

April 4, 1944.

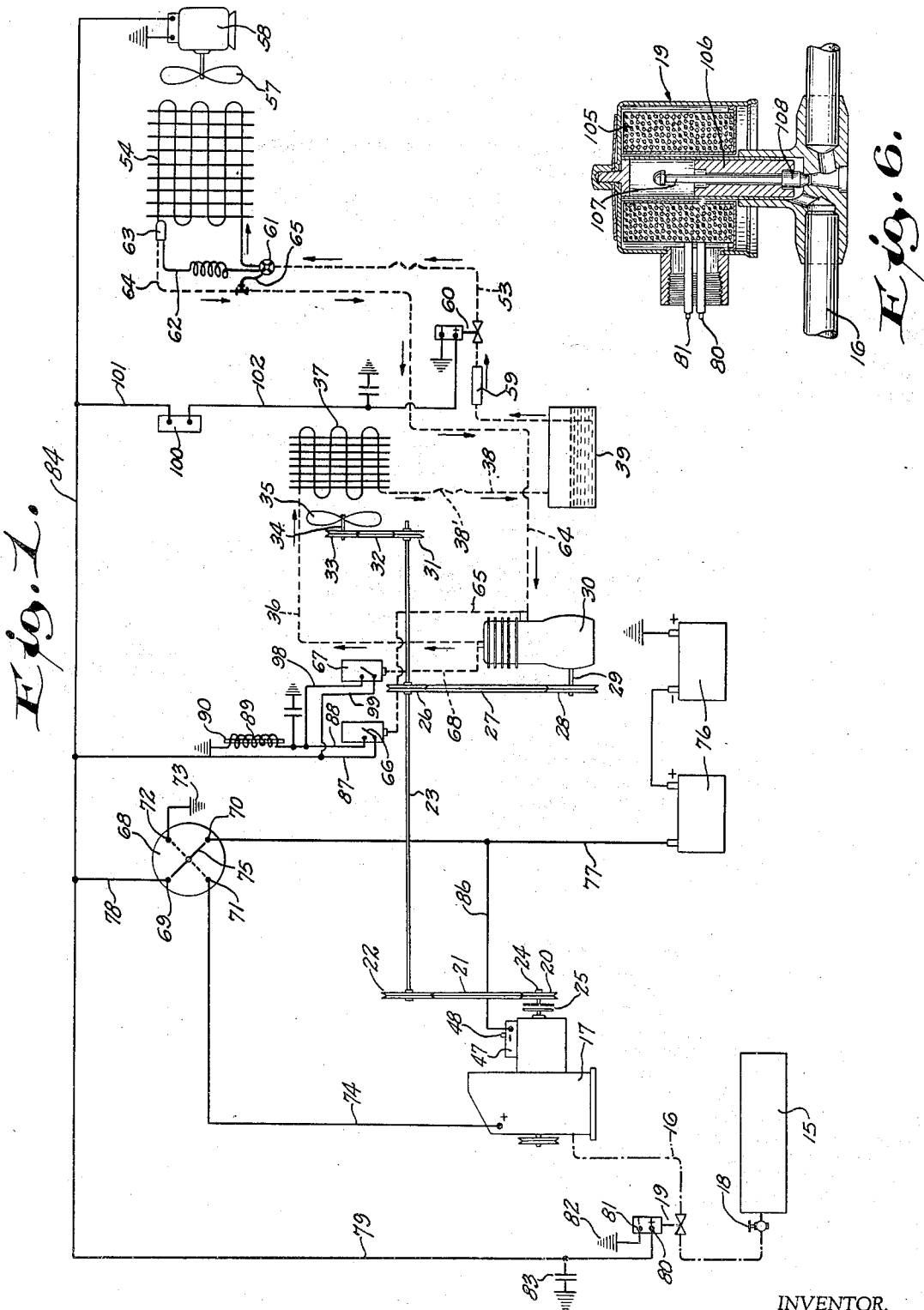
E. O. ERRATH

2,346,017

REFRIGERATING SYSTEM

Filed Dec. 20, 1941

5 Sheets-Sheet 1



INVENTOR.
Edward O. Errath
BY *Morsell Morsell*
ATTORNEYS.

