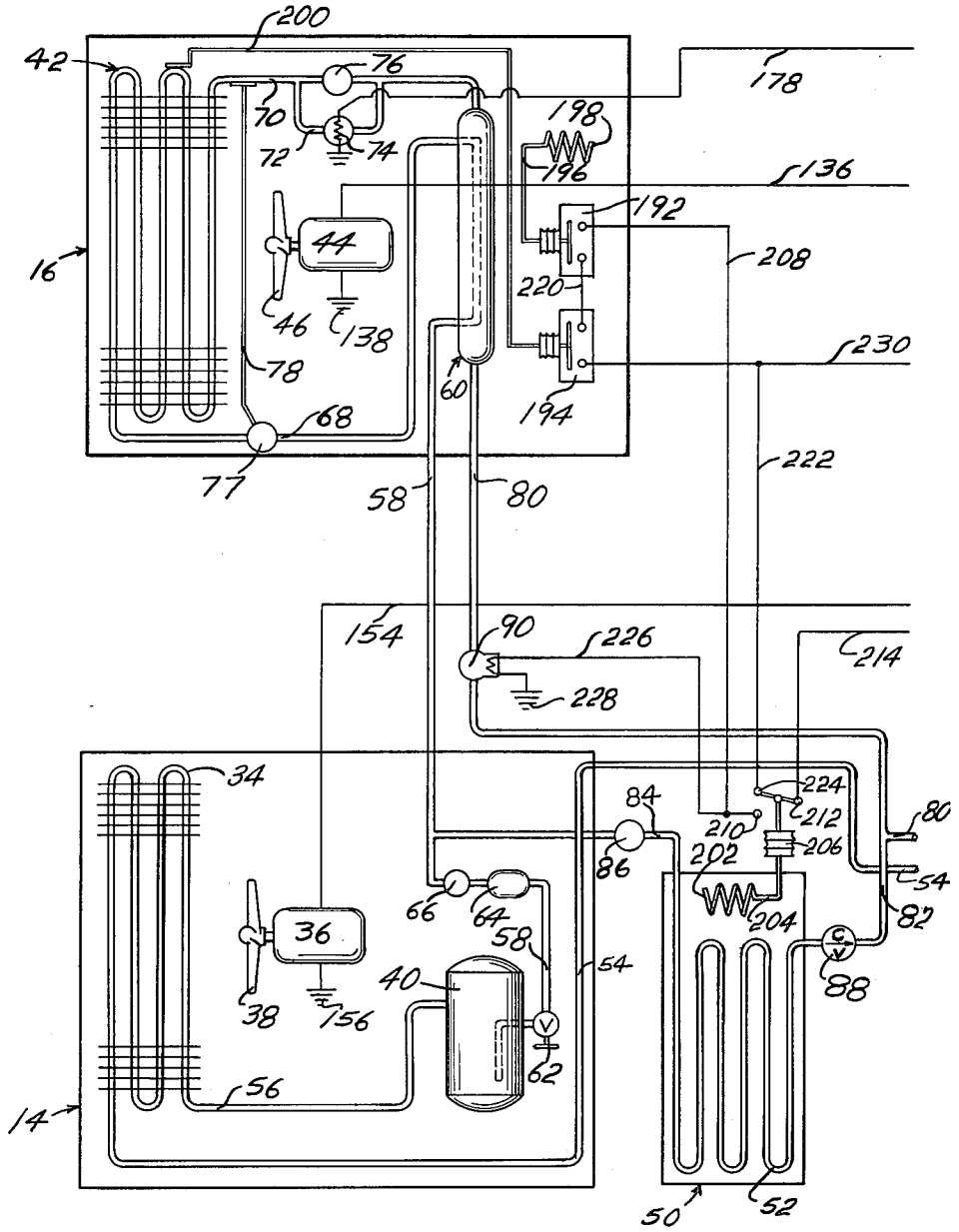
Nov. 9, 1965 J. A. ROWLEY 3,216,216

FEATHERWEIGHT MOBILREEFER

Filed Oct. 5, 1962 4 Sheets-Sheet 1

Fig. 1a



Jack A. Rowley INVENTOR.

