Aug. 26, 1952 D. F. ALEXANDER 2,608,067

ELECTRICAL APPARATUS

Filed March 7, 1946 3 Sheets-Sheet 1

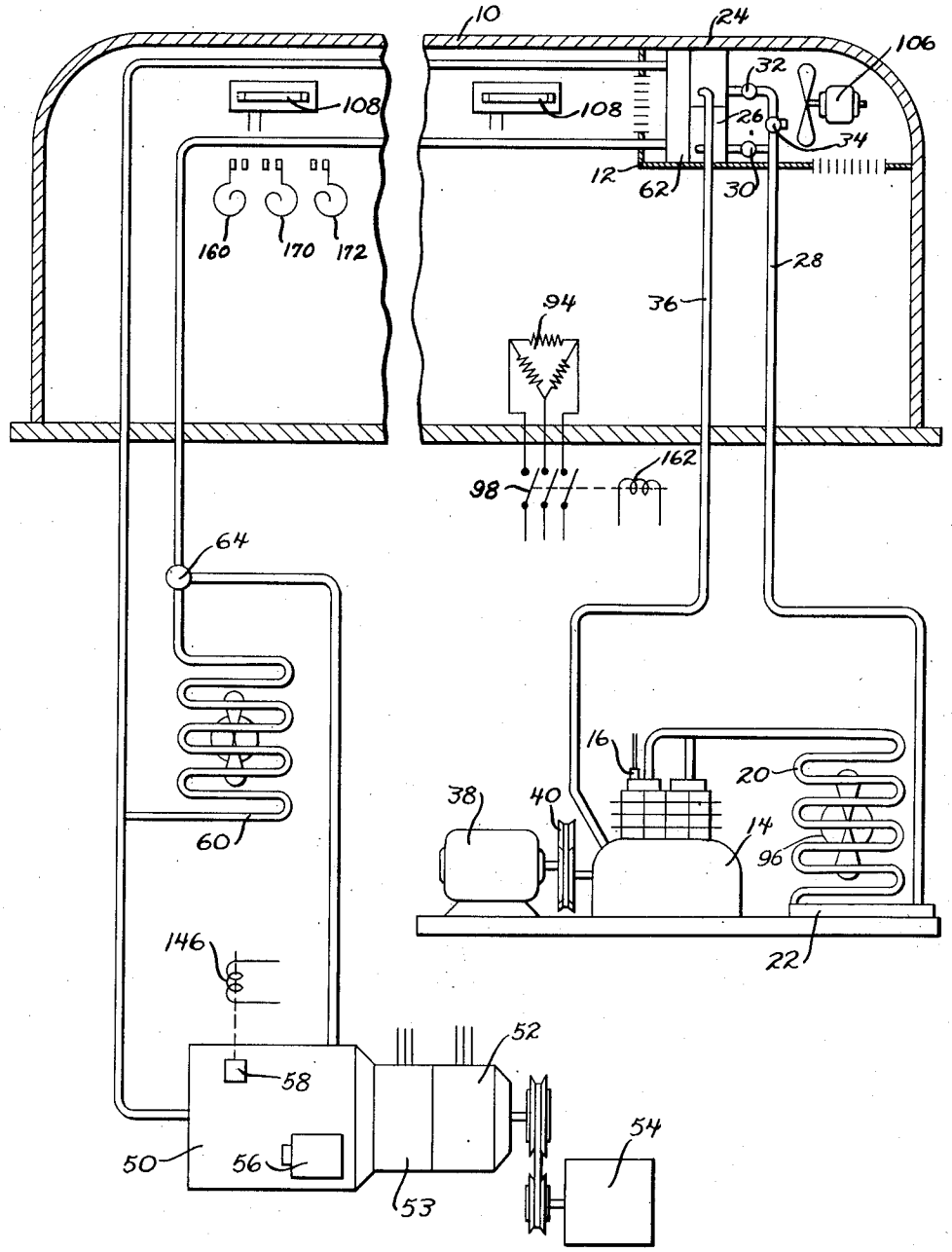


