

Jan. 4, 1938.

H. B. HULL

2,104,386

REFRIGERATING APPARATUS

Filed Jan. 31, 1935

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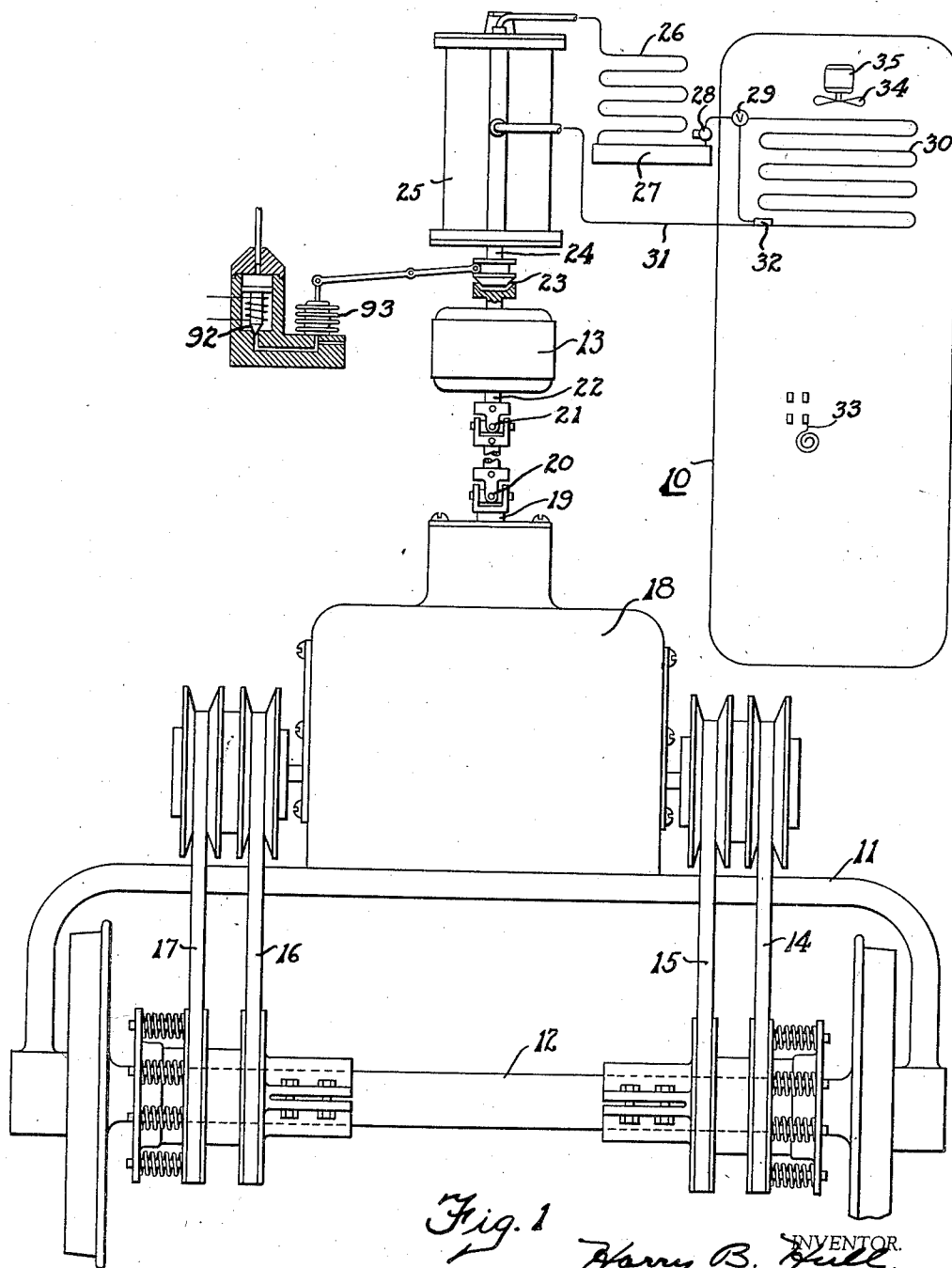


