

[54] REFRIGERATION SYSTEMS WITH VISUAL INDICATORS

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Related U.S. Application Data

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[52] U.S. Cl. 62/126, 62/127, 62/129

[51] Int. Cl. F25b 49/00

[58] Field of Search 62/125, 126, 127, 129, 62/131, 226

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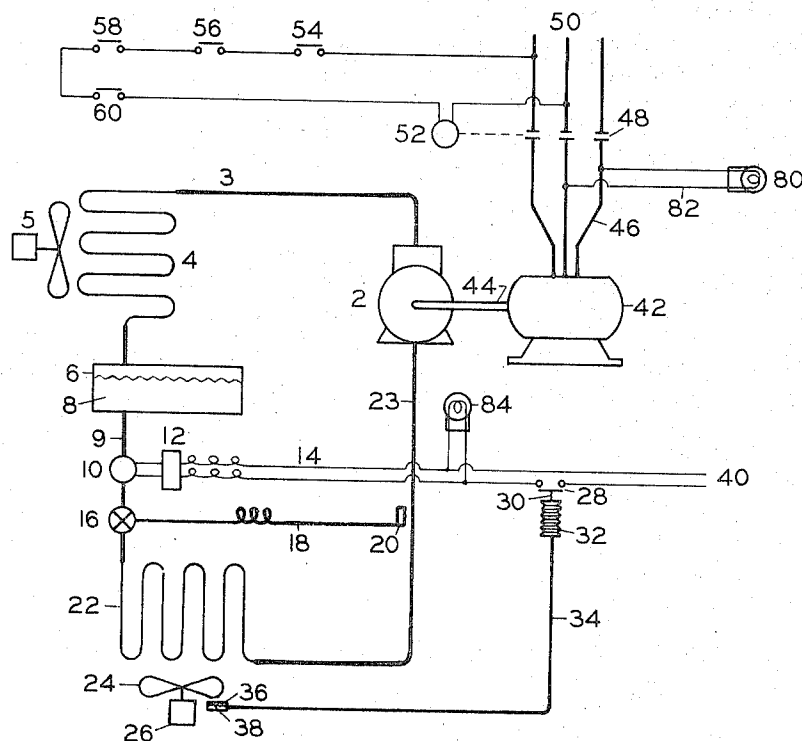
Assistant Examiner—Peter D. Ferguson

[57]

ABSTRACT

A refrigeration system which includes a visual indicator employing lights where one light turns on when the thermostat calls for cooling and second and subsequent lights turn on when compressors controlled by the thermostat start operation and a logical electro-mechanical method for examining the inputs to the lights and deciding whether alarm action should be taken.

