Nov. 19, 1935. G. C. PEARCE 2,021,199

RELAY

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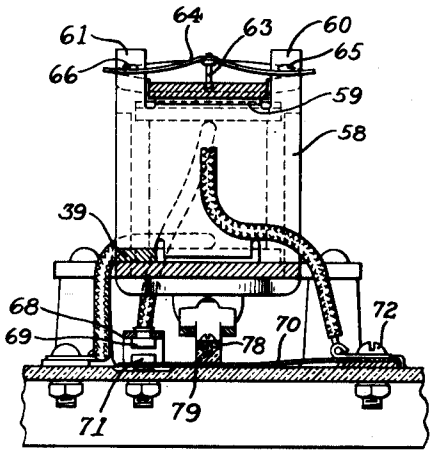


Fig. 3

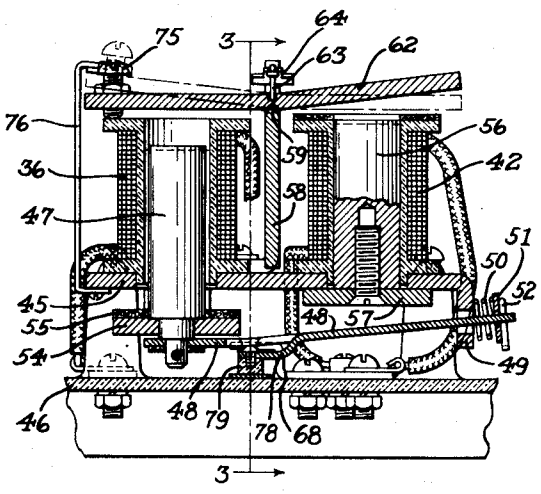


Fig. 2

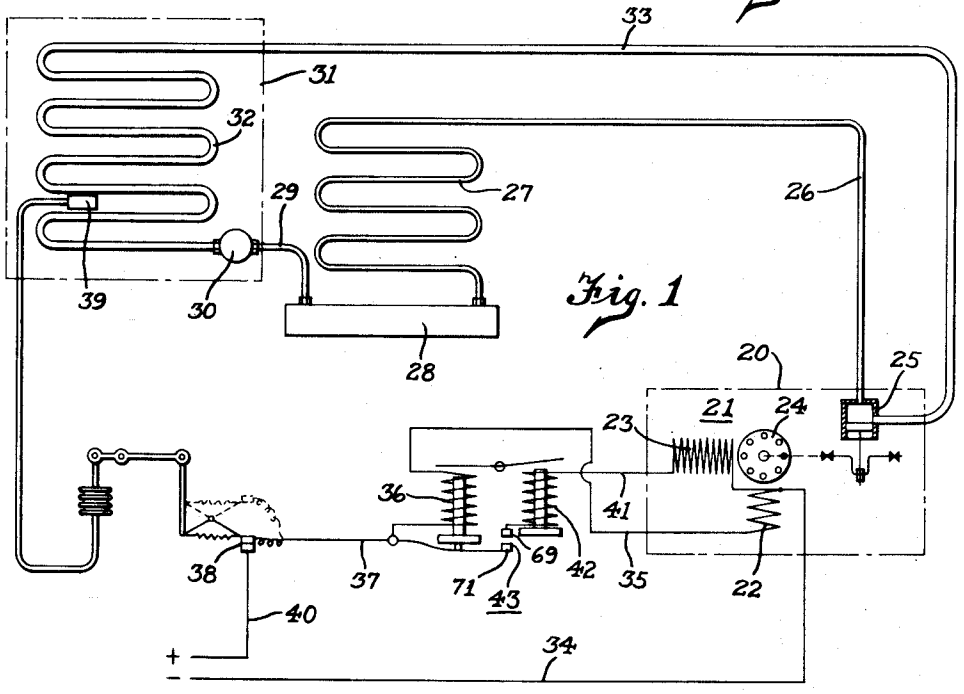


Fig. 1

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RELAY

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7 Claims. (Cl. 172—279)

This invention relates to refrigerating apparatus and more particularly to starting relays for single phase induction motor-compressor units.