Fig. 1

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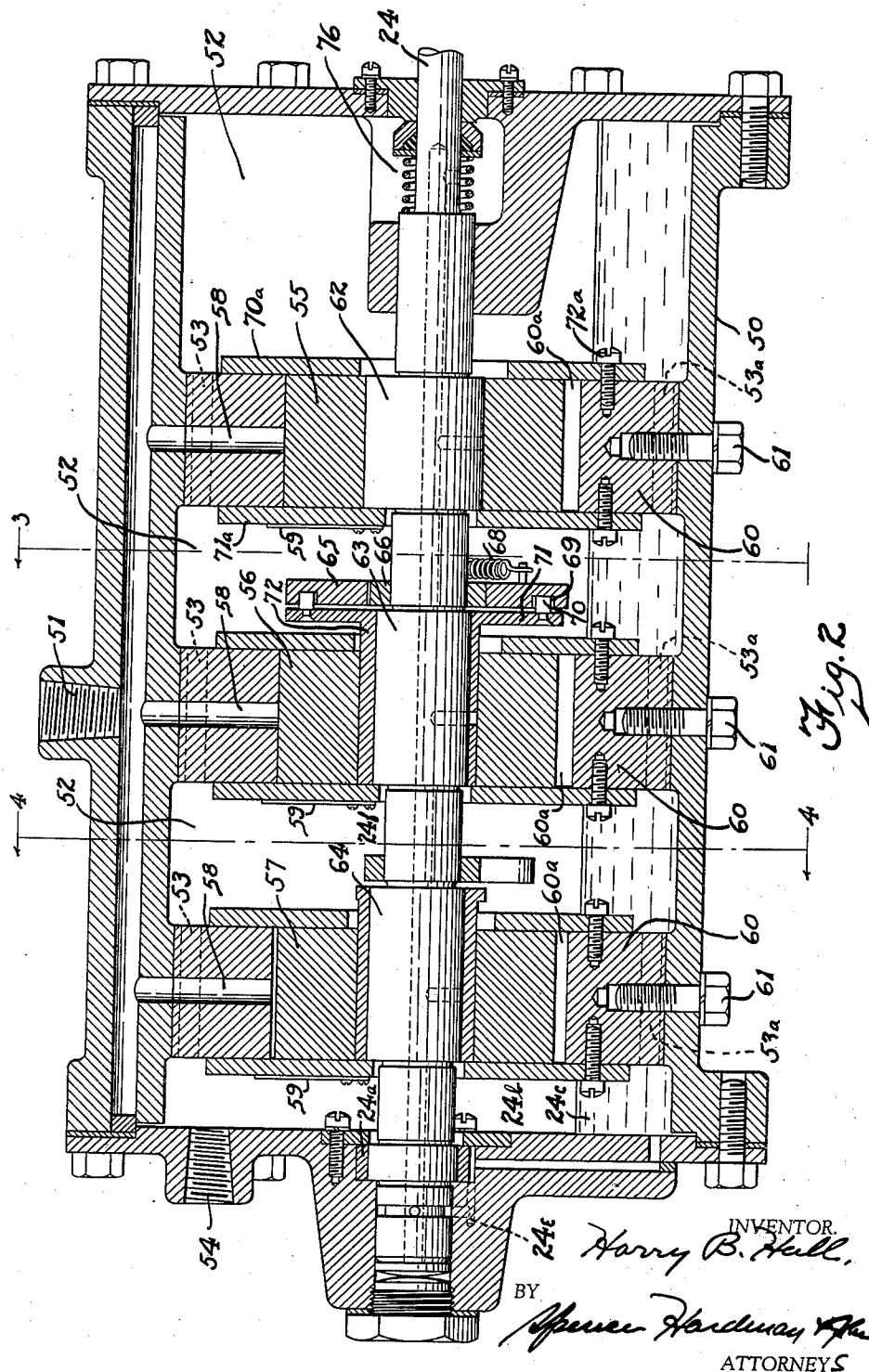
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