

Dec. 20, 1960

W. H. CONE

2,964,923

REFRIGERATION SYSTEM

Filed May 6, 1960

3 Sheets-Sheet 1

Fig. 1.

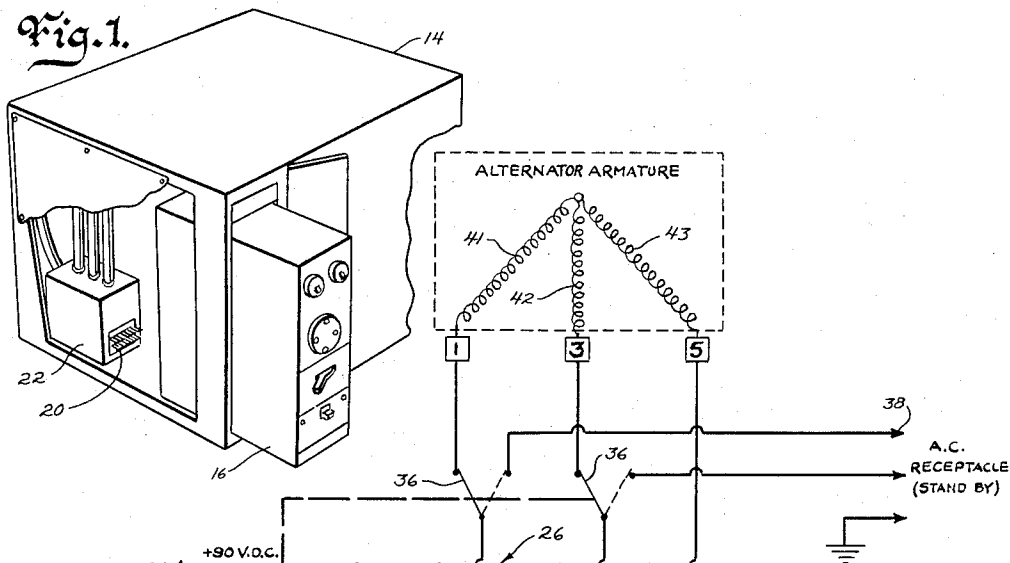
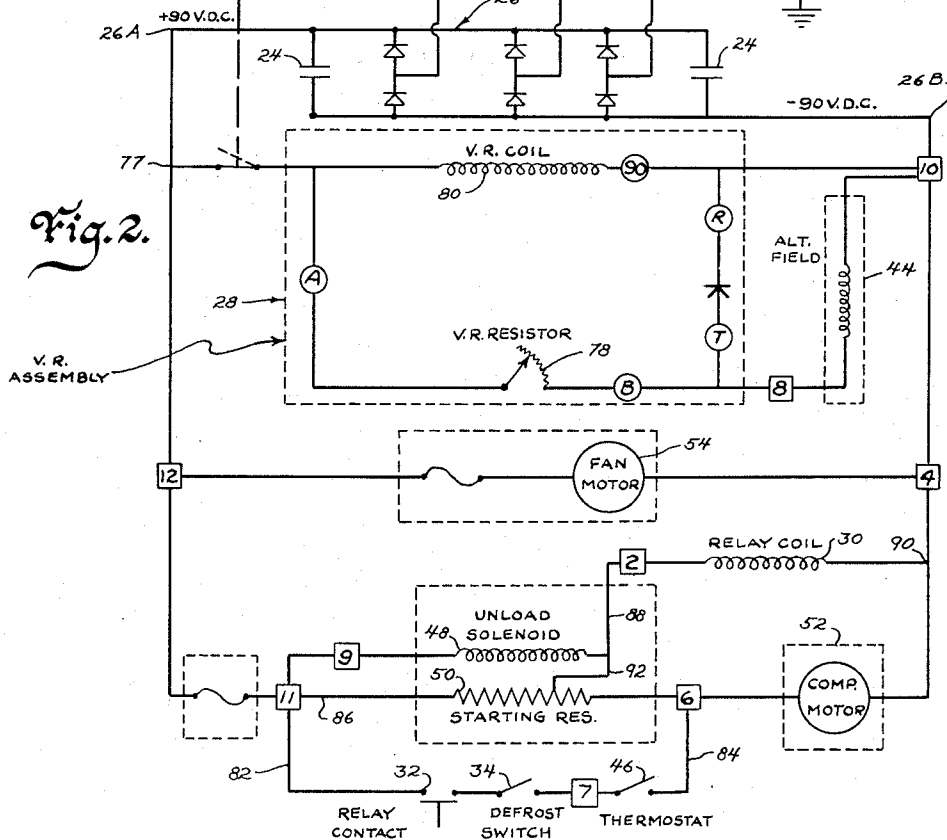


