May 26, 1942. L. H. VON OHLSEN 2,284,546

REFRIGERATION APPARATUS

Filed July 27, 1938 3 Sheets-Sheet 1

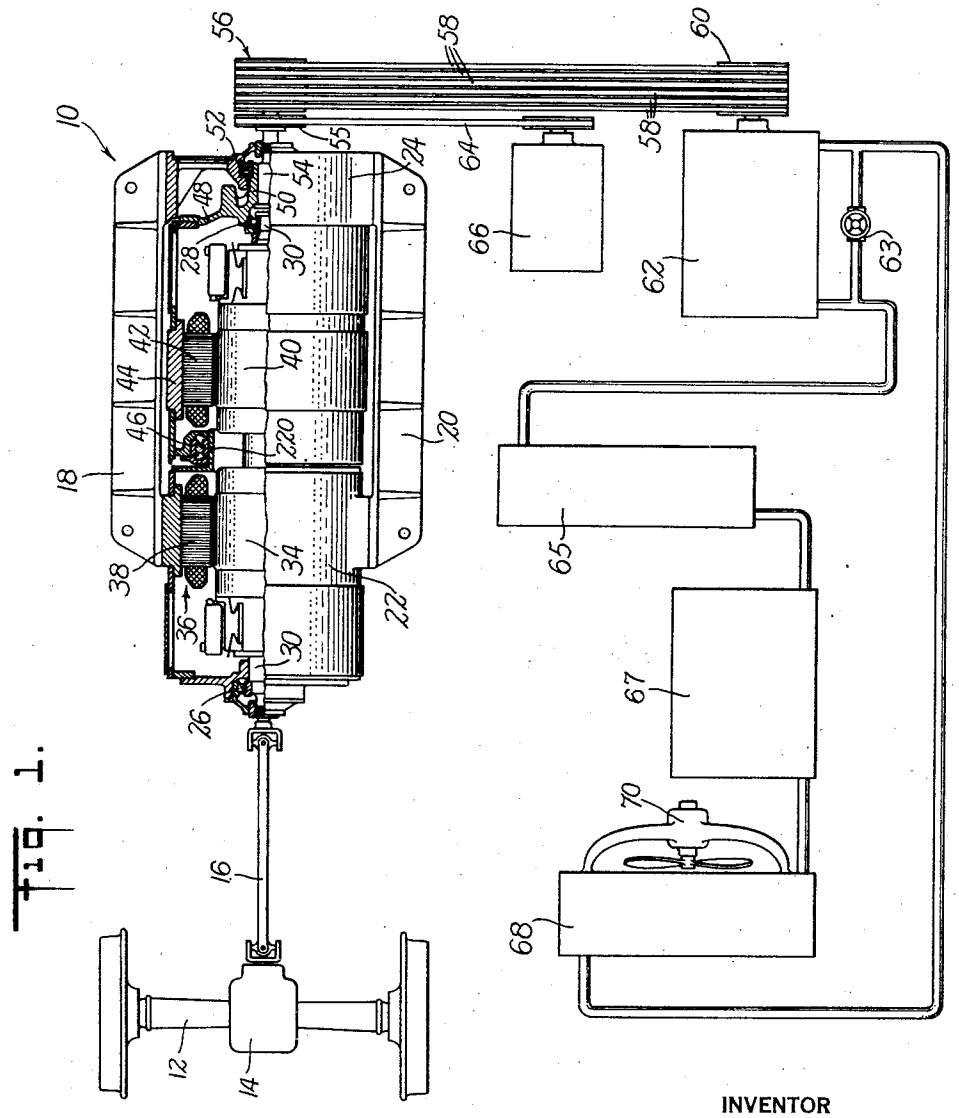


Fig. 1.