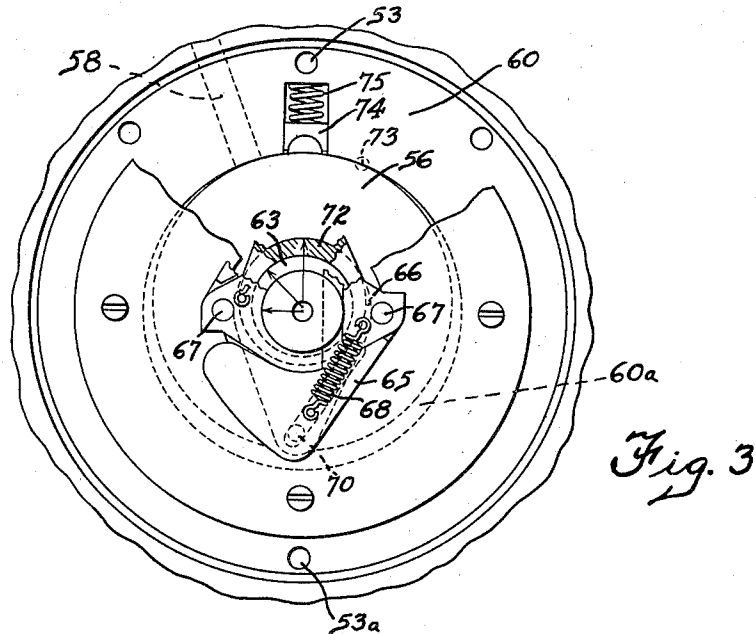
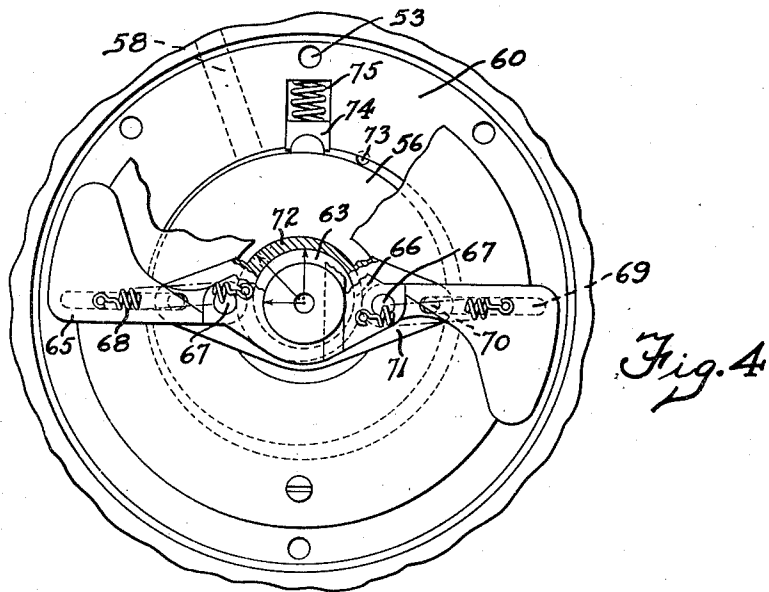
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REFRIGERATING APPARATUS

