Oct. 5, 1937. E. B. NEWILL 2,094,807

REFRIGERATING APPARATUS

Filed Sept. 28, 1934 2 Sheets-Sheet 1

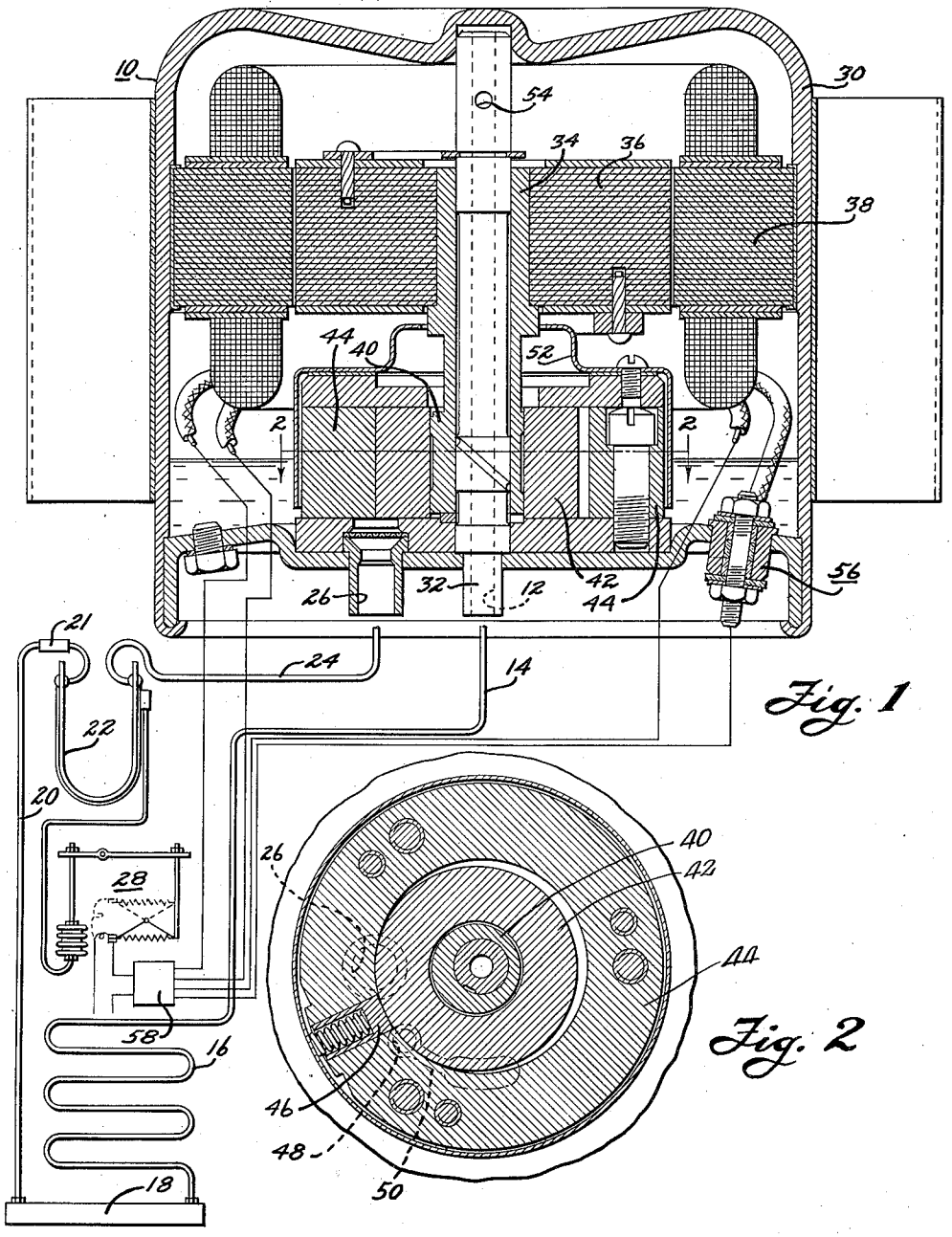


Fig. 1

Fig. 2

INVENTOR
Edward B. Newill,
BY
Spencer, Hardman & Fehr,
ATTORNEYS

Oct. 5, 1937. E. B. NEWILL 2,094,807

REFRIGERATING APPARATUS

Filed Sept. 28, 1934 2 Sheets-Sheet 2

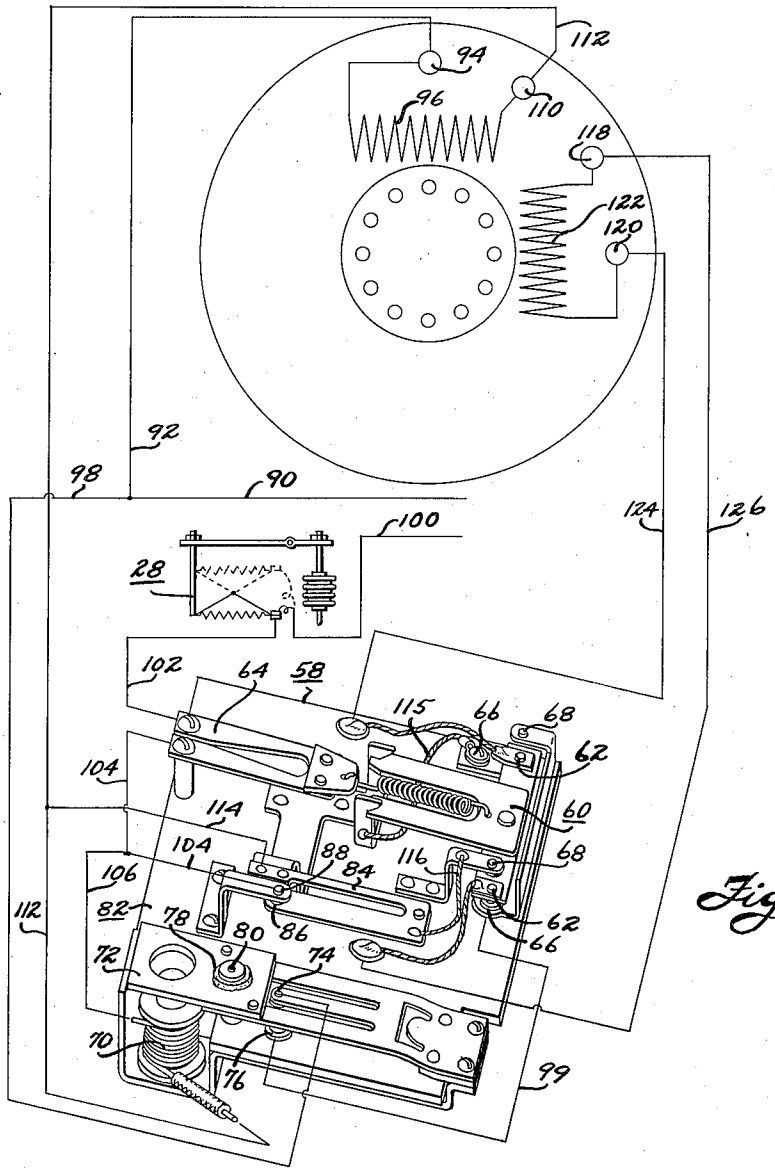


Fig. 3

INVENTOR.
Edward B. Newill,
BY
Bruesar, Hardman & Fyke
ATTORNEYS

Patented Oct. 5, 1937

2,094,807

UNITED STATES PATENT OFFICE

2,094,807

REFRIGERATING APPARATUS

Edward B. Newill, Dayton, Ohio, assignor to General Motors Corporation, Dayton, Ohio, a corporation of Delaware

Application September 28, 1934, Serial No. 745,956

1 Claim. (Cl. 230—2)

This invention relates to refrigerating apparatus particularly of the type including a compressor, a condenser and an expander and more particularly to an improved means for unloading the compressor at the time of starting after an idle period.