BY

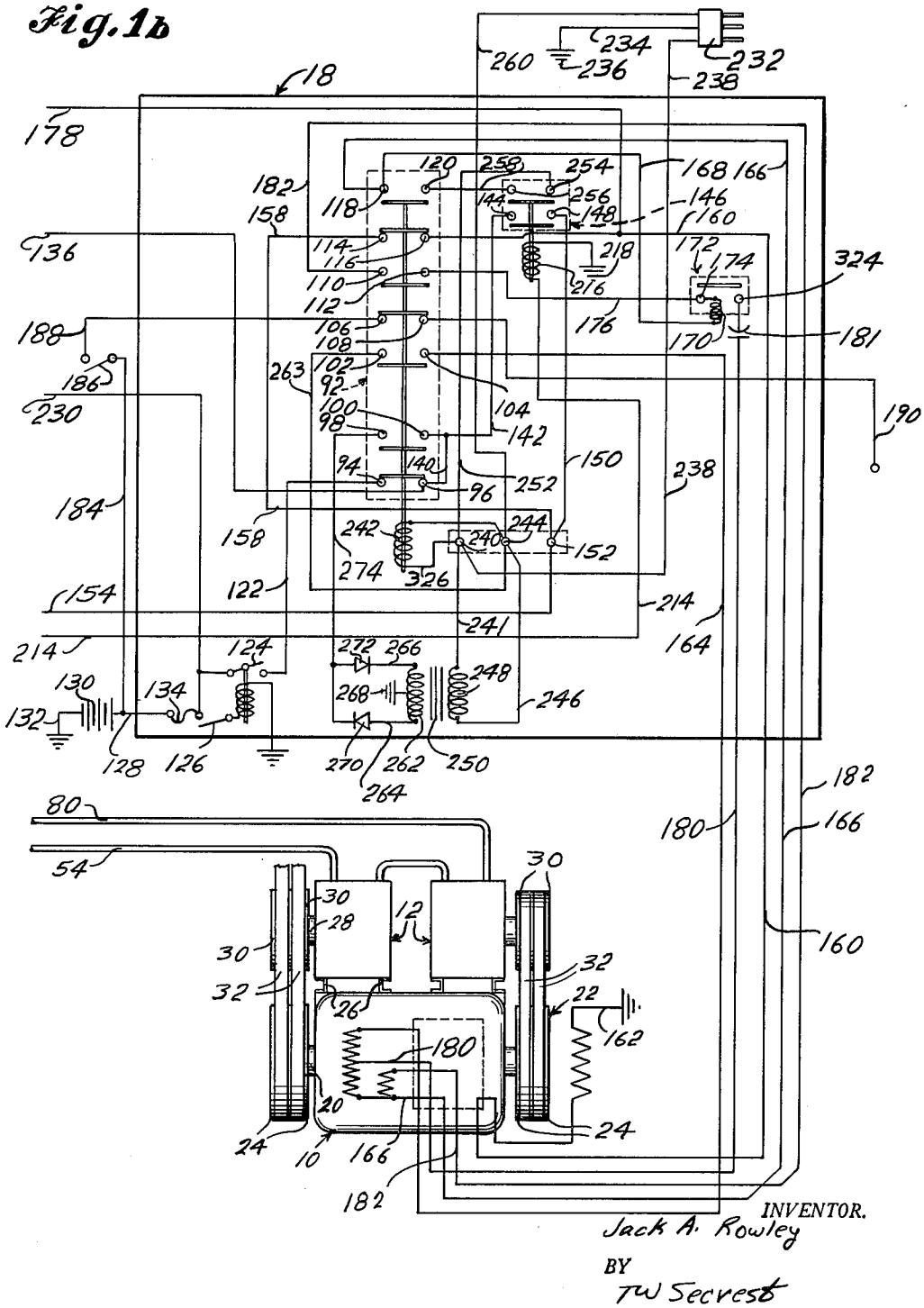
TW Secrest

Nov. 9, 1965 J. A. ROWLEY 3,216,216

FEATHERWEIGHT MOBILREEFER

Filed Oct. 5, 1962 4 Sheets-Sheet 2

Fig. 1b



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FEATHERWEIGHT