Fig. 1

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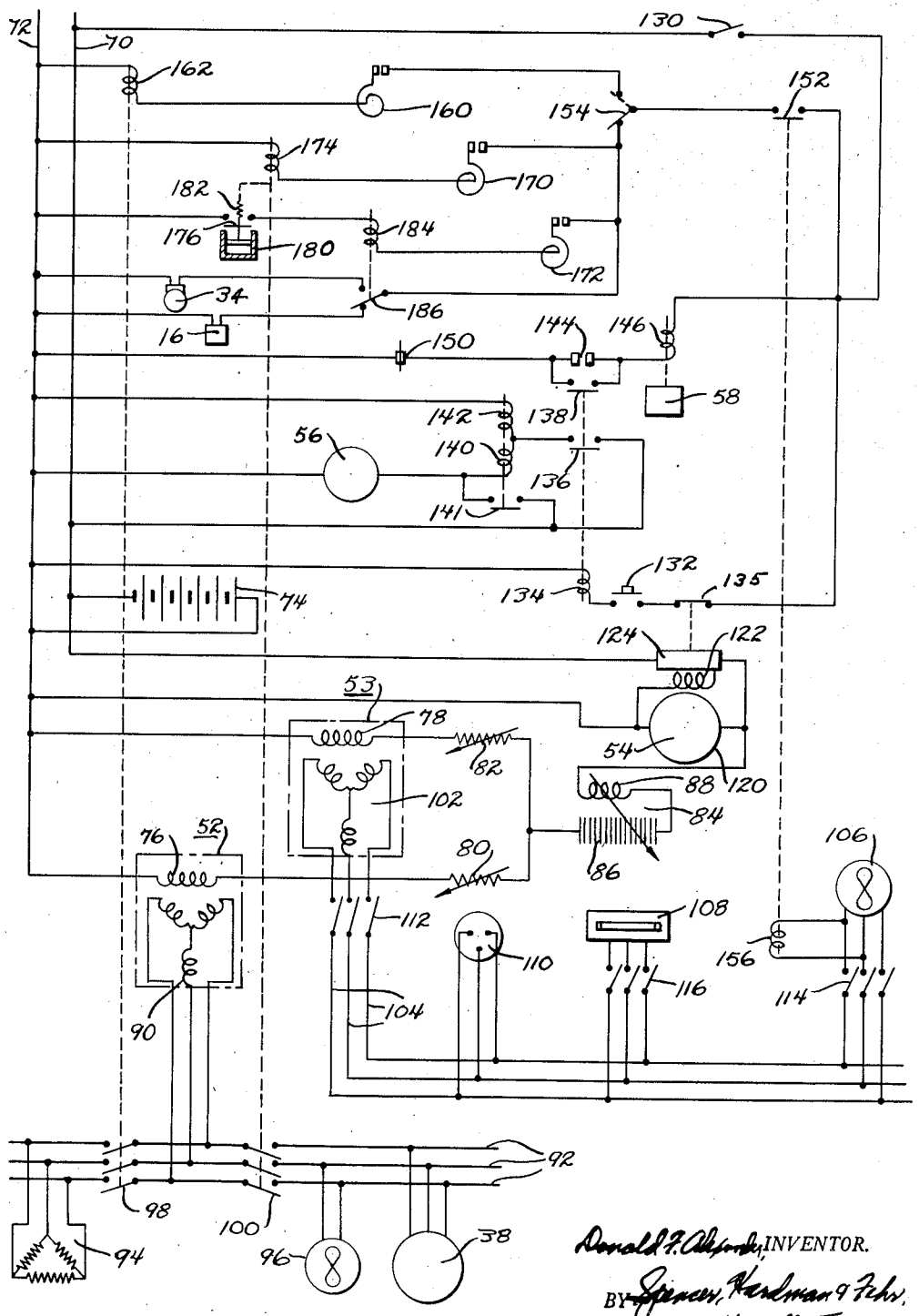