It is customary to provide a running winding which is constantly across the power lines when the motor is in operation and a starting winding of high resistance which is only energized during the starting period to provide a rotating field. For efficient operation of the motor it is desirable to open the starting winding circuit at a certain speed. This however, varies slightly with a line voltage.

Various schemes have been provided for automatically opening the circuit of the starting winding. For open motors the centrifugally operated switch has proved to be satisfactory. However, in certain types of refrigerating systems it is desirable to place the motor and compressor within a sealed unit so that all the rotating parts are placed in one enclosed unit, eliminating stuffing boxes and providing simplicity. This necessitates the operation of the motor within the refrigerant and prevents the satisfactory use of a centrifugally operated switch in connection with a motor so situated. For this reason a gravity operated current relay or electromagnetically operated switch, which closes the starting winding circuit of the motor by the effect of the initial inrush of current through the running windings and the electromagnet upon starting the motor, and which opens the starting winding circuit when the current drops and the electromagnet weakens after the motor picks up speed, has been employed for this purpose. This type of relay however has not been found to be very satisfactory under varying voltage conditions since under conditions of low voltage a relay opens the starting winding too soon and under conditions of high voltage the relay opens the starting winding too late and sometimes not at all. When the relay fails to open the starting winding circuit, the starting winding may burn out.

Consequently, the object of my invention includes the provision of an improved starting relay for an induction motor having compensating means for varying line voltage for insuring the opening of the starting winding circuit at the proper time.

A more specific object of the invention is to provide a compensating means actuated by an electromagnet in the starting winding circuit for a gravity operated current relay which is closed by the initial inrush of current to the running winding of the motor and opened by gravity as the motor comes up to speed, and the current correspondingly increases.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawing:

Fig. 1 is a diagrammatic illustration of the sealed motor compressor unit having an electric motor of a split phase single phase induction type together with a diagrammatic illustration of the remaining element of a compression refrigeration system;

Fig. 2 is a vertical sectional view of my improved relay, and

Fig. 3 is a sectional view along the line 3—3 of Fig. 2.

Referring to the drawing and more particularly to Fig. 1, there is shown diagrammatically for the purposes of illustrating the invention, a sealed motor compressor unit 20 containing a split phase induction motor 21 having a running winding 22, a starting winding 23 and a squirrel cage rotor 24 directly connected to a compressor 25. The refrigerant compressed by the compressor 25 is forwarded through a supply conduit 26 to a condenser 27 where the refrigerant is condensed and collected in the receiver 28. The refrigerant collected in the receiver 28 is forwarded through the short conduit 29 to an expansion valve 30 of any suitable type located within a cold storage compartment 31. The refrigerant, after passing through the expansion valve 30, passes into the evaporator 32 also located within the cold storage compartment 31 where the liquid refrigerant vaporizes under reduced pressure and is returned to the compressor through the return conduit 33.

The electrical circuit for the single phase induction motor comprises the electrical conductor 34 which is connected to one end of both the starting winding 23 and the running winding 22 for supplying electrical energy thereto. The other end of the running winding 22 is connected by means of an electric conductor 35 to the solenoid or relay coil 36 which in turn is connected by means of the electrical conductor 37 to the snap acting switch 38 which is operated by means of a thermostatic bulb 39 located within the cold storage compartment 31. The snap acting thermostatically controlled switch 38 is connected by means of the electrical conductor 40 to the other wire of the single phase alternating current power

supply. The other end of the starting winding 23 is connected by means of an electrical conductor 41 to a second solenoid or relay coil 42. The relay coil 42 is connected through the switch 43 to the electrical conductor 37. The switch 43 is closed by the attraction of the relay coil or electro-magnet 36 to open and close the starting winding circuit at the proper time.