Fig. 2.



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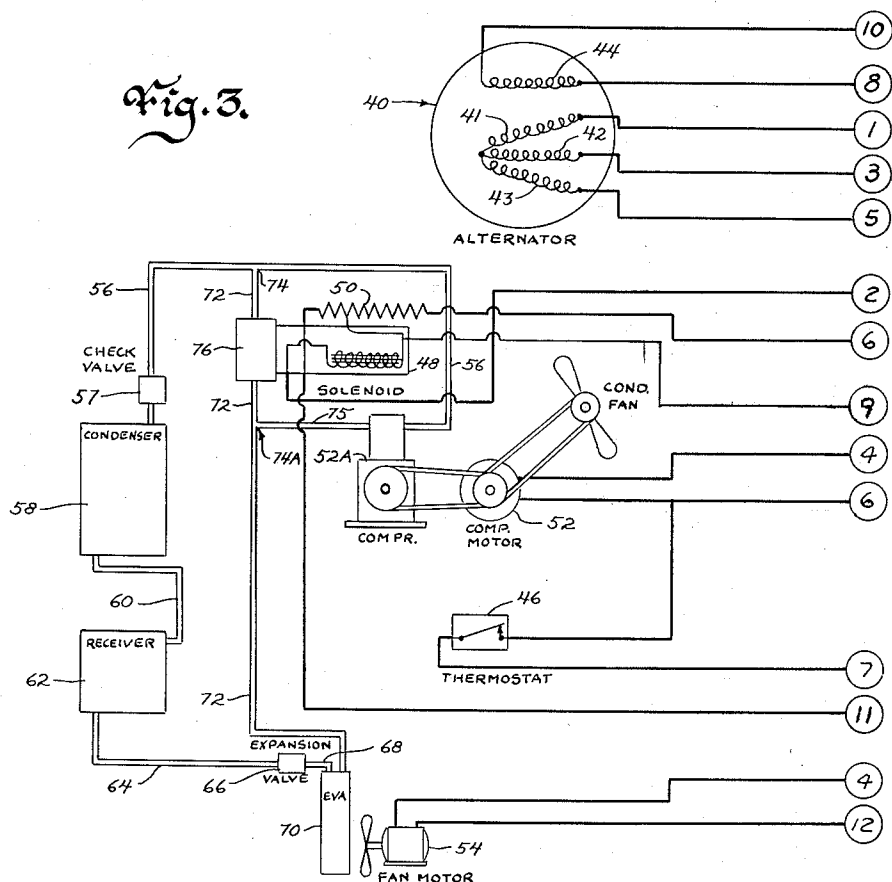


Fig. 6.

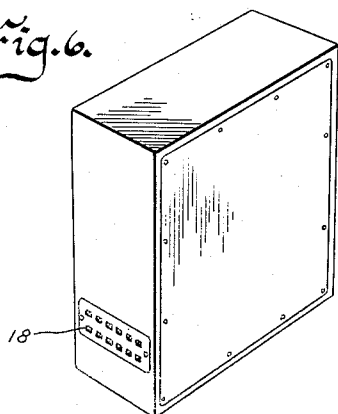
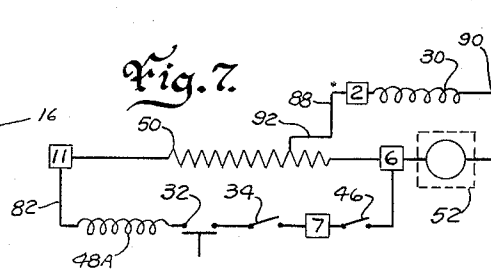


Fig. 7.



