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Cook

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[54] **COLD WEATHER STARTING CONTROL MEANS FOR REFRIGERATING SYSTEMS**

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[51] **Int. Cl.** **G05d 23/32,** F25d 17/00

[58] **Field of Search** 62/158, 157, 180, 181, 187

[56] **References Cited**

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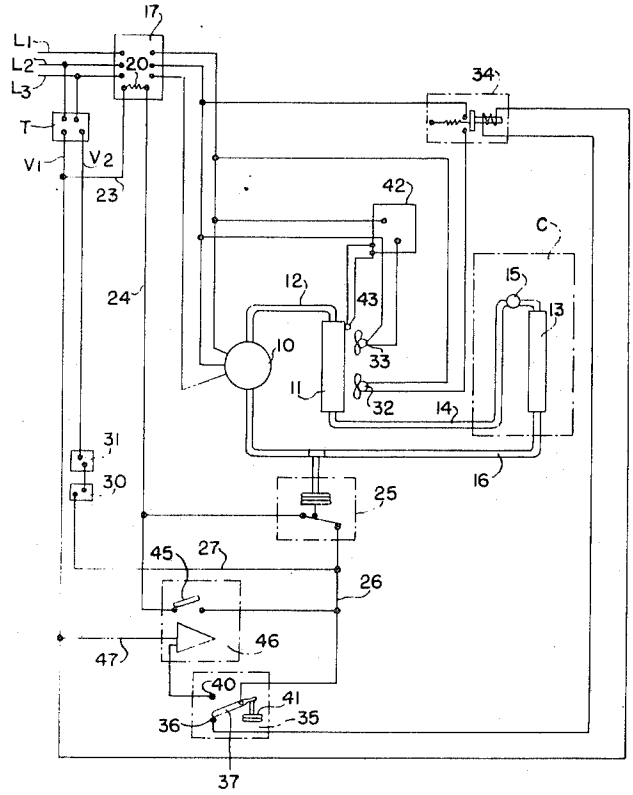
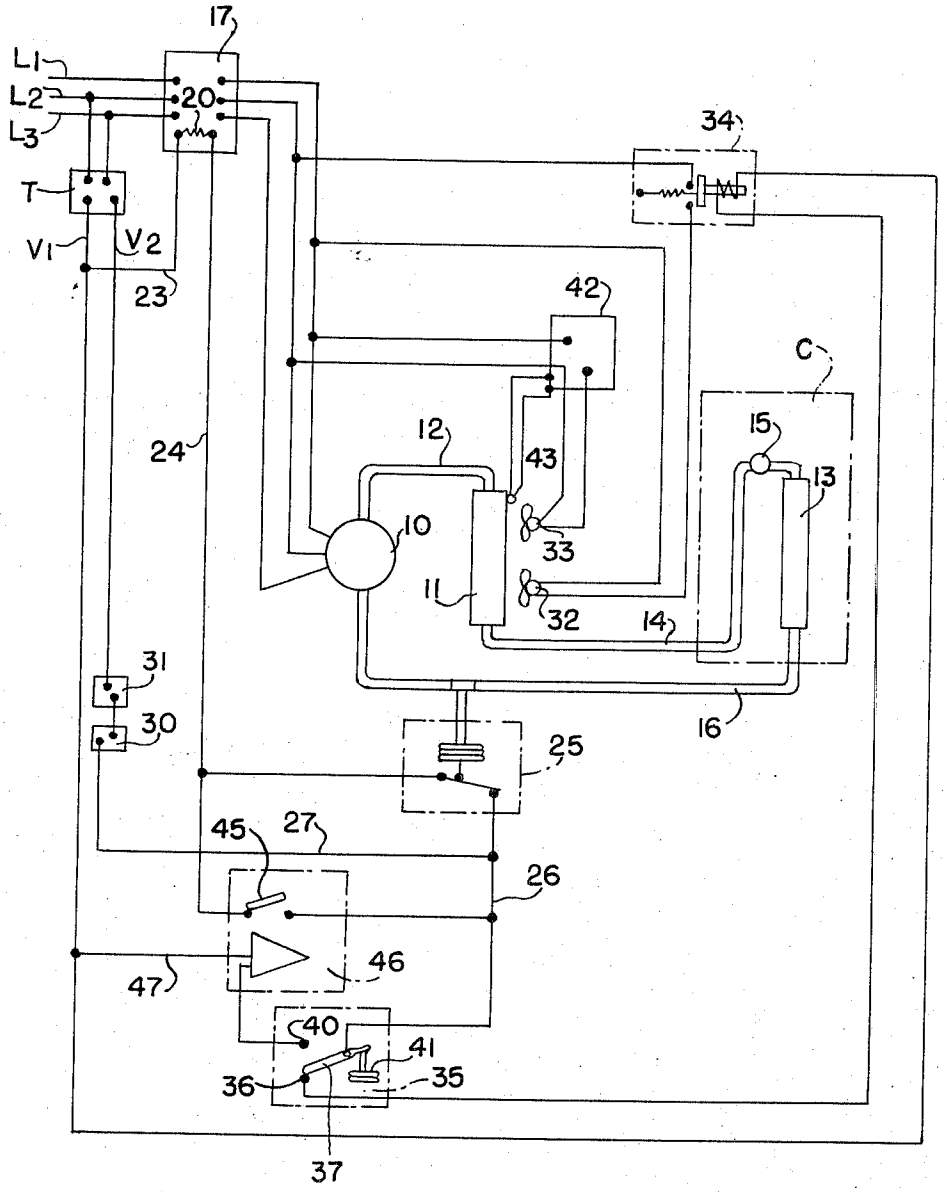
Attorney, Agent, or Firm—Watts, Hoffmann, Fisher & Heinke