INVENTOR
Louis H. Von Ohlsen
BY
Blair, Curtis, Dunne & Hayward
ATTORNEYS

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REFRIGERATION APPARATUS

Filed July 27, 1938 3 Sheets-Sheet 2

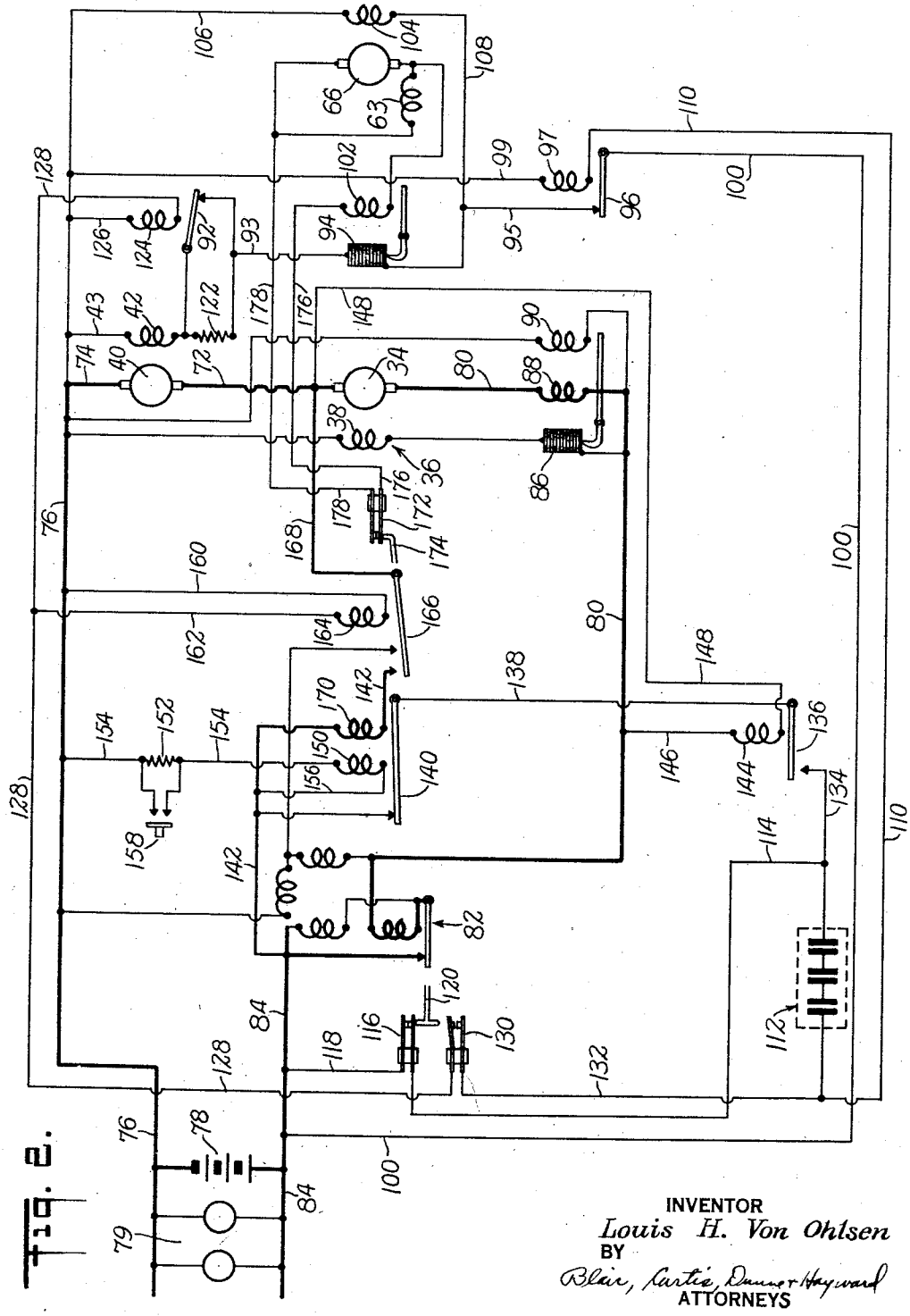


Fig. 2.

INVENTOR
Louis H. Von Ohlsen
BY
Blair, Curtis, Danner & Hayward
ATTORNEYS

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REFRIGERATION APPARATUS

Filed July 27, 1938 3 Sheets-Sheet 3

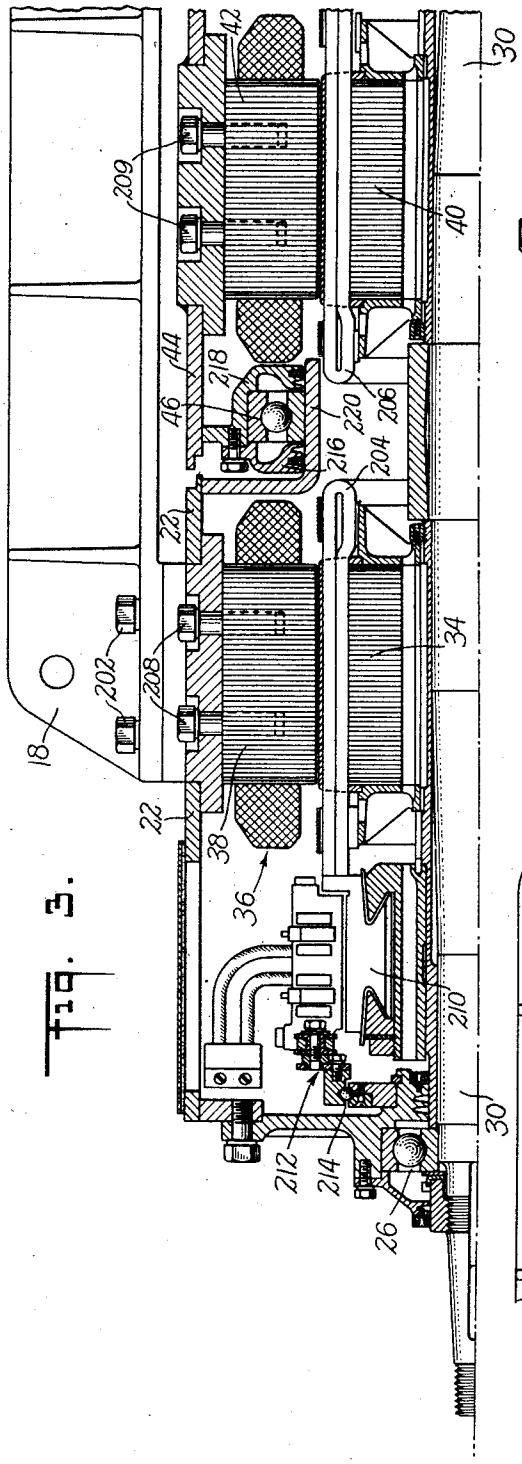


Fig. 5.

