Oct. 5, 1937. G. C. PEARCE 2,094,811

REFRIGERATING APPARATUS

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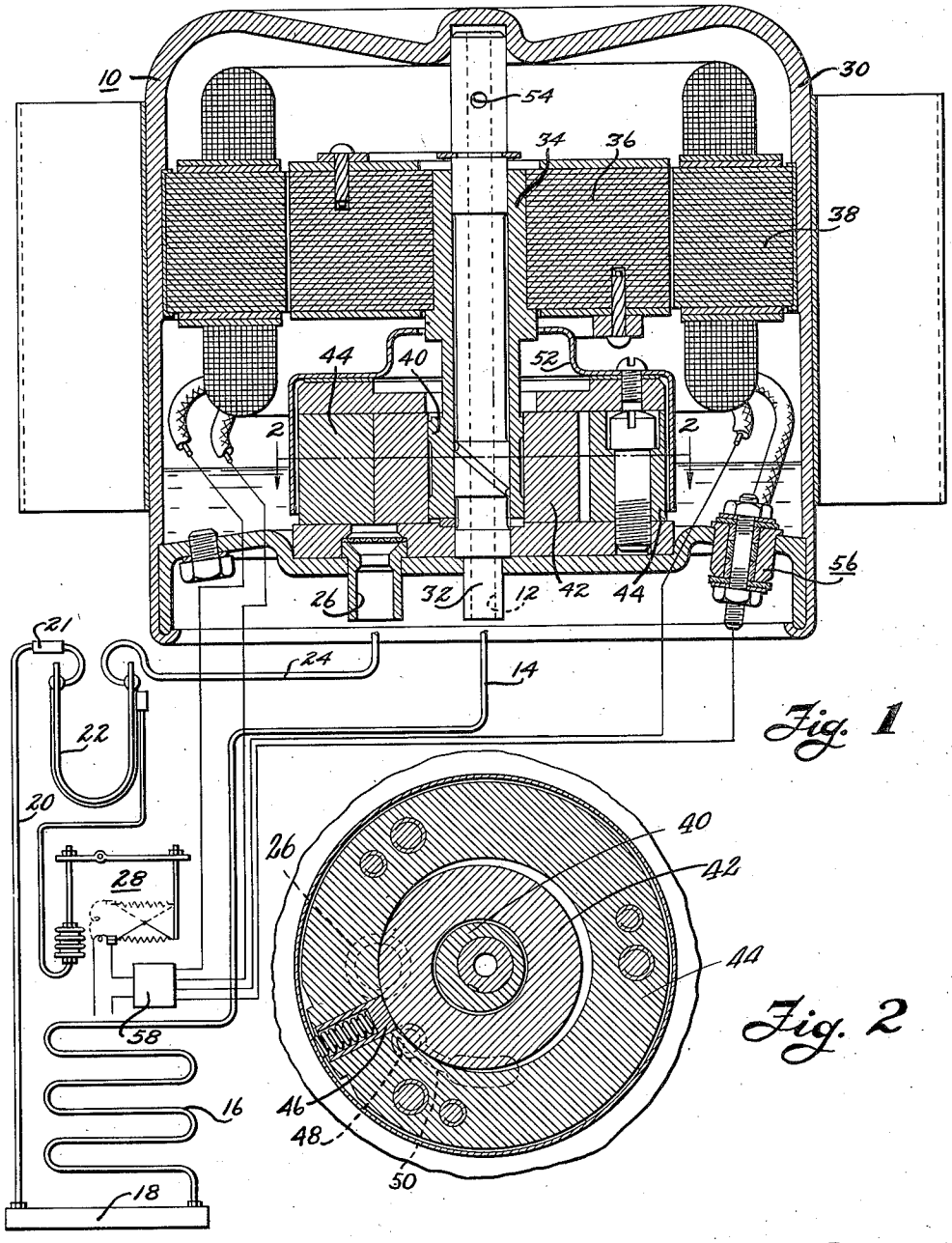