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E. O. ERRATH
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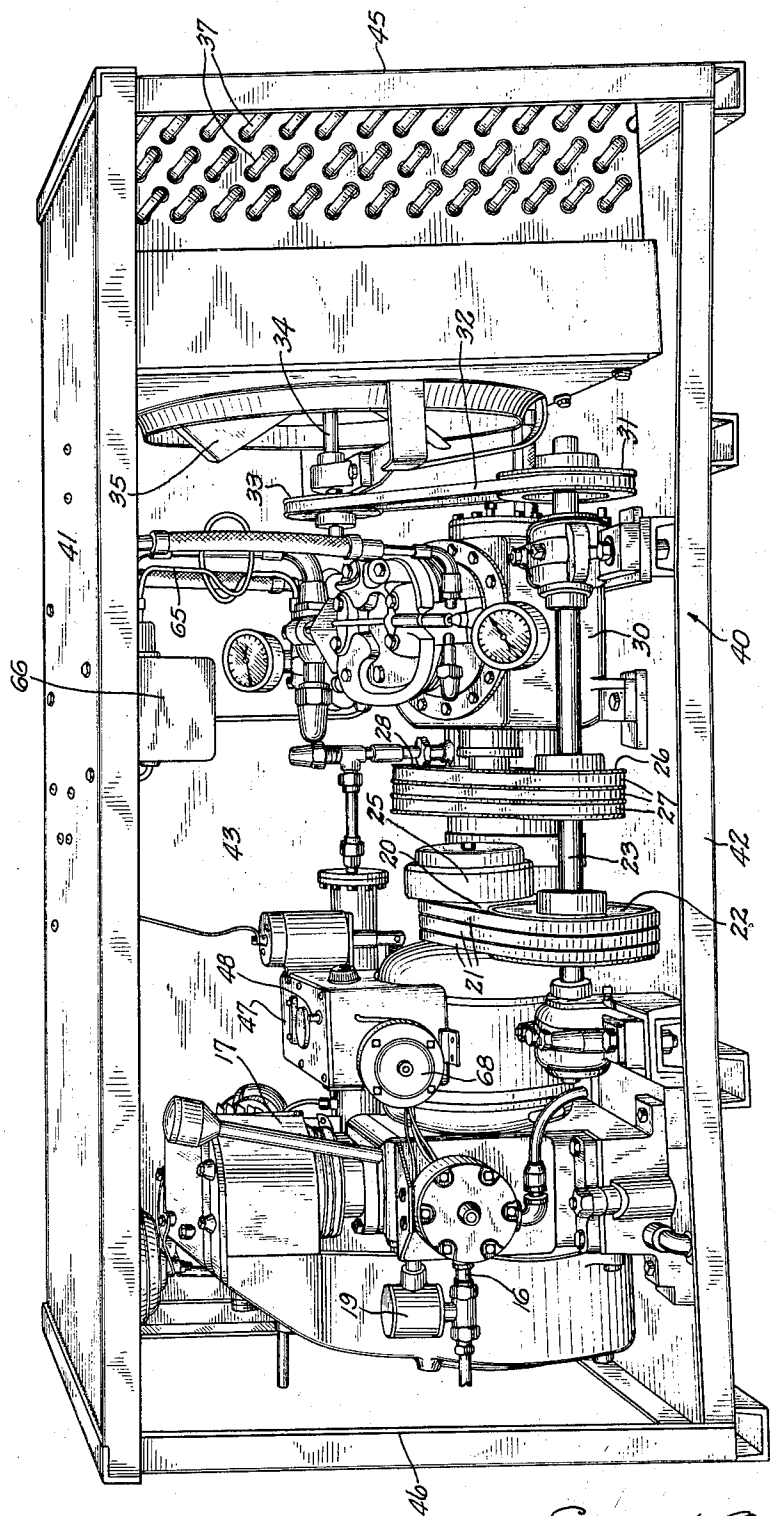


Fig. 2.

INVENTOR.
Edward O. Errath
BY *Mossell, Mossell*
ATTORNEYS.

April 4, 1944.

E. O. ERRATH

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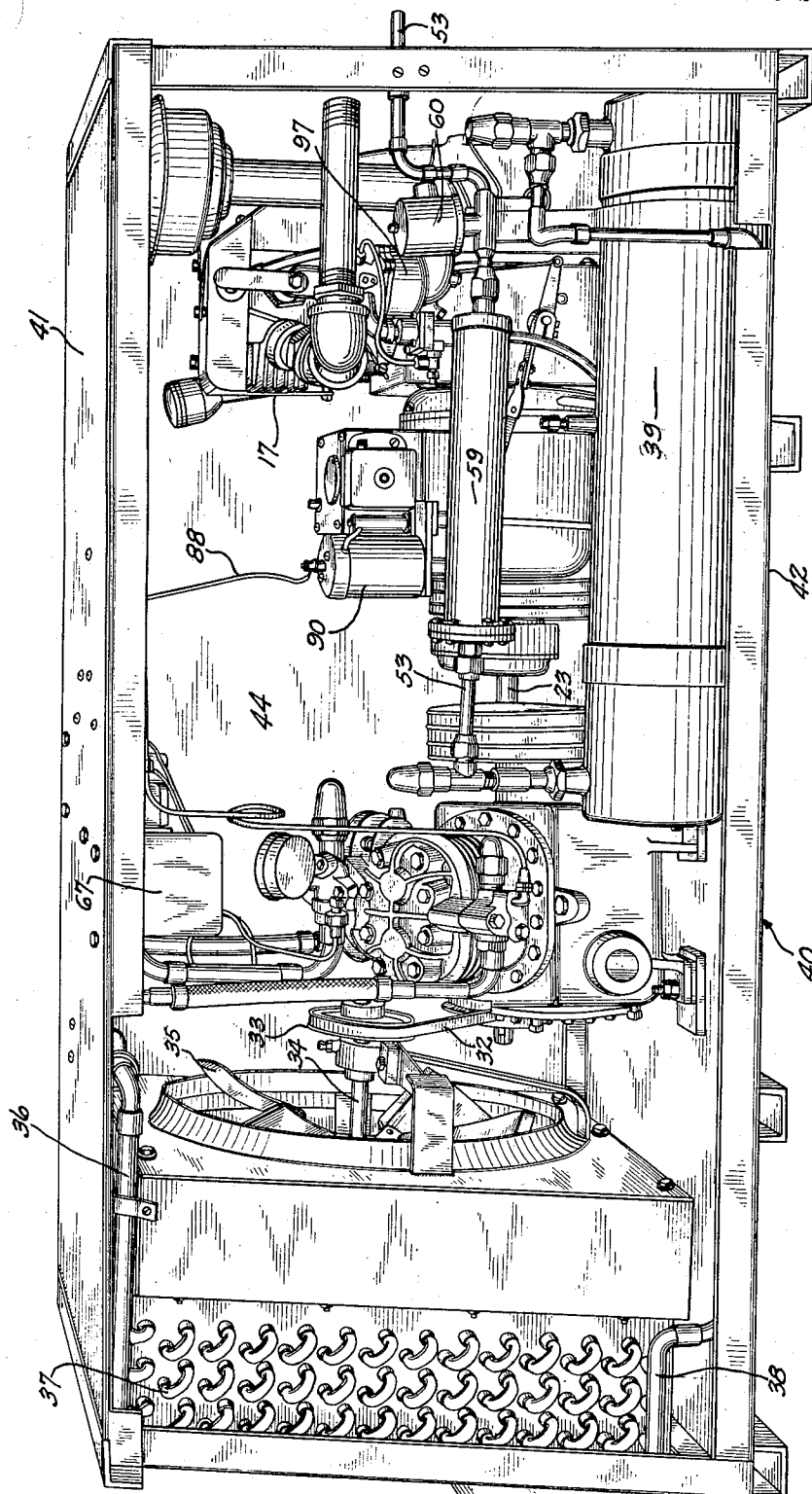