The starting relay is shown in more detail in Figs. 2 and 3. The electro-magnet 36, which is connected in the running winding circuit, and the relay coil or electro-magnet 42, which is connected in the starting winding circuit, are both mounted upon a platform 45 which is in turn mounted upon a bakelite switch base 46. The electro-magnet 36 is provided with a vertically movable core member 47, preferably of soft iron, which is connected at its lower end to a lever 48 which is pivoted at the opposite end of the platform 45 by having its end passing through an aperture 49 and provided with a coil spring 50, a washer 51, and the cotter pin 52. The movable armature 47 is provided at its lower end with a collar 54 and a felt pad 55 for a cushion. The electro-magnet 42 is provided with a fixed armature 56, also of soft iron, which is provided with a bottom plate 57, also of soft iron.

Between the electro-magnet 36 and 42 there is provided a vertical non-magnetic plate member 58 having feet 39 at its lower end which are mounted upon the platform 45 by means of suitable screws and nuts. The upper end of the vertical plate member 58 is provided with a knife edge 59 which is provided with two upwardly extending projections 60 and 61 at each side. A tilting armature of soft iron 62 is pivotally mounted upon the knife edge 59 at its middle and has its ends extending one over the electro-magnet 36 and the other over the electro-magnet 42. The tilting armature 62 is held upon the knife edge 59 by means of a pin 63 which has its lower end held within a recess in the top of the tilting armature 62 and which has its other end held by a leaf spring 64 having its ends forked so as to receive the upstanding projections 60 and 61 of the sheet metal member 58 and which has its ends held down by the cotter pins 65 and 66 which pass through the upstanding projections 60 and 61.

Mounted upon the switch base 46 is a Z-shaped sheet metal member 68 which supports a stationary contact 69. A leaf spring 70 supports at one end a movable contact 71 which is adapted to contact with the stationary contact 69 to close the starting winding circuit. The leaf spring 70 is mounted upon the base 46 at its other end by means of the nut and screw 72. The spring is provided with such a tension as to hold the starting winding contacts 69 and 71 closed. The lever 48 to which the movable armature 47 is connected has a foot or bent down tongue 78 provided with a button 79 which rests upon the flat spring 70 to hold the contacts 69 and 71 separated when the movable armature 47 is in its lower or released position. The tilting armature 62 is provided with a set screw 75 at the end over the electro-magnet 36. This set screw is provided for varying the air gap between the movable armature 47 and the tilting armature 62 when the tilting armature 62 is in full line position, as shown in Fig. 2. By reducing the air gap between the movable armature 47 and the tilting armature 62, the electro-magnet 36 is strengthened; conversely as the air gap is increased the electro-magnet 36 is weakened. A sheet metal stop member 76 has its lower end fastened to the platform 45 and its upper end bent inwardly so as to serve as a stop for the upward movement of the one end of the tilting armature 62 so as to prevent too great a clockwise movement of the tilting armature.

The operation of the starting relay is as follows: When the thermostatic switch 38 is opened and neither winding is energized, the tilting armature 62 assumes the full line position shown in Fig. 2. Likewise, the movable armature 47 is in its lower position, maintaining the starting winding contacts 69 and 71 separated. When the thermostatic switch 38 closes, the current will flow through the running winding 22 and the electro-magnet 36. This initial current is far above the normal amount of current consumed since the motor is stationary and this causes a sufficient pull of the electro-magnet 36 upon the movable armature 47 to raise the movable armature 47 and the lever 48 to allow the flat leaf spring 70 to spring upwardly and to close the starting winding contacts 69 and 71. The closing of the starting winding contacts 69 and 71 will permit electric current to flow through the starting winding 23 as well as the electro-magnet 42. By reason of its high resistance, the starting winding 23 will produce a magnetic field acting upon the rotor 24 which is slightly out of phase from that provided by the running winding 22 and as a result there is provided a rotating field which will cause the rotor 24 to rotate and increase in speed. As the motor increases in speed, the amount of current flowing through the starting and running windings will be reduced so that finally the attraction of the electro-magnet 36 upon the armature 47 will become so weak that the armature 47 will fall or drop out and separate the starting winding contacts 69 and 71.