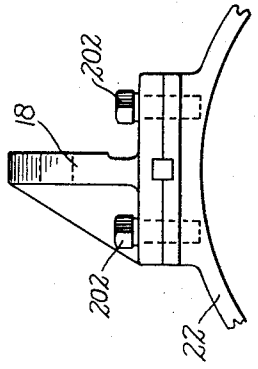
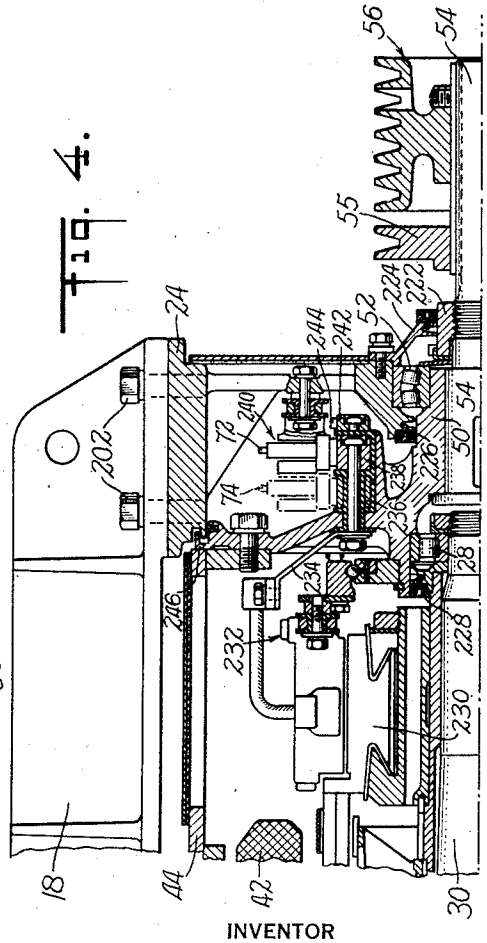


Fig. 4.



INVENTOR
Louis H. Von Ohlsen
BY
Blair, Curtis, Dunne & Hayward
ATTORNEYS

Patented May 26, 1942 2,284,546

UNITED STATES PATENT OFFICE

2,284,546

REFRIGERATION APPARATUS

Louis H. Von Ohlsen, New Haven, Conn., assignor to The Safety Car Heating & Lighting Company Inc., a corporation of Delaware

Application July 27, 1938, Serial No. 221,647

16 Claims. (Cl. 171—313)

This invention relates to air conditioning apparatus and more in particular to such apparatus mounted upon a railway car, and to a method and means for supplying power to operate said air conditioning apparatus.

An object of this invention is to provide a drive for an air conditioning apparatus which is compact and durable in construction and efficient in operation. A further object is to provide mechanism which may be used to provide a constant speed drive for a mechanical load. A further object is to provide a mechanism of the above character, together with a method of operation, for utilizing to the fullest extent power taken from the axle of a railway car. A still further object is to provide apparatus of the above character for selectively converting mechanical power into electric power or electric power into mechanical power, depending upon the source of power available and the demands of the system.

A still further object is to provide equipment of minimum size and weight which is inexpensive to manufacture and operate, and which is durable. These and other objects will be in part obvious and in part pointed out below.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the drawings Figure 1 is a schematic showing with certain parts shown in perspective and certain parts broken away;

Figure 2 is the wiring diagram of one embodiment;

Figures 3 and 4 together form a complete sectional view of one-half of the power unit; and

Figure 5 is an end view of one of the supporting brackets of the power unit.

In order to obtain efficient operation of air conditioning apparatus it is important that a reliable source of power be available so that it will operate at any time that a demand exists. This is especially desirable on vehicles such as railway cars, as the entire equipment must be light in weight and must operate with a minimum of attention and the conditions of use change so rapidly that control is difficult.

In addition to this, when the source of power for operating the equipment is the axle of the car, the power taken by the equipment must be kept at a minimum and should be used efficiently at all times. This is due to the fact that the power taken from the axle of the car is supplied by the locomotive drawing the train, and if an excessive amount of power is taken from an axle of each car the operation of the train may be seriously interfered with.

Referring to Figure 1 of the drawings, the power unit is indicated generally by the numeral 10, and receives power from the axle 12 of the car through a gear mechanism 14 and a propeller shaft 16. Power unit 10 is supported along its two sides through a pair of T-brackets 18 and 20, which rigidly support a cylindrical shell 22 at the left and an annular frame 24 at the right. Supported at its left end through a bearing unit 26 by shell 22 and at its right end through a bearing unit 28 is a main shaft 30.

Mounted upon the left end of main shaft 30 is an armature 34 of a main generator 36 having a field 38 carried by shell 22. To the right of armature 34 upon shaft 30 is an auxiliary armature 40, and surrounding auxiliary armature 40 so as to cooperate therewith is an auxiliary field 42. Auxiliary field 42 is carried by a cylindrical shell 44 which is supported at its left end through an inwardly extending flange structure and a bearing unit 46 by a sleeve 220 upon stationary shell 22. The right end of cylindrical shell structure 44 is provided with an inwardly extending flange 48 having a hub 50. Hub 50 extends through and is supported by a bearing unit 52 which is carried by annular frame 24; the left side of the hub supports the outer race of bearing unit 28, which, as indicated above, supports the right end of main shaft 30.

Rigidly attached to hub 50 and extending through and to the right, is a stub shaft 54 which carries a multiple-belt sheave 56. A plurality of V-belts 58 mechanically connect sheave 56 to a similar sheave 60 on compressor 62 of the air conditioning unit. The air conditioning unit is shown as comprising the compressor 62, a condenser 65, a receiver 67, and an evaporator 68; fan 70 is mounted to direct air over evaporator 68 when desirable.