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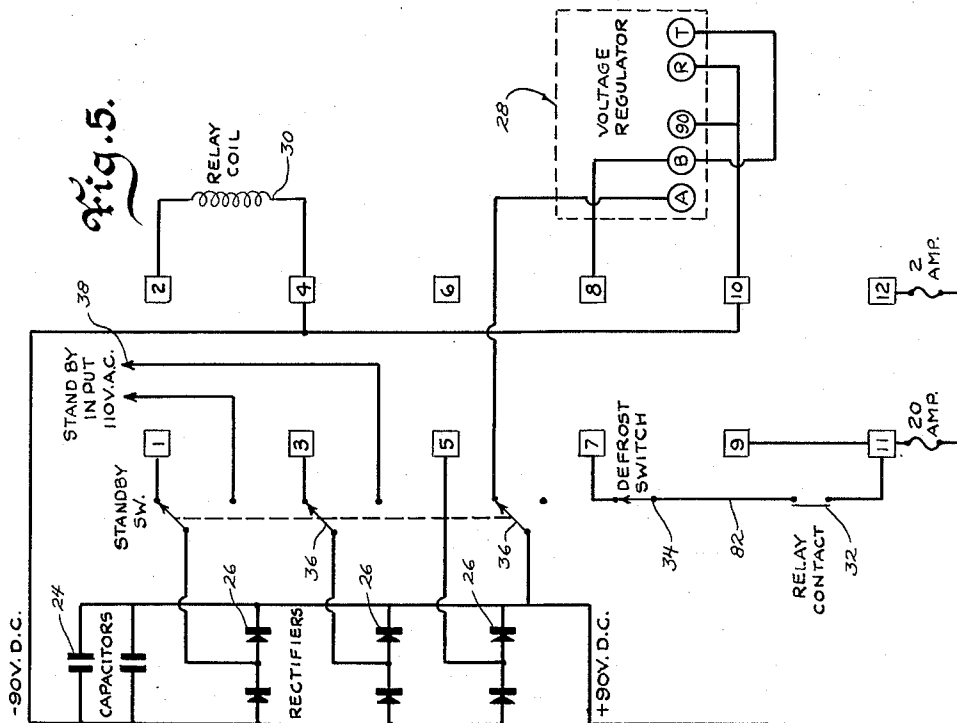
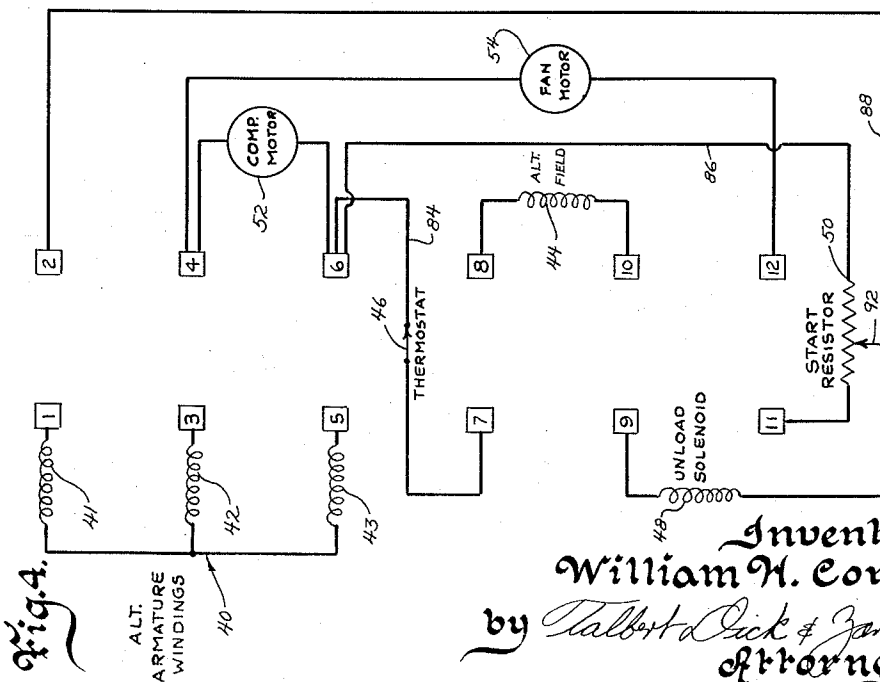
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3 Sheets-Sheet 3



