results because, at ambient temperatures, the oil in the sump of the compressor has a negligible vapor pressure. The refrigerant liquid in the circuit has a great vapor pressure, therefore the refrigerant liquid vaporizers and passes into the sump and goes into solution.

Upon start-up of the compressor, the oil sump which is usually a part of the crankcase of the compressor drops to suction pressure and the compressor mechanism agitates the solution. This action causes the refrigerant in solution to attempt to return to the vapor state. Since the refrigerant at shutdown is in a substantially homogenous solution, the flashing of refrigerant to vapor may carry therewith a substantial amount of the oil charge and may even result in the entire solution turning into a foam.

Substantially all sleeve bearings now commercially used rely on a hydrodynamic wedge of oil for successful bearing operation. It is well known that the foam of oil and refrigerant in a compressor crankcase will not provide this lubricating function and bearing failure may result in a short period of operation under such circumstances.

To avoid this problem, large oil charges are used to assure that all of the oil in the solution in the compressor sump will not pass into foam. The practice has been to provide as much as four pounds of lubricant to each ton of refrigeration. Naturally, for lubrication purposes, this charge is unnecessarily large and further has the disadvantage that excessive space in the sump of the machine is required.

Another approach to the problem of crankcase oil dilution is the provision of crankcase heaters. On shutdown of the compressor, the refrigeration circuit is permitted to pass to ambient temperature with the exception of the compressor crankcase which is suitably heated; a satisfactory temperature being approximately 40° to 60° F. above ambient temperature. At this temperature, a small amount of refrigerant will be absorbed by the oil charge; however, this mixture of oil and refrigerant will have a sufficient vapor pressure to discourage refrigerant from further passing into the vapor state and being absorbed into the crankcase solution.

It has been found that heating elements for this type of service are expensive. Since hermetic compressors are substantially standard equipment in refrigeration systems

today, and since the motor and the crankcase are in a common space in these compressors, use of the motor windings has been suggested for use as a heating element to heat the oil charge within the compressor.

The problem exists in providing a low voltage—for example, 10% of rated voltage—at low cost for heating purposes.

The chief object of the present invention is to provide a low-cost device for heating the crankcase oil of a compressor.

Another object is to provide a device used in conjunction with the motor coils of a compressor motor to supply a low voltage to said coils for the purpose of heating the crankcase oil of the compressor.

Another object is to provide a capacitance in a circuit with the motor coil of a compressor for the purpose of heating the crankcase oil.

A still further object of the invention is to provide a compressor having means for placing capacitors in a circuit with the motor windings so that the windings receive a low voltage for heating purposes. These and other objects of my invention will become more apparent from the following description.

This invention relates to a compressor having a compression mechanism and motor within a common casing, the casing including an oil sump. There is also provided a coil in heat exchange relation with the oil sump and a capacitance in circuit with said coil to cause a low voltage to pass therethrough thereby heating the contents of the oil sump.

The attached drawings illustrate a preferred embodiment of the invention, in which:

FIGURE 1 is a view in section of a hermetic compressor employing the present invention; and

FIGURE 2 is a schematic view of the electric motor circuit used in the present invention.

Referring to FIGURE 1, there is shown a hermetic compressor 2 which comprises a casing 3. This casing includes a body portion 4 having a cavity 4' therein. At one ond of the cavity 4', there is an end member 5, which closes the end of the body portion 4. At the other end of the casing there is shown an end bearing member 6 having an end bearing cover 7 attached thereto. At the upper portion of the casing 3 there is a head member 8 which is suitably bolted to the compressor body 4. Located within the casing, is a bearing 9 which is concentric with the opening in the end bearing 6. This bearing is suitably supported by an apertured web 10.

In the lower portion of the casing there is an oil sump 15 having an oil level 16. Mounted within the casing 3 is a suitable motor 19, having a stator 20 mounted on the body 4 and having a rotor 21 which is suitably mounted to the shaft 22 which is journalled within the bearings 9 and 6. This shaft 22 has suitable eccentrics 23 and 24 located in the body 4. Above the eccentrics 23 and 24 are suitable cylinders 30 and 31. Reciprocatingly mounted within these cylinders are pistons 32 and 33, which are connected to the eccentrics by means of suitable wrist-pins (not shown) and connecting rods 34 and 35. Above the cylinders 30 and 31 is located a suitable valve plate 38, having suitable valve members which place the cylinders 30 and 31 into communication with the head cavity 8'.