In refrigerating apparatus of the character described, particularly those in which a hermetically sealed motor-compressor unit is used, difficulty is sometimes encountered in getting the motor-compressor unit to start after an idle period, due to the fact that the starting torque of the electric motor is necessarily low due to the limitations inherent in a sealed unit construction and is insufficient to start the compressor under full load. Various unloading devices have been in use heretofore, all of which employ some mechanism within the compressor unit itself usually for operating a valve to relieve the load on the compressor during the starting period or until the motor has come up to speed. It has been difficult to construct unloading devices of that type without the use of numerous small parts which are apt to get out of order, and being within the sealed casing of the unit, are thus extremely inaccessible for repair.

It is an object of the present invention, therefore, to devise a novel means for unloading a compressor which may be utilized in connection with a hermetically sealed motor-compressor unit and which avoids the use of any additional mechanism within the sealed casing of such a unit.

A further object is to provide a novel means for unloading a rotary compressor of the type in which the direction of fluid flow therethrough is reversed upon reverse rotation by driving the compressor backwardly at least one revolution before attempting to start the same forwardly.

A further object is to provide a motor-compressor unit having an electric motor capable of operating the compressor reversely as well as forwardly.

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 drawings:

Fig. 1 is a vertical cross section of a motor compressor unit showing diagrammatically the elements of a refrigerating system;

Fig. 2 is a cross section on line 2—2 of Fig. 1; and

Fig. 3 is a perspective view of a switch for controlling the motor of Fig. 1 and showing diagrammatically the circuit connections between the switch and the motor.

Referring now to Fig. 1, there is shown a refrigerating system comprising a hermetically sealed motor-compressor unit 10 having an outlet 12, from which compressed refrigerant is delivered by means of a conduit 14 to a condenser 16. Refrigerant condensed in the condenser 16 is collected in a receiver 18, whence it is delivered by a conduit 20 to an expansion device, preferably a fixed restrictor 21. The restrictor 21 permits the refrigerant to expand into an evaporator 22 for withdrawing heat from an object to be cooled (not shown). The expanded refrigerant is delivered by means of a conduit 24 to the inlet 26 of the motor compressor unit 10. A suitable automatic control switch 28 may be provided for maintaining substantially constant temperatures, the switch illustrated being of the type comprising a thermostat responsive to evaporator temperatures.

The motor-compressor unit may be of any well known type having a prime mover which may be operated in either direction of rotation and having a compressor of the type in which the direction of fluid flow therethrough is reversed on reverse rotation thereof. In the form illustrated in the drawings, the unit comprises a hermetically sealed housing 30 having a central stationary hollow shaft 32 on which is journalled the drive shaft 34 for the motor-compressor unit. The shaft 34 carries at its upper end the rotor 36 of an electric motor. A stator assembly 38 is secured to the inner wall of the housing 30 in a suitable manner and may be of any suitable type capable of operating the rotor 36 in either direction. For example, for use with single phase alternating current, the motor may be either of the split phase or capacitator type having the lead-in connections to the running winding separate from and independent of the lead-in connections to the starting winding rather than having a common lead-in to one side of each. At the lower end of the shaft 34, there is formed an eccentric 40 on which is journalled a cylindrical impeller member 42. A compressor body member 44 is secured to the bottom portion of the housing and includes a cylindrical compression chamber within which the impeller 42 is given a revolving motion by the eccentric 40. A spring pressed divider block 46 (see Fig. 2) divides the compression chamber into a suction space and a com-

pression space. The inlet connection 26 is located in the base plate of the compressor body adjacent one side of the divider block 46, while an exhaust orifice 48 having a flapper valve 50 is provided in the top plate of the compressor body adjacent the opposite side of the divider block 46. The exhaust orifice 48 and flapper valve 50 are shown in dotted lines in Fig. 2 although it will be understood that they are located above the plane upon which the section of Fig. 2 is taken. The gas discharged from the orifice 48 is freed of lubricant by an enclosure member 52 surrounding the compressor body and passes outwardly and upwardly through the air gap of the motor to enter the hollow shaft 32 through one or more openings 54 at the top thereof, whence it is conducted through hollow shaft 32 to the outlet connection 12. Each of the four lead-in connections to the motor is carried through the housing by suitable insulated terminal bushings 56, only one of which is shown, and each of the terminals is connected to a control switch 58 located between the motor and the thermostatic switch 28.

