Sept. 11, 1962 W. L. McGRATH 3,053,057

PROTECTIVE DEVICE FOR COMPRESSOR IN AIR CONDITIONING UNIT

Filed March 4, 1960

FIG. 3

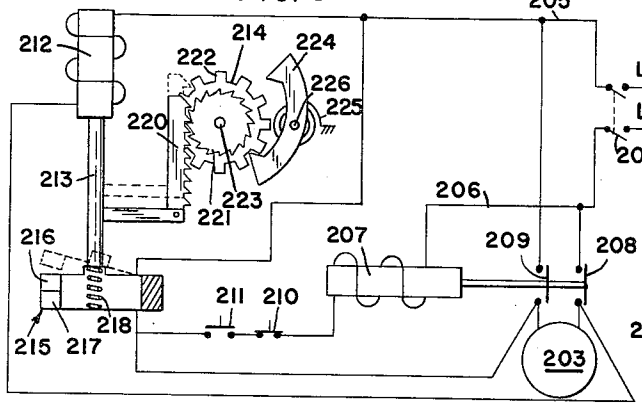
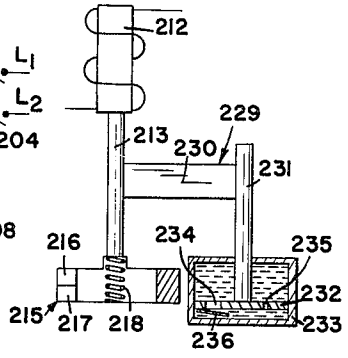


FIG. 4



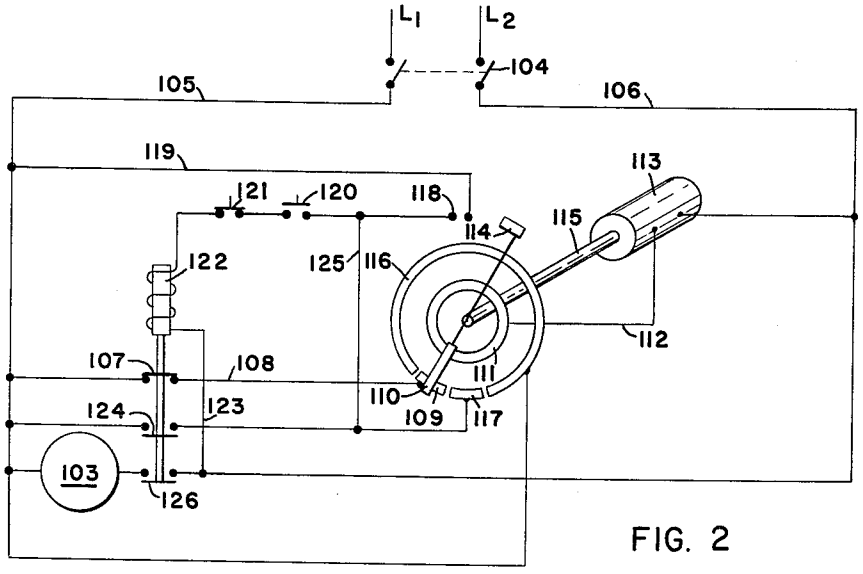


FIG. 2

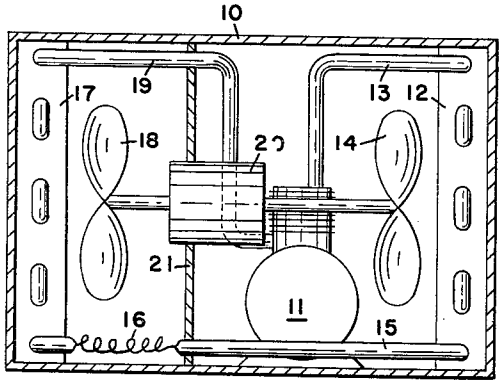


FIG. 1

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United States Patent Office 3,053,057
Patented Sept. 11, 1962

3,053,057

PROTECTIVE DEVICE FOR COMPRESSOR IN AIR CONDITIONING UNIT

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Filed Mar. 4, 1960, Ser. No. 12,783
4 Claims. (Cl. 62—158)

This invention relates to an air conditioning unit, and more particularly to a new protective device for compressors used in the refrigerating systems of such unit.