Fig. 2

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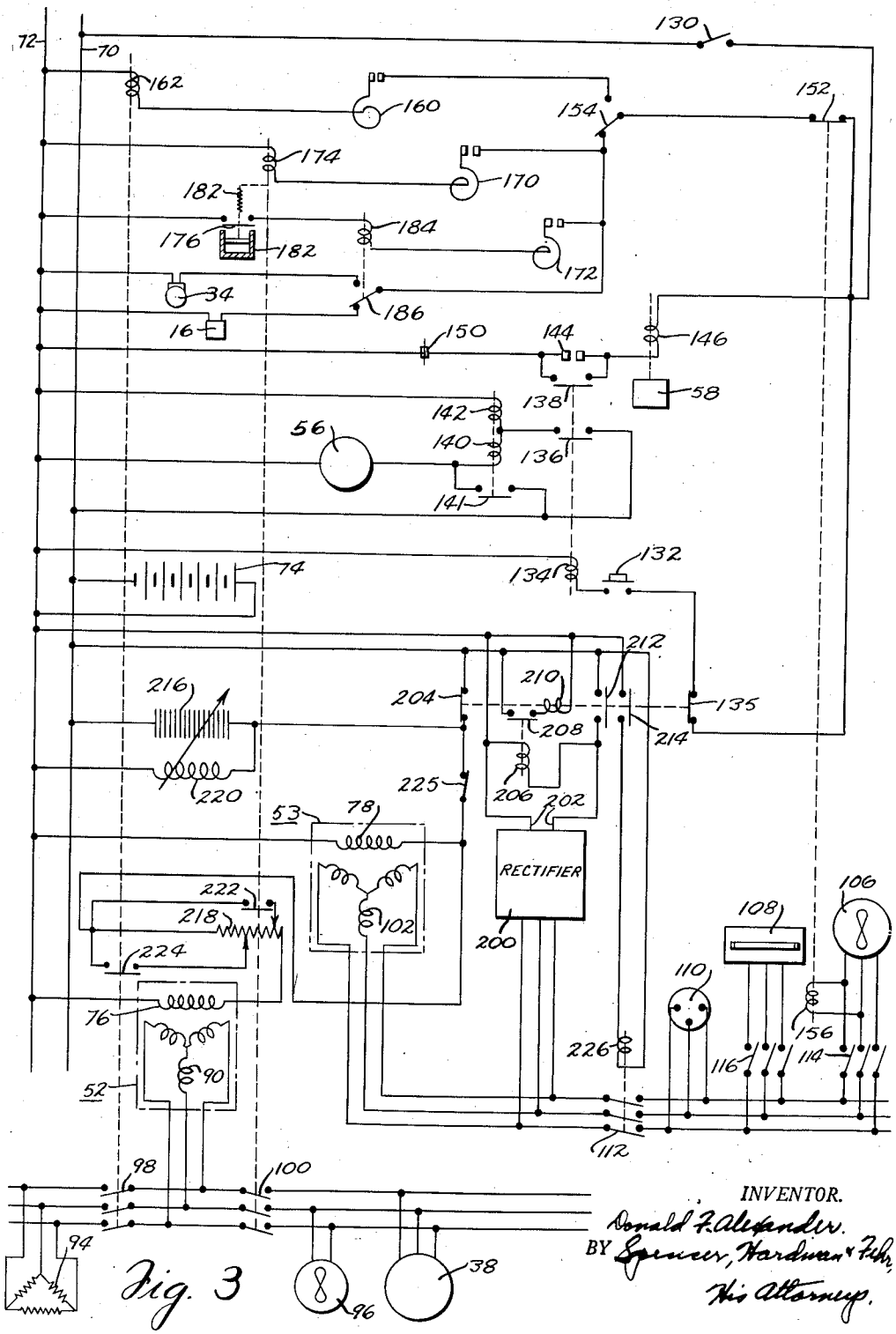


Fig. 3

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UNITED STATES PATENT OFFICE

2,608,067

ELECTRICAL APPARATUS

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Application March 7, 1946, Serial No. 652,515

11 Claims. (Cl. 62—4)

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This invention relates to electrical apparatus and more particularly to an improved railway electrical and lighting system.

It is an object of this invention to provide a system which is simple and reliable in operation.

It is a further object of this invention to provide a system which does not require the use of expensive voltage regulators, transformers, and controls.

Another object of this invention is to provide an improved arrangement for varying the capacity of the refrigeration system so as to prevent frequent cycling.

Another object of this invention is to provide a system in which the air conditioning apparatus may be cycled of modulated without causing any fluctuations in the voltage supplied to the lighting apparatus.