Mounted at the end of the shaft 22 are suitable blades 41 and 42 which rotate with the shaft in such a manner as to dip into the oil sump 15 thereby casting the oil upwardly into the cavity 4'. Located in the end member 5 is a suitable trough 43 which is connected by means of a tube 44 to the shaft 22 and connected thereto by means of a bushing 45.

By this means, oil thrown upwardly into the cavity 4', falls into the trough 43 and is then sent into the hollow

shaft 22. The shaft 22 has suitable apertures in communication with the bearing surfaces 9 and 6 and the eccentrics 23 and 24, whereby lubricant is directed to these surfaces.

Considering the operation of the compressor, as the motor is energized, the rotor rotates simultaneously rotating the eccentrics 23 and 24, causing the pistons 32 and 33 to reciprocate within the cylinders 30 and 31. Simultaneously, the blades 41 and 42 rotate through the oil sump 15, throwing the oil into the previously described trough and tube system and thereby lubricating the parts of the compressor. As the compressor comes into operation, the pressure within the cavity 4' decreases and suction gas which is drawn into the compressor passes through the suction inlet 50 into the motor compartment, thereby cooling the motor and then passes by suitable openings (not shown) into the head cavity 8'. The head member 8 has suitable compartments therein, one of which is at suction pressure, the other is at discharge pressure. The suction gas passes into the suction portion of the head and is drawn through the valve plate 38 into the cylinders where the gas is compressed and then discharged into the other head compartment and out the discharge opening 39.

The compressor is connected to a suitable refrigeration circuit which consists of a discharge gas line 51 connected to a condenser 52; from the condenser extends a liquid line 53 which connects the condenser to the evaporator 54; by means of the suction line 55 the evaporator 54 is connected to the suction inlet 50 of the compressor. In order to meter the amount of refrigerant to the evaporator, a suitable thermo-expansion valve may be provided in the liquid line. This thermo-expansion valve 57 is connected by means of the tube 58 to a suitable bulb 59 which is in heat exchange relation with the suction line 55.

Referring to FIGURE 2, there is shown a schematic view of the electrical diagram for the motor used in the present invention. The lines 70 and 71 are connected to a suitable source of single phase alternating current. Located in the line 70 is a suitable switch 74, which opens and closes in response to refrigeration requirements normally sensed by a thermostat. In the line 71 there is also indicated a suitable overload mechanism 73. The lines 70 and 71 are connected to the terminals 75 and 76 respectively. Across these terminals is connected a suitable run winding 77 which is mounted on the stator 20, shown in FIGURE 1. Across the terminals 76 and 78 is connected the start winding 79 which is also mounted on the stator 20 shown in FIGURE 1. Connected across the terminal 78 and the terminal 81 which latter terminal is located in the line 70 prior to the switch 74 is a suitable run capacitor 80, the function of which will be described more fully hereinafter.

The circuit also includes a suitable start capacitor 84 which is usually of the electrolytic type connected across the terminals 75 and 78. Between terminals 75 and 78 is also included a relay switch 85 which opens and closes in response to the potential across the winding 79.

In normal operation this potential is high enough to maintain the circuit between the terminals 75 and 78 open. However, at startup and for purposes to be described more fully hereinafter, the capacitor 84 is in the starting circuit.

In normal starting circuits of this type, the capacitor 80 is normally connected to the terminal 75; however, in the present invention, the capacitor is connected to a point before the switch 74. It will be realized that the potential level at 75 and 81 are the same during normal operation. However, when the switch 74 is opened, a circuit from juncture 81 across to juncture 76 is closed.

During normal operation, current is passed through the lines 70 and 71 to the junctures 75 and 76 permitting current to pass through the run winding 77. However, it is well known that in a single phase motor at zero speed, the torque in the motor is also zero therefore various devices are utilized to start the motor. In compressors it is normal to use a capacitor start motor which includes a separate start winding. This particular type of starting device is favored because of its high starting torque characteristics. In the present device this includes a second circuit which extends from the juncture 81 through the capacitor 80 to the juncture 78, includes the start winding 79 and terminates at the juncture 76. By means of placing the run capacitor 80 in this circuit, a phase difference exists between the current in the start winding 79 and the run winding 77 thereby in effect giving the motor the attributes of a polyphase motor including some starting torque.