Referring now to Fig. 3, the control switch 58 preferably comprises a snap acting reversing switch 60 having a pair of movable contacts 62 having active contact faces at both the top and bottom of each. The reversing switch 60 may be actuated by a bimetallic member 64 which is adapted to act as a timer in accordance with the rate of current flow therethrough. Each of the movable contacts 62 is adapted to engage alternately either a pair of bottom contacts 66 or a pair of top contacts 68. A master switch for the starting winding is also provided in the switch 58 and comprises a relay including an electromagnet 70 having a movable armature 72 adapted to actuate a movable master contact 74 which coacts with a fixed master contact 76. Suitable stop means is provided for the armature 72 comprising a resilient bumper 78 located on a pin 80 passing through a hole in the armature 72 and anchored to the base member 82. The switch 58 also includes a timer switch for controlling the relay coil 70 and which preferably comprises a bimetallic actuating member 84 having a movable contact 86 coacting with a fixed contact 88 for shunting the relay coil 70.

The circuit connections from the line through the switch 28 and switch 58 to the motor are made as follows: one side 90 of the line is connected by a conductor 92 to a terminal 94 of the running winding 96. The side 90 is also connected by a conductor 98 to the master contact 74. The fixed master contact 76 is connected by a conductor 99 to one of the lower contacts 66 and also to the opposite upper contact 68 of the reversing switch 60. The opposite side of the line 100 is connected through the thermostatic switch 28 to one side of the bimetal actuator 64 by a conductor 102. The other side of the bimetal 64 is connected by conductor 104 to the fixed timer contact 88 and also by conductor 106 to the electro-magnet 70. The electromagnet 70 is in turn connected to the other terminal 110 of the running winding 96 by conductor 112 and to the fixed end of the bimetal timer 84 by conductors 112 and 114. The fixed end of timer 84 is connected by conductor 115 to the other bottom contact 66 of the reversing switch 60. The movable end of the bimetal timer 84 is connected by conductor 116 to the other top contact 68 of reversing switch 60. The terminals 118 and 120 of the starting winding 122 are connected to the movable contacts 62 of the reversing switch 60 by the conductors 124 and 126.

In operation assuming that the motor compressor unit has been idle for a sufficient interval to permit pressure to build up in the compression chamber by gas leakage, but that insufficient time has elapsed for the pressure within the evaporator to become equal to the pressure within the condenser by the passage of refrigerant through the restrictor 21, it will be noted that any leakage of high pressure gas from within the housing 30 into the suction side of the compression chamber will immediately pass through the inlet connection 26 through conduit 24 into the evaporator 22. In other words, the suction side of the compression chamber is always at evaporator pressure regardless of leakage within the compressor while the compression side gradually builds up to condenser pressure.

If it were attempted to start the motor-compressor unit forwardly under these conditions, it will be seen that the compressor is under full load at the instant of starting and unless the motor be made much larger and more powerful than is necessary for normal running, its starting torque will not be sufficient to overcome the resisting force of the compressor.

With the present invention, however, the starting coils of the electric motor are placed in circuit with the line and with the running coils in such a manner that the first rotation of the motor compressor unit is in a backward direction. This in effect causes the compressor to pump refrigerant from the compression chamber and from the exhaust orifice 48 as far up as the seat of the valve 50 into the inlet connection 26 and suction pipe 24. A single revolution of the motor-compressor unit backwardly will serve to completely exhaust the compression chamber and exhaust orifice 48 with the result that the pressure in the compression chamber is made at least as low as the pressure in the suction conduit 24 and often lower. If the reverse rotation be continued, the effect will be substantially negligible and serve merely to maintain the low pressure condition within the compression chamber.

If now the connections to the starting winding be reversed relative to the running winding, the motor will be caused to rotate forwardly and will be able to start effectively since the compressor will have at least a zero starting resistance. If the pressure in the compression chamber has been reduced to a point below that in the suction conduit 24, there will be a slight assistance from the compressor in starting the motor forwardly. As soon as the motor comes to speed, the starting winding may be disconnected from the line and the motor caused to run normally on the running winding alone, as is well known in the art.