A further object of this invention is to eliminate light flicker in a combination air conditioning and lighting system such as that used on railway cars and similar installations.

Still another object of this invention is to provide a generator system in which one generator supplies 220 volts for the air conditioning apparatus and another generator supplies 120 volts for the lighting and ventilating apparatus.

A further object of this invention is to provide an improved arrangement for supplying electrical energy from one railway car to another railway car for operating emergency lighting and ventilating equipment.

More specifically it is an object of this invention to provide a system using a single diesel engine which operates one exciter and a pair of alternators for supplying current at different voltages to the air conditioning and lighting apparatus.

A further object of this invention is to provide a simplified field control arrangement.

Still another object of this invention is to provide a system in which a rectifier may be used for exciting the fields of two alternators driven by a common prime mover.

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

In the drawings:

Fig. 1 is a diagrammatic view showing a railway car equipped with a system embodying features of my invention;

Fig. 2 is a diagrammatic view showing a preferred circuit arrangement; and

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Fig. 3 is a diagrammatic view showing a modified circuit in which the usual exciter has been eliminated and a rectifier has been provided for supplying the necessary field excitation.

For purposes of illustration, the combination lighting and air conditioning system has been shown applied to a railway car whereas many features of my invention are equally applicable to stationary installations such as may be used in theaters and office buildings.

Referring now to Fig. 1 of the drawing, wherein a preferred embodiment of my invention has been shown, reference numeral 10 designates a conventional railway car provided with an air conditioning plenum chamber 12 located adjacent the one end of the car and within which a pair of refrigerant evaporators 24 and 26 are mounted as shown. The refrigerating system employs a multiple cylinder compressor 14 of the type adapted to be operated at a constant speed. The compressor 14 is provided with means 16 for rendering one or more of the cylinders inoperative when reduced capacity is desired. The cylinders may be rendered inoperative in any of several well known ways such as by lifting one or more of the discharge valves.

The compressed refrigerant is discharged into the condenser 20 from whence the condensed refrigerant flows into the receiver 22. Liquid refrigerant is supplied from the receiver 22 to the evaporator sections 24 and 26 through the line 28. A conventional thermostatic expansion valve 30 controls the flow of liquid refrigerant to the evaporator section 26 in accordance with well known practice. A similar thermostatic expansion valve 32 controls the flow of refrigerant to the evaporator section 24. A solenoid valve 34 has been provided in the liquid refrigerant line leading to the valve 32 for shutting off the supply of refrigerant to the evaporator section 24 when it is desired to operate the refrigeration system at a reduced capacity.

The refrigerant vapor leaving the evaporator sections 24 and 26 is conveyed to the compressor through the vapor line 36 as shown. The compressor 14 is driven by a 220 volt alternating current motor 38. The motor 38 may be directly connected to the compressor 14 or it may drive the compressor through a belt means 40 as indicated in Fig. 1.

Each railway car is provided with a complete power system which supplies all the necessary electrical energy for operating the refrigerating apparatus, car lights and all other electrical equipment. By providing such a separate power

system on each railway car, the load on the head engine is very materially reduced with the result that more cars can be used in a single train and better acceleration can be obtained. In the modification shown in Fig. 1 of the drawing, a diesel engine 50 has been provided for operating the dual alternators 52 and 53 and the exciter 54. Reference numerals 56 and 58 designate the engine starter and the magnetically controlled engine throttle, respectively.

The heat generated in the diesel engine may be dissipated by the engine radiator 60 or it may be dissipated by the heat exchange unit 62 located in the plenum chamber 12. The heat exchange unit 62 may be used for reheating the air during the cooling season and for supplying heat to the conditioned space during the heating season. A three-way valve 64 has been provided for controlling the flow of heating medium to the heat exchangers 60 and 62. In order to simplify this disclosure the valve 64 has been shown as a manually controlled valve, whereas it may be automatically controlled in response to either the temperature, the relative humidity, or a combination of both within the conditioned space.

The preferred electrical arrangement has been diagrammatically shown in Fig. 2 of the drawing, wherein reference numerals 70 and 72 designate the main direct current power lines from whence power is supplied to the various automatic controls to be described hereinafter. Reference numeral 74 designates a conventional storage battery which is connected across the lines 70 and 72 for supplying emergency direct current power when the exciter 54 is not in operation.

