Jan. 16, 1934. G. E. HULSE 1,943,967

REFRIGERATION

Filed Dec. 3, 1930 2 Sheets-Sheet 1

Fig. 1.

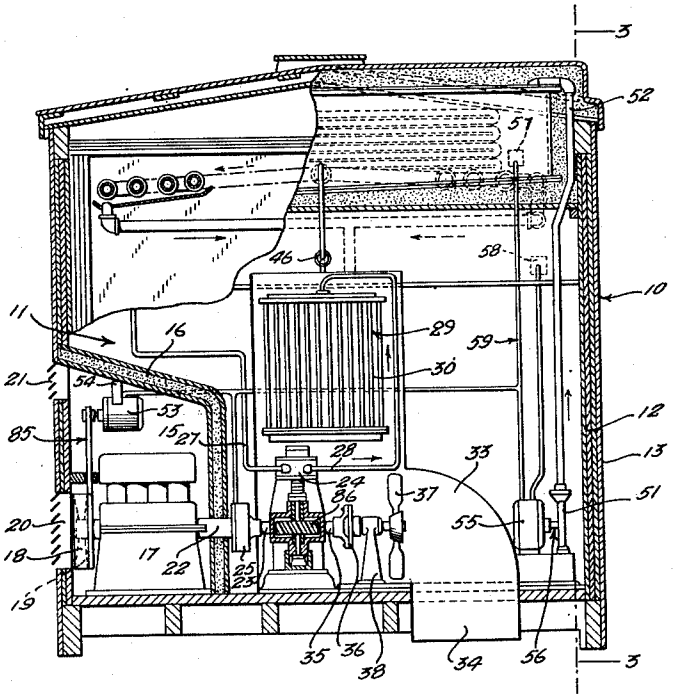
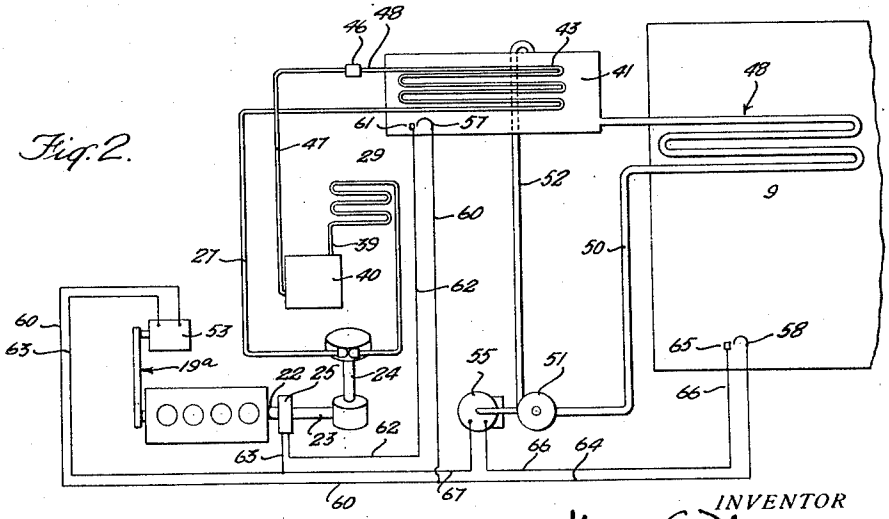


Fig. 2.