MOBILREEFER

Filed Oct. 5, 1962 4 Sheets-Sheet 3

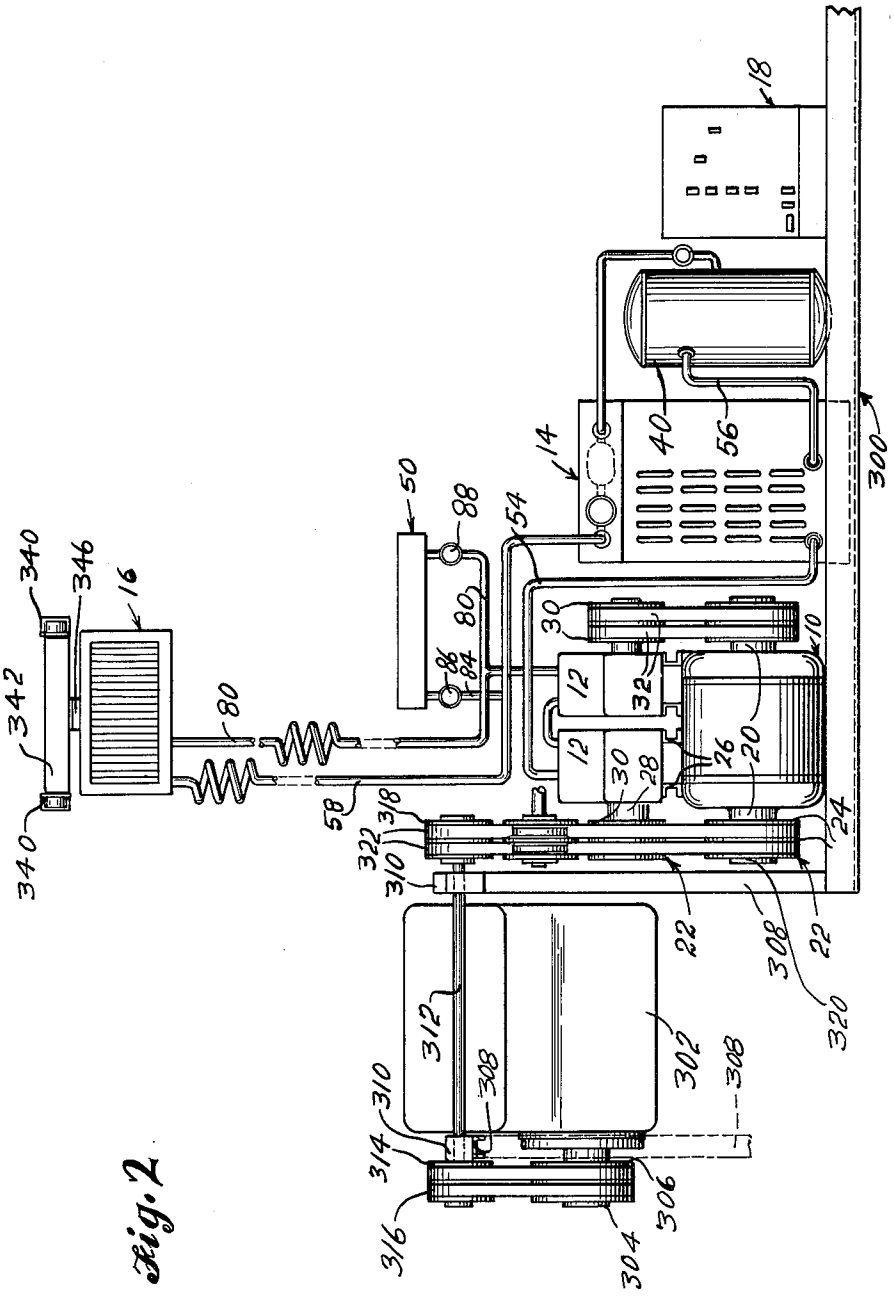


Fig. 2

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Nov. 9, 1965 J. A. ROWLEY 3,216,216