The general object of this invention is to provide an air conditioning unit having a refrigerating system including a compressor motor protection system wherein when the compressor motor stops, it will normally not be permitted to restart until a predetermined period of time subsequent to stopping has elapsed.

In the conventional air conditioning unit refrigerating system, when the electrical circuit to the compressor motor is opened for any reason, as for example by opening a safety switch responsive to an abnormal load condition in the electrical circuit, the circuit is completed again immediately by closing the safety switch. The refrigerant pressure in the system may not have had sufficient time to equalize so that when the circuit is closed, the split capacitor motor commonly employed to drive the compressor, having a low starting torque, will be unable to start the compressor. The overload relay usually provided would prevent the surge current from running through the motor for too long a period of time if the motor should fail to start, but continued rapid cycling of the overload relay would result in overheating and damage to the insulation on the motor windings.

On repeated power interruptions, the compressor of the conventional system could cycle rapidly and the compressor motor could be thrown across the line with reduced voltage presenting a possibility of damage.

This invention relates to an air conditioning unit having in combination a casing, a refrigeration system including a compressor, a condenser, expansion means and an evaporator placed in the system in such order, a partition dividing the casing into a condenser compartment and an evaporator compartment, a motor operatively connected to said compressor, a condenser fan for supplying air over the condenser, an evaporator fan for supplying air over the evaporator, motor means for actuating said fans, a circuit adapted to be connected to a source of electric current, control means for interrupting the circuit in response to an abnormal load condition, and timing means in the circuit energized in response to interruption of the circuit by the control means to hold the circuit open for a predetermined length of time, whereby, when the control means interrupts the circuit, the motor is stopped and restart is substantially prevented until after the predetermined length of time.

The specific details of the invention and their mode of functioning will be made most manifest and particularly pointed out in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a schematic illustration of a type of air conditioning unit to which the present invention applies;

FIGURE 2 is a schematic wiring diagram of a preferred form of applicant's air conditioning unit compressor motor protection system;

FIGURE 3 is a schematic wiring diagram illustrating a modified form of compressor motor protection system; and

FIGURE 4 schematically illustrates a modification of the retarding means shown in FIGURE 3.

Referring now more particularly to the drawings, like numerals in the various figures will be taken to designate like parts.

One embodiment of the invention will be described as it pertains to an air conditioning unit of the room cooler type which is schematically illustrated in FIGURE 1. As is well known to those skilled in the art a housing or casing 10 supports the components of the room cooler within a window having the lower sash in the raised or upper position. The casing 10 is usually positioned within a cradle secured to the window sill. A motor-compressor unit 11, which may be hermetically enclosed, forwards high pressure vaporous refrigerant to the condenser 12 through line 13. The vaporous refrigerant is converted to the liquid phase in the condenser as air at ambient temperatures is circulated over condenser 12 by fan 14. From the condenser, the liquid refrigerant flows through line 15 to an expansion means shown in the form of a capillary tube 16. It will be obvious that other expansion means, such as an expansion valve, may be used in place of the capillary tube. The liquid refrigerant flows from the capillary tube 16 to the evaporator 17 where a change in phase occurs as air at room temperature is circulated over the evaporator by fan 18. Electric motor 20 drives the fans 14 and 18 although separate motors may be employed if desired.

The liquid refrigerant in the evaporator is evaporated by its heat exchange relation with the warm air directed over the evaporator by fan 18, the vapor returning to compressor 11 through suction line 19 while the cooled air is directed through grilles formed in casing 10 into the room to be treated.

A partition 21 in the casing divides the refrigeration system in such a manner that the compressor and condenser is located in that part of the casing positioned outside the window and the evaporator in that part of the casing positioned inside the window.