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REFRIGERATION SYSTEM

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9 Claims. (Cl. 62—196)

My invention relates to refrigeration systems and more particularly to an electrical circuitry in a refrigeration system particularly adapted for use in truck refrigeration units.

There are certain fundamental refrigeration components present in every refrigeration system. Special elements are added to the basic refrigeration system in various instances, but whatever the resulting combination, there are always certain individual elements which characteristically have a much higher incidence of maintenance than do other elements which seldom experience malfunctioning. In the case of truck refrigeration systems, malfunction of the systems is more prevalent because of the rough use to which they are subjected. The failure of a truck refrigeration system has heretofore been especially serious, because not only is there some danger of spoilage to the cargo, but the repair of a unit ties up the whole truck or necessitates the difficult removal and replacement of the unit. Both of these events are expensive to the truck owner in labor and/or lost trucking revenues.

A further shortcoming of the refrigeration systems known to me is that certain of their key elements are not protected from the adverse effects of uncontrolled peak or "spike" voltages. These damaging voltages can occur when a grounding of certain wires in the system shunts out the customary voltage regulator; or when an element such as the compressor motor is suddenly removed from the circuitry.

Therefore, the principal object of my invention is to provide a refrigeration system that can protect its more sensitive elements, such as rectifiers and the like, by eliminating the occurrences of damaging "spike" voltages.

More specifically, one of the primary objects of my invention is to provide a refrigeration system whereby the grounding of any wire in the system will not shunt out the voltage regulator.

A further primary object of my invention is to provide a refrigeration system that will allow the alternator output to either run the compressor motor full speed or will run the compressor motor at a low speed while a portion of the alternator output is dissipated in a suitable resistance.

A further object of my invention is to provide a refrigeration system with a control means that will automatically shunt out the output-dissipating resistance when high speed compressor motor speeds are desired, and which will automatically revert to its output-dissipating condition when the refrigeration cycle is dormant.

A still further object of my invention is to provide a refrigeration system that will automatically coordinate the load of the refrigerant on the compressor with the speed conditions of the compressor motor and the refrigeration requirements of the system.

A still further object of my invention is to provide a refrigeration system where the more sensitive and maintenance-prone elements can be separately contained and detachably secured to the rest of the unit so that if maintenance

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work is required on the elements in the self-contained package, the package can be detached, replaced and then repaired without encumbering the use of the whole system and the truck or other unit to which it may be attached.

A still further object of my invention is to provide a refrigeration system that is economical of manufacture and durable in use.

These and other objects will be apparent to those skilled in the art.

My invention consists in the construction, arrangements, and combination, of the various parts of the device, whereby the objects contemplated are attained as hereinafter more fully set forth, specifically pointed out in my claims, and illustrated in the accompanying drawings in which:

Fig. 1 is a partial perspective view of my device with the detachable compartment thereof partially removed;

Fig. 2 is a simplified wiring diagram of the circuitry of my device without regard for the physical location of the separate electrical elements;

Fig. 3 is a schematic diagram showing the relation of the refrigeration system to the electrical junction terminals that connect them to the electrical elements in my detachable container;

Figs. 4 and 5 are wiring diagrams of the electrical components of my device which are located outside and inside, respectively, of my detachable container;

Fig. 6 is a perspective view of my detachable container showing the end thereof opposite to the end shown in Fig. 1; and

Fig. 7 is a partial wiring diagram of an alternate species of my device.