FEATHERWEIGHT MOBILREEFER

Filed Oct. 5, 1962 4 Sheets-Sheet 4

Fig. 3

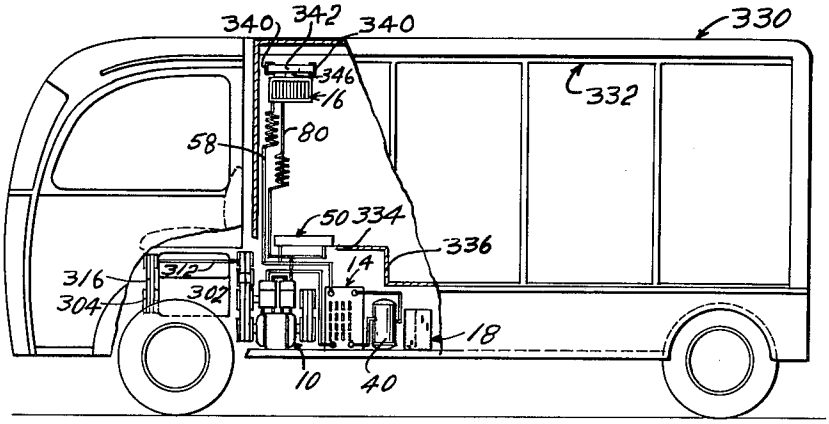
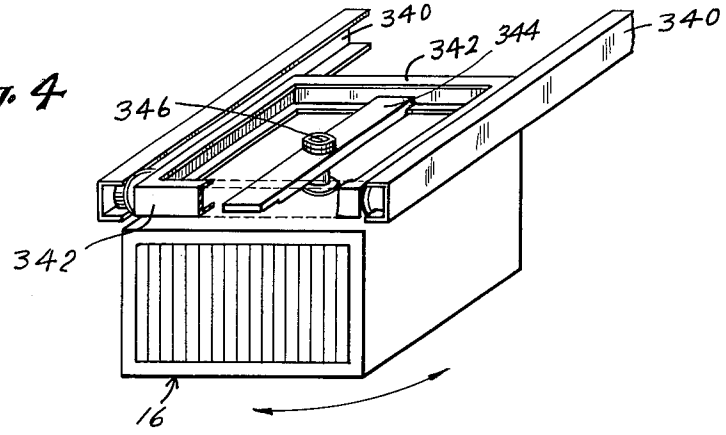


Fig. 4



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United States Patent Office

3,216,216

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3,216,216

FEATHERWEIGHT MOBILREEFER

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Filed Oct. 5, 1962, Ser. No. 228,570

5 Claims. (Cl. 62—204)

This invention is for a light-weight refrigeration unit which can be used in a delivery truck such as an ice-cream delivery truck and a milk delivery truck.

In delivery trucks used for delivering products at a cool temperature or at a low temperature such as 34° F., there has been a problem of maintaining the temperature in this range during the daytime deliveries. More particularly, the temperature of the cold-storage space has been lowered in the previous evening to the range of 34° F. Then, during the daytime operation, the refrigerant has been relied upon to maintain the temperature in this range. During the hot summer months, the refrigerant has not always been capable of maintaining this temperature in the cold-storage space. In addition to this problem of maintaining the temperature, there has been the problem of the weight of the refrigeration apparatus. More particularly, in the previously commonly employed refrigeration units, there has been used the ammonia system with its heavy, bulky plates and apparatus. The weight of the heavy refrigeration apparatus decreases the effective payload of the truck and, in addition, there is required more fuel to transport the apparatus. Also, the bulk of the apparatus decreases the volume of the payload of the truck, as the apparatus uses vital cold-storage space. With this knowledge of previously employed refrigeration apparatus, I have invented a refrigeration apparatus which is readily installed in delivery vans; is light-in-weight; is small-in-bulk or volume; is capable of being operated off the engine of the truck or off an external source of electricity; an apparatus capable of operating one high temperature unit at a relatively high temperature of about 34° F. and a low temperature unit at a relatively low temperature of about 0° F. to —10° F.; and, which apparatus is relatively inexpensive to build, to install and to operate in the van.

These and other important objects and advantages of the invention will be more particularly brought forth upon reference to the drawings, the detailed specification of the invention and the appended claims.