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4 Sheets-Sheet 3



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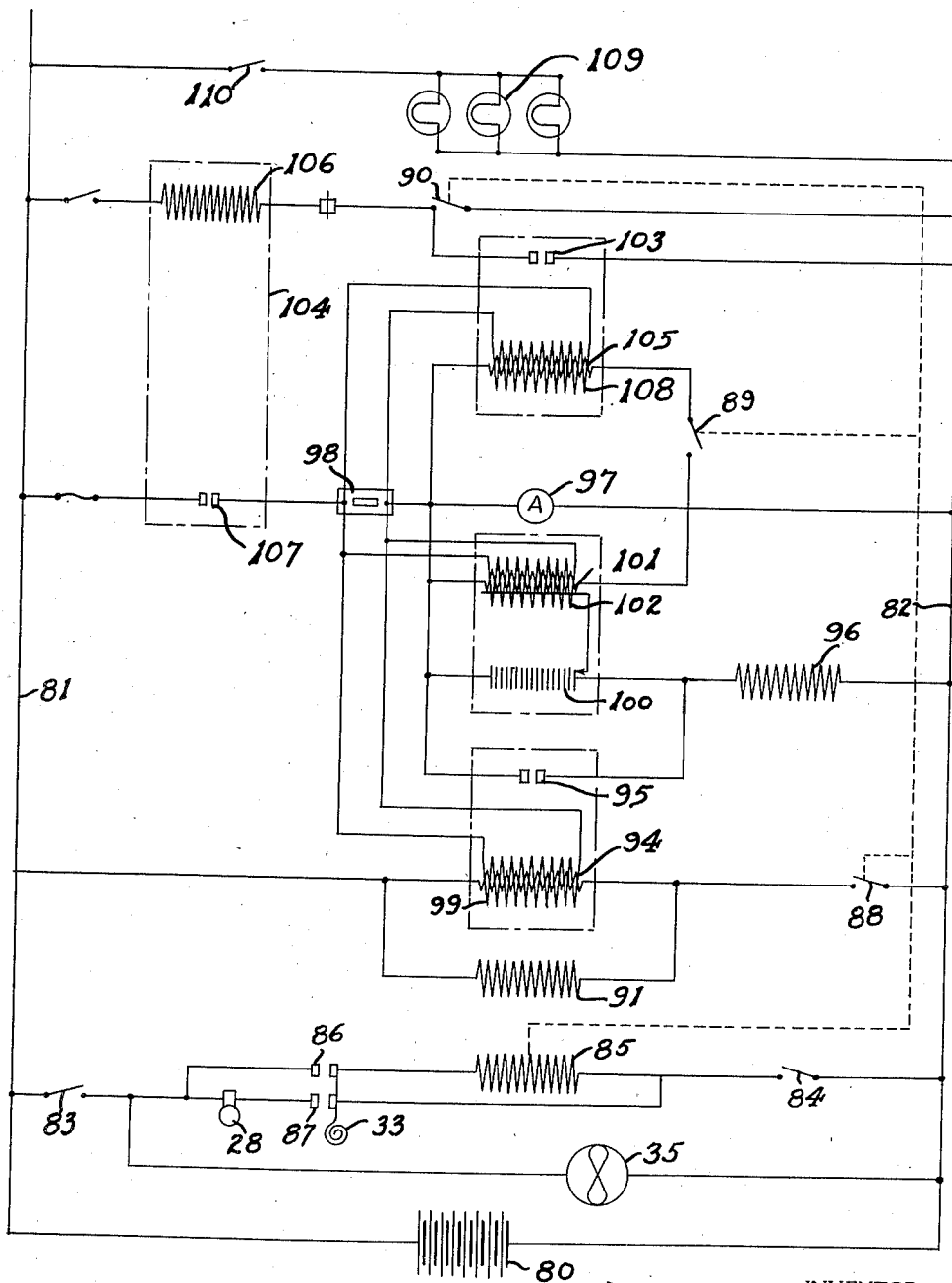


Fig. 5

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UNITED STATES PATENT OFFICE

2,104,386

REFRIGERATING APPARATUS

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Application January 31, 1935, Serial No. 4,344

8 Claims. (Cl. 62—117)

This invention relates to refrigeration and more particularly to the conditioning of air for railway cars and the like.

It is an object of this invention to provide an air conditioning system for railway cars or the like in which the compressor may be driven at varying speeds and yet furnish satisfactory refrigeration for the car.

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 representation of the drive and refrigerating system on the car;

Fig. 2 is a view in cross-section of a compressor which may be used in the system shown in Fig. 1;

Fig. 3 is a cross-section of the compressor taken along the lines 3—3 of Fig. 2;

Fig. 4 is a cross-section similar to Fig. 3, but showing the centrifugal weights in their extended position; and

Fig. 5 is a wiring diagram which may be used in conjunction with this system.

The car to be refrigerated may be provided with the usual body 10 which carries a wheel truck 11 which in turn carries one or more wheel axles 12. The truck 11 is free to turn with respect to the body 10. The body 10 also carries a compartment the air for which is to be conditioned.

A suitable drive is provided between the car axle 12 and a motor-generator 13, which is carried on the body 10, such that the motor-generator is driven in the same direction regardless of the direction of travel of the car. The rate of rotation of the generator may be varied in accordance with the speed of the car. To this end, suitable belt drives 14, 15, 16, and 17 may be interposed between the shaft 12 and the gear box 18 such that the shaft 19 has imparted to it rotation in the same direction regardless of the rotation of the shaft 12. Any suitable construction of gears may be used in gear box 18, and merely as an example, reference is made to the copending application of Harry B. Hull and D. F. Alexander, Serial No. 4,345, filed January 31, 1935. The shaft 19 is placed in axial sliding keyways such that it can enter or recede from the box 18. The shaft 19 is connected by means of universal joints 20 and 21 with the shaft 22 of the motor-generator 13. The shaft 22 is connected by a clutch 23 with the shaft 24 of the compressor which is also carried on the body 10. The arrangement is such that the motor-generator 13 drives, as a motor, the compressor 24 when the car is standing still or when it is running below a generating speed. This is accomplished because the gear box 18 is provided with an

overrunning clutch which permits the motor to run without driving the car. When the car reaches a generating speed, the motor-generator charges a battery and the clutch 23 is actuated in accordance with temperature conditions created by the apparatus to start and stop the compressor 25. The axle therefore drives the generator to charge the battery, and drives the compressor under control of a thermostat or the like.