Fig. 3.

INVENTOR.

BY

Edward O. Errath
Morsell Morsell
ATTORNEYS.

April 4, 1944.

E. O. ERRATH

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Fig. 4.

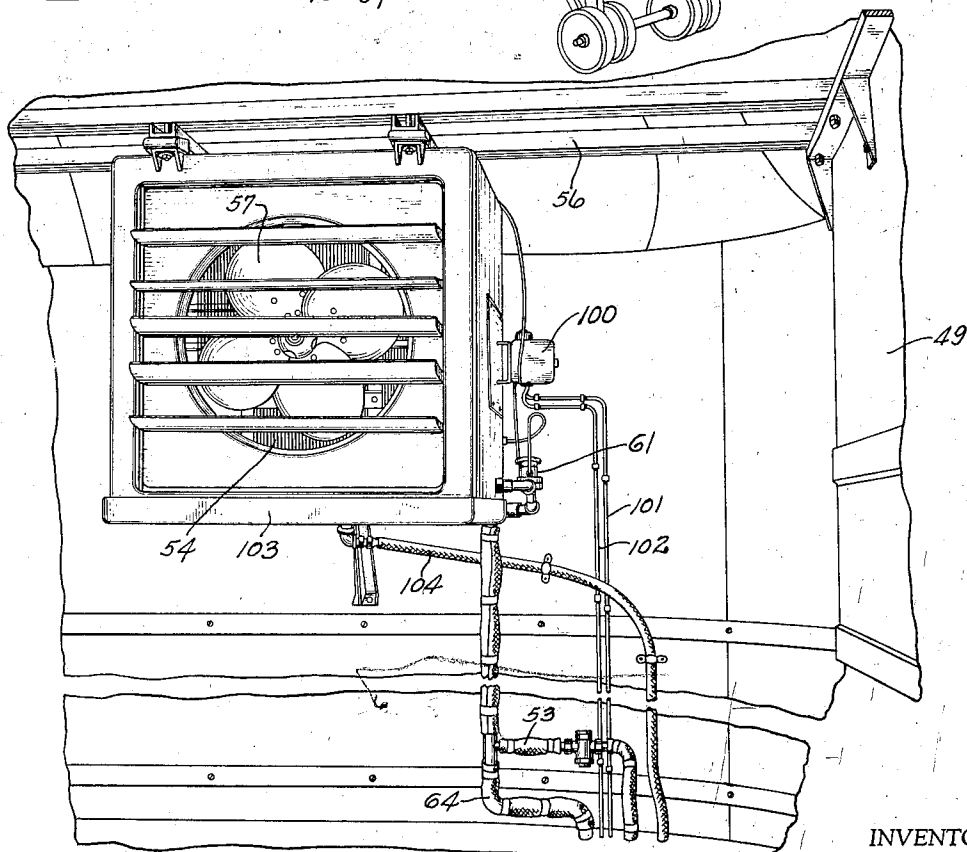
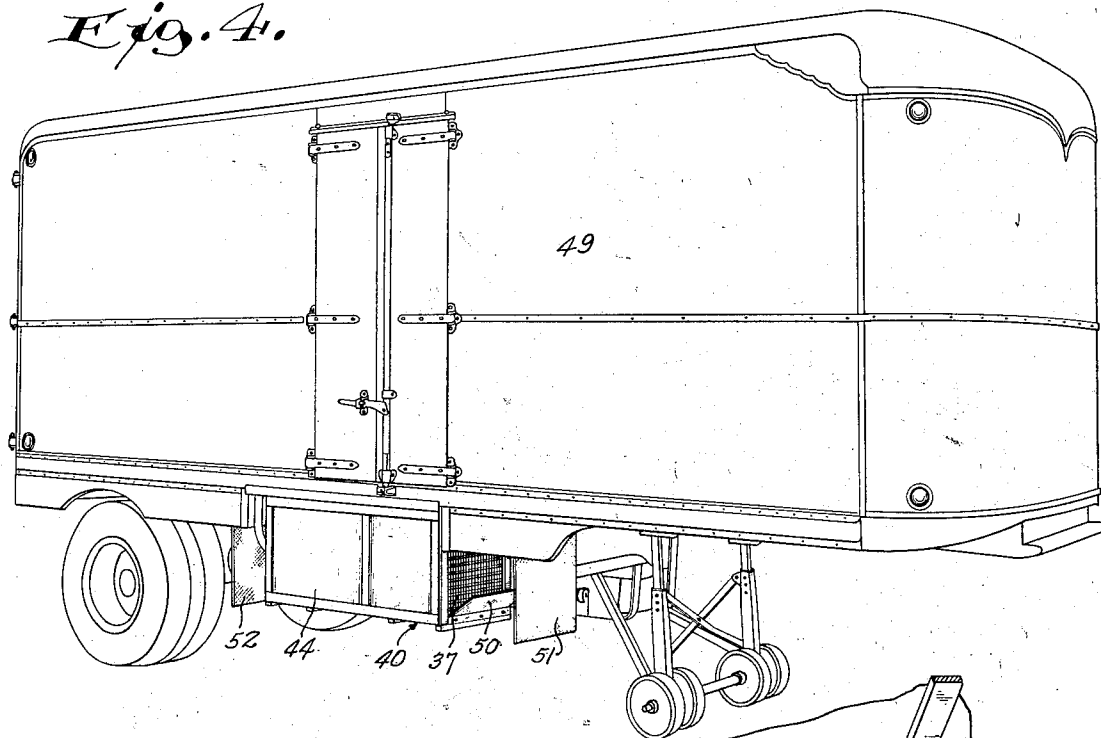