[57] **ABSTRACT**

An electric motor powered compressor-condenser-expander type refrigerating apparatus having its compressor and condenser outdoors and the condenser cooled by one or more motor driven fans is controlled by a thermostatic switch inside a compartment cooled by the expander or evaporator. A pressure responsive switch normally terminates operation of the compressor when a low pressure limit is reached. An outdoor temperature responsive switch causes a timer to shunt out the pressure responsive switch for a limited period when a refrigerating cycle is initiated and the outdoor temperature is sufficiently low to reduce the refrigerant pressure in the low side of the system to a point otherwise causing the pressure switch to terminate compressor operation. The outdoor temperature responsive switch also controls a condenser cooling fan to reduce cooling air flow over the condenser.

7 Claims, 1 Drawing Figure

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COLD WEATHER STARTING CONTROL MEANS FOR REFRIGERATING SYSTEMS

BACKGROUND OF THE INVENTION

Electric motor driven compressor-condensor-expander type refrigeration systems are frequently employed in refrigerating and air conditioning systems where the compressor and condensor are located out of doors. Generally, such systems include a compressor control switch which is responsive to the pressure in the suction side of the compressor to either cycle the operation of the compressor to maintain refrigerating temperatures in the expander or evaporator, or to prevent operation of the compressor when the suction pressure falls below that which is safe for continued operation of the system. This switch is referred to as a low pressure cut-out control. When the out of doors temperature falls below certain temperatures, the refrigerant pressure in the condenser and suction side of the system drop to an extent which causes the low pressure cut-out control to open and prevent starting of the compressor or the suction pressure is quickly reduced by operation of the compressor to cause the low pressure cut-out to shut down the compressor. As a consequence, normal refrigerating pressures cannot be established in the refrigerating system.

Various arrangements have been utilized for temporarily rendering the low pressure cut-out ineffective for initiating operation of the compressor under the conditions noted, including the provision of a timer for establishing a shunt circuit about the low pressure cut-out switch. See U.S. Pat. Nos. 3,289,429 and 3,636,369, for examples. These types of controls, however, have not proved to be entirely satisfactory as they are generally complicated, expensive and not easily maintained.

THE PRESENT INVENTION

The present invention provides a compact, reliable and relatively inexpensive control system for refrigerating apparatus of the type mentioned, characterized in that an ambient or outdoor temperature controlled timer device is provided for shunting out the low pressure cut-out switch when the ambient temperature falls to a point which would otherwise result in pressures in the low side of the refrigerating apparatus causing undesirable operation of the low pressure cut-out. Thus, upon the initiation of a refrigerating cycle the compressor will be operated for a period to establish normal operating pressures in the refrigerating circuit regardless of lower than normal pressures in the suction side of the compressor.

Other objects and advantages of the invention will be apparent from the following description of one form of the invention and in which reference is made to the accompanying schematic drawing showing a refrigerating system embodying the invention.

Referring to the drawings, a refrigerating system embodying the invention is shown for cooling a food storage cabinet C. The refrigerating system is of a conventional construction, comprising an electric motor driven compressor **10** connected with a condenser **11** by a pipe **12.** The condenser includes a receiver, not shown, for collection of the liquefied refrigerant, and the receiver is in communication with an evaporator or expander **13** by way of a pipe **14.** A restrictor **15** is in

the inlet of the evaporator, as is usual practice. The outlet of the evaporator is connected by a pipe **16** to the intake, or suction side, of the compressor **10.** The compressor **10** and condenser **11** are located outside the building housing the cabinet C and are subjected to atmospheric temperatures.