INVENTOR

George E. Hulse

BY

Janney, Blair & Curtis ATTORNEYS

Jan. 16, 1934. G. E. HULSE 1,943,967

REFRIGERATION

Filed Dec. 3, 1930 2 Sheets-Sheet 2

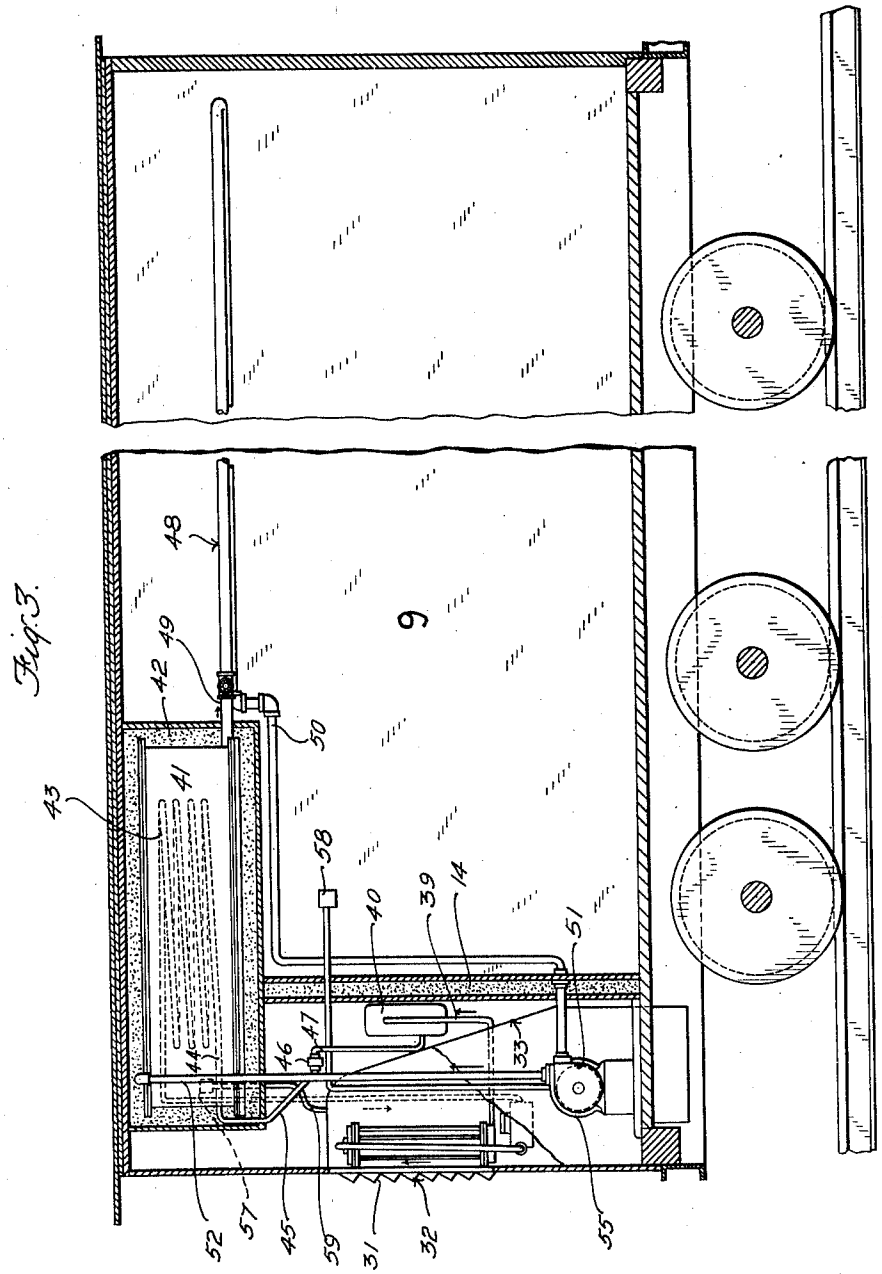


Fig. 3.

INVENTOR
George E. Hulse

BY
Janney, Blair & Curtis ATTORNEYS

Patented Jan. 16, 1934 1,943,967

UNITED STATES PATENT OFFICE

1,943,967

REFRIGERATION

George E. Hulse, New Haven, Conn., assignor to The Safety Car Heating & Lighting Company, a corporation of New Jersey

Application December 3, 1930. Serial No. 499,668

7 Claims. (Cl. 62—117)

This invention relates to refrigeration.