Fig. 5.

BY

INVENTOR.
Edward O. Errath
Mossell & Mossell
ATTORNEYS.

April 4, 1944.

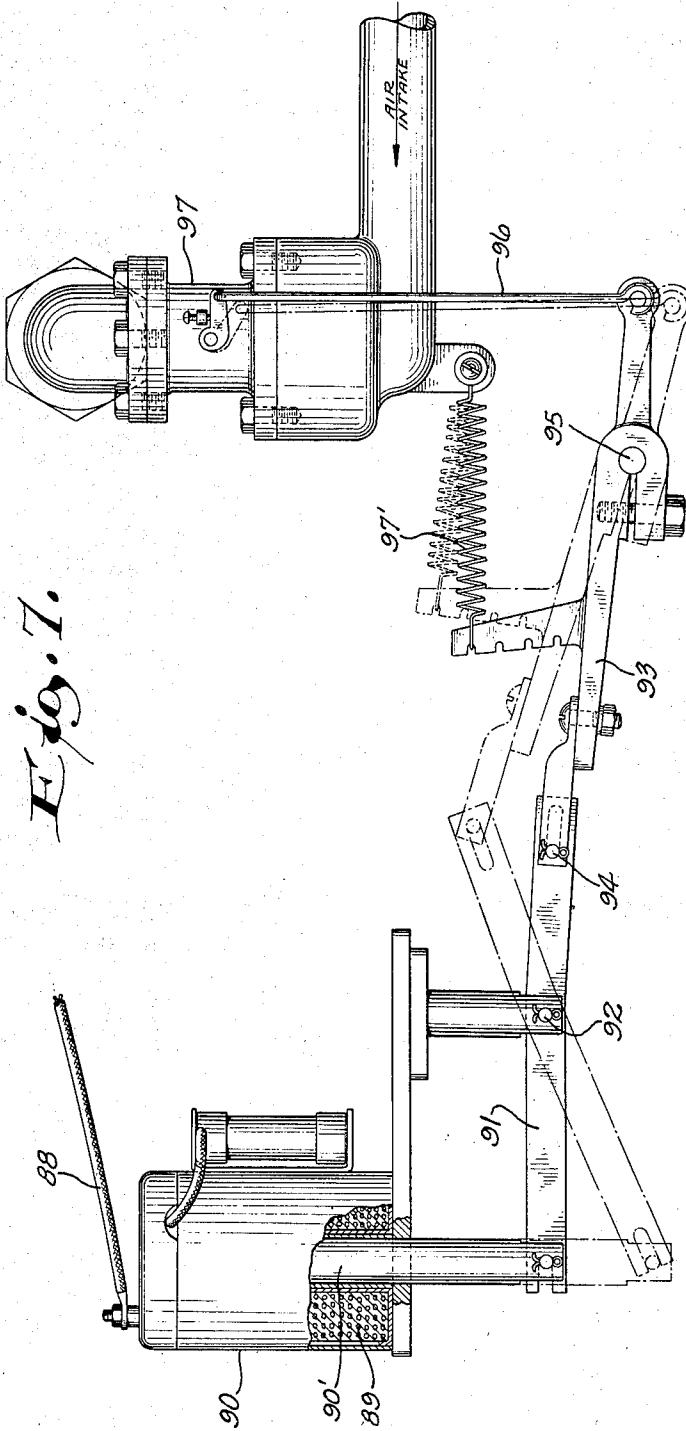
E. O. ERRATH

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5 Sheets-Sheet 5



INVENTOR.
Edward O. Errath
BY *Mossell, Mossell*
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,346,017

REFRIGERATING SYSTEM

Edward O. Errath, Milwaukee, Wis., assignor to
The Heil Co., Milwaukee, Wis., a corporation
of Wisconsin

Application December 20, 1941, Serial No. 423,752

9 Claims. (Cl. 62—2)

This invention relates to improvements in refrigerating systems, and more particularly to a system and unit which is specially, but not exclusively, adapted for use in transportation vehicles such as trailers, vans, railroad cars, or the like.