In the drawings:

FIGURES 1*a* and 1*b*, on two sheets, are schematic illustrations of the condenser unit, the evaporator unit, the high temperature cold unit, the low temperature cold unit, the compressor, and the wiring diagram of the refrigeration apparatus;

FIGURE 2 is a schematic illustration of the arrangement of the components of the refrigeration apparatus such as the truck engine, the drive from the engine to the compressor, the condenser unit, the evaporator unit, and the two cold units;

FIGURE 3 is a fragmentary view of a delivery van illustrating the position of the refrigeration apparatus in the van.

FIGURE 4 is view of the evaporator unit mounted on a track and a swivel for allowing the evaporator unit to be positioned at various places inside of the van and, also, to be directed in various directions in the van.

In the discussion of the refrigeration system there is used the terminology "day operation" and "night operation." "Day operation" is used to signify when the truck refrigeration unit is operating from the truck engine and on the road. In other words, the engine of the truck is driving the refrigeration unit. "Night operation" is used to signify when the truck refrigeration unit is operating on the dock power or while the truck unit is parked

and connected to an external electrical power supply. In other words, the refrigeration unit is being operated from an external source of electricity.

In FIGURE 1, a schematic illustration of the invention, it is seen that there is a motor **10**, two compressors **12**, a condenser unit **14**, an evaporator unit **16**, and an electrical system **18**. The motor **10** comprises shaft **20**. On the input end of the shaft there is an electric clutch **22**. On the output end of the shaft there is a pulley **24**. On the motor **10** there are brackets **26**. The compressors **12** are mounted on these brackets. Leading into the compressors are shafts **28**. Mounted on the shafts **28** are pulleys **30**. Belts **12** interconnect the pulleys **24** and **30** so as to drive the compressors **12**.

The condenser **14** comprises a condenser unit **34**, a fan motor **36** for driving a fan **38**, a receiver or reservoir **40**. The condenser **34** is of a tube-and-fin-type construction for dissipating heat. As is illustrated, the fan **38** is positioned with respect to the condenser **34** so as to force relatively cool air past the tubes and fins so as to collect heat from **34**. The motor **36** may be an A.C.–D.C. motor of low voltage for driving the fan. It is seen that the condenser unit **14** comprises the elements **34**, **36**, **38** and **40**.

The evaporator **16**, to allow the refrigerant to expand so as to remove heat from the regrigeration area, comprises an evaporator coil **42** of a tube-and-fin-type construction. Also, there is an electric motor **44** of A.C.–D.C. type of low voltage for driving a fan **46**. Naturally, the fan **46** blows the air across the tube and fin evaporator **42** so as to allow heat to transfer to the refrigerant and thereby expand. The tube and fins **42**, the motor **44** and the fan **46** are of a unit construction. The evaporator **16** is designed to maintain the temperature in the range of approximately 34–38° F.

In addition to the evaporator **16** there is provided a low temperature evaporator unit **50** having coils **52**. The function of the unit **50** is different from the function of the unit **16**. The function of the unit **16** is to cool the atmosphere in the delivery van or in the refrigeration area so as to maintain a relatively high temperature of about 34–38° F. As contrasted with this, the function of the evaporator unit **50** is to maintain a relatively low temperature in the range of 0° F. to —10° F. Instead of air being forced past the coils **52**, the coils **52** may be juxtapositioned with respect to the material to be maintained at a low temperature. In an ice-cream truck this would keep ice cream frozen and maintained at this relatively low temperature of 0° F. to —10° F.

Naturally, there are various pipes and other control units interconnecting the compressor **12**, the condenser **14**, and the two evaporator units **16** and **50**. More particularly, a pipe or tube **54** leads from the compressor **12** and carries the refrigerant and runs to the condenser unit **34** in the condenser **14**. In the condenser unit **34** some of the heat in the refrigerant is absorbed by air passing over the tubes and coils, and the refrigerant condenses to form a liquid. A tube **56** connects the condenser unit **34** with the receiver or reservoir **40**. In the reservoir **40** the liquid refrigerant is collected. A tube **58** leads from the receiver **40** and connects with heat exchanger **60**. In the tube **58** and positioned near the reservoir **40** is a manually controlled king valve **62** for closing and opening the system. Positioned in the tube **58**, between the valve **62** and the heat exchanger **60**, is a dehydrator **64** and a liquid indicator **66**. The tube **58**, upon leaving the heat exchanger **60** is now identified as **68**. The tube **68** connects with the evaporator unit **42**. The outlet of the evaporator unit **42** connects with a tube **70**. The tube **70** branches into a tube **72**. In the tube **72** there is positioned the solenoid valve **74** operated by