I have used the numeral 14 to generally designate a refrigeration housing that is adapted to be secured to a truck or the like. A small container 16 is detachably secured to housing 14 in any convenient manner. A conventional Cinch-Jones female electrical plug 18 with twelve separate connecting terminals is mounted in one face of container 16 and is adapted to receive the conventional Cinch-Jones male plug 20 which is mounted within junction box 22 in housing 14. In Figs. 2, 3, 4 and 5, the twelve contact points in the Cinch-Jones connection are identified with the numbers 1 through 12.

Mounted within container 16 in any convenient manner are capacitors 24, rectifiers 26, a voltage regulator 28, a relay having a coil 30 and contact points 32, a defrost switch 34, main switch 36 and a standby input plug 38.

An alternator 40 with alternator windings 41, 42 and 43, and alternator field windings 44, is mounted in any convenient fashion to the vehicle frame (not shown) and is usually mounted in close proximity to the truck motor. Mounted within housing 14 but outside of container 16 are a thermostat 46, an unload solenoid 48; a starting resistor 50, a compressor motor 52 and a blower motor 54. As shown in Fig. 3, a refrigeration circuit is comprised of compressor 52A, conduit 56, check valve 57, condenser 58, conduit 60, receiver 62, conduit 64, expansion valve 66, conduit 68, evaporator 70 and conduit 72, which is connected with conduit 56 at point 74. A conduit 75 connects the suction side of the compressor 52A with conduit 72 at point 74A. To unload the compressor at times, a valve 76 operated by unload solenoid 48 is imposed within conduit 72 between points 74 and 74A. When the solenoid 48 is electrically excited, the valve 76 is opened so that the refrigerant can freely move from the pressure side of the compressor to point 74 through conduit 56, thence through valve 76 and conduit 72 to point 74A, and thence back to the suction side of the compressor through conduit 75, so that no refrigeration effect occurs.

Fig. 2 is a composite of the two diagrams shown in Figs. 4 and 5 and is the exact circuitry existing in the refrigeration system when the twelve Cinch-Jones contact male and female terminals are connected. For purposes of clarity, individual lead wires will not be given separate identifying numerals unless the identification of certain components cannot be otherwise determined. As shown in Fig. 2, the alternator armature windings 41, 42 and 43 are connected to the rectifier 26 through Cinch-Jones terminals (hereafter called "terminals"), Nos. 1, 3 and 5 to produce positive and negative voltages on opposite sides of the rectifier. The points 26A and 26B in Fig. 2 on opposite sides of rectifier 26 can be regarded as positive and negative voltage terminals. The voltage regulator 28 is connected in parallel directly across the line as indicated by points 77 and terminal 10. The alternator field is connected between terminals 8 and 10 and is thereupon connected in series with the variable resistor 78 of voltage regulator 28. The numeral 80 designates the voltage regulator coil. Fan motor 54 is similarly connected across the line in parallel with voltage regulator 28 as indicated by terminals 12 and 4.

Again, with reference to Figs. 2 and 5, it is seen that terminal 11 is connected to terminal 7 by electroconducting lead 82 with relay contact points 32 and defrost switch 34 interposed therein. As shown in Fig. 2, terminal 7 is thereupon electrically connected to terminal 6 by lead 84 which has thermostat 46 interposed therein. Lead 86 connects terminals 11 and 6 with starting resistor 50 interposed therein to place the starting resistor in parallel with the relay contact points 32, defrost switch 34 and thermostat 46.

The unload solenoid 48 and relay coil 30 are electrically connected by lead 88 and terminal 2. The unload solenoid 48 is connected to the positive side of the line through terminals 9 and 11 and the relay coil 30 is electrically connected to the minus side of the line as designated by the numeral 90. Lead 92 electrically connects in parallel the unload solenoid 48 with starting resistor 50. As shown in Figs. 2 and 4, the compressor motor 52 is interposed between terminals 4 and 6.