The details of construction of the power unit are best shown in Figures 3, 4, and 5. The T-bracket 18 is attached to shell 22 and annular frame 24 by a plurality of stud bolts 202. As best shown in the center of Figure 3, armature 34 is clamped to main shaft 30 and is provided with a winding 204, and in a like manner rotor 40 is clamped to main shaft 30 and is provided with a winding 206. A plurality of stud bolts 208

securely hold stationary field 38 to shell 22, and similar stud bolts 209 hold auxiliary field 42 to rotatable shell 44.

At the left of armature 34, winding 204 is connected to a commutator 210, which is contacted by a plurality of brushes held by brush supporting assembly units generally indicated at 212. Each brush supporting assembly unit 212 is mounted upon a ball bearing construction 214 to permit it to move arcuately and thus automatically adjusts itself when rotation is started, so that the voltage generated will not be reversed when there is a reversal of the direction of movement of the car. Ball bearing unit 26 is provided with suitable sealing means at its two sides and in a like manner, (as shown near the center of Figure 3), ball bearing unit 46 is provided with two sealing rings 216 and 218, which contact the supporting sleeve 220 extending from shell 22.

Referring now to Figure 4, stud shaft 54 is securely held to hub 50 by a threaded sleeve 222 and unit 52 is sealed at the right by a sealing flange 224 and at the left by a seal 226. In a like manner, bearing unit 28, which is supported by hub 50 and in turn supports the adjacent end of main shaft 30, is sealed by a flange 228.

Auxiliary armature 40 is provided with a commutator 230, which is contacted by a plurality of brushes, which are supported by a suitable number of brush supporting assembly units 232. Brush supporting assembly units 232 are mounted in the same manner as are the brush supporting assembly units 212 for the main armature 34 with the result that auxiliary armature 40 always builds up a potential in the same direction regardless of the direction of movement of the car. The brushes of the brush supporting assembly units 232 are connected through a plurality of bus bars 234 to two collector rings 236 and 238, which are in turn contacted by brush assembly units generally indicated at 240. Brush assembly units 240 are in turn connected to leads 72 and 74 and thus into the circuit in a manner which will be more fully pointed out below. The leads from auxiliary winding 42 are not shown in this figure, but one side of the winding is connected to one side of armature 40, and the other side of the winding extends to the right of ring 238 to a collector ring 242. Collector ring 242 is contacted by a brush 244, which is in turn connected in the circuit as will be explained below. The annular space occupied by the collector rings and the brush assembly units is sealed at its outer edge (the upper side of Figure 4) by a plurality of interengaging flanges 246 upon the adjacent portions of rotatable shell 44 and annular frame 24.

As pointed out above, there is a sheave 56 rigidly attached upon stud shaft 54, and keyed in place with sheave 56 and to the left thereof is a sheave 55. Referring again to Figure 1, sheave 55 is connected through a single V-belt 64 to a control generator 66. In this manner control generator 66 operates at a speed proportionate to the speed of compressor 62, and the output voltage of this generator may thus be used as a reliable indicator. Thus, as will be more fully pointed out hereinafter, the voltage output of the generator 66 has a controlling effect on field 42.

Shaft 30 with its two armatures 34 and 40 rotates at a speed which varies directly with the speed of the car, and shell 44 drives compressor 62 through sheave 56 and control generator 66 through sheave 55, as described above. Auxiliary field 42 is mounted upon shell 44 and is free to rotate; when energized field 42 tends to rotate with armature 40. Accordingly the degree of energization of field 42 is controlled by control generator 66 and this determines the degree to which field 42 is locked to and moves with armature 40. The greater the energization of field 42, the stronger the tendency to rotate with field 40 and consequently the more power taken from the axle through the shaft 30 as described above. This action is automatic and if the car speed increases, shell 44 tends to lag behind armature 40 so as to cause a "slip" sufficient to maintain a proper compressor speed.

The wiring and control mechanism is shown in Figure 2, and referring particularly to the left-hand side of this figure a set of batteries 78 with two main lines 76 and 84 is indicated as supplying power to an electrical load 79, for example, including lights, fans, etc. On the right-hand side of Figure 2, one side of auxiliary armature 40 is shown connected directly to main line 76 by a lead 74 with its other side connected through a lead 72 in series with armature 34 of the main generator 36. The other side of armature 34 is connected through a lead 80 and a reverse current relay 82 to main line 84.

In this figure the various elements are in the position which they occupy when the car is moving at normal speed with the battery charging and the air conditioning unit in operation, and armatures 34 and 40 are thus connected in series across the main lines. The field 38 of the main generator 36 is connected in series with a variable resistance in the form of a carbon pile 86, the resistance of which is controlled by a voltage coil 90 connected across the line voltage, and a current coil 88 in lead 80 and thus responsive to the generator load. Armatures 34 and 40 rotate together and thus they normally tend to build up voltages in series so as to divide the total load between themselves.

However, armature 40 cooperates with the rotatable field 42 which is energized sufficiently to cause it to tend to rotate with rotor 40. Rotatable field 42 is energized by being connected across the main line voltage; one side of the field is connected by a lead 43 to main line 76 and the other side is connected through a normally-closed switch 92, a lead 93, a carbon pile 94, a lead 95, a switch 96 (shown closed) and a lead 100 to main line 84. The resistance of carbon pile 94 is controlled by a coil 102, which is energized by the output voltage of control generator 66. One side of the field 104 of generator 66 is connected through a lead 106 to main line 76 and the other side of the field is connected through a lead 108 to lead 95 and thus through switch 96 and lead 100 to main line 84.