the truck voltage. This valve is normally open and is used to by-pass the crank-case-pressure-regulating valve during day operation of the unit so as to utilize the full capacity of the compressor. The crank-case-pressure-regulating valve **76** is in the line **70** and is in parallel with the solenoid valve **74**. This crank-case-pressure-regulating valve **76** is to maintain a set low-side pressure for the compressor so as to limit the capacity of the compressor **12** for the night operation. It is seen that, in the evaporator **16** and in the line **68**, there is an expansion valve **77**. The tube **78** connects the expansion valve **77** with the line **70** between the evaporator unit **42** and the by-pass tube **72**. This valve **77** is an automatic expansion valve and has a twenty-five pound pressure limit. As previously stated, the tube **70** connects with the heat exchanger **60**.

A suction tube **80** leads from the heat exchanger **60** and from the evaporator unit **16**.The tube **80** leads back to the compressor unit **12**. However, between the evaporator unit **16** and the compressor unit **12**, the tube **80** connects with the tube **82**. The tube **82** connects with the coil **52** in the evaporator unit **50**. The coil **52** and the evaporator unit **50** connects with a tube **84** in the inlet side and which tube **84** in turn connects with tube **58** leading to the heat exchanger **60**. In the tube **84** between the connection with the tube **58** and the tube **52**, there is an expansion valve **86**. Also, in the tube **82** between the coil **52** and the tube **80**, there is a check valve **88** which allows the refrigerant to flow from the tube **52** to the tube **80** but does not allow the refrigerant to flow from the tube **80** to the tube **52**.

In the tube **80** there is a valve **90** for controlling the flow of the refrigerant to the compressor **12**. This valve **90** is a solenoid operated valve, and stops the flow from the high temperature evaporator and allows the low temperature evaporator to operate.

In the electrical control **18** there is a main relay unit **92**. This unit comprises contacts or terminals **94** and **96**; **98** and **100**; **102** and **104**; **106** and **108**; **110** and **112**; **114** and **116**; and, **118** and **120**.

The contact **94** connects with the leads **122** which in turn connects with the ignition switch **124**. The ignition switch **124** connects through switch **126** with the lead **128**. The lead **128** connects with the battery **130** and which battery is grounded at **132**. In the lead **128**, there is a fuse **134**. The contact **96** connects by means of the lead **136** with the electric motor **44**. The electric motor **44** is grounded at **138**. The contacts **94** and **96**, daytime operation, are normally closed. The contact **96** is tied with the contact **100** by means of a strap **140**. The contacts **98** and **100**, during day operation, are normally open. The contact **100** connects by means of wire **142** with a terminal **144** in a relay unit **146**. In the unit **146** there is a contact **148**. The relay **146** in daytime operation controls the electric clutch **22** and the refrigeration apparatus and in night time operation controls the electric motor and the refrigeration apparatus. The contact **148**, by means of lead **150**, connects with terminal **152** in terminal board **153**. The terminal **152** by means of the lead **154**, connects with the electric motor **36** in the condenser unit **14**. The motor **36** is grounded at **156**. The terminal **152**, by means of the lead **158** connects with the contact **114**. The contacts **114** and **116** are normally in a closed circuit or are normally closed during daytime operation. The contact **116**, by means of lead **160**, connects with the electric clutch **22**. The electric clutch **22** is grounded at **162**.