In order to increase the phase shift of the circuit including the capacitor 80 and the start winding 79, a supplemental start capacitor 84 is placed in the circuit. This capacitor is placed in parallel with the capacitor 80. By this means, the phase shift across the start winding 79 is greatly increased thereby increasing the starting torque. The capacitance of the capacitor 84 is great and this capacitor is of the electrolytic type. This type of capacitor is extremely expensive, and it is desirable that after a short time this capacitor be removed from the circuit or else it will be burned out. In order to achieve this result, a potential relay 85 is placed across the start winding 79. Since the potential across the relay 85 and the winding 79 are the same, as the potential across the winding 79 increases, the relay will open the circuit including the capacitor 84 and leave only the start winding 79 and capacitor 80 in parallel with the first circuit which comprises the run winding 77. At this point, the increased capacitance is no longer needed because of the changed impedance of the motor circuits.

In certain areas of the country, it is very possible that the compressor will not be in service for nine months of the year. During this period or substantially shorter periods, the liquid refrigerant within the coils 52 and 54 of the refrigeration circuit, because of its vapor pressure will tend to pass into the vapor state. This vapor passes through the suction line 55 into the compressor casing. As previously outlined, the oil in the sump 15 is freely miscible at ambient temperatures and in all proportions with the refrigerant vapor entering the cavity 4'. After a nine month period, or a much lesser period, it is conceivable that substantially all the refrigerant within the refrigeration circuit will be absorbed in the oil charge located in the sump 15.

Upon startup of the compressor, the rotor will churn through a portion of the oil sump and simultaneously the pressure within the cavity 4' will tend to decrease to operating suction pressure. Since the oil sump contains a homogenous solution of refrigerant and oil, as a result of the agitation and low pressure within the cavity 4', there is a tendency of the refrigerant in the oil sump solution to pass into the vapor state. There is a rapid movement of vapor through the solution and out of the solution, carrying therewith substantially all the oil charge in the sump. As a result the compressor cavity 4' is filled with a foam-like mixture of oil and refrigerant vapor.

As the compressor shaft 22 rotates, it relies on a hydrodynamic wedge of oil for lubrication purposes at the eccentrics and at the bearings. The foam-like mixture within the compressor is unable to perform this function and bearing failure results.

In order to avoid this situation, the present invention visualizes heating the compressor by means of utilizing the motor windings. The heating of the motor windings as previously outlined causes the slight mixture of oil and refrigerant in the compressor to have an increased vapor pressure which will form a barrier to restrain the passage of liquid refrigerant from the coils 52 and 54 of the refrigeration circuit. In this manner the concentration of refrigerant vapor within the sump is held extremely low and upon startup substantially no foaming will

result, thereby assuring that a liquid having a lubricating quality is passed to the various bearings and bearing surfaces of the compressor.

It will be noted at this point that it is desirable that a low voltage be impressed across the winding **77** and **79**, since a full line voltage will burn the windings out or start the compressor. It is also desirable to obtain this desirable low voltage with a minimum of extra components. Since it is normal practice to provide the capacitor **80** which is normally of the oil type and capacitor **84** which is of the electrolytic type for starting purposes, it is highly desirable that these existing components be used.

Referring to FIGURE 2, it is noted that when the switch **74** is open, discontinuing line voltage across the first circuit including the run winding **77** between the terminals **75** and **76**, current may flow from the juncture **81** through the capacitor **80**, through the start winding **79**, to the juncture **76** and through the line **71**. Simultaneously, current may pass through the capacitor **80** and at the juncture **78** pass through the closed terminals of the relay **85** through the electrolytic capacitor **84**, through the run winding **77** to the terminal **76**.

It has been found in actual practice that, if desired, the voltage drop across the start winding may be approximately 10% of rated voltage. It has also been found that at this 10% of rated voltage through the start winding, the current passing in the circuit including the juncture **78**, capacitor **84**, juncture **75**, run winding **77** and juncture **76** is of such a low value that the electrolytic capacitor **84** will not fail. As previously mentioned, at rated voltage this capacitor may only be kept in the line a short time without the capacitor burning out.