As pointed out above in connection with Figure 1, control generator 66 is rotated at a speed proportionate to the speed of compressor 62 and its voltage therefore varies with the compressor speed. In this manner if the compressor speed exceeds certain predetermined value, the voltage of generator 66 impressed across coil 102 is sufficient to cause an increase in the value of the resistance of carbon pile 94, and the current through auxiliary field 42 is automatically decreased.

It is thus seen that auxiliary armature 40 carries a current which is the total output current of the power unit, whereas auxiliary field 42 associated with it carries a current the value of which decreases with increases in the speed of the com-

pressor. During operation, when the car is running at a predetermined speed somewhat below normal speed, the respective currents through armature 40 and field 42 are such that field 42 tends to lock in with field 40 and rotate with it.

However, as pointed out above, when the car speed increases and as a result the compressor speed tends to increase, the voltage of control generator 66 rises and coil 102 and carbon pile 94 become effective to decrease the current through auxiliary field 42. This decrease in field current causes the field to lag behind armature 40, with the result that there is sufficient "slip" to cause field 42 (and shell 44) to continue rotating compressor 62 at the preferred speed. In this way the compressor speed is maintained at the desired value and this can be controlled by adjustment when necessary.

A solenoid 63 is energized by the output voltage of generator 66 and closes a by-pass valve (see also Figure 1) only when the compressor has reached normal speed; in this manner compressor 62 may be brought up to speed without difficulty.

Switch 96, which controls the energization of field 42 as well as field 104, is normally open, and is moved to the closed position shown by the energization of coil 97. When there is a refrigeration demand coil 97 is energized by connecting it across the main lines 84 and 76; one side of coil 97 is connected to main line 76 by lead 99, and the other side is connected through a lead 110 to one side of a control circuit comprising a thermostat, a high pressure switch, and a low pressure switch, generally indicated by the numeral 112. The other side of the control circuit 112 is connected through a lead 114, a switch 116, and a lead 118, to main line 84. Switch 116 is interlocked with reverse current relay switch 82 and it is closed by an arm 120 when the reverse current relay switch is closed.

As pointed out above, auxiliary armature 40 and rotatable field 42 act as a motor energized by batteries 78 when the car is stationary and there is a demand for refrigeration. When operating in this manner armature 40 acts as the stator, and rotor 42 is energized sufficiently to cause it to rotate at the desired speed. In order to supply the desired voltage to rotor 42 a resistance unit 122 is placed in series with the rotor by opening switch 92. Switch 92 is opened by the energization of coil 124, one side of which is connected by a lead 126 to line 76, and the other side of which is connected through a lead 128 to a switch 130. Switch 130 is closed by arm 120 when it moves downwardly as reverse current switch 82 and switch 116 open. The other side of switch 130 is connected to the control circuit 112 by a lead 132 and the other side of the control circuit is connected through a lead 134, a normally-closed switch 136, a lead 138, a relay switch 140, and a lead 142 to main line 84.

The normally-closed switch 136 is held open when the circuit conditions of Figure 2 exist by the energization of coil 144, which is connected by leads 146 and 148 directly across main generator 34. Thus, switch 136 is automatically opened when main generator 34 starts building up, but is closed again when the car stops. Relay switch 140 normally tends to remain open but is provided with a holding coil 150 which holds it closed and is connected in series with a resistance unit 152 by leads 154 and 156 across the main lines 76 and 84. With normal battery voltage coil 150 is sufficiently strong to hold relay switch 140 closed, although if the battery voltage drops due to abnormal conditions, as when the battery becomes discharged, relay switch 140 automatically opens. After relay switch 140 opens, it will not be closed automatically, as coil 150 is too weak; thus, a push-button short-circuit switch 158 is provided around resistance unit 152 and when this switch is pressed the entire battery voltage is impressed across coil 150, with the result that the switch is closed and will remain so until the battery voltage drops below a certain predetermined safe value.

Connected in parallel with coil 124 by a pair of leads 160 and 162 between main line 78 and lead 128 is a coil 164, which, when energized, closes a main switch 166. Main switch 166 connects the lead 72 on one side of auxiliary armature 40 through a lead 168 directly to lead 142, which is connected to main line 84. In this manner auxiliary armature 40 is connected directly across the main lines and is energized by the full battery voltage. A current coil 170 is connected in lead 142 to hold switch 140 closed if the battery voltage drops momentarily during the starting of the power unit as a motor. However, under normal conditions, when the unit is operating as a motor, and when the batteries become discharged, the pull of coil 170 and coil 150 is not sufficient to hold switch 140 closed, and the unit will be disconnected from the line.

A switch 172 is interlocked with switch 166 by a lever 174 so that it is open when switch 166 is closed. Switch 172 is connected by a pair of leads 176 and 178 in series with coil 102 to disconnect the carbon pile control upon the current through field 42 when the power unit is operating as a motor. However, control generator 66 still controls the opening and closing of valve 63 to cut down the load during starting.

During the operation of the unit as a motor, if the temperature of the car is brought down to the desired value, the circuit is broken by the thermostat to deenergize coils 164 and 97 and open their respective switches 166 and 96. The opening of these switches in turn deenergizes the auxiliary armature 40, auxiliary field 42, and field 104 of the control generator 66. However, switches 140 and 136 remain closed and the air conditioning unit is subject to demand as indicated by the thermostat. At the same time the batteries are protected from undue drain for the entire circuit is broken by the opening of relay switch 140 when the battery voltage becomes dangerously low. As pointed out above, when switch 140 opens due to low voltage it remains open until push button 158 is pressed; in this manner the storage battery will not be used to operate the power unit as a motor unless conditions warrant such usage.