The power for driving the compressor **10** is provided by three phase 240 VAC commercial power supply lines **L1,L2,L3.** The energizing circuit for the compressor **10** is controlled by a contactor **17,** which includes a solenoid **20** which acts upon an armature to close a normally open contactor switch when the solenoid is energized.

The power for the solenoid **20** is supplied by the secondary winding of a step-down transformer T which comprises low voltage lines **V1,V2.** The control circuit for the solenoid **20** includes the line **V1,** wire **23,** solenoid **20,** wire **24,** a low pressure cut-out switch **25,** wires **26,27,** a high pressure cut-out switch **30,** a thermostatic switch **31** and the line **V2.**

The controls **25,30** and **31** are of well known types and are present in conventional refrigerating systems of the type described. The low pressure switch **25** is responsible to the pressures in the suction side of the refrigerating system and is arranged to open in response to a predetermined low pressure and close at a suitable higher pressure so that the compressor **10** will by cycled to assure an adequate supply of liquid refrigerant in the receiver for feeding through the valve **15** to the evaporator. This type of compressor control is conventionally employed in refrigerating systems of the type described to prevent damage to the compressor due to abnormally low suction conditions and to efficiently maintain a supply of liquid refrigerant to the evaporator.

The high pressure cutout switch **30** responds to the pressures in the discharge side of the compressor and is operative to open and break the contactor solenoid circuit in response to abnormally high pressure which would otherwise damage components of the refrigerating system. The control **31** is responsive to the temperature in the cabinet C and closes and opens in response to increases and decreases in temperature.

The condenser **11** is normally cooled by forcing a flow of air therethrough by two electric motor driven fans **32,33.** The circuit for the fan **32** is controlled by the contactor **17** and by a normally closed relay switch **34** as seen in the drawing. The solenoid of the relay **34** is energized to open the relay switch by completion of a circuit between the low voltage lines **V1,V2** through a double throw ambient temperature responsive switch **35** and the switches **30,31.** The switch **35** is adapted to respond to ambient temperatures of the compressor and condenser so as to close its contacts **36** and **37** when the ambient temperature increases to 50° F. and to shift the contact **37** to a contact **40** when the temperature falls to 20°F., for example. The mechanism of the switch **35** is of a type well known in the art and includes an expansible wafer type element **41** containing a vapor which changes in pressure in the range of temperatures at which the switch contacts are actuated. It will be seen that when the ambient temperatures are below 20°F. the fan motor **32** is inoperative.

The circuit for fan motor **33** comprises the current supply lines from the contactor **17** to the compressor **10** through a speed control circuit **42.** The speed control circuitry **42** is like that shown in U.S. Pat. No.

3,469,177 and includes a thermistor 43 which is attached in close heat exchange relation with a portion of the condenser 11 so as to sense the temperature of the fluid in the condenser. The thermistor should be placed on the condenser at a point which will not be subjected to superheated refrigerant. The circuitry 42 is arranged to reduce the speed of the fan motor 31 as the condenser temperature falls below 50°F.

The low pressure cutout switch 25 is arranged to be shunted out of circuit through a normally open timer mechanism operated switch 45. The timer switching mechanism comprises an electronic timer circuit 46 which when initially enerziged is adapted to close the movable contact of the switch 45 on a fixed contact. After the circuit 46 has been energized from 2 to 5 minutes, the timer is operative to open the switch 45 and break the shunt circuit around the low pressure cutout switch 25. The timer circuit 46, including the switch 45, is like that described in U.S. Pat. application Ser. No. 72,464 filed Sept. 15, 1970 and assigned to the assignee of the present application

The timer circuit 46 is energized from the transformer T via a circuit comprising the line V1, wire 47, circuit 46, contacts 40 and 37 of the ambient temperature responsive switch 35, wires 26,27, switches 30,31 and the line V2. Thus, the timer circuit 46 is energized when the ambient temperature is below 20°F. and the circuit between the line V1,V2 is closed to energize the solenoid 20.