The current flowing through the starting winding circuit is responsive to the line voltage and the speed of the motor. For the same motor speed the current through the coil or electro-magnet 42 will vary according to the line voltage. Therefore, the pull of the electro-magnet 42 will vary according to the line voltage. The set screw 75 of the tilting armature 62 is preferably so set as to make the air gap such an amount that the starting relay will operate properly at the lowest line voltage which is to be met in operation. At this lowest line voltage the tilting armature 62 will be in the full line position of Fig. 2. However, when higher line voltages occur, the attraction of the electro-magnet 42 upon the tilting armature 62 will be increased, causing the tilting armature 62 to be tilted clockwise a sufficient amount, which is controlled by the attraction of both the electromagnets, so as to increase the air gap a sufficient amount to cause the electro-magnet 36 to be weakened and to permit the movable armature to fall or drop out sooner at a lower speed and in this way give a proper compensation for higher voltage operation. The tilting armature 62 will move to the proper position to properly compensate for line voltages above the minimum for which the starting relay is set. In this way proper starting of the compressor motor is assured. An advantageous feature of this starting relay is that the opening of the starting winding circuit also prevents the flow of current through the compensating electro-magnet 42, preventing any consumption of the electric energy after tripping the starting switch and also preventing any chattering of the tilting armature 62.

Thus I have provided a starting relay which

properly compensates itself for varying line voltages and which also prevents the use of the electrical energy by the compensating electromagnet after the starting relay has tripped, thus preventing chattering of the tilting armature 62 which is then held in full line position by the attraction of the electro-magnet 36.

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. A starting relay switch for an induction motor, including a solenoid having a movable armature, a second solenoid, a set of switch contacts, means connecting said movable armature and one of said switch contacts to open and close said switch contacts, and means controlled by the magnetic attraction of the first mentioned and the second solenoid for varying the actuation of the movable armature.

2. A starting relay switch for an induction motor including a solenoid having a movable armature with a variable air gap, a second solenoid, a set of switch contacts, means connecting said movable armature and one of said switch contacts to open and close said switch contacts, and means controlled by the magnetic attraction of said first mentioned and said second solenoids for controlling the air gap of the movable armature.

3. A starting relay switch for an induction motor including a solenoid having a movable armature with a variable air gap, a second solenoid, a set of switch contacts, means connecting said movable armature and one of said switch contacts to open and close said switch contacts, and means moved by said second solenoid for increasing the air gap of the movable armature.

4. A starting relay switch for an induction motor including two solenoids, one of said solenoids having a movable armature, a pivoted compensating armature in inductive relation with both of said solenoids, a set of switch contacts, said movable armature being operatively connected with one of said switch contacts to open and close said switch contacts.

5. A starting relay switch for an induction motor including a solenoid having a stationary armature, a second solenoid having a movable armature, said solenoids being positioned side by side, a tilting compensating armature in inductive relation with both of said solenoids, the power of said second solenoid being varied by the movement of said tilting compensating armature, a set of switch contacts, said movable armature being connected to one of said switch contacts to open and close said switch contacts.

6. A starting control means for a single phase induction motor having a running winding and a starting winding including an electrical circuit for supplying electrical energy to said starting and running windings, a solenoid in series with said running winding, a set of switch contacts in series with said starting winding adapted to be opened and closed to control the flow of electrical energy to the starting winding, a movable armature for said solenoid, said movable armature being connected to close said switch contacts when attracted by said solenoid and being returned by yielding means to open said switch contacts, and electromagnetic means in series with said starting winding for varying the inherent strength of said solenoid to compensate for varying voltage conditions to cause said switch contacts to be opened at the proper time.

7. An electromagnetic switch for an electric circuit including a solenoid having a movable armature, a second solenoid, a tilting armature in inductive relation with each of said solenoids, a switch means connected to one of the armatures for controlling the flow of electric energy through the electric circuit, said other armature having means for varying the effective strength of one of the solenoids.

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