The normal operation of my device is as follows: The alternator output is fed through terminals 1, 3 and 5, through switch 36, through the full wave bridge connected rectifier 26, to provide a plus 90 volts (D.C.) through point 77 and the voltage regulator coil 80 to terminal 10. This completes a circuit and allows the voltage regulator coil to sense the voltage across the line. The variable resistor 78 of the voltage regulator 28 is in series with the alternator field 44 as indicated above. Since the voltage regulator 28 and alternator field 44 are not connected to the ground, the grounding of a wire anywhere in the entire circuit will not result in the shunting of the voltage regulator circuit. Thus, with the voltage regulator always intact, the grounding of a positive wire in the system will not permit the alternator output to continue to climb until the voltage reaches a point that results in rectifier failure.

The relay contact points 32 are normally open and, under normal starting conditions, the defrost switch 34 and thermostat 46 are closed. As the alternator output commences, current flows through point 77 and terminal 12 to terminal 11, thence through the starting resistor 50, terminal 6, compressor motor 52 and thence to the minus side of the line. The compressor motor thereupon starts on the starting resistor 50 which prevents the collapse of the alternator field. The voltage drop across the starting resistor 50 is "seen" by the unload solenoid 48 which is connected in parallel with the starting resistor by means of terminal 11, terminal 9, and lead 92. The unloading solenoid is thereupon energized which opens valve 76 to unload the compressor 52A and compressor motor 52 while the motor is running on the starting resistor.

As voltage builds in the system, the relay coil 30 senses the voltage rise and, when voltage reaches a predetermined point, the relay coil closes the relay contact points

32. With the defrost switch 34 and thermostat 46 in a closed condition, the closing of the relay points 32 completes a shunt circuit around the starting resistor 50 and unload solenoid 48, extending from terminal 11, through the relay contact points 32, defrost switch 34, terminal 7, thermostat 46 and thence to terminal 6. The shunting of the starting resistor de-energizes the unload solenoid 48 and brings the compressor motor to full speed operation. As the unload solenoid 48 is de-energized, the valve 76 closes to divert the refrigerant through the system, thereupon loading the compressor.

When the thermostat is satisfied and opens, the above-described shunting circuit is opened and the compressor motor 52 falls back on the starting resistor 50. The compressor motor circuit once again is completed from terminal 11, through starting resistor 50, terminal 6, compressor motor 52, and thence to terminal 4. As the starting resistor 50 once again becomes a part of the compressor motor circuit, the compressor motor 52 runs at a reduced speed and the unload solenoid becomes energized to open valve 76. The opening of valve 76 allows the refrigerant to by-pass the refrigeration system to effect the unloading of the compressor motor 52 which is then running at a reduced speed. When the thermostat calls for compressor operation again, the thermostat closes to complete the above described shunt circuit; the motor 52 goes to full speed operation and the de-energized unload solenoid 48 closes valve 76 to load the compressor 52a.

Thus, by using alternator output to either run the compressor motor at full speed, or to run the compressor at a reduced speed and use excess current to heat the starting resistor 50, the peak voltages resulting from inductive loads are substantially eliminated. This results because the compressor motor circuit is never opened entirely even when the thermostat 46 opens, and inductive loads are therefore not present.

As indicated above, the energization of the unload solenoid 48 causes the valve 76 to open to unload the compressor motor 52. The solenoid 48 is therefore controlled by the above described shunt circuit so that it will be allowed to permit the valve 76 to assume its normally closed position whenever the shunt circuit assumes control of the system. However, there are certain advantages to using a solenoid which would require energy to close rather than to open valve 76. Such a solenoid 48A is shown imposed in the shunt circuit of Fig. 7. The respective components in Fig. 7 operate in the same manner as described above, except that solenoid 48A is energized to close valve 76 and load compressor motor 52, which is exactly opposite to the function of solenoid 48 in Fig. 2. The location of this solenoid 48A in the shunt circuit, as shown in Fig. 7, would cause the opening of solenoid 48A whenever a voltage sag in the entire circuit occurred. This phenomenon automatically opens valve 76 and unloads the compressor whenever such a voltage sag takes place.