When the car starts movement again the voltage of armature 34 of the main generator 36 starts building up and this energizes coil 144 to open switch 136 and thus stop the operation of the power unit as a motor. Shortly thereafter as the voltage of the generator increases the reverse current switch closes so as to restore the circuit conditions shown in Figure 2 and thus the air conditioning unit is available upon demand.

Later when the compressor is being operated and the car speed increases to such an extent that there is sufficient slip between rotatable field 42 and auxiliary armature 40 the relative movement between these two units will cause a voltage to be built up in armature 40, which is

in series with the voltage of armature 34. As a result, the total voltage across the two armatures in series is momentarily increased so that voltage coil 90 comes into play to increase the resistance of carbon pile 86 and decrease the excitation current through the main generator field 38. Consequently, the voltage of armature 34 decreases, and armature 40 takes over a portion of the load upon main generator 36 and a portion of the power transmitted by the axle to the auxiliary generator unit 40—42 is converted into electric energy.

Thus, in the illustrative embodiment herein disclosed, if a train of cars is standing in the station and the cars are warm, the air conditioning unit of each car is started with the power unit acting as a motor, and power is taken from the batteries. As the train starts moving, the power unit of the car ceases to operate as a motor, and there is no load on either the axle or the batteries during the major portion of the acceleration period of the train. Later as the train approaches normal speed, the reverse current relay operates, and the main generator starts charging the battery.

If there is still a demand for car cooling, the auxiliary field 42 is energized to cause it to rotate with auxiliary armature 40 and compressor 62 is operated. Upon a further increase in the car speed, auxiliary field 42 and compressor 62 are maintained at a constant speed by increasing the slip within the unit 40—42. As this slip increases, a voltage is built up across armature 40 which is in series with the main generator armature 34. Main generator 36 and the auxiliary generator unit 40—42 thus cooperate to convert mechanical power into electrical power with the result that there is a decrease in the load upon the main generator corresponding to the amount of electrical power produced by the auxiliary generator.

In this manner, the amount of power taken from the axle is only that which is needed to operate compressor 62 and charge the batteries at the most efficient rate, and the axle load is not increased as the car speed increases. Further, when the train is running at high speed the batteries are brought up to full charge, and later when the train is stopped the car temperature is kept down by the operation of the power unit as a motor which withdraws energy from the batteries to operate the air conditioning unit.

In the present embodiment the compressor is designed to operate at a speed corresponding to a relatively low car speed. The power unit is then controlled to drive the compressor at this speed at all times even though the train speed is greatly increased. Yet the power unit is efficient in operation as no more power is delivered to the power unit than is needed. The power received by the power unit is either delivered to the compressor, or it is converted into electricity and stored in the batteries on the car, depending upon the demand and the conditions of the system. Later if the car is stationary and there is a demand for operation of the compressor a portion of the power unit acts as a motor driven by the car batteries and converts electricity into mechanical power to operate the compressor.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

It will thus be seen that I have provided a practical and efficient system and apparatus for accomplishing the several objects hereinabove mentioned as well as many others in a successful manner.

I claim:

1. In an electrical system of power distribution of the class wherein a variable source of power drives a generator to deliver power to an electrical system and the connection between the generator and the electrical system is automatically regulated, the combination with said generator of a clutch-motor unit to drive a load, said unit having an armature and a field winding, a resistance assembly connected in series with said field winding, a common mechanical drive connected to drive said generator and said clutch-motor unit, and control means responsive to the generator voltage and having a switching mechanism operable substantially simultaneously with the connection and disconnection of said generator to said electrical system to place the proper amount of resistance in series with said field winding to cause said clutch-motor unit to be operable as a motor when said generator is disconnected and to be operable as a clutch when said generator is connected.

2. In an electrical system of power distribution of the class wherein a variable source of power drives a generator to deliver power to an electrical system and the connection between the generator and the electrical system is automatically regulated, the combination with said generator of a clutch-motor unit to drive a load, said unit including an armature and a field winding, a common mechanical drive connected to drive said generator and said clutch-motor unit, a resistance assembly including means to vary the current through said field winding and thereby control the slip when said clutch-motor unit is acting as a clutch and to control the field produced by said field winding when said clutch-motor unit is acting as a motor, and switching means responsive to the generator voltage to render ineffective the means to vary said current and to connect said clutch-motor unit to be operable as a motor substantially at the time of the disconnection of said generator from said electrical system.

3. In an apparatus of the character described wherein mechanical power is received from a variable source and electrical power is transmitted to and received from an electrical system and certain of the mechanical power is utilized to drive a mechanical load, the combination of: a power unit including, a main generator having a main armature and a main field winding assembly, and an auxiliary generator having an auxiliary armature and an auxiliary field winding assembly, and means mounting said auxiliary armature and said auxiliary field winding assembly to be rotated independently of each other; means mechanically connecting said auxiliary field winding assembly to the mechanical load; means mechanically connecting said armatures to the variable source of mechanical power; and a control means to control the operation of said power unit including, demand means responsive to a demand for mechanical power by said load to cause said auxiliary field winding assembly to be driven from said auxiliary armature to thereby drive the load, means cooperating with said demand means and re-

sponsive to the availability of power from said variable source to connect said auxiliary generator to be operated as a motor when mechanical power is not available from said source and to connect said auxiliary generator to act as a magnetic clutch when power is available from said variable source, and means to connect said main generator so that it will supply electrical power to said electrical system and to connect said auxiliary generator to produce electrical power in series with said main generator when there is power consuming slip between said auxiliary field winding assembly and said auxiliary armature.