The compressor 25 is of the character which automatically varies its volumetric capacity with changes in speed of rotation. Any type of compressor capable of accomplishing this may be used.

The compressor delivers compressed refrigerant to a condenser 26 which discharges into the liquid refrigerant receiver 27 and from whence refrigerant flows through the solenoid valve 28 and automatic expansion valve 29 to evaporator 30 and from which the refrigerant returns through the line 31 to the compressor 25. The valve 29 may be of the character which automatically introduces refrigerant into the evaporator 30 when the pressure therein is lowered to a predetermined limit, but this action is modified by a thermostatic bulb 32 which automatically throttles the valve 29 when a sufficient refrigerating effect reaches the bulb 32. The operation of the refrigerating system is controlled by a thermostat 33, placed in the compartment to be cooled, in a manner hereinafter more fully described. Air is forced over the evaporator 30 by a fan 34 driven by a motor 35, the air which is blown by the fan 34 coming either from the compartment 10 or from the outside or both.

A type of compressor which varies its volumetric capacity in accordance with a change of speed is shown in Figs. 2, 3 and 4. In this compressor, a cylindrical casing 50 is provided with an intake 51 which is connected to the pipe 31. The spaces 52 in the casing 50 are on the compression side of the system and are interconnected by passageways 53 and 53a so that the compressed refrigerant from all of the compressing cylinders may be discharged through the opening 54 to the condenser 26 and so that the lubricant may equalize throughout the casing 50. The pistons 55, 56, and 57 are gyrated by the rotation of shaft 24 so that refrigerant is taken into the compression chambers 60a through the branches 58, and the compressed refrigerant is discharged past the check valves 59 into the spaces 52. The casing 50 is provided with a plurality of pumping cylinders 60 which are secured within casing 50 in any suitable manner, as by bolts 61, a plurality of these bolts being used around the circumference. The shaft 24 is provided with a plurality of eccentrics 62, 63, and 64 and the arrangement is such that pistons 56 and 57 are automatically rendered inactive as

the speed of the shaft 24 increases. Any suitable centrifugal arrangement may be used for this purpose. Thus a plurality of centrifugal weights 65 are swingingly mounted to the rings 66 secured to the shaft 24, the fulcrum thereof being indicated at 67. Suitable springs 68 hold the centrifugal weights 65 in a retracted position (as shown in Fig. 3) until the speed exceeds the pulling power of the springs when the weights fly outward as indicated in Fig. 4. The weights 65 are provided with slots 69 which cooperate with pins 70 carried by arms 71 of eccentric sleeves 72. The arrangement is such that the combined maximum eccentricity of the eccentrics 63 or 64 and 72 is just sufficient to bring the pistons 56 or 57 into pumping engagement with the cylinders 60. When the eccentrics 63 or 64 and 72 are thrown out of alignment to each other by the outward movement of the weights 65, then the engaging contact between the piston and the cylinder is broken as indicated in Fig. 4. The springs on the weights which govern piston 56 are made somewhat stronger than those on the weights of piston 57. Thus when a certain speed is attained piston 57 is made inoperative. Then if the speed increases to another predetermined speed, piston 56 becomes inoperative and thereafter one piston 55 furnishes refrigeration during the highest speeds of the car. The number of pistons shown is merely illustrative of the invention, however, and any number may be used, as desired.

Any suitable arrangement of piston may be used. In the particular embodiment shown the pistons are annular in cross-section and are held in place by plates 70a and 71a which are bolted to the cylinders 60 by means of bolts 72a distributed around the circumferences of plates 70 and 71. An opening 73 is made in the plate 71 which provides an outlet for the compressed gases, the opening 73 being closed by the check valve 59. A suitable divider plug 74, urged against the piston 56 by the spring 75, is provided to divide the compression and suction sides of the chamber. Any suitable type of seal, indicated at 76 may be provided to prevent the escape of gases along the shaft 24 where it emerges from the casing 50.