Fig. 1

Fig. 2

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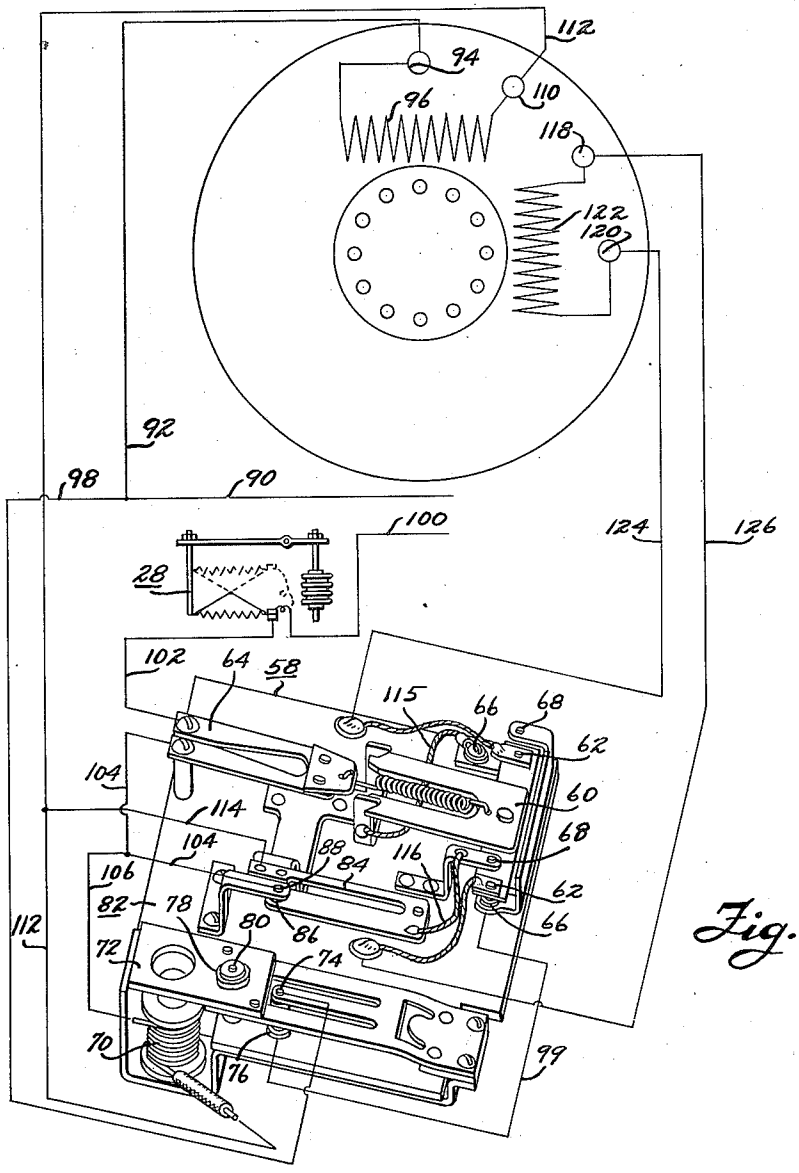


Fig. 3

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REFRIGERATING APPARATUS

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Application September 29, 1934, Serial No. 746,245

13 Claims. (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 and method 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 an automatic mechanism which will operate to cause reverse rotation of the motor-compressor unit before forward rotation is initiated at each time that the main circuit to the motor is closed.

It is also an object to provide a novel switch for a motor-compressor unit which will initiate reverse rotation of the motor before initiating the forward rotation.

It is a further object to provide a novel control switch for a motor-compressor unit which controls not only the direction of rotation of the motor in proper sequence to secure the unloading of the compressor, but also controls the starting windings of the motor to disconnect them after the motor has come up to speed.

A further object is to provide a switch for controlling the direction of rotation of a motor-compressor unit and for controlling the starting windings in such a manner that it is impossible for the motor to be placed into normal running condition in the reverse direction.

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.