The dual alternators 52 and 53 are direct connected to the diesel engine 50 so as to be operated thereby whenever the engine 50 is in operation. The engine 50 is preferably a constant speed engine capable of operating the alternators at uniform speed irrespective of the load placed on the alternators. The alternator 52 is provided with a field coil 76 which is connected in circuit with the exciter 54 as shown. The alternator 53 is similarly provided with a field coil 78 which is connected in parallel circuit relationship with the field coil 76. Adjustable resistances 80 and 82 are provided for manually varying the resistances of the respective field circuits in accordance with well known practice. The flow of current to the field coils 76 and 78 is controlled by means of the constant current regulator 84 which comprises a carbon pile 86 and a solenoid 88 which is used for varying the resistance of the carbon pile 86 so as to maintain the flow of current through the regulator 84 substantially constant at all times.

The alternator 52 is provided with an armature 90 which supplies three phase, 60 cycle, 220 volt current to the power lines 92 for energizing the car heating elements 94, the compressor motor 38, the condenser fan motor 96 as well as any other heavy duty electrical equipment which it might be found desirable to have on the car. The flow of current to the electric heaters 94 is controlled by the switch 98 and the flow of current to the compressor motor 38 and the condenser fan motor 96 is controlled by the switch 100 arranged in the circuit as shown.

The alternator 53 is provided with an armature 102 which supplies 3 phase, 60 cycle, 110 volt power to the 110 volt power lines 104 which in turn supply power to the evaporator fan motor 106, the fluorescent car lights 108, and the car jumper connection 110. A switch unit 112 is provided for disconnecting the 110 volt equipment from the alternator 53. This switch makes it possible to disconnect the armature 102 from the circuit when it is desired to energize the 110 volt equipment from a similar alternator provided on an adjacent car. The jumper connection 110 is intended to be used only in emergencies for connecting the 110 volt equipment on one car with the 110 volt equipment on an adjacent car so as to provide car lighting and air circulation on two adjacent cars from a single alternator when only one of the diesel engines is in operation. The blower motor 106 is controlled by the manual switch 114 and the lights are controlled by the manual switch 116.

By virtue of the above described alternator arrangement, it becomes practical to provide a low voltage jumper connection for directly connecting the lights and blower motors from two separate cars to a single alternator without using any transformers. In the prior art systems using a single high votage alternator for supplying current to the heavy duty air conditioning apparatus and the lighting equipment, it is necessary to provide special voltage regulators for preventing light flicker when the heavy duty equipment is turned on, and it is also necessary to provide transformers for supplying 110 volts to the lights, etc. Voltage regulators and transformers require frequent servicing by specially trained men and are not too dependable. Thus it is apparent that many service difficulties may be eliminated by providing one high voltage alternator for supplying the heavy duty apparatus and by providing a separate low voltage alternator for supplying current to the lighting and generating circuits. Even though two alternators are provided, only one prime mover, one storage battery, and only one exciter need be provided when using the system disclosed herein.

The exciter 54 keeps the battery 74 charged and energizes the field windings 76 and 78 of the two alternators. It comprises the usual armature 120, field coil 122, and voltage regulator and reverse current relay 124 all of which function in their well known manner and need no further description.

A master control switch 130 controls the supply of power from the line 70 to the various control circuits as shown. In order to start the diesel engine, it is first necessary to close the switch 130 and then operate the push button 132 which is arranged in series with the solenoid 134. Energization of the solenoid 134 lifts the starting motor switch 136 and the throttle operating switch 138. Closing of the switch 136 directly energizes the heavy current or pull-in coil 140 and the voltage or holding coil 142 so as to initiate operation of the starting motor 56 in accordance with conventional practice. After the diesel engine 50 has been brought up to speed, the oil pressure within the diesel engine will cause closing of the oil pressure operated switch 144 with the result that the throttle solenoid 146 will remain energized even after the push button 132 has moved to the open position and the switches 136 and 138 have dropped into the open circuit position. Energization of the voltage coil 142 and the pull-in coil 140 causes closing of the switch 141 with the result that the pull-in coil 140 will be short circuited and the switch 141 will be held closed merely by the holding coil 142. A safety switch

150 is provided in circuit with the throttle solenoid 146 and is adapted to be opened immediately in the event that the diesel engine overheats. The relay 124 holds open the switch 135 at all times when the exciter and consequently the engine 50 are in operation.