A preferred form of compressor motor protection system is shown in FIGURE 2. A suitable source of current (not shown) is adapted to supply current via lines L_1 and L_2 to split phase motor 103 which drives the compressor. It will be, of course, understood that the system can operate on three-phase current if it is suitably modified. A suitable manual switch 104 is provided to selectively control the flow of current to lines 105 and 106.

Preferably the time delay means includes a timing motor 113, a contactor ring 111, and a plurality of contactor segments 109, 116 and 117, concentrically disposed about the contactor ring. The timing motor drives shaft 115 to which are secured a pair of commutator arms 110 and 114. Commutator arm 110 makes electrical contact between one of the contactor segments and the contactor ring. The outer extremity of arm 114 is adapted to close switch 118.

The motor controller means or starting relay includes a winding or coil 122, normally closed contact 107, and two normally open contacts 124 and 126.

The control means comprise thermal-actuated switch 120 responsive to the temperature in the area to be air conditioned, and safety switch means connected in series therewith. The safety switch means may comprise a normally closed high pressure cutout switch 121 attached to the compressor or any other part of the high pressure side of the refrigeration system and operable to open the circuit if the compressor pressure exceeds a predetermined maximum. As will be apparent to those skilled in the art, other safety switches, as for example, a high temperature compressor motor cutout switch, a low suction pressure switch, a low oil pressure switch or an overload switch may be placed in the circuit, if desired.

When manual switch 104 is closed, closure of thermal actuated switch 120 completes a circuit through L_1, switch 104, line 105, line 119, switch 118, switch 120, switch 121, starting relay winding 122, line 123, and line 106 energizing the starting relay winding 122, opening

contact 107 and closing contacts 124 and 126. A circuit is completed through the compressor motor 103 via line 106, contact 126, compressor motor 103 and line 105, starting the compressor motor.

At the same time a circuit is completed to the timing motor via line 105, contact 124, contactor segment 117, arm 110, timing motor 113 and line 106. When arm 110 moves onto contactor segment 109, the outer extremity of arm 114 opens the switch 118, and since contact 107 is open, the circuit is broken and the timing motor is stopped. The circuit remains in this condition for normal operation of the compressor.

During normal operation, if thermal-actuated switch 120 or safety switch 121 is opened the starting relay winding 122 is deenergized, closing contact 107 to energize contactor segment 109. A circuit is completed through L_1, switch 104, line 105, contact 107, line 108, contactor segment 109, commutator arm 110, contactor ring 111, line 112, timing motor 113, line 106, and line L_2. Timing motor 113 is energized and arms 110 and 114 are rotated clockwise about the axis of shaft 115. The arm 110 moves from segment 109 and engages contactor segment 116 completing a holding circuit through line 105, contact segment 116, arm 110, contactor ring 111, line 112, timing motor 113 and line 106. The arms rotate approximately 340° in an interval of four to five minutes during which switch 118 remains open making it impossible to energize the starting relay winding 122 and operate the compressor motor 103. During this portion of the timing cycle which continues for a period of approximately four to five minutes starting of the compressor motor is precluded. When the arm 110 engages contactor segment 117, the outer portion of arm 114 closes switch 118 and, provided if the thermal-actuated switch 120 or safety switch 121 has remained open, the timing motor commences another timing cycle. If the open switch 120 or 121 closed during the timing cycle, upon closing of switch 118, a circuit would be completed via line L_1, line 105, line 119, switch 118, switches 120 and 121 starting relay winding 122, line 123, line 106 and line L_2, energizing starting relay winding 122. Contact 107 is opened and contacts 124 and 126 are closed. Upon closing of contact 126, compressor motor 103 is energized. When arm 110 moves from contactor segment 117 to contactor segment 109 the circuit to timing motor 113 is broken, as contact 107 is open, and timing motor 113 is de-energized.

Another modification of our invention is illustrated in FIGURE 3. Current is supplied via lines L_1 and L_2 to the motor 203 which drives the compressor. Manual switch 204 selectively controls the flow of current from lines L_1 and L_2 to lines 205 and 206.

The motor controller means or starting relay includes coil or winding 207 and normally open contacts 208 and 209.