One of the objects of this invention is to provide a refrigeration system of thoroughly simple and practical arrangement and of dependable and lasting action. Another object of this invention is to provide a refrigeration system which will be highly efficient in operation while reliably coping with certain variable conditions met with in practice. Another object is to provide a refrigeration system which will be economical in use. Another object is to provide a refrigeration system which because of the fundamental simplicity of its working parts will require a minimum amount of attention and may be operated by unskilled attendants. Another object is to provide a railway car refrigeration system of practical construction and reliable action and well adapted to meet the peculiar requirements and conditions met with in railway practice. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is shown one of various possible embodiments of my invention,

Figure 1 is a transverse cross-sectional view of a railway refrigerator car showing certain parts of my apparatus and system in end elevation.

Figure 2 is a diagrammatic view illustrating a preferred arrangement of the parts in my refrigeration system, and

Figure 3 is a longitudinal cross-sectional view taken along the line 3—3 of Figure 1, showing certain parts in side elevation.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Considering first certain of the mechanical features of this invention, and referring principally to Figures 1 and 3, there is generally indicated at 10 a railway refrigerator car body which may be of any suitable construction and within one end of which is formed a compartment generally indicated at 11. Compartment 11 is insulated by walls 12 from the exterior walls 13 of the car and is also insulated from the remaining part 9 of the car interior by a wall 14, as viewed in Figure 3 of the drawings.

In a small compartment 15 (Figure 1) insulated from compartment 11 by a wall 16 is an internal combustion engine 17. This engine may be of any desired construction, although I have found it preferable to employ a small Diesel engine adapted to run continuously for substantial periods of time. Any suitable means may be employed for cooling the engine. Illustratively, engine 17 may be provided with a fan 18 on the fly-wheel 19 of the engine, and adjacent this fly-wheel-fan is an opening 20 in the side wall of the car, leading to the exterior. Another opening 21 is provided preferably at the top of the compartment 15. Thus cool air is drawn in by fan 18 through the opening 20, coming in contact with all the working parts of the engine 17 and leaving through the opening 21. This constant circulation of air cools the engine to an efficient working temperature. However, the heat generated in the normal operation of engine 17 is prevented from reaching the other parts of the refrigeration unit as well as space 9 containing the perishable goods by the walls 16 and 14 respectively, both of which are constructed in any suitable manner to resist the passage of heat therethrough.

The crank shaft 22 of engine 17 extends through wall 16 in substantial alignment with a driving shaft 23 connected by suitable gearing 86 to drive a compressor 24 of the refrigeration unit. Interposed between crank shaft 22 and driving shaft 23 is a magnetic clutch 25 so constructed that when current is applied to and energizes the winding of clutch 25, the latter will be actuated to connect crank shaft 22 with driving shaft 23 of compressor 24, and, if the circuit of this current is broken, clutch 25 will disengage to disconnect engine 17 from the parts it drives.

The compressor 24 is preferably of the rotary type, and is provided with an inlet pipe connection 27 and an outlet pipe connection 28. The outlet pipe connection 28 is connected to a condenser 29 formed of a plurality of turns of tubing 30 as shown in Figures 1 and 3, and is adapted to receive from the compressor 24, a suitable gaseous refrigerant, such as sulphur dioxide, the latter, after being compressed by the compressor 24, is passed through condenser 29 where it is reduced in temperature and condensed to liquid form. The condenser 29 is positioned adjacent an opening 31 in an end wall of the car, as is more clearly shown in Figure 3. This opening is provided with a sheet metal grating generally indicated at 32, thus permitting the ingress of outside air therethrough. A sheet metal conduit generally indicated at 33 has its upper portion fitted about opening 31 and encloses condenser

29, compressor 24 and the various working parts thereof.