It will be noted that by this means, the start and run windings are utilized during shutdown as heating elements. No new parts are required and all existing parts are utilized to obtain this heating effect. The main advantage of the entire arrangement is that capacitors such as **80** and **84** expend a negligible amount of current since a capacitor is essentially an energy storing element, rather than an energy expending element. However, the elements **77** and **79** are subject to heating losses as a result of (I^2R) losses or joule heating. Heating also results from hysteresis, eddy currents, laminar leakage and also due to the inductive heating of the rotor **21** of the motor.

Under the latest practices, it has been possible in many instances to dispense with the circuit including the relay **85** and the capacitor **84** because the compressor starts in a comparatively unloaded condition therefore, not requiring a high starting torque. In such a situation the run capacitor provides adequate phase shift. On shutdown no current would pass through the run winding **77** and the circuit used for heating would merely include the line **70**, juncture **81**, the capacitor **80**, juncture **78**, start winding **79**, juncture **76** and line **71**. The run winding would be substantially isolated in this instance.

It is believed that an invention has been disclosed wherein crankcase heating is possible without the addition of any new components and furthermore substantially all the heating is imparted to the compressor crankcase since the devices utilized to obtain the low voltage utilize a negligible amount of energy.

While I have described a preferred embodiment of my invention, it will be understood that my invention is not limited thereto, since it may be otherwise embodied within the scope of the following claims.

I claim:

1. In a compressor, the combination of a compression mechanism, means operatively associated with the compression mechanism for lubricating the compression mechanism, said means including an oil sump, means connected to a source of line current, a single phase motor connected to said compression mechanism and comprising a run winding, a start winding, said start winding being in heat exchange relation with the oil sump, a capacitance in series with the start winding, and means for passing line voltage across said start winding and the capacitance when line voltage is not passed across the run winding to heat the oil in the sump.

2. In a compressor, the combination of a compression mechanism, means operatively associated with the compression mechanism for lubricating the compression mechanism, said means including an oil sump, a single phase motor connected to said compression mechanism and being in heat exchange relation with said sump, said motor comprising a first circuit including a run winding, a second circuit in parallel with said first circuit, said second circuit having a start winding in series with a capacitance, means for passing line voltage across the run winding, and means for passing line voltage across the second circuit when the passage of current to the first circuit is discontinued.

3. In a compressor, the combination of a compression mechanism, means operatively associated with the compression mechanism for lubricating the compression mechanism, said means including an oil sump, a single phase motor connected to said compression mechanism and being in heat exchange relation with said sump, said motor comprising a first circuit including a run winding, a second circuit in parallel with said first circuit, said second circuit having a start winding in series with a capacitance, a third circuit having a start capacitance connected between the first circuit and a point between the capacitance and the start winding of the second circuit, means for passing line voltage across the run winding, means for withdrawing said start capacitance from the third circuit in response to a predetermined voltage across the start winding, and means for passing line voltage across the second circuit when the passage of current to the first circuit is discontinued.

4. A compressor according to claim 3 in which one of said circuits is at least partially submerged in the oil sump.

5. In a compressor, the combination of a compression mechanism for compressing a refrigerant, means for lubricating the compression mechanism operatively associated with said compression mechanism, said means including an oil sump, a motor connected to said compression mechanism, a source of electric current, said motor being connected to the source of electric current, said motor comprising a first circuit including a run winding, a second circuit in parallel with the first circuit and having a start winding in series with a capacitance, at least said start winding being disposed in heat exchange relation with said sump, means for passing line voltage across the run winding and means for passing line voltage across the second circuit when the passage of current to the first circuit is discontinued.

References Cited in the file of this patent

UNITED STATES PATENTS

2,107,887	Davenport	Feb. 8, 1938
2,145,354	Hull	Jan. 31, 1939
2,512,342	Larkin	June 20, 1950

FOREIGN PATENTS

527,448	Great Britain	Oct. 9, 1940
700,028	France	Dec. 22, 1930

OTHER REFERENCES

Electrical World, January 10, 1942, volume 117, pages 88 and 90.