A suitable lubricant pump 24a may be mounted on the shaft 24 and may have its intake 24b connected with the lubricant 24c. The discharge 24e connects with an axial bore 24f which distributes lubricant to the bearings and to the oil sump of seal 76 and other parts of the compressor.

Any suitable electrical connection between the battery, the motor-generator, the thermostat and the solenoid valve may be provided. As shown in Fig. 5, the battery 80 is provided with terminal lines 81 and 82. The motor fan 35 is controlled by a switch 83. By closing only the switch 83 the fan 34 may be operated without refrigeration. If refrigeration is desired, switch 84 is also closed, which throws the solenoid valve 28 and a master solenoid 85 under the control of thermostat 33. When thermostat 33 closes contacts 86 and 87, the valve 28 is opened and the solenoid 85 is energized. The solenoid 85, when energized, places the switches 88, 89, and 90 in the "summer" or s position, which is the position which produces refrigeration. The placing of switch 88 in the s position places the clutch solenoid 91 across the battery which actuates valve 92 and controls the flow of air to bellows 93 and thus closes the clutch 23. At the same time the motor-

generator 13 is made to operate as a motor. This is accomplished because the energization of coil 94 closes the contacts 95 and places the field coil 96 across the armature in motoring position. Thereafter the motor-generator 13 continues to operate as a motor so long as the thermostat 33 remains closed. The speed of the motor is preferably made such that all of the pistons of the compressor will operate to provide the correct amount of volumetric capacity for the system.

As the speed of the car increases to a generating speed, the flow of current at the armature 97 reverses so that the flow of current across the shunt plug 98 reverses. This reversal of current causes a reversal in the coil 99, which now bucks the coil 94, and opens the contacts 95. This throws the variable resistance 100 in series with the field coil 96 so that the motor-generator now acts as a generator. The variable resistance 100 is governed by the coil 101 in accordance with the voltage across the armature 97 and in accordance with the current by the coil 102 placed across the shunt plug 98. Under such conditions, so long as the thermostat 33 remains closed, the motor-generator 13 is driven as a generator, the variable resistance 100 compensating for changes in speed, and the compressor 25 is driven at varying speeds by the car, the centrifugal weights throwing the compressing pistons in and out of operation in a manner heretofore described. If for any reason the temperature in the car should fall to a predetermined limit, so that the thermostat 33 opens the contacts 86 and 87, then the switches 88, 89, and 90 are thrown to the w position so that the compressor is declutched and the motor-generator 13 alone is continued to be driven as a generator as long as the car runs at a generating speed, and is prevented from "motoring" if the car slows down below a generating speed. This is accomplished because the opening of switch 88 deenergizes the clutch solenoid 91 and opens the clutch 23. The closing of switch 89 and the opening of switch 90 places the contacts 103 in control of the starter 104. When the current across the armature flowing across the coil 105 reaches a sufficiently high voltage to charge the battery the coil 105 closes contacts 103 which in turn energizes coil 106 and closes the contacts 107. The armature is then across the battery and charges the battery so long as current flows across the shunt plug 98 in the proper direction. If the speed of the armature should fall below a charging speed and should attempt to motor, the reversal of current across the plug 98 reverses the current through the solenoid 108 which now bucks the solenoid 105 and opens the contacts 103. As the switch 90 is now open, the solenoid 106 is deenergized which causes the contacts 107 to open and thus disconnect the armature from the battery, and "motoring" is prevented.

The usual lights or other fixtures 109 may be placed across the battery under control of their respective switches 110.

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, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a vehicle, a live axle assembly; a compressor; a unitary motor-generator; a battery; torque transmitting means from said live axle assembly to said compressor and motor-generator and between said compressor and motor-generator; control means, automatically responsive to

vehicle running conditions, to cause said motor-generator to act as a motor energized from said battery, to drive said compressor independently of said live axle assembly when said vehicle is standing and, when said vehicle is in motion, to cause said live axle assembly to drive, through said torque transmitting means, said compressor and said motor-generator, said motor-generator arranged to act as a generator to charge said battery, said compressor having a plurality of pistons; and means for varying the number of pistons in operation.