The switch 58 operates to cause the sequence of operations described above automatically at each time that the line circuit is closed after an interruption in current supply to the motor. When the bimetal actuator 62 is cold after a period of idleness, it maintains the switch 60 in the down position closing the contacts 62 and 66. This prearranges the apparatus for connecting the starting winding 122 to the line in such relation to the running winding 96 that the motor will run backwardly. When the switch 28 is first closed after a period of idleness, the running winding 96 is placed in circuit across the line in series with the switch 28, the bimetal actuator 64

and the electro-magnet 70. The relay is so calibrated that it will close on the initial surge of current to the running winding alone, but will not stay closed on the normal running current to the running winding alone. This energizes the armature 72 causing the master contacts 74 and 76 to close the circuit to the starting winding 122. The starting winding 122 is thus placed in circuit across the line in series with the switch 28, bimetal actuator 64, and relay coil 70, as well as the master contacts 74 and 76 and the reversing switch contacts 62 and 66. It will be noted that the entire current to the motor passes through the bimetal actuator 64 and through the relay coil 70. This causes a rapid heating of the former, resulting in its flexing upwardly to actuate the reversing switch 60 opening the contacts 62 and 66 and closing the contacts 62 and 68. Likewise, the current of both motor windings is sufficient to hold contacts 74 and 76 closed regardless of motor speed. The movement of switch 60 results in reversing the connection to the running winding 96 and in addition places the bimetal timer 84 in series with the starting winding 122. This change in circuit may be traced by noting that when the reversing switch 60 is down, the circuit to the starting winding 122 from the bimetal actuator 64 is through the conductors 104, 106, coil 70 and conductors 112, 114 and 115 to the bottom contact 66 on the far side of the switch 58. However, when the switch 60 is in the up position, the circuit from the bimetal actuator 64 to the starting winding is through the conductors 104 and 106, relay coil 70, conductors 112 and 114 to the fixed end of the bimetal timer 84 and thence through the conductor 116 to the top contact 68 on the near side of the switch 60. Thus, the bimetal timer 84 is placed in series with the starting windings only when the switch 60 is in the top position in which the motor is connected for starting forwardly. The current to the starting windings passing through the bimetal timer 84 causes the same to warp closing the contacts 86 and 88 after an interval long enough to permit the motor to come up to speed. The closing of the contacts 86 and 88 shunts the electro-magnet 70 by the circuit including conductors 112 and 114, contacts 86 and 88, bimetal timer 84 and conductors 104 and 106. The armature 72 is, therefore, permitted to rise and open the master contacts 74 and 76, thus interrupting the circuit to the starting winding 122. The bimetal timer 84 is permitted to return nearly to normal position by the fact that the current to the running winding which continues to pass therethrough is insufficient to maintain it fully warped. Further energization of the armature 72 is prevented since the normal current in the running winding is insufficient to actuate the same. It will be noted also that the bimetal actuator 64 carries the current for the running winding during normal running of the motor. The proportions of the bimetal actuator are, however, such that the normal running current is insufficient to hold the switch 60 in the up position and thus it is insured that at the beginning of an idle period, the reversing switch 60 will be in a position to connect the starting winding for reverse rotation.

This application is related to application Serial No. 746,245, filed September 29, 1934, in which George C. Pearce is the applicant and in which the automatic means for reversing the direction of rotation is claimed.

It will thus be seen that the present invention provides a novel means and method for insuring the starting of a motor-compressor unit by giving it a reverse rotation before attempting to start it forwardly. Also, the mechanism for thus unloading the compressor is particularly adapted for use with hermetically sealed motor-compressor units and has the advantage that should the unloading mechanism become disarranged for any reason, it may be repaired or replaced without having to open the hermetically sealed casing of the motor-compressor unit.

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, all coming within the scope of the claim which follows.

What is claimed is as follows:

In an intermittently operating system employing a motor driven compressor, means whereby said motor positively operates said compressor first in one direction to unload said compressor, and means whereby said motor will thereafter positively operate said compressor in the opposite direction to compress fluid.

EDWARD B. NEWILL.