7 Claims, 7 Drawing Figures



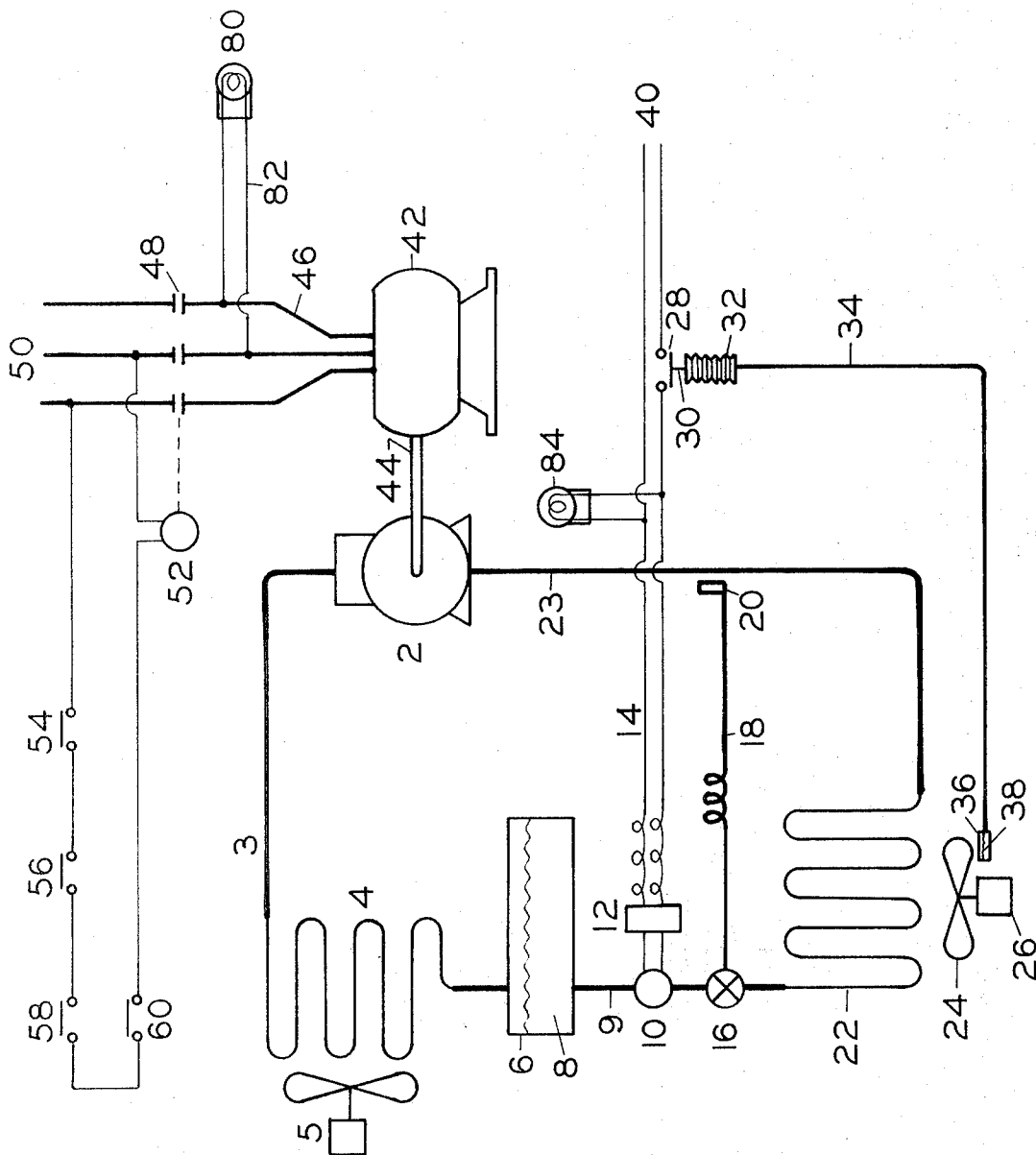


FIG. 1.