A general object of the invention is to provide a refrigerating system including a compact condensing unit which may be readily suspended beneath a vehicle, the equipment forming said unit being so arranged as to provide for quick access to all component parts.

A further object of the invention is to provide a device including a condensing unit as above described wherein there is a novel arrangement of the power drive with respect to the component parts of the unit, resulting in an efficient as well as compact installation.

A further object of the invention is to provide a device as above described wherein the condensing unit is housed in an elongated enclosure open at both its front and rear ends, with the condenser coil and fan adjacent the front end opening. With this arrangement operating efficiency is materially increased because air which enters the front opening of the housing is forcibly propelled, both by the condenser fan and by reason of the motion of the vehicle, in a rearward direction over the compressor, starter generator, and engine to cool the latter devices and effectively reduce the head pressure on the compressor.

A further important object of the invention is to provide novel control means whereby, when refrigeration is not required, the prime mover is automatically idled and wherein said idling immediately initiates the operation of mechanism for automatically disengaging the compressor drive to completely stop said compressor. This is to be distinguished from prior methods of either completely stopping the prime mover in order to shut off the compressor, or of merely reducing the speed of the prime mover and consequently reducing the speed of the compressor driven thereby. The first-mentioned prior method is particularly objectionable when a gas engine is used because of the necessity of frequently re-starting said engine, and the second-mentioned prior method calls for unnecessary operation of the compressor during periods when cooling is not required.

A further object of the invention is to provide a refrigerating system wherein the novel control is so arranged and constructed as to cause automatic defrosting. Thus the necessity of uti-

lizing the usual hose attachment to pass defrosting water through the evaporator coils is eliminated.

A further object of the invention is to provide a simple, compact and completely automatic self-contained refrigerating system suitable for any use where refrigeration is desired.

With the above and other objects in view, the invention consists of the improved refrigerating system and all its parts and combinations as set forth in the claims, and all equivalents thereof.

In the accompanying drawings illustrating one complete embodiment of the preferred form of the invention, in which the same reference numerals designate the same parts in all of the views,

Fig. 1 is a diagrammatic view of the entire system;

Fig. 2 is a perspective view of the condensing unit, looking at said unit from the curb side when it is installed in a vehicle, the corresponding side of the housing being omitted;

Fig. 3 is a perspective view of the condensing unit, looking at the opposite side from that shown in Fig. 2;

Fig. 4 is a perspective view of a trailer showing the improved unit installed thereon;

Fig. 5 is a fragmentary perspective view showing the evaporating unit or high side of the refrigerating system installed in the interior of the trailer;

Fig. 6 is a fragmentary vertical sectional view of one of the solenoid operated valves; and

Fig. 7 is an enlarged detail view showing in front elevation the mechanism for idling the gas engine.

Engine and mechanical drive

Referring more particularly to the drawings, and especially to Fig. 1, the numeral 15 designates a fuel tank for supplying fuel through a tubular conduit 16 to a gas engine 17. Interposed in the line 16 is a hand-operated valve 18 and also a solenoid operated supply tank shut-off valve 19. It is preferred to utilize an engine of a type which will burn propane gas.

The engine 17 drives sheaves 20 which are preferably connected by three V-belts 21, with sheaves 22 on a drive shaft 23. The drive shaft 24 of the engine, on which the sheaves 20 are mounted, is also equipped with a centrifugal clutch 25 which automatically disengages the engine from the power drive for the unit when the speed of the engine falls below a predetermined value, and which causes automatic re-en-

gagement when the speed of the engine exceeds a predetermined value. These clutches are standard articles and a number of suitable types are available. These clutches are provided with speed adjustments. It is preferred to employ the centrifugal pulley clutch manufactured by Briggs & Stratton Corporation.

The drive shaft 23 is also provided with rigidly mounted sheaves 26 which are connected, preferably by three V-belts 27, with sheaves 28 mounted rigidly on the drive shaft 29 of the compressor 30 to drive said compressor.

In addition the drive shaft 23 is equipped with a sheave 31 which is connected by an endless belt 32 with a sheave 33 rigidly mounted on the drive shaft 34 of a condenser fan 35.

It is apparent from the above that operation of the gas engine 17 will, when the automatic clutch 25 is in engagement, cause simultaneous operation of the compressor 30 and condenser fan 35.

Refrigerating equipment proper

The refrigerating equipment proper includes the compressor 30, which preferably utilizes freon or F.12 as a refrigerant, and said compressor is adapted to pump the refrigerant in gaseous form through a tubular conduit 36 into one end of a condenser coil 37. Because of the air which is drawn through and over the condenser coil by the fan 35, the gas inside of the coil is condensed to liquid form, and the liquid refrigerant is forced out of the condenser coil into a tubular conduit 38 having a flexible connection 38' therein. Line 38 leads to a liquid receiver 39.

Referring more particularly to Figs. 2 and 3, the engine and condensing equipment are all enclosed in a housing 40 which has a closed top 41, a closed bottom 42, and closed sides 43 and 44. In Fig. 2 the side 44 is removed, and in Fig. 3 the side 43 is removed. The front end 45 of the housing is open as is the rear end 46. Positioned adjacent the open front end is the condenser coil 37, and directly behind the coil is the condenser fan 35. The compressor 30 is mounted in an intermediate position in the housing, and the liquid receiver 39 is mounted inwardly of the compressor (see Fig. 3). The gas engine 17 and starter generator 47, having a starter button 48, are mounted adjacent the rear end of the unit.