4. In apparatus of the character described, the combination of, a battery system, a first generator having a first armature and a first field producing means, a second generator having two independently rotating members in the form of a second armature and a second field producing means, means constituting a variable source of mechanical power to drive said generators and thereby convert some of the mechanical power into electrical power, means to connect said generators in series across said battery system and to limit the voltage of said first generator in response to the instant demand, a mechanical load connected to be driven by said second generator with the two members of said second generator acting as a magnetic clutch, means to control the driving of said load by regulating the relative movement between said second field producing means and said second armature and to thereby regulate the voltage produced by said second generator, and means to connect said second generator to act as a motor deriving electrical power from said battery system and driving said load when mechanical power is not available from said variable source of mechanical power.

5. In an electrical railway lighting system, the combination of, a battery-load circuit, a main generator, an auxiliary unit, means to mechanically connect said main generator and said auxiliary unit to be driven from the car axle, mechanical means connecting said auxiliary unit to drive a load by acting as a magnetic clutch transmitting mechanical power from the car axle to the load, electrical means to operate upon demand said auxiliary unit as a motor deriving electrical power from said battery-load circuit and driving said load, a main switch means responsive to the condition of said battery-load circuit and to the voltage produced by said main generator to connect said main generator to supply electrical energy to said battery-load circuit, and interlocking switch means mechanically related to said main switch means and operative when said main switch is moved to its open position to condition said auxiliary unit to act as a motor and effective when said main switch is moved to its closed position to condition said auxiliary unit to act as a clutch unit.

6. In an electrical system of power distribution of the class wherein a source of mechanical power drives a generator to deliver power to an electrical system and the connection between the generator and the electrical system is automatically regulated, the combination with said generator of an auxiliary clutch-motor unit to drive a load, a common mechanical drive connected to drive said generator and said clutch-motor unit, and a control means responsive to generator voltage to automatically connect said generator and said clutch-motor unit in cooperating relationship to deliver electrical power to the electrical system and to simultaneously act as a clutch to transmit mechanical power through the clutch-motor unit to a load with the clutch-motor unit producing electrical power by virtue of the slip between the two elements of the clutch-motor unit, said control means including means to regulate the output of said generator dependent upon the electrical output of said clutch-motor unit.

7. In an electrical system of power distribution of the class wherein a source of mechanical power drives a generator to deliver power to an electrical system and the connection between the generator and the electrical system is automatically regulated, the combination with said generator of an auxiliary clutch-motor unit to drive a mechanical load, a common mechanical drive connected to drive said generator and said clutch-motor unit, and a control means responsive to the condition of said electrical system and to the voltage produced by said generator to automatically connect said generator and said clutch-motor unit in cooperating relationship to deliver electrical power to the electrical system and to simultaneously act as a clutch to transmit mechanical power through said clutch-motor unit to a mechanical load with the clutch-motor unit producing electrical power by virtue of the slip between the two elements of the clutch-motor unit, said control means including means to regulate the output of said generator dependent upon the electrical output of said clutch-motor unit and said generator and upon the voltage of said electrical system.

8. In an electrical system of power distribution of the class wherein a source of power drives a generator to deliver power to an electrical system and the connection between the generator and the electrical system is automatically regulated, the combination with said generator of a clutch-motor unit to drive a compressor, said unit having an armature and a field winding assembly, a current control assembly connected with said field winding assembly to regulate the current therethrough, a common mechanical drive connected to drive said generator and said clutch-motor unit, and control means associated with said current control assembly and with said generator to exert control upon the current through said field winding assembly by regulating said current control assembly and to control the production of electrical power, said control means having a switching mechanism operative substantially simultaneously with the connection and disconnection of said generator to said electrical system to thereby condition the circuits to cause the proper amount of current to flow through said field winding assembly and the remainder of the circuits to cause said clutch-motor unit to be operated as a motor when said generator is disconnected and to be operative as a clutch when said generator is connected.

9. In an electrical system of power distribution on a railway car of the class wherein a source of power drives a generator to deliver power to an electrical system and the connection between the generator and the electrical system is automatically regulated, the combination with said generator of a clutch-motor unit to drive a load, said unit having an armature and a field winding assembly, a current control assembly connected in series with said field winding, a common mechanical drive connected to drive said generator and said clutch-motor unit, and con-

trol means responsive to the generator voltage and to the voltage of the system and having a switching mechanism operative substantially simultaneously with the connection and disconnection of said generator to said electrical system to initiate the conditioning of said current control assembly for varying the current flowing through said field winding assembly to cause said clutch-motor unit to be operated as a motor when said generator is discontinued and to be operated as a clutch when said generator is connected.

10. In railway apparatus of the character wherein mechanical power is received from a source and electrical power is transmitted to and received from an electrical system and certain of the mechanical power is utilized to drive a mechanical load, the combination of: a power unit comprising, a fixed main field winding assembly, a rotatable auxiliary field winding assembly mounted coaxially with said main field winding assembly, an armature assembly mounted coaxially with said field winding assemblies to rotate as a unit cooperating with said main field winding assembly to constitute therewith a main generator and cooperating with said auxiliary field winding assembly to constitute an auxiliary generator; means mechanically connecting said auxiliary field winding assembly to the mechanical load; a control means to control the operation of said power unit including, demand means responsive to a demand for mechanical power by the load to cause said auxiliary field winding assembly to be driven from said armature assembly to thereby drive the load; means cooperating with said demand means and responsive to the availability of power from said source to connect said auxiliary generator to be operated as a motor when mechanical power is not available from said source and to connect said auxiliary generator to act as a magnetic clutch when power is available from said source; and means to connect said main generator so that it will supply the electrical power to said electrical system and to connect said auxiliary generator to produce electrical power in cooperating relationship with said main generator when there is power consuming slip between said auxiliary field winding and said armature assembly.