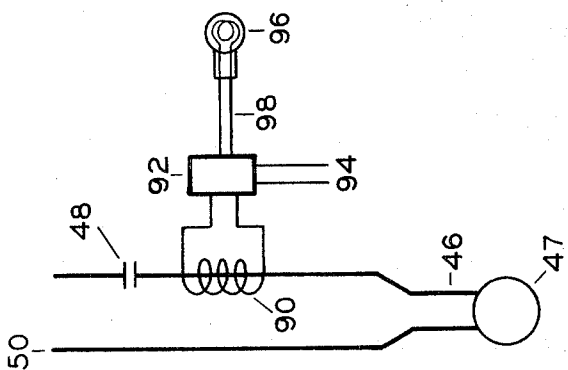


FIG. 2

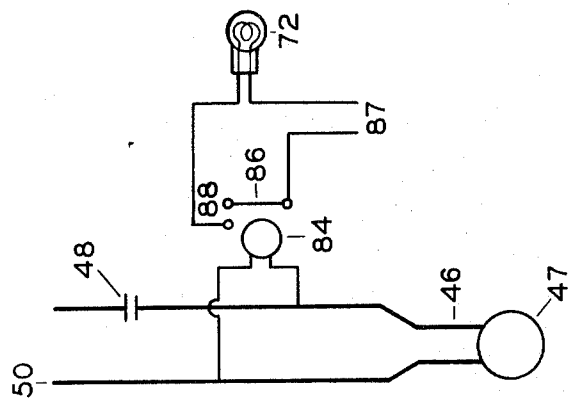


FIG. 3

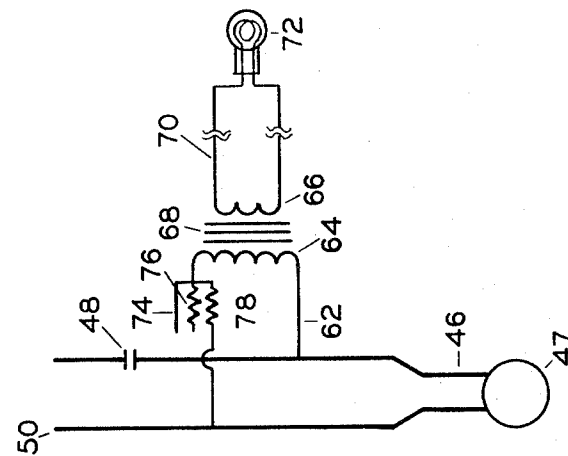


FIG. 4

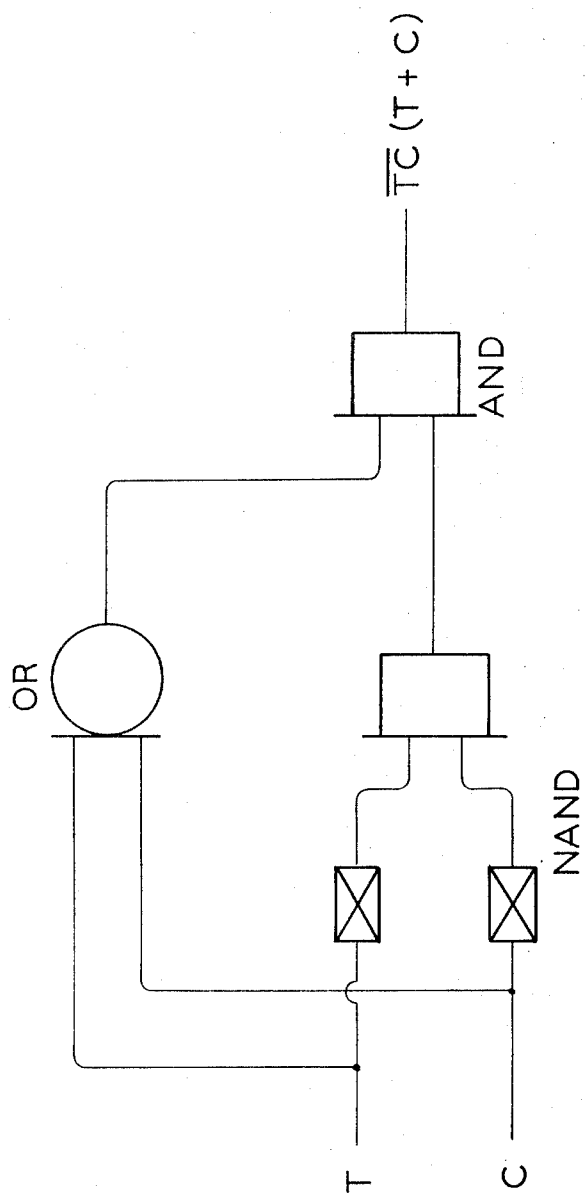


FIG. 5.