The contacts **102** and **104** are normally opened during daytime operation. It is seen that the contact **104**, by means of lead **164**, connects with the winding of the motor **10**. Also, the winding of motor **10** connects by means of lead **166** with the contact **118**. The contacts **118** and **120** are also normally open during the daytime operation. The lead **166** near the contact **118** connects with the lead **168**. The lead **168** connects with the relay

coil **170**. The relay coil **170** is in relay **172**. The relay coil **170** connects with the contact **174**. The contact **174**, by means of lead **176**, connects with the contact **112**. The contacts **110** and **112** are normally open during daytime operation. In day operation the coil **170** is not actuated. It is seen that a lead **178** connects the contact **116** and the solenoid valve **74**. As is recalled, this solenoid valve is normally closed and is used to by-pass the crank-case-pressure-regulating valve during day operation so as to give full capacity for the compressor. Also, it is seen that there is a lead **180** from the electrical motor **10**. This lead **180** connects with the capacitor **181**. The capacitor is for starting the motor **10** for actuating the compressor **12** during the night operation. It is seen that there is a lead **182** leading from the winding of the motor **10**. This lead **182** connects with the contact **110**. The reason for the winding of the motor **10**, during day operation, to be in open or broken state is that, from experience, we have found that it is necessary to have the windings open or the motor will be burned and destroyed.

It is seen that a lead **184** connects with the battery and a switch **186**. Also connecting with the switch **186** is a lead **188** which connects with the contact **106**. The contacts **106** and **108**, during daytime operation, are in a closed state. The contact **108** connects with the lead **190**. The lead **190** is the ignition power supply to the truck engine or connects with the ignition system of the truck engine. As is seen with the contacts **106** and **108** being closed in the daytime it is possible to supply power to the truck engine. However, in nighttime operation, or when the truck engine is not running, the leads **106** and **108** are in an open state. Therefore, when the refrigeration system is being run off an external power supply it is impossible to start the truck engine and therefore impossible to drive off the truck while the refrigeration system is plugged into an external source of electricity.

In the evaporation unit **16** there is a temperature control unit **192** and also a defrost control unit **194**. It is seen that the temperature control unit **192** connects by means of tube **196** to the temperature-sensitive bulb or unit **198**. It is seen that the ice-control unit **194** connects by means of tubing **200** with the evaporator coil in the tube-and-fin unit **42**. The temperature-control unit **192** regulates the temperature in the high temperature refrigerated area. The ice-control unit **194** controls the defrosting of the ice from the tube-and-fin-construction unit **42**. In the low temperature refrigerated area **50** there is a temperature sensing unit **202**. This unit **202** connects by means of tube **204** with a bellows switch **206**. The temperature-control unit **192** by means of lead **208** connects with contact **210** of the bellows switch **206**. The contact **212** by means of a lead **214** connects with the coil **216** of the relay **146**. The coil **216** is grounded at **218**. The control unit **192** connects with the ice-control unit **194** by means of lead **220**. The ice-control unit **194** connects by means of lead **222** with the contact **224**. The contact **224** is one contact in the switch **206**. The contact **210** in the switch **206** by means of lead **226** also connects with the solenoid valve **90** in the tube **80**. The valve **90** is grounded at **228**. It is seen that the lead **222** of the ice-control **194** connects by means of lead **230** with the fuse **134** or the equivalent of that and with the battery **130**. The switch **206**, either in day or night operation, functions to control the temperature in the low temperature cold unit **50**, and allows the high temperature switch **192** to be in the off or on position. In other words when either switch **206** or **192** calls for refrigeration the relay holding coil **216** is activated. With the activation of the holding coil **216** the electric clutch **222** is activated for daytime operation. As is recalled in daytime operation the fan motor **36** is activated and the by-pass valve **74** is activated. More particularly, with the cold unit at too high a temperature the contacts **212** and **224** are closed. Upon the premise that the high temperature unit **16** is at a satisfactory low temperature the

switch 192 is open. The solenoid valve 90 is closed thereby allowing only the low temperature unit 50 to function. The power supply is from the battery 130 through the fuse 134, lead 230, lead 222, contacts 224 and 212, lead 214, holding coil 216 and ground 218. With the energization of the holding coil 216 the contacts 144 and 148 are closed. Contact 148 connects with terminal 152. This terminal connects by means of lead 158 with the relay contacts 114 and 116. Contact 116 by means of the lead 160 connects with the electric clutch 22 so as to energize the same. Terminal 152 by means of lead 154 connects with the fan motor 36, providing daytime refrigeration for low temperature unit 50.