As long as the outdoor temperature is above the temperature at which the contacts 36,37 of the switch 35 are closed, the refrigerant compressor 20 is cycled by operation of the thermostatic switch 31 in the usual manner to maintain proper temperatures in the cabinet C. In the event that the atmospheric temperature drops below 20°F. the switch 35 operates to break the circuit of fan motor relay solenoid 34 at contacts 36,37 and to close the circuit for the timer 46 through contacts 37,40. When the thermostatic switch 31 closes to initiate a refrigeration cycle, the solenoid 20 is energized to cause starting of the compressor 10. The initial running of the compressor will normally result in an abnormally low vacuum in the suction side of the system which causes switch 25 to open the circuit for the contactor solenoid. However, for the first 2 to 5 minutes of operation of the compressor, the circuit for the contact solenoid 20 will be maintained around the switch 25 through the closed switch 45. During this short period of operation the usual high side and low side pressures will normally be developed in the condenser and evaporator. These pressure values will be promoted due to the fact that the fan motor 32 is inoperative to effect cooling of the condensor and the speed of fan motor 33 is reduced by the control 42. Thus, under normal circumstances operating pressures will rapidly prevail in the refrigerating system so that the low pressure cutout switch 25 will reclose before the switch 45 opens by operation of the timer circuit 46. If for any reason an undesirable low pressure is maintained in the suction side of the system which is likely to damage the compressor, when timer operated switch 45 opens, the circuit for the contactor solenoid 20 will be interrupted, thereby shutting down the refrigerating system.

In the form of the invention described, two condenser cooling fans 32,33 are shown. It may be desirable to provide a single fan, in which case the fan 32 would be eliminated and the fan 33 would be retained with its speed regulation controlled according to the temperature in the condenser 11.

I claim:

1. In a refrigerating system comprising a motor driven compressor, a condenser and an evaporator, a compressor controlling circuit comprising first switch means having an open condition effective to open said circuit and deenergize said compressor in response to relatively low pressure in said refrigerating system and second switch means having a closed condition for shunting said first switch means to complete said compressor controlling circuit when said first switch means is open, electric timer means energizable at the initiation of a refrigeration cycle to actuate said second switch means to said closed condition and after a given period to reopen said second switch means, and timer controlling means for controlling energization of said timer means in response to the ambient temperature of said condenser, said timer controlling means comprising a switch having a first condition for enabling energization of said electric timer means upon initiation of a refrigeration cycle when ambient temperature is below a given value and a second condition for preventing operation of said timer means upon initiation of a refrigeration cycle when ambient temperature is above said value.

2. A refrigerating system as defined in claim 1 further characterized by said compressor controlling circuit including a third switch means responsive to temperature produced by operation of said refrigerating system and in series with said timer means.

3. A system as claimed in claim 1 wherein said switch effects operation of a condenser cooling fan in said second condition.

4. A system as claimed in claim 1 further comprising condenser cooling fan means for directing a flow of cooling air to the condenser in relation to sensed condenser temperature independently of the condition of said switch.

5. In a refrigeration system having an evaporator disposed in a space to be cooled, a condenser exposed to atmospheric cooling air, a compressor, and a control arrangement for governing operation of the compressor, said control arrangement comprising:

a. thermostatic switch means for initiating and terminating operation of the compressor in response to temperature of the space;

b. pressure responsive switch means having an open condition for disabling said compressor when refrigerant pressure in the system is reduced below a predetermined level;

c. timer controlled switch means having a closed condition for enabling operation of said compressor when said pressure responsive switch is in said open condition;

d. said pressure responsive switch means and said timer controlled switch means electrically connected in parallel with each other and connected in series with said thermostatic switch means, said timer controlled switch means and said thermostatic switch means cooperable to enable operation of said compressor notwithstanding the condition of said pressure responsive switch means;

e. electrically operated timer means for operating said timer controlled switch means, said timer means connected in a circuit with said thermostatic switch means so that when said thermostatic switch

means operates to initiate operation of said compressor said timer means is energizable to operate said timer controlled switch means to the closed condition for a predetermined period of time; and,

f. atmospheric temperature responsive switch means connected in a circuit with said timer means and said thermostatic switch means, said atmospheric temperature responsive switch means operable to permit energization of said timer means by said thermostatic switch means only when atmospheric temperatures are less than a predetermined relatively low temperature.

6. The system claimed in claim **5** further including a condenser cooling means and wherein said atmospheric temperature responsive switch means is effective to render said condenser cooling means effective in response to sensed atmospheric temperatures above a predetermined level.

7. The system claimed in claim **6** further comprising a condenser cooling fan and a fan speed control for operating said cooling fan in response to temperature of said condenser whereby heat is dissipated from said condenser by said cooling fan as a function of condenser temperature, said condenser cooling fan operable independently of said timer means so that the temperature of said condenser is controlled while said timer controlled switch means is in the closed condition.

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