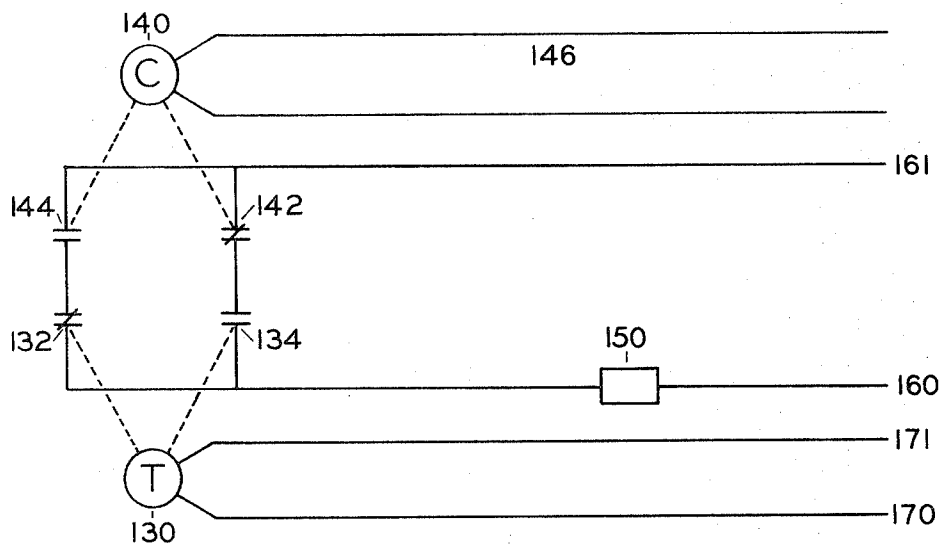


FIG. 6

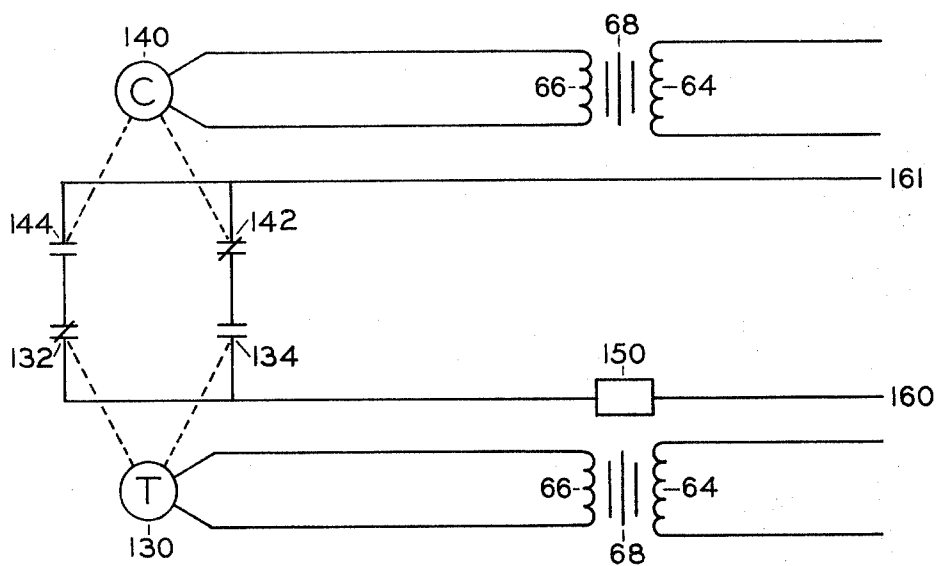


FIG. 7

REFRIGERATION SYSTEMS WITH VISUAL INDICATORS

This application is a continuation in-part of application Ser. No. 196,020, filed Nov. 5, 1971, and now abandoned.

BACKGROUND OF THE INVENTION

1. Field

This invention relates to refrigeration systems with visual indicators for monitoring the condition of refrigeration apparatus.

2. Description of the Prior Art

A signal light which lights when the compressor or controlled device is on, is old. Signal lights which light to specifically identify the nature of the malfunction are also well known. For instance, a panel containing a series of lights marked as follows: high pressure cut-out, compressor overload, high winding temperature, low oil pressure and high discharge temperature is well known. Each light, or its actuating element is connected across the contacts of the appropriate safety device. Trippage of a device results in an open circuit across the contacts, resulting in the application of full control circuit voltage across the light or its actuator. This system requires as many lights or visual indicators as there are possible safety devices. Failure to operate, not caused by one of the safety devices, will not actuate any of the lights. Nor will this system warn about excessively frequent operation of a normal operating control, such as a low pressure switch.

SUMMARY OF THE INVENTION

The invention teaches a method for providing visual indication of the status of a refrigeration system by providing a first light which glows when the temperature controller, sensing the temperature of the cooled space, calls for cooling and a second light which directly or indirectly senses the operation of the compressor, and lights when the compressor is energized. A system of relays, utilizing a logical method for sensing the status of the controller and compressor, activates a single light or alarm either when the temperature controller calls for cooling and the compressor does not operate or when the temperature controller does not call for cooling and the compressor does operate.

The National Electrical Code allows wiring, utilizing voltages below 30, to dispense with many formal requirements of protection which are required for circuits which utilize voltages over 30. Therefore, it is an object of this invention to provide a means for energizing signal lights with low voltages even where the element monitored utilizes line voltages of 115 and 230 or higher.

One enabling structure, utilizing the method of the invention uses a relay whose activating coil is connected across the monitored element and whose contacts control the flow of low voltage electricity generated by a transformer provided for the purpose.

A second structure, which is non-mechanical, utilizes a step-down transformer whose primary bridges the monitored element and whose secondary is selected to deliver an output voltage which is less than 30. With either arrangement, the pilot light would be selected to cooperate with the voltage supplied by the transformer.

A third structure utilizes a current transformer to sense current flow to the monitored element and actuate means for allowing or preventing current flow to the pilot lights in response thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows schematically a refrigeration system of the compression type including a liquid solenoid valve and a compressor with a motor, including controls for each, and two signal lights, one directly connected to light when the compressor is energized and the second directly connected to light when the liquid solenoid is energized.

FIG. 2 shows the use of a step-down transformer with resistors in series with the primary to provide multiple voltage capability. The transformer secondary provides low voltage power for lighting the pilot when power is applied to a load.

FIG. 3 is a schematic wiring diagram which shows the use of a relay as a potential sensing device to turn on the pilot light when a contact closes, applying power to a load.