This application is related to application Serial No. 745,956, filed September 28, 1934, in which Edward B. Newill is the applicant and in which means whereby the motor positively operates the compressor first in one direction to unload the compressor and means whereby the motor will thereafter positively operate the compressor in the opposite direction to compress fluid is claimed.

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 compression 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 the hollow shaft 32 to the outlet connection 12. Each of the four lead-in connections to the motor are 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 actuator 64 is connected by conductor 104 to the fixed time contact 88 and also by the conductor 106 to the electro-magnet 70. The electro-magnet 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 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 20, 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 **64** 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 calibrated so that it will close on 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 **122** 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 to 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 windings for reverse rotation.

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 claims which follow.

What is claimed is as follows:

1. In an intermittent motor-compressor unit, the combination of a compressor of the type in which the direction of fluid flow therethrough is reversed upon reverse rotation thereof, a reversible electric motor driving the compressor and having starting and running windings, and automatic means operable to connect both the starting and running windings to a source of current for reverse rotation after each period of idleness and subsequently to change said connections to produce forward rotation during the remainder of each operating period.

2. In an intermittent motor-compressor unit, the combination of a compressor of the type in which the direction of fluid flow therethrough is reversed upon reverse rotation thereof, a reversible electric motor driving the compressor and having starting and running windings, and automatic means operable to connect both the starting and running windings to a source of current for reverse rotation after each period of idleness, and subsequently to change the connections of one of said windings to the line while the other winding remains connected as before to produce forward rotation during the remainder of each operating period.

3. In an intermittent motor-compressor unit, the combination of a compressor of the type in which the direction of fluid flow therethrough is reversed upon reverse rotation thereof, a reversible electric motor driving the compressor and having starting and running windings, and automatic means operable to connect both the starting and running windings to a source of current for reverse rotation after each period of idleness, and subsequently to change the connections of one of said windings to the line while the other winding remains connected as before to produce forward rotation, and thereafter to disconnect the starting winding.

4. In an intermittent motor-compressor unit, the combination of a compressor of the type in which the direction of fluid flow therethrough is reversed upon reverse rotation thereof, a reversible electric motor driving the compressor and having starting and running windings, and automatic means operable to connect both the

starting and running windings to a source of current for reverse rotation after each period of idleness, and subsequently to change the connections of one of said windings to the line while the other winding remains connected as before to produce forward rotation, and means conditioned for operation only after the windings are connected for forward rotation for disconnecting the starting winding.

5. In an intermittent motor-compressor unit, the combination of a compressor of the type in which the direction of fluid flow therethrough is reversed upon reverse rotation thereof, a single phase induction motor having starting and running windings, a hermetically sealed casing surrounding the motor and compressor, and an automatic switch outside the casing automatically operable to connect both the starting and running windings to source of current for reverse rotation after each period of idleness and subsequently to change said connections to produce forward rotation during the remainder of each operating period.

6. An intermittently operated motor-compressor unit including a motor and a compressor driven by the motor, said compressor having a compressing chamber provided with a check valve at its outlet for preventing the flow of compressed gas back into the compressing chamber and a piston for the compressor capable of forcing gas from the compressing chamber through the check valve at its outlet when the motor operates in its forward direction, said piston being capable of sweeping gas from the compressor chamber through the inlet to the compression chamber when the motor operates in the reverse direction, said motor having starting and running windings and current responsive control means for first requiring the current to flow through one of said windings in a reverse direction to cause the motor to first turn in a reverse direction after a period of idleness and thereafter causing the current to flow through the motor windings in a normal manner to cause the motor to start and run in the normal forward direction during the remainder of each operating period.

7. A motor-pump unit comprising pumping means having a rotatable drive member and containing a pumping chamber provided with means for preventing entrance of fluid upon reverse rotation of the rotatable drive member to expel fluid from and to evacuate said pumping chamber upon the reverse rotation of the rotatable drive member for unloading said pumping chamber, a reversible electric motor for driving said pumping means through said rotatable drive member, automatic control means effective after a period of idleness of the unit for initially energizing said motor to operate in the reverse direction for reversely rotating said rotatable drive member of said pumping means to evacuate said pumping chamber for unloading said pumping means and then changing the energizing of said motor to operate said motor in the forward direction as long as the motor remains energized irrespective of the length of time of energization of the motor, and a second control means for controlling the energization and deenergization of the motor.