In the bottom of the car is an opening 34 through which extends the discharge end of conduit 33, to permit the discharge of air therefrom. Secured to a shaft 35 as by a coupling 36 is a fan 37. This fan is rotatably mounted in a standard 38 and when actuated, draws air in through opening 31, causing it to flow freely over and extract heat from condenser 29 and compressor 24 under the guidance of the conduit 33, from which the heated air discharges through opening 34. Thus a constant supply of air for cooling purposes will be supplied to the condenser 29 and the compressor 24 to carry away the heat developed by these parts in operation and to insure an efficient action on the whole of the entire apparatus.

The fluid in condenser 29 which has been described as sulphur dioxide, merely for purposes of illustration, and which has taken a liquid form because of the compression action of compressor 24 and the cooling action of condenser 29, is passed by a pipe 39 to a receiver 40 wherein it is allowed to accumulate. This receiver may for purposes of convenience be positioned adjacent to or within the conduit 33 so that it may receive the benefit of cooling therefrom.

A reservoir 41 near the top of the car in Figures 1 and 3 is insulated on all sides by walls 42 constructed of heat insulating material. Reservoir 41 contains a supply of brine. Positioned within this reservoir and submerged in the brine is a coil 43 one end 44 of which is connected as by a pipe 45 and a pipe 47 to receiver 40. Interposed between these pipes is an expansion valve 46. Thus the required sulphur dioxide may be conducted through pipe 47 and the expansion valve 46 into cooling coil 43. Here the liquefied gas expands and evaporates, absorbing heat from the brine surrounding cooling coil 43 and reducing the temperature of the brine. From cooling coil 43 the expanded gas passes into inlet pipe 27 leading the warmed expanded gas to the inlet side of compressor 24 whereupon the above described cycle repeats itself. In this manner, I achieve a reduction in temperature of the brine in reservoir 41.

In order to bring the brine in reservoir 41 into thermal contact with all portions of that part of the car to be refrigerated, a series of pipes generally indicated at 48 are positioned in space 9 presenting a large exposed surface thereto. A pipe 49 preferably leading from the lower portion of reservoir 41 is connected to one side of series of pipes 48, and the other end of these pipes is connected to a pipe 50 passing through the wall 14 into compartment 11 to a rotary pump 51 (Figures 1 and 3). Pump 51 is connected by a pipe 52 to the top of reservoir 41, thus completing a path for brine circulation.

When the rotary pump 51 is actuated, brine in the reservoir 41 in contact with cooling coil 43 is circulated through pipes 48, from there to the rotary pump 51, through pipe 50, and back to the reservoir for re-cooling by pipe 52.

A generator 53 (Figure 1) is positioned in the upper portion of compartment 15 and is secured thereto by any desired means such as brackets 54. Generator 53 is driven by any suitable driving means, generally indicated at 85, from engine 17. Thus when the engine 17 is in operation, generator 53 is actuated. A motor 55, so constructed as to run efficiently from current supplied by generator 53, is positioned adjacent rotary pump 51 and connected thereto by a shaft 56 to drive the rotary pump 51 to circulate brine throughout the system described above.

A thermostatic switch 57 is thermally related to reservoir 41 and a thermostatically controlled switch 58 is thermally related to space 9 of the car. Suitable conduits, generally indicated at 59, enclose a wiring system for connecting switch 57, switch 58, motor 55, generator 53 and clutch 25 in a manner to be described hereinafter more in detail.

Considering now more specifically the method and arrangement by which I control the various working parts of my refrigeration system and referring more particularly to Figure 2, one side of the generator 53 is connected by a line 60 to one side of thermostatic switch 57 controlled by the temperature of the brine in reservoir 41. The opposite contact 61 of thermostatic switch 57 is connected by a line 62 to one side of the magnetic clutch 25. Connected to the other side of the magnetic clutch 25 is a line 63 running back to the opposite side of the generator 53. When the generator 53 is running and supplying current, a circuit is established therefrom to magnetic clutch 25, dependent for completion on the closing of thermostatic switch 57.