The cooling and heating control circuits are controlled by the switch 152 arranged in series with the manually operated change over switch 154. This latter switch is used to turn on either the heating equipment or the cooling equipment depending on which form of air conditioning is required. The switch 152 is under control of the solenoid 156 which in turn is automatically energized whenever the blower motor 106 is turned on by the manual switch 114. Closing of the switch 114 causes closing of the switch 152. The change over switch 154 may be manually operated or it may be automatically operated in response to the outside temperature or any other condition which might be used to indicate the need for either heating or cooling. By moving the switch 154 from the full line position in which it is shown in Fig. 1 to the dotted line position, the thermostat 160 is placed in control of the solenoid 162 which in turn controls the switch 98 and the flow of current to the electric heater 94. The thermostat 160 is adapted to close at a given temperature which indicates the need for heating.

When the change-over switch 154 is in its full line position, it connects the motor control thermostat 170 and the modulating thermostat 172 in circuit. The thermostat 170 is designed to close when the temperature in the car first exceeds that temperature at which the air conditioning apparatus should turn on. Closing of the thermostat 170 energizes the solenoid 174 which then closes the compressor motor control switch 100. The solenoid 174 is also arranged to operate the time delay switch 176 which is adapted to close approximately five seconds after the compressor motor 38 has been energized. The five second delay allows the compressor motor to come up to speed before the switch 176 closes. A dashpot 180 has been provided for delaying the closing of the switch 176. The spring connection 182 has been provided so as to allow the switch 100 to close without waiting for the switch 176 to move to its uppermost position.

The thermostat 172 is adapted to close at a slightly higher temperature than the thermostat 170 and is arranged in series with the solenoid 184. Before the solenoid 184 can be energized it is necessary that both the switch 176 and the thermostat 172 be in their closed circuit position. When the solenoid 184 is first energized, it moves the switch 186 into its upper position, in which position the circuit to the solenoid valve 34 is closed. This causes the valve to open so as to allow the flow of refrigerant to the evaporator section 24, whereby both evaporator sections are effective to cool the air for the space to be conditioned. Lifting of the switch 186 also deenergizes the unloader 16 whereby the compressor is operated at full capacity. When the switch 186 returns to its lowermost position, the refrigerant valve 34 shuts off the flow of refrigerant to the one evaporator section and the unloader solenoid 16 becomes energized whereby the compressor is operated at a reduced capacity.

A slightly modified circuit arrangement has been shown in Fig. 3. The system shown therein is substantially the same as the system shown in Fig. 2 except that a rectifier 200 has been provided for energizing the fields of the alternators in lieu of the direct current generator or exciter 54 shown in Fig. 2. The same reference numerals have been used to designate corresponding elements in Figs. 2 and 3 and unless otherwise indicated the elements shown in Fig. 3 function in the same manner as the corresponding elements shown in Fig. 2.

As indicated in Fig. 3 of the drawing, a rectifier 200 has been provided for supplying direct current to the power lines 70, 72 during normal operation of the diesel engine and the alternators driven thereby. The alternator 53 supplies alternating current to the rectifier 200 which rectifies the current and supplies direct current to the rectifier output lines 202. Since the rectifier 200 is incapable of supplying power until after the alternator 53 has started generating current, it is necessary to energize the field of the alternator directly from the storage battery until the rectifier output is sufficient to properly excite the fields of the alternators.