8. A motor-pump unit comprising a pumping means having a pumping chamber provided with means at the outlet of the pumping chamber for preventing the flow of fluid through the outlet into the pumping chamber, said pumping chamber being provided with a pumping member capable of being actuated in one direction to draw in fluid into the pumping chamber and expelling said fluid from the pumping chamber through said outlet, said pumping member being capable of expelling fluid from the chamber through the inlet while preventing the entrance of additional fluid to evacuate the pumping chamber when actuated in the reverse direction, a reversible electric motor for actuating said pumping member, and current responsive control means for first requiring the electric motor to first actuate said pumping member in the reverse direction to unload the pumping means after every period of idleness and thereafter requiring the electric motor to actuate said pumping member in said one direction for pumping fluid during the remainder of every operating period.

9. A motor-pump unit comprising pumping means of the type which is unloaded upon reverse operation thereof, a reversible electric motor having starting and running circuits for operating said pumping means, a reversing switch means biased during idle periods to the reversing position for energizing said electric motor for reverse operation at the start of each operating period to operate the pumping means in the reverse direction to unload the pumping means, means for moving said reversing switch means from reversing to normal position for energizing the electric motor for starting in the normal forward direction, and additional switch means effective only when said reversing switch means is in the normal position for changing the energization of the electric motor starting circuit.

10. A motor-pump unit comprising pumping means of the type in which the pumping chamber is evacuated upon reverse actuation of the pumping means, reversible driving means for actuating said pumping means, and electric curent controlled means effective after every period of idleness of the motor-pump unit to require said reversible driving means to initially operate in the reverse direction to apply reverse actuation to the pumping means to evacuate the pumping chamber and unload the pumping means and thereafter to change the control of said reversible driving means to require the driving means to operate in the forward direction to normally actuate the pumping means for pumping purposes as long as the unit continues to operate irrespective of the length of time of operation.

11. A motor-pump unit comprising pumping means having a rotatable drive member and containing a pumping chamber provided with means for preventing the entrance of fluid upon reverse rotation of the rotatable drive member and provided with means for expelling fluid from and to evacuate said pumping chamber upon the reverse rotation of the rotatable drive member for unloading said pumping chamber, a reversible electric motor for driving said pumping means through said rotatable drive member, electric current controlled means effective after a period of idleness of the unit for initially energizing said motor to operate in the reverse direction for reversely rotating said rotatable drive member of said pumping means to evacuate said pumping chamber for unloading said pumping means and then changing the energization of said motor to operate said motor in the forward direction as long as the motor remains energized irrespective of the length of time of energization.

12. A motor-pump unit comprising pumping means having a rotatable drive member and con-

taining a pumping chamber provided with means for preventing the entrance of fluid upon reverse rotation of the rotatable drive member and provided with means for expelling fluid from and to evacuate said pumping chamber upon the reverse rotation of the rotatable drive member for unloading said pumping chamber, a reversible electric motor for driving said pumping means through said rotatable drive member, temperature controlled means effective after a period of idleness of the unit for initially energizing said motor to operate in the reverse direction for reversely rotating said rotatable drive member of said pumping means to evacuate said pumping chamber for unloading said pumping means and then changing the energization of said motor to operate said motor in the forward direction as long as the motor remains energized irrespective of the length of time of energization.

13. In an intermittent motor-compressor unit, the combination of a compressor of the type in which the direction of fluid flow therethrough is reversed upon reverse rotation thereof, a reversible electric motor driving the compressor, and automatic means operable to drive the motor in a reverse direction to unload the compressor after each period of idleness and subsequently to cause said motor to produce forward rotation during the remainder of each operating period.

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