Connected to line 60 of generator 53 is a line 64 leading to one side of thermostatic switch 58 controlled by the temperature in space 9 of the car. Connected to the opposite contact 65, of thermostatic switch 58 is a line 66 leading to one side of motor 55 and the opposite side of motor 55 is connected by a line 67 to line 63 of generator 53. Thus when the generator 53 is running, a circuit will be established therefrom to motor 55, dependent for completion on the closing of thermostatic switch 58, and this action is independent of any action which might accrue from the closing of thermostatic switch 57. By this arrangement of parts, circulation of brine through pipes 48 in space 9 may be controlled by the action of thermostatic switch 58 and consequently by the temperature in this space.

Turning now to the action of my refrigeration system, let it be assumed that the refrigerating car is in transit and is loaded with perishable goods which should be maintained at a certain definite temperature value for best storage. Reservoir 41 and its associated system of piping are filled with a brine of suitable composition to meet the requirements of use most efficiently and the engine 17 is started. As described above, this engine is of such a construction that it will run continuously for substantial periods of time, such as during the entire "run" of the car, and when the car is in transit this engine runs as long as the space 9 is to be maintained at a definite temperature value. While the engine is running, there is a continuous circulation of cold air in compartment 15 by means of fan 18 which draws in air through inlet 20 and forces it out through outlet 21. Thus the engine is maintained at an efficient working temperature. Thermostatic switch 57 and thermostatic switch 58 are adjusted to maintain space 9 at a certain temperature which may be assumed, for purposes of illustration, to be 40° F. If the temperature of the space 9 is to be maintained at 40°, the temperature of the brine may be maintained at 35° F.

After the perishable goods are loaded into the car and engine 17 has been started, as described above, the refrigeration system starts operating to lower space 9 to a temperature of 40°, it

being assumed that the temperature of the interior is above 40°. Further it is assumed that the brine in the reservoir 41 is above 35°, and in this case the thermostatic switch 57 closes.

Referring now to Figure 2, the closing of thermostatic switch 57 establishes a circuit between magnetic clutch 25 and generator 53; this circuit consisting of the line 60, thermostatic switch 57, contact 61, line 62, to one side of the clutch 25, line 63 connecting the other terminal of the clutch to the opposite side of the generator. This circuit being established, magnetic clutch 25 is actuated and connects crank shaft 22 of engine 17 with the driving shaft 23 of compressor 24.

As compressor 24 is now set in operation, compressed sulphur dioxide escapes through outlet pipe 28 to condenser 29 to be cooled. The operation of compressor 24 also drives fan 37 and this fan induces a current of cold air to flow down past the coils 30 of condenser 29 and over compressor 24 to escape through outlet 34. Thus a cooling and condensing effect takes place in condenser 29 and at the same time compressor 24 is maintained at an efficient working temperature. The liquefied sulphur dioxide leaves condenser 29 through pipe 39 to be stored in receiver 40. From the latter liquefied gas is conducted through pipe 47, expansion valve 46, to expansion coil 43, through pipe 45, and the expansion and evaporation of gas taking place in this coil absorbs heat to cool the brine contained in reservoir 41. The expanded gas then returns to inlet pipe 27 of compressor 24 to repeat the cycle. Thus the brine in reservoir 41 is finally cooled to 35°, whereupon thermostatic switch 57 is actuated to open the circuit of magnetic clutch 25 and disconnect the refrigeration unit from the engine 17.

Simultaneously with the above described action thermostatic switch 58 closes, coming into engagement with contact 65, for it has been assumed that the temperature of space 9 is above 40°. As a result, a circuit is established between generator 53 and motor 55; this circuit consisting of line 60, line 64, thermostatic switch 58, contact 65, line 66 to one side of motor 55, and from the other side of the motor lines 67 and 63 to the opposite side of the generator. This circuit being established, motor 55 attains its operating speed to drive rotary pump 51. Thus the brine, which has been cooled in reservoir 41 through the action of cooling coil 43, circulates in space 9 through pipes 48 to pump 51 and back to reservoir 41 through pipe 52. As this cool brine circulates, heat is absorbed from space 9, and subsequently the temperature therein is lowered to 40° F.