In view of the foregoing, it is seen that my invention will accomplish at least all of its stated objectives.

Some changes may be made in the construction and arrangement of my refrigeration system without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claims, any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope.

I claim:

1. In combination with a refrigeration system comprised of at least a compressor having pressure and suction ports, an electrical compressor motor operatively secured to said compressor, a condenser, an evaporator unit, and a refrigerant-carrying conduit interconnecting said compressor, condenser and evaporator units; an electrical control system comprised of a means providing a source of direct current output and having a positive voltage terminal and a negative voltage terminal, a start-

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ing resistor and said compressor motor electrically connected in series between said positive and negative terminals with said motor being on the negative side of said resistor, a relay having a relay coil and relay contact points, a by-pass conduit connecting the suction and pressure ports of said compressor, a normally closed valve in said by-pass conduit to prevent the flow of refrigerant through said by-pass conduit at times, an unload solenoid secured to said valve to open said valve upon becoming electrically excited, the coil of said relay being connected in parallel with said motor and interposed in said system between the negative side of said starting resistor and said negative terminal, said unload solenoid connected in parallel with said starting resistor, and a shunt circuit connected in parallel around said starting resistor, said shunt circuit having a thermostat and said relay contact points series connected therein, said relay contact points being normally open and being adapted to close whenever said relay coil senses a predetermined voltage, and said thermostat being normally open and being adapted to close when subjected to a predetermined temperature.

2. The structure of claim 1 wherein the refrigeration system is mounted in a housing, at least a portion of the elements of said electrical control system being mounted in a container which is detachably secured within said housing, terminal elements on said container electrically connected to the electrical elements within said container, terminal elements on said housing electrically connected to the electrical elements outside said container, and the terminal elements on said housing and said container adapted to be detachably, electrically secured together.

3. The structure of claim 1 wherein the source of direct current output includes an alternator having field windings and armature windings, a full wave rectifier interposed between said armature windings and said positive and negative terminals, a voltage regulator connected between said positive and negative terminals, a variable resistance in said voltage regulator, and said variable resistor being electrically connected in series to the field windings of said alternator.

4. In combination with a vehicle having a frame; a refrigeration system operatively secured to said frame and being comprised of at least a compressor having pressure and suction ports, an electrical motor operatively secured to said compressor, a condenser, an evaporator unit, and a refrigerant-carrying conduit interconnecting said compressor, condenser and evaporator unit; and an electrical control system comprised of a source of direct current output and having a positive voltage terminal and a negative voltage terminal, said electrical control system including an alternator secured to said frame, said alternator having field windings and armature windings, a full wave rectifier interposed between said armature windings and said positive and negative terminals, a voltage regulator connected between said positive and negative terminals, a variable resistance in said voltage regulator, said variable resistor being electrically connected in series to the field windings of said alternator, a starting resistor and said compressor motor electrically connected in series between said positive and negative terminals with said motor being on the negative side of said resistor, a relay having a relay coil and relay contact points, a by-pass conduit connecting the suction and pressure ports of said compressor, a normally closed valve in said by-pass conduit to prevent the flow of refrigerant through said by-pass conduit at times, an unload solenoid secured to said valve to open said valve upon becoming electrically excited, the coil of said relay being connected in parallel with said motor and interposed in said system between the negative side of said starting resistor and said negative terminal, said unload solenoid connected in parallel with said starting resistor, and a shunt circuit connected in parallel around said starting resistor, said shunt cir-

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cuit having a thermostat and said relay contact points series connected therein, said relay contact points being normally open and being adapted to close whenever said relay coil senses a predetermined voltage, and said thermostat being normally open and being adapted to close when subjected to a predetermined temperature.