2. In a vehicle, a live axle assembly; a compressor; a unitary motor-generator; a battery; torque transmitting means from said live axle assembly to said compressor and motor-generator and between said compressor and motor-generator; control means, automatically responsive to vehicle running conditions, to cause said motor-generator to act as a motor energized from said battery, to drive said compressor independently of said live axle assembly when said vehicle is standing and, when said vehicle is in motion, to cause said live axle assembly to drive, through said torque transmitting means, said compressor and said motor-generator, said motor-generator arranged to act as a generator to charge said battery; and means in said compressor automatically varying its volumetric capacity per cycle with changes in the speed of said compressor.

3. In a vehicle, a live axle assembly; a compressor; a unitary motor-generator; a battery; torque transmitting means from said live axle assembly to said compressor and motor-generator and between said compressor and motor-generator; control means, automatically responsive to vehicle running conditions, to cause said motor-generator to act as a motor energized from said battery, to drive said compressor independently of said live axle assembly when said vehicle is standing and, when said vehicle is in motion, to cause said live axle assembly to drive, through said torque transmitting means, said compressor and said motor-generator, said motor-generator arranged to act as a generator to charge said battery, said compressor having a plurality of pistons; and means for automatically rendering one of said pistons inoperative when said compressor reaches a predetermined speed.

4. In a vehicle, a live axle assembly; a compressor; a unitary motor-generator; a battery; torque transmitting means from said live axle assembly to said compressor and motor-generator and between said compressor and motor-generator; and control means, automatically responsive to vehicle running conditions, to cause said motor-generator to act as a motor energized from said battery, to drive said compressor independently of said live axle assembly when said vehicle is standing and, when said vehicle is in motion, to cause said live axle assembly to drive, through said torque transmitting means, said compressor and said motor-generator, said motor-generator arranged to act as a generator to charge said battery, said compressor comprising a variable capacity rotary compressor.

5. In a vehicle, a live axle assembly; a compressor; a unitary motor-generator; a battery; torque transmitting means from said live axle assembly to said compressor and motor-generator and between said compressor and motor-generator; control means, automatically responsive to vehicle running conditions, to cause said

motor-generator to act as a motor energized from said battery, to drive said compressor independently of said live axle assembly when said vehicle is standing and, when said vehicle is in motion, to cause said live axle assembly to drive, through said torque transmitting means, said compressor and said motor-generator, said motor-generator arranged to act as a generator to charge said battery; said compressor comprising a variable capacity rotary compressor; and means responsive to refrigeration conditions for controlling the operation of said compressor.

6. In a vehicle, a live axle assembly; a compressor; a unitary motor-generator; a battery; torque transmitting means from said live axle assembly to said compressor and motor-generator and between said compressor and motor-generator; control means, automatically responsive to vehicle running conditions, to cause said motor-generator to act as a motor energized from said battery, to drive said compressor independently of said live axle assembly when said vehicle is standing and, when said vehicle is in motion, to cause said live axle assembly to drive, through said torque transmitting means, said compressor and said motor-generator, said motor-generator arranged to act as a generator to charge said battery; and mechanical means automatically maintaining the same direction of current generated by said motor-generator when the vehicle travels in either direction, said torque transmitting means comprising a shaft extending longitudinally of the vehicle, and said compressor comprising means for varying its capacity.

7. In a vehicle, a live axle assembly; a compressor; a unitary motor-generator; a battery; torque transmitting means from said live axle assembly to said compressor and motor-generator and between said compressor and motor-generator; and control means, automatically responsive to vehicle running conditions, to cause said motor-generator to act as a motor energized from said battery, to drive said compressor independently of said live axle assembly when said vehicle is standing and, when said vehicle is in motion, to cause said live axle assembly to drive, through said torque transmitting means, said compressor and said motor-generator, said motor-generator arranged to act as a generator to charge said battery, said compressor comprising a variable capacity rotary compressor, and said torque transmitting means comprising a universal joint and a drive shaft longitudinal to the vehicle.

8. In a vehicle, a live axle assembly; a compressor; a unitary motor-generator; a battery; torque transmitting means from said live axle assembly to said compressor and motor-generator and between said compressor and motor-generator; control means, automatically responsive to vehicle running conditions, to cause said motor-generator to act as a motor energized from said battery, to drive said compressor independently of said live axle assembly when said vehicle is standing and, when said vehicle is in motion, to cause said live axle assembly to drive, through said torque transmitting means, said compressor and said motor-generator, said motor-generator arranged to act as a generator to charge said battery; and means for varying the capacity of the compressor per cycle in response to changes in speed.

HARRY B. HULL.