When the temperature of space 9 reaches 40°, thermostatic switch 58 opens, thus breaking the circuit between the generator 53 and motor 55. Motor 55 ceases operation and the brine is not circulated in pipes 48 until this temperature rises above 40°, when the above described operation is repeated.

Thermostatic switch 57 opens as above noted, when the brine contained in reservoir 41 reaches its intended temperature breaking the circuit between magnetic clutch 25 and generator 53. Clutch 25 springs out of engagement, disconnecting engine 17 from compressor 24, and the refrigerating action taking place in cooling coil 43 stops until the temperature of the brine surrounding the coil rises above this temperature. Engine 17 continues to operate awaiting a time when current is needed by motor 55 or power for operation of compressor 24.

It will be understood that the actions above described take place independently of each other. If the temperature of the space 9 is at or below 40° and the brine contained in reservoir 41 rises above 35°, thermostatic switch 57 closes and refrigeration takes place in coil 43 to reduce the brine to its preferred temperature. Furthermore, if the brine should be at or below 35° and thermostatic switch 57 should be open so that no refrigeration occurs in cooling coil 43, and the temperature in space 9 rises above 40°, thermostatic switch 58 closes. Thus the cool brine circulates in space 9 absorbing heat to cool the space, and this action will continue independently of the action controlled by thermostatic switch 57. Reservoir 41 may be of sufficient capacity to store a substantial quantity of cooled brine; in any event, when the brine is unduly raised in temperature due to its circulation in and absorption of heat from the space 9, cooling coil 43 is promptly brought into action.

It will thus be seen that by this thoroughly simple and practical construction and apparatus, I have provided a refrigeration system well adapted to withstand the heavy wear and tear of operation on vehicles such as railroad cars. The great reduction and simple action of the working parts reduce greatly the possibility of failure damage to working parts, and thus insure reliable refrigeration for the perishable goods to be stored in the car. The automatic character of the operation and control of my system makes it particularly advantageous for use on those railroad cars in which a minimum amount of attention can be given the apparatus while the latter is in operation. Because, for example, little more need be manually done than to start the engine after completion of loading, this system may be operated by unskilled or careless labor with small, if any, risk of failure or damage. By employing a brine circulating system operating to meet directly refrigeration needs independently of the other parts of my refrigeration system, I am able to maintain the refrigerated interior of the vehicle at a temperature whose variation is slight and inconsiderable. Thus the perishable goods to be stored will be free from possible damage due to a quick rise of temperature, or due to delay in counteracting such a rise. These and many other important advantages of this system, together with the various objects above set forth will be seen to be successfully achieved.

As many possible embodiments may be made of the above invention, and as many changes may be made in the embodiment above set forth, 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.

I claim:

1. In a refrigeration system for a vehicle, in combination, a vehicle, a chamber in said vehicle whose temperature is to be regulated over a period of time, means containing a liquid refrigerant, means forming a path of circulation between said containing means and said chamber, pumping means in said path, motive means for said pump, thermostatic means for controlling said motive means in response to the temperature of said chamber, a refrigeration unit for said containing means, an internal combustion engine adapted to run continuously for said period of time for driving an element of said

refrigeration unit, a clutch member disposed between said engine and said element, and means for controlling the operation of said clutch in response to the temperature of said refrigerant in said container.