11. In railway apparatus of the character described, the combination of, an isolated battery system, a first generator having a first armature and a first field producing means, a second generator having two independently rotating members in the form of a second armature and a second field producing means, means to mechanically connect said generators to an axle to thereby drive the generators at a variable speed and convert some of the mechanical power into electrical power, means to connect said generators in series across said battery system and to control the voltage of said first generator in response to the instant demand, a mechanical load connected to be driven by said second generator with the two members of said second generator acting as a magnetic clutch, means to control the driving of said load by regulating the relative movement between said second field producing means and said second armature to thereby regulate the voltage produced by said second generator, and means to connect said second generator to act as a motor deriving electrical power from said battery system and driving said load when mechanical power is not available from the axle.

12. In apparatus of the character described, the combination of, a battery system, a first generator having a first armature and a first field producing means, a second generator having two independently rotating members in the form of a second armature and a second field producing means, means constituting a variable source of mechanical power to drive said generators said thereby convert some of the mechanical power into electrical power, means to connect said generators in series across said battery system and to control the voltage of said generators in response to the instant demand, a compressor of a refrigeration system constituting a mechanical load connected to be driven by said second generator with the two members of said generator acting as a magnetic clutch, means to control the driving of said compressor by controlling the flux linkage between and thereby regulating the relative movement between said second field producing means and said armature and to thereby regulate the voltage produced by said second generator, and means to connect said second generator to act as a motor deriving electrical power from said battery system and driving said load when mechanical power is not available from said variable source of mechanical power.

13. In railway car apparatus of the character described, the combination of, a battery system, a first generator having a first armature and a first field producing means, a second generator having two independently rotating members in the form of a second armature and a second field producing means, means to mechanically connect said generators to an axle to thereby drive the generators at a variable speed and convert some of the mechanical power into electrical power, means to connect said generators in series across said battery system and to control the voltage of said first generator in response to the instant demand, a compressor of a refrigeration system constituting a mechanical load connected to be driven by said second generator with the two members of said generator acting as a magnetic clutch, means to control the driving of said compressor by regulating the relative movement between said second field producing means and said second armature to thereby regulate the voltage produced by said second generator, and means to connect said second generator to act as a motor deriving electrical power from said battery system and driving said compressor when mechanical power is not available from said axle.

14. In railway apparatus of the character described, the combination of: a battery system; an electromotive generator assembly comprising, a fixed first field producing means, a rotatably mounted second field producing means, and an armature assembly including a plurality of windings rotatably mounted and having an armature portion adapted to cooperate with each of said field producing means; means constituting a source of mechanical power and adapted to be mechanically connected to rotate said armature assembly and to thereby convert some of the mechanical power into electrical power; means to connect windings of said generator assembly in series across said battery system and to limit the output of said electromotive generator assembly in response to the instant demand; a mechanical load connected to said second field producing means to be driven upon rotation of said second field producing means with said second field producing means and the cooperating portion of said armature assembly

acting as a magnetic clutch; means to control the driving of said load by regulating the relative movement between said second field producing means and said armature assembly and to thereby regulate the voltage produced in the armature assembly by virtue of the flux linkage between the armature assembly and said second field producing means; and means to connect certain of the windings of said armature assembly and said second field producing means to act as a motor deriving electrical power from said battery system with said second field producing means rotating about said armature assembly and driving said load when mechanical power is not available from said source of mechanical power.

15. In railway apparatus of the character described, the combination of, a battery system, a first generator having a first armature and a first field winding assembly, a second generator having two independently rotating members in the form of a second armature and a second field winding assembly, means constituting a source of mechanical power to drive said generators and thereby convert some of the mechanical power into electrical power, means to connect said generators in series across said battery system and to limit the generation of current by said first generator by reducing the current flowing through said first field winding assembly in response to the cooperative action of the flux of two solenoids one of which produces flux which varies in response to variations in current through said first armature and the other of which produces flux which varies in response to variations in the voltage of said battery system, a mechanical load connected to be driven by said second generator with the two members of said second generator acting as a magnetic clutch, means to control the driving of said load by controlling the current flowing through said second field winding assembly to thereby regulate the relative movement between said second field winding assembly and said second armature and to thereby regulate the voltage produced by said second generator, and means to connect said second generator to act as a motor deriving electrical power from said battery system and driving said load when mechanical power is not available from said source of mechanical power.

16. In an electrical system of power distribution of the class wherein a variable source of power drives a generator to deliver power to an electrical system and the connection between the generator and the electrical system is automatically regulated, the combination with said generator of an auxiliary clutch-motor unit to drive a load, a common mechanical drive connected to drive said generator and said clutch-motor unit, and a control means responsive to the generator voltage and including a switch which opens to automatically disconnect said clutch-motor unit as a motor when the voltage of said generator reaches a predetermined value and another switch which is operated to condition said clutch-motor unit to operate as a clutch, and said control means including means operable in response to the connection of said generator to said electrical system to operate the last-named switch.

LOUIS H. VON OHLSEN.