The main power drive shaft 23 extends longitudinally of the housing adjacent the outer side thereof, as shown in Fig. 2, in such a manner as to provide for an efficient drive from the engine to the compressor and condenser fan without interfering with the compactness of the unit. The arrangement of parts is such that the fan 35 causes air to pass rearwardly within the housing to effectively cool the compressor 30, starter generator 47, and engine 17, and this air leaves the unit from the rear end opening 46. In addition when the unit is employed on a moving vehicle, such as the trailer of Fig. 4, the motion of the vehicle additionally causes air to move longitudinally through the unit from the front to the rear thereof, with the air passing through the condenser coil before it passes over the compressor, starter, generator, and engine. This efficient cooling arrangement results in reducing the head pressure on the compressor and increases its operating efficiency. The capacity of the starter generator on the gas engine is also considerably increased because of the effective cooling action.

The condenser unit housed within the enclosure 40 may be mounted beneath a trailer 49, as shown in Fig. 4, or beneath any desired type of vehicle.

The condenser unit is, of course, also adapted for refrigeration other than in moving vehicles, and in such other uses the compactness of the unit is also an advantage. When used on a vehicle there may be an outwardly and upwardly inclined guard plate 50 on the front end of the unit, and the unit may be additionally protected against mud or the like by front and rear flaps 51 and 52 suspended from the bottom of the vehicle.

From the receiver 39 the liquid refrigerant is forced through a liquid conduit 53 leading to an evaporator 54 mounted in the space to be cooled. Fig. 5 shows the evaporator suspended from the ceiling 56 of the interior of the trailer 49. In front of the evaporator is the usual evaporator fan 57 driven by an electric motor 58. In the liquid line 53 for the evaporator is a dehydrator and strainer 59, a solenoid operated shut-off valve 60, and an expansion valve 61. The expansion valve 61 is connected by a conduit 62 with a bulb 63 clamped onto the suction line 64. The expansion valve is also connected with the suction line by an equalizer connection 65. The suction line 64 leads back to the compressor 30, as indicated by the arrows in Fig. 1. The suction line is also connected by a tubular conduit 65 with a suction pressure control switch 66. A similarly constructed discharge pressure control switch 67 is connected by a tubular conduit 68 with the gas line 36 leading to the condenser coil 37.

Electrical system and controls

A two-way snap switch 68 is equipped with four contacts 69, 70, 71 and 72. The contact 72 is connected to the vehicle frame as at 73, and the contact 71 is connected by an electric wire 74 with the magneto of the gas engine 17. Thus when the movable switch arm 75 is in the dotted-line position of Fig. 1 the magneto is grounded. When the switch arm 75 is thrown to the full-line position of Fig. 1, the current flows from the storage batteries 76 through electric wires 77, switch arm, electric wire 78, wire 79, to the positive terminal 80 of the solenoid embodied in the solenoid operated supply shut-off valve 19. The negative terminal 81 of the solenoid is grounded as at 82. A condenser 83 may also be interposed in the electric line 79 leading to the solenoid. It is thus apparent that when the switch arm 75 is in the full-line position of Fig. 1, that the solenoid actuated valve 19 is energized, causing the valve to be opened in the gas line 16 so that fuel is supplied to the engine 17.

In addition when the switch arm 75 is in the full line position of Fig. 1, current also flows from the electric wire 78 in the opposite direction through the electric wire 84 leading to the motor 58 for operating the evaporator fan 57 within the space to be refrigerated.

Also when the switch arm 75 is in the full-line position the magneto wire 74 is disconnected from the frame 74, allowing the engine to be started. Electricity is furnished to the electric starter 47 by wire 86 leading from the storage battery 76, and the engine is started by pressing down on the starter button 48.

The engine 17 will then run either at slow speed or high speed, depending upon the pressure in the gas suction line 64. The suction pressure control switch 66 is responsive to pressure in the gas suction line 64 because of the connecting line 65. When this pressure is above a predetermined value, as will be hereinafter explained, the switch 66 is opened breaking the

connection between electric wires 87 and 88. The wire 87 leads from the electric supply line 84, and the wire 88 connects with a solenoid 89 embodied in a solenoid control 90 adjacent the engine 17 (see Fig. 7). When the pressure in the gas suction line 64 is above a predetermined value, the control switch 66 remains open and no current can flow to the solenoid 89. When, however, the pressure drops below a predetermined value, the solenoid 89 is energized pulling vertically upwardly on the solenoid pole 90'. This causes upward movement of one end of a lever 91, which lever is fulcrumed as at 92. The other end of the lever 91 is pivotally connected to a throttle lever 93 as at 94. The throttle lever 93 is fulcrumed as at 95 and has its inner end connected by a link 96 with the throttle on the carburetor 97. Thus when the solenoid 89 is energized to pull upwardly on the connected end of the lever 91, the opposite end of said lever pushes downwardly on one end of the throttle lever 93 to cause the opposite end to push upwardly and actuate the line 98 in an upward direction. This overcomes the tension of the throttle spring 97' and automatically throttles the engine down to a low speed, such as 1500 R. P. M. When the suction pressure control switch 66 breaks the circuit to the solenoid, then the solenoid pole 90 is free to float in the dotted line vertical position, and the throttle spring 97' maintains the throttle in an open condition allowing the engine to run at a high speed, such as 3150 R. P. M.