2. In a refrigeration system for a vehicle, in combination, a vehicle, a chamber in said vehicle whose temperature is to be regulated over a period of time, means containing a liquid refrigerant, means forming a path of circulation between said containing means and said chamber, pumping means in said path, an electric motor for driving said pump, a refrigeration unit for cooling said refrigerant in said containing means, an internal combustion engine adapted to run continuously for said period of time for driving an element of said refrigeration unit, means for controlling the operative effectiveness of said element in response to the temperature of said refrigerant, a generator driven by said engine, a thermostatic switch in said chamber, and a circuit between said generator switch and motor.

3. In a refrigeration system, in combination, a vehicle whose interior temperature is to be regulated over a period of time, containing means for a refrigerating medium, means forming a circulating path between said containing means and said interior, pumping means in said path, an electric motor for driving said pumping means, a refrigeration unit for said containing means, an internal combustion engine adapted to run continuously for said period of time for driving an element of said refrigeration unit, an electrically actuated clutch disposed between said engine and said element, a generator driven by said engine, a circuit between said generator and said clutch, a circuit between said generator and said engine, a thermostatic switch responsive to the temperature of said refrigerating medium in said first-mentioned circuit, and a thermostatic switch responsive to the temperature of said interior in said second-mentioned circuit.

4. In a refrigeration system for a vehicle, in combination, a chamber in said vehicle whose temperature is to be regulated over a period of time, containing means for a refrigerant on said vehicle, the walls thereof being thermally insulated, means for circulating said refrigerant between said containing means and said chamber in accordance with the temperature requirements of said chamber, a refrigeration unit for said refrigerant in said containing means and including a compressor and condenser, enclosing means for said compressor and condenser having openings to the exterior of said vehicle at a plurality of points, means for causing air to circulate through said enclosing means between said openings, an internal combustion engine adapted to run continuously for said period of time for driving said compressor, enclosing means for said engine forming a compartment therefor, means forming openings from said compartment to the exterior of said vehicle, means causing air to circulate through said compartment between said openings to cool said engine, and means responsive to the temperature of said refrigerant in said containing means for controlling the connecting and disconnecting of said engine with said compressor.

5. In a refrigeration system, in combination, a vehicle whose interior temperature is to be regulated over a period of time, means forming a circulating path through said interior for brine for extracting heat therefrom, a refrigeration unit including a compressor and an expansion member for cooling said brine, an internal combustion engine adapted to run continuously for said period of time and adapted to drive the compressor of said unit, a clutch disposed between said engine and said compressor, thermostatic means for actuating said clutch to connect said compressor with said engine when the temperature of said brine rises above a certain value and to disengage said clutch when said temperature is at or below said value, a pump for circulating said brine through said path, and thermostatic means responsive to the temperature of said interior for controlling the actuation of said pump.

6. In a refrigeration system, in combination, a vehicle whose interior temperature is to be regulated over a period of time, means forming a circulating path through said interior for brine, a refrigeration unit including a compressor and an expansion member for cooling said brine, an internal combustion engine adapted to run continuously for said period of time and adapted to drive the compressor of said unit, a clutch disposed between said engine and said compressor, thermostatic means for actuating said clutch to connect said compressor with said engine when the temperature of said brine rises above a certain value and to disengage said clutch when said temperature is at or below said value, a pump for forcing said brine through said circulating path, motive means for actuating said pump, and thermostatic means in said interior for controlling the actuation of said pump.

7. In a refrigeration system, in combination, a vehicle whose interior temperature is to be regulated over a period of time, containing means for a refrigerating brine, means forming a circulating path between said containing means and said interior, pumping means in said path, an electric motor for driving said pumping means, a refrigeration unit for said containing means, an internal combustion engine adapted to run continuously over said period of time for driving an element of said refrigeration unit, an electrically actuated clutch disposed between said engine and said element, a generator driven by said engine, a circuit between said generator and said clutch, a circuit between said generator and said motor, and a pair of thermostatic switches one responsive to the temperature of said brine and one responsive to the temperature of said interior each in one of said circuits for controlling each of said circuits independently of each other.

GEORGE E. HULSE.