The control means includes a thermal-actuated switch 211 responsive to a predetermined temperature condition in the area to be air conditioned and a safety switch 210. The safety switch may be a high pressure cutout switch. Other safety switches can be used, as previously explained.

The timing means shown in FIGURE 3 comprises a solenoid coil 212, an armature 213, retarding means 214, and timing switch 215. The contacts 216 and 217 of the timing switch are urged to open position by suitable means, preferably a spring 218.

The retarding means or escapement mechanism 214 includes a rack 220 secured to the armature 213, a ratchet wheel 221 coaxially mounted on shaft 223 with ratchet wheel 222, double ended pawl 224 mounted on shaft 226, and spring 225 for urging the lower end of the pawl 224 into engagement with the ratchet wheel 222.

A cycle of operation will be briefly described. Switch 204 is normally closed as is switch 210. Since coil 212 is deenergized, the armature is in its lower position, maintaining the timing switch 215 closed. When switch 211 is closed in response to a predetermined temperature condition, a circuit is completed through line 206, winding 207, switch 210, switch 211, timing switch 215 and line 205, energizing the winding 207. Upon energization of winding 207, contacts 208 and 209 are closed and a circuit is completed through line L_1, line 205, contact 209, motor 203, contact 208, line 206, and line L_2, starting the motor 203. A split-phase motor or capacitor motor may be used, as desired.

At the same time, a circuit is completed through line 205, solenoid coil 212, contact 208, and line 206, energizing the solenoid coil 212 and raising the armature 213. The armature rises rapidly for the teeth on rack 220 merely slide past the teeth on wheel 221. Spring 218 urges the contacts 216 and 217 apart to open timing switch 215.

If thermal-actuated switch 211 or safety switch 210 were opened, the winding 207 would be deenergized and contacts 208 and 209 would open, stopping motor 203. Solenoid coil 212 would be deenergized. The armature 213 would start to fall, but the falling would be slowed by retarding means 214. The closing of the timing switch is delayed for about four minutes. If during this interval of time the switch 210 or switch 211 should be closed, restart is precluded, for timing switch 215 is open. After the predetermined interval of time, the motor 203 can be started as soon as switch 215 is closed.

A dash pot-type of retarding means 229 is shown in FIGURE 4. This retarding means can be used in place of the escapement mechanism depicted in FIGURE 3.

An arm 230 is connected between the armature and piston rod 231. Piston rod 231 is secured to piston 232 movable in cylinder 233. If desired, the cylinder may be filled with oil. A large orifice 234 and a small orifice 235 are formed in the piston. A check valve 236 is mounted on the piston 232. It is to be understood that other types of dash pot retarding means could be used without departing from the spirit of the invention.

When the coil 212 is energized, the check valve 236 opens and permits the rapid porting of fluid through orifice 234. Armature 213 is permitted to move upwardly rapidly and the spring 218 can open the contacts 216 and 217 of the timing switch 215. Upon deenergization of the coil 212, the armature falls slowly, for check valve 236 closes and the fluid in the chamber below piston 232 can flow to the chamber above piston 232 only through orifice 235. The retarding means provides a delay of about four minutes duration between deenergizing of coil 212 and closing of timing switch 215. As set forth with regard to the modification of FIGURE 3, the motor 203 cannot be started subsequent to stopping until the timing switch 215 is closed.

I have provided an air conditioning unit with a refrigerating system having novel compressor motor protection means to provide an automatic delay in restarting subsequent to the deenergization of the compressor motor. The compressor motor is protected against damage from abnormal conditions in the electrical power distribution system and is also protected against damage from abnormal conditions in the refrigerating system. The novel compressor motor protection means can be employed in applications other than in air conditioning units, as for example, in refrigerating systems in general, and in condensing units.