The automatic centrifugal clutch 25 is so constructed that as soon as the suction pressure control has operated to cause idling of the engine, then the resulting slow speed operation of the engine causes automatic disengagement of the clutch 25 so that the main drive shaft 23 stops rotating, thereby shutting off the compressor as well as the condenser fan 35.

It is preferred to have the suction pressure control 66 so adjusted as to open the electrical circuit to the solenoid 89 when the pressure reaches 37 lbs. per square inch, and the suction pressure control is also so adjusted as to cause closing of the electrical circuit to the solenoid when the pressure drops to 15 lbs. per square inch.

As an additional safety factor the control switch 67 is also utilized. This control switch is responsive to abnormal pressures in the gas line 36. It is preferred to have the control switch 67 adjusted so that if pressure in the line 36 exceeds 175 lbs. per square inch the circuit between the wires 98 and 99 is closed causing energization of the solenoid 89, idling of the engine 17, disengagement of the centrifugal clutch 25, and shutting off of the compressor 30 and condenser fan 35. A thermostat 100 located in the space to be cooled has one terminal connected by a wire 101 with the electrical supply line 84, and another terminal connected by the wire 102 with the solenoid operated shut-off valve 60 in the liquid line 53 leading to the evaporator. If the space requires cooling, the contacts of the thermostat 100 close, causing current to flow through the line 102 leading to the solenoid of the solenoid operated valve 60. This causes opening movement of the valve in the line 53 allowing liquid refrigerant to flow toward the evaporator.

Defrosting

Heretofore it has been common practice to pro-

vide hose attachments for the purpose of passing water adjacent the evaporator coils to defrost the same. The present invention, however, embodies an automatic defrosting arrangement which maintains the coils in a proper defrosted condition at all times.

With the present invention after the compressor 30 has been stopped through the action of the pressure switch 66 causing the gas engine to idle, the compressor does not again operate until the pressure in the lines 64 and 65 reaches 37 lbs. per square inch. The pressure switch 66 is adjusted to meet this purpose. A pressure of 37 lbs. per square inch in the line 64 corresponds to a temperature in excess of 32° F. in the coil 54. Thus at this point in the cycle of operation the coil 54 has refrigerant which is above freezing passing through it and the coil will automatically defrost itself. This defrosting takes place, of course, after the thermostat 100 has called for additional cooling and immediately after the compressor starts to operate after a period of inaction. The defrosting will take place until the operation of the compressor has gone on sufficiently long to cause a reduction in the temperature of the refrigerant passing through the coil 54. Thus each time the pressure switch 66 causes the speeding up of the operation of the engine and the re-starting of the compressor there will be a period when defrosting will automatically take place. During defrosting the evaporator fan 57 will circulate air from the inside of the trailer or other space to be refrigerated over the evaporator coils. This action together with the presence of refrigerant over 32° F. in the coils 54 will cause the frost formed on the coils to melt and collect in the drain pan 103 (see Fig. 5), and flow out of the pipe 104 to a point of discharge.

The solenoid operated valves 19 and 60 are of the type shown in Fig. 6 and include a coil 105 which when energized causes upward movement of a plunger core 106. The coil is adapted to abut the upper end of a valve stem 107 to lift the valve member 108 from its seat so that liquid can flow through the conduit in which the valve is mounted, such as the conduit 18, and past said valve.

The pressure operated switches 66 and 67 are standard articles, and it has not been considered necessary to describe the details of construction of said pressure any more than has heretofore been done. Both switches are, of course, adjustable so that the operating range thereof can be varied to meet particular requirements. While the operation of the switch 66 is a direct result of a change in pressure in the suction line 64, the operation of said switch is of course also responsive to a change in temperature in the space to be refrigerated. The reason it is also responsive to a change in temperature is that when no refrigeration is required the thermostat 100 will cause closing of the valve 60 in the liquid conduit 53, and when the valve 60 is closed the pressure in line 53 beyond the valve 60 in the evaporator 54 and in the suction line 64 will become reduced until it falls to 15 lbs. per square inch. At this point the pressure operated switch 66 will close to cause the idling of the engine 17 and the stopping of the compressor 30 and condenser fan 35. After the compressor is stopped the pressure in the system will rise until it approximates the pressure corresponding to the surrounding temperature. Inasmuch as this pressure is in ex-

cess of 37 lbs. per square inch, the control switch will eventually re-open to cause acceleration of the gas engine and re-starting of the compressor.

Although only one form and adaptation of the invention has been shown and described, it is obvious that various modifications and other adaptations may be made without departing from the spirit of the invention, and all of such changes and adaptations are contemplated as may come within the scope of the claims.

What I claim is:

1. In a refrigerating system having a compressor and having a refrigerant suction line leading to said compressor, a prime mover normally operable continuously either at idling speed or at a higher speed, a drive between said prime mover and compressor, an electric pressure switch connected to said suction line and responsive to a predetermined pressure in said suction line, a magnetically operated throttle in the electric circuit to said pressure switch cooperable with the prime mover to cause operation of the latter at idling speed when said pressure switch is closed in response to a reduced pressure in said suction line, and means included in the compressor drive operable each time said pressure switch is closed for disconnecting the compressor drive.

2. In a refrigerating system having a compressor and having a refrigerant suction line leading to said compressor, a prime mover normally operable continuously either at idling speed or at a higher speed, a drive between said prime mover and said compressor, a control including a pressure switch connected to said suction line and responsive to a predetermined reduced pressure in said suction line for causing idling of said prime mover, and means included in said compressor drive operable each time said control causes idling of the prime mover for disconnecting the compressor drive.