The switch 204 has been provided in the circuit as shown for directly connecting the fields 76 and 78 of the alternators 52 and 53 across the storage battery until the output of the alternator 53 is sufficient to supply the rectifier with enough power to energize the relay 206 which is arranged across the output lines 202 of the rectifier. Energization of the relay 206 causes closing of the switch 208. The switch 208 is arranged in series with the solenoid 210 which, when fully energized, opens the switches 135 and 204 and closes the switches 212 and 214. Opening switch 204 places the carbon pile rheostat 216 in series with the field windings 76 and 78 of the alternators 52 and 53 respectively. The carbon pile rheostat 216 is controlled by the voltage coil 220 which is arranged in circuit as shown. The resistance 218 which is in series with the field coil 76 is controlled by the switches 222 and 224. The switch 222 which is operated by the solenoid 174 shorts out a portion of the resistance 218 when the solenoid 174 closes the switch 100 leading to the compressor motor 38 and the condenser fan 96. By virtue of this arrangement the field excitation of the alternator 78 is automatically adjusted to take care of the change in load on the alternator 52 when the refrigeration equipment is turned on.

A switch 224 has been provided for shorting out a portion of the field resistance 218 when the electric heaters 94 are turned on in response to a demand for electric heating. A switch 225 has been provided for disconnecting the alternator fields 76 and 78 when the diesel engine is not in operation. The switch 225 may be a manually operated switch or it may be operated automatically to open the circuit in response to stopping of the diesel engine.

Closing of the switch 212 by the solenoid 210 connects the output of the rectifier 200 to the direct current power lines 70, 72 so as to make it possible to charge the storage battery 74 from the rectifier. Closing of the switch 214 energizes the solenoid 226 which automatically closes the switch 112 leading to the car jumper 110, the fluorescent car lights 108 and the evaporator blower 106. By virtue of this switching arrangement, it is apparent that the alternator 53 is not called upon to supply power to the car lights, etc., until after the rectifier has

been supplied with enough power to properly excite the fields of the alternators.

The relay 210 operates much like a reverse current relay in that it is capable of holding the switches 212 and 214 closed only so long as the rectifier is supplying direct current to the lines 202. Thus, when the diesel engine and the alternators are stopped, the rectifier becomes ineffective to supply the necessary voltage required for properly energizing the relay 210 with the result that the switches 212 and 214 open and the switches 135 and 204 close.

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, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. In combination, a prime mover, a first generator including a field circuit and an armature circuit, a second alternating current generator including a field circuit and an armature circuit, a first electric power consuming means, a second electric power consuming means, current rectifying means connected to the armature circuit of said second generator for supplying rectified current to the field circuits of said first and second generators, means for supplying current from said first generator to said first and second power consuming means, said field circuit of said first generator including a resistance unit, first means for shorting a portion of said resistance unit, second means for shorting a portion of said resistance unit, means operable upon energization of said first power consuming means controlling the first of said shorting means, and means responsive to energization of said second power consuming means for controlling said second shorting means.

2. In combination, a first generator including a field circuit and an armature circuit, a second alternating current generator including a field circuit and an armature circuit, electric power consuming means, electric lighting means, means for rectifying current supplied by one of said armature circuits, means for supplying said rectified current to said field circuits, means for supplying current from said first generator to said power consuming means, means for supplying current from said second generator to said lighting means, said field circuit of said first generator including a resistance unit, means for shorting a portion of said resistance unit, and means operable in response to energization of said power consuming means for controlling said shorting means.

3. In combination, a power source, a first alternating current generator driven by said power source, a second alternating current generator driven by said power source, means for rectifying current generated by one of said generators, said first and second alternating current generators comprising field coil means, and means for supplying current from said rectifying means to said field coil means, electrically energized means, means for supplying electrical energy to said electrically energized means from said first alternating current generator, electric lighting means, and means for supplying electrical energy to said electric lighting means from said second named alternating current generator whereby changes in load on said first named alternating current generator do not cause said electric lighting means to flicker.

4. In combination, a prime mover, a first alternating current generator driven by said prime mover, a second alternating current generator driven by said prime mover, means for rectifying current generated by one of said generators, said first and second named generators comprising field coil means, means for supplying said rectified current to said field coil means, electric power consuming means, means for supplying electrical energy to said power consuming means from said first named alternating current generator, electric lighting means, and means for energizing said electric lighting means from said second named alternating current generator, whereby changes in load on said first named generator do not cause said electric lighting means to flicker.