5. The structure of claim 4 wherein the refrigeration system is mounted in a housing which in turn is secured to said frame, at least a portion of the elements of said electrical control system being mounted in a container which is detachably secured within said housing, terminal elements on said container electrically connected to the electrical elements within said container, terminal elements on said housing electrically connected to the electrical elements outside said container, and the terminal elements on said housing and said container adapted to be detachably, electrically secured together.

6. In a control circuit for refrigeration systems, a source of direct current output having a positive terminal and a negative terminal, a compressor motor adapted to operate a compressor in a refrigeration system, an unload solenoid adapted to actuate a valve in a compressor unloading conduit in a refrigeration system upon being electrically excited, a starting resistor and said compressor motor electrically connected in series between said positive and negative terminals with said motor being on the negative side of said resistor, a relay having a relay coil and relay contact points, the coil of said relay being connected in parallel with said motor and interposed in said system between the negative side of said starting resistor and said negative terminal, said unload solenoid connected in parallel with said starting resistor, and a shunt circuit connected in parallel around said starting resistor, said shunt circuit having a thermostat and said relay contact points series connected therein, said relay contact points being normally open and being adapted to close whenever said relay coil senses a predetermined voltage, and said thermostat being normally open and being adapted to close when subjected to a predetermined temperature.

7. In combination with a refrigeration system comprised of at least a compressor having pressure and suction ports, an electrical compressor motor operatively secured to said compressor, a condenser, an evaporator unit, and a refrigerant-carrying conduit interconnecting said compressor, condenser and evaporator units; an electrical control system comprised of a means providing a source of direct current output and having a positive voltage terminal and a negative voltage terminal, a starting resistor and said compressor motor electrically connected in series between said positive and negative terminals with said motor being on the negative side of said resistor, a relay having a relay coil and relay contact points, a by-pass conduit connecting the suction and pressure ports of said compressor, a normally closed valve in said by-pass conduit to prevent the flow of refrigerant through said by-pass conduit at times, the coil of said relay being connected in parallel with said motor and interposed in said system between the negative side of said starting resistor and said negative terminal, and a shunt circuit connected in parallel around said starting resistor, said shunt circuit including said unload solenoid and having a thermostat and said relay contact points series connected therein, said relay contact points being normally open and being adapted to close whenever said relay coil senses a predetermined voltage, and said thermostat being normally open and being adapted to close when subjected to a predetermined temperature.

8. In a control circuit for refrigeration systems, a source of direct current output having a positive terminal and a negative terminal, a compressor motor adapted to operate a compressor in a refrigeration system, an unload solenoid adapted to actuate a valve in a compressor unloading conduit in a refrigeration system upon being

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electrically excited, a starting resistor and said compressor motor electrically connected in series between said positive and negative terminals with said motor being on the negative side of said resistor, a relay having a relay coil and relay contact points, the coil of said relay being connected in parallel with said motor and interposed in said system between the negative side of said starting resistor and said negative terminal, and a shunt circuit connected in parallel around said starting resistor, said shunt circuit including said unload solenoid and having a thermostat and said relay contact points series connected therein, said relay contact points being normally open and being adapted to close whenever said relay coil senses a predetermined voltage, and said thermostat being normally open and being adapted to close when subjected to a predetermined temperature.

9. In a control circuit for refrigeration systems, a source of direct current output having a positive terminal and a negative terminal, a compressor motor adapted to operate a compressor in a refrigeration system, an unload solenoid adapted to close a valve in a compressor unloading conduit in a refrigeration system upon being elec-

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trically excited, a starting resistor and said compressor motor electrically connected in series between said positive and negative terminals with said motor being on the negative side of said resistor, a relay having a relay coil and relay contact points, the coil of said relay being connected in parallel with said motor and interposed in said system between the negative side of said starting resistor and said negative terminal, and a shunt circuit connected in parallel around said starting resistor, said shunt circuit including said unload solenoid and having a thermostat and said relay contact points series connected therein, said relay contact points being normally open and being adapted to close whenever said relay coil senses a predetermined voltage, and said thermostat being normally open and being adapted to close when subjected to a predetermined temperature.

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