FIG. 4 shows the use of a current sensing device to turn on the pilot light when current flows through a wire feeding power to a load.

FIG. 5 is a diagram employing the symbolism of binary algebra to illustrate the logic which a human or logical mechanism would use in deciding whether or not to activate an alarm in a response to the presence or absence of signals or electrical currents or potentials which are established in response to activation of a thermostat and operation of a compressor.

FIG. 6 is a schematic diagram of a system of relays which will accomplish the logical output of FIG. 5 in response to the same input.

FIG. 7 is a schematic diagram of a system of relays similar to FIG. 6 illustrating the use of transformers to energize the relay coils.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates a refrigeration system which utilizes the invention and comprises a compressor 2, driven by motor 42 by a shaft or drive 44. The compressor discharges refrigerant vapor to the condenser 4 by a discharge line 3. The refrigerant vapor condenses to a liquid in the condenser and flows to the receiver 6, wherein it collects as liquid 8.

Under control of liquid solenoid valve 10, energized by electrical coil 12, liquid refrigerant leaves the receiver through liquid line 9 and flows to expansion valve 16 which meters liquid refrigerant at reduced pressure to the evaporator 22 where it evaporates under the influence of heat input from the medium to be cooled. The refrigerant vapor returns to the compressor via suction line 23 where the vapor is compressed and delivered to discharge line 3, beginning the cycle again.

The opening and closing of the liquid solenoid 10 is under control of controller 30, which senses the temperature of the cooled medium and closes contact 28 when the medium is warmer than desired. Closure of the thermostat energizes the coil 12 of the solenoid valve 10 from power supply wires 40 causing the valve to open. At the same time voltage is applied across the solenoid coil 12 by the closure of the thermostat contacts the pilot light 84, designed to operate at the

same voltage as applied to the solenoid coil, lights. Any visual indicator other than a pilot light may be used, such as electro-mechanical semaphore. The bulb 84 preferably is mounted in a position which can be visually monitored. The compressor 42 operates from electric power supplied by an electric circuit 46 from a power source 50. The power to the compressor is controlled by an element which may be a contactor with contacts 48 and control coil 52. The coil 52 is energized when all the contacts in the control and safety devices 54, 56, 58 and 60 are closed.

These devices shown are low pressure switch 54, high pressure switch 56, oil safety switch 58, compressor overload protectors 60, although more or fewer or different devices could be used without affecting the intent of the invention.

When all controls and safeties have their contacts closed, contactor 52 will be energized, closing contacts 48, causing the compressor to run and simultaneously applying full compressor line voltage causing pilot light bulb 80, selected for cooperation with the compressor voltage, to light.

An observer of the lights used to monitor refrigeration systems of the type shown in FIG. 1 can easily identify trouble and even approximate the cause by referring to a chart of table 1.

If no liquid solenoid was to be used but the thermostat was to control the compressor contactor directly, signal light 84 would be connected across contactor coil 52 and the lights would provide the same logical result.

FIG. 2 shows a load 47 which could be a compressor or a solenoid coil, the current flow to which is controlled by a contact 48. A low voltage light bulb 72 is actuated through transformer 68. The transformer has a primary 64 and a secondary 66. Primary 64 is designed to cooperate with the lowest voltage load 47 to which the warning light may be applied. In order to enable the same transformer assembly to be suitable for higher voltages, resistors 76 and 78 are provided along with a direct connection to the primary 74. The resistors are selected to cooperate with the primary winding 64 providing sufficient voltage drop according to the usual electrical law $E = IR$ to insure the correct voltage on the primary of the transformer.

FIG. 3 again shows contact 48, power supply 50 and load 47 of FIG. 2, where the voltage on the load 47 is, in part, used to actuate relay 84, which, when energized, attracts its clapper 86 to close contacts 88, allowing the low voltage source 87 to transmit its power to light bulb 72.

FIG. 4 again shows contact 48, power supply 50 and load 47 of FIG. 1. Here a current transformer 90, utilizing a feeler coil wrapped around one of the conductors from the contact to the load, senses current flow in conductor 46 to the load. If current flow occurs the relay 92 will be energized, closing contacts which allow low voltage power from source 94 to be applied to bulb 96, lighting it.

I intend that the means shown in FIGS. 2, 3 and 4 for lighting a light in response to energization of a load be applicable to either the solenoid coil 12 of FIG. 1 or the compressor motor 42 of FIG. 1 by connecting the primary of the transformer 64 or the leads of relay coil 84 in the same way as lights 80 or 84 of FIG. 1 are connected.