5. In combination, a prime mover, a first alternating current generator driven by said prime mover, a second alternating current generator driven by said prime mover, means for rectifying current generated by one of said generators, said first and second named generators comprising field coil means, means for supplying said rectified current to said field coil means, electric power consuming means, means for supplying electrical energy to said power consuming means from said first named alternating current generator, electric lighting means, means for energizing said electric lighting means from said second named alternating current generator, whereby changes in load on said first named generator do not cause said electric lighting means to flicker, storage battery means, means for connecting the out-put of said current rectifying means to said storage battery means, and means for energizing said field coil means from said storage battery when said rectifying means is ineffective to energize said field coil means.

6. In combination, a power source, a first generator driven by said power source, a second generator driven by said power source, a motor, means for supplying electrical energy to said motor from said first generator, electric lighting means, means for energizing said electric lighting means from said second generator whereby changes in load on said first generator do not cause the electric lights to flicker, means for starting and stopping said motor, said first and second generators comprising field coil means, a rectifier, means for connecting the out-put of one of said generators to said rectifier, means for supplying rectified current from said rectifier to said field coil means, resistance means for controlling the flow of current through said field coil means, and means for varying the flow of current through said resistance means.

7. In combination, a prime mover, a first alternating current generator driven by said prime mover, a second alternating current generator driven by said prime mover, means for rectifying current generated by one of said generators, said first and second named generators comprising field coil means, means for supplying said rectified current to said field coil means, electric power consuming means, means for supplying electrical energy to said power consuming means from said first named alternating current generator, electric lighting means, means for energizing said electric lighting means from said second named alternating current generator, whereby changes in load on said first named generator do not cause said electric lighting means to flicker, storage battery means, means for connecting said storage battery to the output of said rectifying means, and means for supplying current

from said storage battery to said field coil means when said rectifying means is ineffective to energize said field coil means.

8. In combination, a power source, a first generator driven by said power source, a second generator driven said power source, a motor, means for supplying electrical energy to said motor from said first generator, electric lighting means, means for energizing said electric lighting means from said second generator whereby changes in load on said first generator do not cause the electric lights to flicker, means for starting and stopping said motor, said first and second generators comprising field coil means, a rectifier, means for connecting the output of one of said generators to said rectifier, means for supplying rectified current from said rectifier to said field coil means, resistance means for controlling the flow of current through said field coil means, means for varying the flow of current through said resistance means, means for short circuiting said resistance means, and means responsive to the output of said rectifier for controlling said short circuiting means.

9. Air conditioning means for an enclosure including a multiple cylinder compressor, means for unloading at least one but not all of the cylinders, a two-position control means for said unloading means having a first position for unloading said one cylinder and a second position for loading said one cylinder, condensing and evaporating means operably connected to said compressor, means for flowing air for said enclosure in thermal exchange with said evaporating means, a first thermostatic control means responsive to a predetermined temperature within said enclosure for starting said compressor, a second higher temperature thermostatic control means for controlling said two-position control means to move it to unloading position at lower temperatures to unload said one cylinder under starting and light load conditions and responsive to the higher temperature to move the two-position control means to the loading position.

10. In combination, a first alternating current generating means including a field circuit and an armature circuit, a second generating means including a field circuit and an alternating current armature circuit for generating alternating current and a direct current supply means, a single common power source for driving said first and second generating means, electric power consuming means connected to the armature circuit of said first generating means, said field circuits being connected in parallel circuit relationship, means for supplying direct current from said direct current supply means in parallel circuit relationship to both of said field circuits, and a common constant current regulating means connected in series with both of said field circuits and responsive to the flow of current from said direct current supply means to said field circuits for providing a substantially constant flow of current through both of said field circuits.

11. In combination, a first alternating current generating means including a field circuit and an armature circuit, a second generating means including a field circuit and an alternating current armature circuit for generating alternating current and a direct current supply means, a single common power source for driving said first and second generating means, electric power consuming means connected to the armature circuit of said first generating means, said field circuits being connected in parallel circuit relationship, means for supplying direct current from said direct current supply means in parallel circuit relationship to both of said field circuits, and a common constant current regulating means connected in series with both of said field circuits and responsive to the flow of current from said direct current supply means to said field circuits for providing a substantially constant flow of current through both of said field circuits, one of said field circuits being provided with an adjustable variable resistance for regulating its current flow.

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