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

I claim:

1. A control circuit for a compressor motor comprising a supply circuit for said motor; a controller including a first switch for connecting said motor to said supply circuit, said controller including an energizing winding, a second normally closed switch and a third normally

open switch; a switch device; a normally open timing switch, a timing motor; a contactor ring; first, second, and third contact segments concentrically disposed about the contactor ring; a pair of oppositely disposed commutator arms operatively connected to said timing motors; one of said commutator arms engaging the contactor ring and one of the contactor segments and the other of said commutator arms adapted to close the timing switch; a first circuit connecting said second controller switch, said first contact segment, said one of said commutator arms, said contactor ring, and said timing motor in series with the supply circuit; said second contact segment connected to the supply circuit across said second controller switch and said first contact segment; a second circuit connecting said timing switch, said switch device, and said controller winding in series with the supply crcuit; a third circuit connecting said third normally open controller switch and said third contactor segment in series with the supply circuit; and a fourth circuit connected to said second circuit between the timing switch and switch device and connected to the third circuit between the third controller switch and the third contactor segment; whereby, when the switch device is closed, the timing motor is energized to rotate the commutator arms, closing the timing switch and opening the third circuit to stop the timing motor, closing of the timing switch permitting the controller winding to be energized thus closing the first controller switch and energizing the compressor motor, and when the switch device is opened, the controller winding is deenergized, stopping the compressor motor, and the timing motor is energized to open the timing switch to substantially preclude restarting of the compressor motor for a predetermined period of time.

2. In a refrigerating system, the combination of a compressor, a condenser, expansion means and an evaporator connected in such order; an electric motor for actuating the compressor; a supply circuit for energizing the electric motor; means for opening and closing the supply circuit in response to predetermined load conditions to start and stop the electric motor; a timing switch in said supply circuit; a timing motor in said supply circuit; contactor means in said supply circuit; and commutator means driven by said timing motor and engaging said contactor means, said timing switch being maintained open for a predetermined interval of time for substantially precluding starting of the electric motor for a predetermined period of time subsequent to stopping of the electric motor.

3. In an air conditioning unit, the combination of a casing, a refrigeration system in said casing including a compressor, condenser, expansion means, and an evaporator interconnected in refrigerant flow relationship, a partition in said casing forming a condenser compartment and an evaporator compartment; an electric motor for actuating the compressor; a circuit for connecting said motor to a source of electric current; means for opening and closing the circuit in response to predetermined load conditions to start and stop the electric motor; and timing means including a timing switch in said circuit, contactor means in said circuit, commutator means for engaging said contactor means, and a timing motor in said circuit for selectively moving said commutator means into engagement with said contactor means and operative in response to opening of the circuit to maintain the timing switch open for a predetermined interval of time for substantially precluding starting of the electric motor for a predetermined period of time subsequent to stopping of the electric motor.

4. In an air conditioning unit, the combination of a casing, a refrigerating system in said casing including a compressor, a condenser, expansion means and an evaporator interconnected in refrigerant flow relationship, a partition in said casing forming a condenser compartment and an evaporator compartment; an electric motor for actuating the compressor; a circuit for connecting said motor to a source of electric current; means for opening and closing the circuit in response to predetermined load conditions to start and stop the electric motor; a starting relay in the circuit for connecting said electric motor to a source of current; and timing means including a timing switch in said circuit, a timing motor in said circuit operative in response to opening of the circuit to maintain the timing switch open for a predetermined interval of time for precluding starting of the electric motor for a predetermined period of time subsequent to stopping of the electric motor, a pair of commutator arms driven by said timing motor, a contactor ring, and contact segments concentrically arranged around said contactor ring, one of said commutator arms engaging the contactor ring and a contact segment to permit energizing the timing motor and the other arm closing the timing switch in the circuit at the end of the predetermined period of time to permit energization of the starting relay.

References Cited in the file of this patent

UNITED STATES PATENTS

2,276,369	Buchanan	Mar. 17, 1942
2,500,298	Smith	Mar. 14, 1950

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,053,057 September 11, 1962

William L. McGrath

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 34, strike out "provided"; column 5, line 5, for "motors" read -- motor --.

Signed and sealed this 26th day of March 1963.

(SEAL)
Attest:

ESTON G. JOHNSON
Attesting Officer

DAVID L. LADD
Commissioner of Patents