An apparatus to monitor the loads or the lights for the purpose of activating an alarm which does depend on visual interpretation of lights is shown in FIG. 5.

In the language of binary algebra, variables can have only either of two values, 1 or 0. AND is a symbolic device or gate having one output but one or more inputs which provides an output of 1 when all its inputs are 1. OR is a symbolic gate which provides an output of 1 when any of its inputs are 1. NAND is a symbolic gate which provides an output of 1 when any input is 0 and an output of 0 only when all inputs are 1. T represents the thermostat where call for cooling = 1 and failure to call for cooling or satisfaction = 0. C represents the compressor where operation = 1 and non-operation = 0.

The signal from the thermostat and the compressor is sent into both a NAND gate and an OR gate with the outputs of the OR and NAND gates actuating an AND gate whose output activates an alarm if 1 or keeps the alarm silent if 0. This arrangement of logical gates is known as an "Exclusive OR".

This circuit provides an output of one, equivalent to activating the alarm when either the thermostat or the compressor is energized but not the other and provides no alarm, equivalent to an output of zero, when both the thermostat and the compressor are energized or when neither of them are energized. The following truth table expresses the logical output of FIG. 5:

TRUTH TABLE

T	C	Output
1	1	0
1	0	1
0	1	1
0	0	0

FIG. 6 shows a combination of standard relays which achieves the output equivalent to the logical circuit of FIG. 5.

There are 2 relays, each single pole double throw with coils 130 and 140. Coil 130 is connected across the compressor motor 42 like the light 80 in FIG. 1. Coil 140 is connected across the solenoid coil 12 like light 84 in FIG. 1. When coil 130 is energized, contact 134 is closed and contact 132 is open. When coil 130 is deenergized, contact 134 is open and contact 132 is closed.

When coil 140 is energized, contact 144 is closed and contact 142 is open. When coil 140 is de-energized, contact 144 is open and contact 142 is closed. If both coils 130 and 140 are energized because the compressor motor 42 of FIG. 1 is energized and the solenoid coil 12 of FIG. 1 is energized, Alarm 150 will be de-energized because open contacts 142 and 132 prevent current flow to the alarm. If both coils 130 and 140 are de-energized because the motor 42 and coil 12 of FIG. 1 are de-energized the alarm 150 will not activate because contacts 144 and 134 will be open, preventing current flow to the alarm 150. However, if coil 140 is energized while coil 130 is deenergized, then contact 144 will be closed and contact 132 will be closed, allowing current to flow to alarm 150 to activate it. Conversely, if coil 140 is de-energized while coil 130 is energized, contacts 142 and 134 will both be closed, allowing current to flow to alarm 150, activating it.

The relay contacts in FIG. 7 work the same as the contacts in FIG. 6 except the relay coils 130 and 140 are energized by transformers 68, whose primaries 64 are connected in place of the bulbs 80 and 84 of FIG. 1.

I claim:

1. An improved refrigerating system for cooling a medium comprising conduit-connected motor-driven compressor, having energized and de-energized conditions; condenser; liquid valve having energized and de-energized conditions; expansion device; and evaporator; a first control means for energizing and de-energizing the motor; a second control means for energizing and de-energizing the valve; wherein the improvement comprises means for sensing and means for continuously indicating the relative conditions of the motor and the valve.

2. A refrigerating system as in claim 1 where the means for sensing are relays.

3. A refrigerating system as in claim 1 where the means for sensing are transformers.

4. A refrigerating system as in claim 3 where the means for indicating are lights.

5. A refrigerating system as in claim 1 having a first light connected to light when the motor is in its ener-

gized condition, and a second light connected to light when the valve is in its energized condition.

6. A refrigerating system as in claim 1 where the first control means is a pressure switch connected to the low pressure side of the system and the second control means is a thermostat sensing the temperature of the cooled medium.

7. A method for monitoring the condition of a refrigeration system where the system comprises: a motor, having energized and de-energized conditions; a first controller connected to the motor for controlling the condition of the motor; a coil, having energized and de-energized conditions; a second controller connected to the coil for controlling the condition of the coil; a first light and a second light, and conduit-connected compressor, connected to and driven by the motor; condenser; valve on which the coil is mounted for opening and closing it in response to the energization or de-energization of the coil; expansion device; and evaporator where the method comprises the steps of -

1. lighting the first light in response to one condition of the motor, and

2. lighting the second light in response to one condition of the coil.

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