3. In a refrigerating system having a compressor, having an evaporator, and having a suction line leading from the evaporator to the compressor, a prime mover normally operable continuously either at idling speed or at a higher speed, a drive between said compressor and prime mover, a control responsive to a predetermined low pressure in said suction line for causing idling of said prime mover, and clutch means included in said compressor drive and operable each time that said pressure control operates in response to said predetermined low pressure for disconnecting said compressor drive, said control being constructed to again increase the speed of the prime mover only when the pressure in the suction line is of such value as to correspond to a refrigerant temperature in excess of 32° F. in the evaporator whereby defrosting automatically takes place, and said clutch means being responsive to said increase in speed of the prime mover to re-connect said compressor drive.

4. In a refrigerating system having a compressor and having a refrigerant suction line leading to said compressor, a prime mover normally operable continuously either at idling speed or at a higher speed, a drive between said prime mover and compressor, an electric pressure switch responsive to a predetermined pressure change in said suction line, a magnetically operated throttle in the electric circuit to said pressure switch cooperable with the prime mover to cause idling of the latter when said pressure switch is closed, and means included in said compressor drive and operable each time the pressure switch

is closed for disconnecting the compressor drive.

5. In a refrigerating system having a compressor, having an evaporator, having a liquid line leading to the evaporator, and having a suction line leading from the evaporator to the compressor, a prime mover normally operable continuously either at idling speed or at a higher speed, a drive between said compressor and prime mover, a thermostatically controlled valve in the liquid line operable to shut off flow of liquid refrigerant to the evaporator when a predetermined change in temperature takes place in the space to be refrigerated, a control connected to said suction line and responsive to a predetermined low pressure in said suction line for causing idling of said prime mover, and clutch means included in said compressor drive and operable each time said control functions to cause idling of the prime mover to disconnect said compressor drive, said control being constructed to again increase the speed of the prime mover above idling only when the pressure in the suction line is of such value as to correspond to a refrigerant temperature in excess of 32° F. in the evaporator whereby defrosting automatically takes place, and said clutch means being responsive to said increase in speed of the prime mover above idling to re-connect said compressor drive.

6. In a refrigerating system having a compressor, having an evaporator, having a liquid line leading to the evaporator, and having a suction line leading from the evaporator to the compressor, a prime mover normally operable continuously either at idling speed or at a higher speed, a drive between said compressor and prime mover, a thermostatically controlled valve in the liquid line operable to shut off flow of liquid refrigerant to the evaporator when a predetermined change in temperature takes place in the space to be refrigerated, a control connected to said suction line and responsive to a predetermined low pressure in said suction line for causing idling of said prime mover, and clutch means included in said compressor drive and operable each time said control functions to cause idling of the prime mover to disconnect said compressor drive, said control being constructed to again increase the speed of the prime mover only when the pressure in the suction line is of such value as to correspond to a refrigerant temperature in excess of 32° F. in the evaporator whereby defrosting automatically takes place, and said clutch means being responsive to said increase in speed of the prime mover above idling to re-connect said compressor drive, and an evaporator fan operable continuously both when the prime mover is idling and when said prime mover is at high speed, the speed of said fan being independent of the speed of said prime mover.

7. In a refrigerating system having a compressor, having an evaporator, having a liquid line leading to the evaporator, and having a suction line leading from the evaporator to the compressor, a prime mover normally operable continuously either at idling speed or at a higher speed, a drive between said compressor and prime mover, a thermostatically controlled valve in the liquid line operable to shut off flow of liquid refrigerant to the evaporator when a predetermined change in temperature takes place in the space to be refrigerated, a control connected to said suction line and responsive to a predetermined low pressure in said suction line for

causing idling of said prime mover, and clutch means included in said compressor drive and operable each time said control functions to cause idling of the prime mover to disconnect said compressor drive, said control being constructed to again increase the speed of the prime mover only when the pressure in the suction line is of such value as to correspond to a refrigerant temperature in excess of 32° F. in the evaporator whereby defrosting automatically takes place, and said clutch means being responsive to said increase in speed of the prime mover to re-connect said compressor drive, and an electrically operated evaporator fan operable continuously and at substantially uniform speed both when the prime mover is idling and when said prime mover is at high speed.

8. In a refrigerating system having a compressor and having a refrigerant suction line leading to said compressor, a prime mover normally operable continuously either at idling speed or at a higher speed, a drive between said prime mover and compressor, and an electric pressure switch responsive to a predetermined pressure in the refrigerating system, a magnetic device in the electric circuit to said pressure switch cooperable with the prime mover to cause idling of the latter when said pressure switch is

5 closed, a second electric pressure switch responsive to dangerously high pressures on the opposite side of the compressor from the first electric pressure switch, said magnetic device also being in the electric circuit to said second pressure switch and cooperable with the prime mover to cause idling of the latter when said second pressure switch is closed, and means included in said compressor drive operable each time either 10 of the said pressure switches is closed for disconnecting the compressor drive.

9. In a refrigerating system having a compressor and having a suction line, a prime mover normally operable continuously either at idling speed or at a higher speed, a drive between said prime mover and compressor, a control operable intermittently during normal operating conditions in response to a predetermined reduced pressure in the suction line for causing idling 15 of the prime mover, a control operable in response to an abnormally high pressure in the refrigerating system for causing idling of said prime mover, and means included in said compressor drive and operable each time either of said controls causes idling to disconnect the compressor drive. 20 25

EDWARD O. ERRATH.