With the temperatures of the cold unit 50 and the evaporator unit 16 both being too high the operation of the cold unit 50 and the fan 36 are the same. However, the switch 192 is closed and also the switch 194 is closed. The solenoid valve is energized from the battery 130 and through the fuse 134, lead 230, switch 194, switch 192, lead 208 and lead 226 to the ground 228. In this manmanner refrigerant is allowed to flow through the coil and fin system 42.

The refrigeration units 16 and 50 are secured in an off position when either switch 194 or switch 192 are open and with switch 206 in such a position that contacts 210 and 212 are closed or bridged. Under these conditions there is no power across the solenoid valve 90 or relay coil 216.

For nighttime operation or that operation when the truck is at the dock and is being supplied by an external source of electricity, there is provided a plug 232. This plug is adapted for 220-volt A.C. electricity. It is seen that there is one lead 234 which is grounded at 236. There is another lead 238 which connects with the terminal 240. The terminal 240 is connected with the relay coil 242 of the main relay assembly 92. As is recalled, the relay coil functions to open and close the contacts 94 and 96; 98 and 100; 102 and 104; 106 and 108; 110 and 112; 114 and 116; and, 118 and 120. The relay 242 connects with terminal 244. The terminal 244 connects with a lead 246 which in turn connects with the primary coil 248 of the transformer 250.

The primary 248 connects with the terminal 240, and by means of lead 252 connects with the contact 254 of relay 146. The contact 254 is teamed with contact 256 in said relay. The contact 256 by means of lead 258 connects with the contact 120. The contacts 254 and 256 start and stop the electric motor 10. The power supply for contact 254 is from the terminal 240. The terminal 244, by means of lead 260, connects with the plug on the other side of the 220-volt A.C. line. Also, the terminal 244, by means of lead 263, connects with the contact 102. Again, in daytime operation, the contacts 102 and 104 are open, and in nighttime operation, contacts 102 and 104 are closed. The transformer 250 comprises a secondary coil 262 which connects with the lead 264 and the lead 266. The coil 262 is grounded at 268. In the lead 264 there is a silicon rectifier 270 and in the lead 266 there is a silicon rectifier 272. The leads 264 and 266 connect with the lead 274 which in turn connects with the contact 98. As is recalled, in daytime operation contacts 98 and 100 are open, and in night operation, these contacts are closed. The transformer 250 transforms the 220 volts A.C. to 6 volts A.C. and also the silicon rectifiers rectify the alternating current into direct current.

In day operation, the refrigeration system is driven off the engine of the truck. In this regard, see FIGURE 2. Reference numeral 300 indicates a truck and chassis system. The engine is designated by 302, and has a crankshaft 304. On the crankshaft there is a pulley 306. Mounted on the chassis of the engine are two spaced-apart supporting brackets 308 and these brackets are positioned adjacent to the engine 302. On the upper part of the brackets are positioned bearings 310. In the bearings is journaled shaft 312. On that end of the shaft near the pulleys 306 are the pulleys 314. Belts 316 interconnect the pulleys 306 and 314 so that the pulleys 306 are in driving relationship with the pulleys 314. On the other end of the shaft 312 or the rear end of the engine 302, there are positioned pulleys 318. As illustrated in FIGURE 2, there are two compressors 12 and 12 mounted on the electric motor 10. The electric motor 10 has a shaft 320. On the shaft 320 is the electric clutch 22 and associated pulley setup. Interconnecting the pulley 24 and the pulley 318 are belts 322. These belts 322 are in driving relationship with one compressor 12. The compressor 12 has a shaft 28 and pulleys 30 mounted on this shaft. As is illustrated in FIGURE 2, the belts 322 drive the pulleys 30 and thereby the shaft 28 of the compresor 12. On theother end of the shaft 320 in the electric motor, there are mounted pulleys 24 and belts 32 for driving a second compressor 12. From this arrangement it is seen that there are two compressors 12, one is driven directly by the belts 322 and the other through the electric motor 10 and by the belts 322. Again, in day operation, the electric motor 10 does not function as an electric motor but, instead, functions as a shaft or an arbor. In such an arrangement the two compressors function during daytime operation while only one compressor functions during nighttime operation.

The operation of the apparatus during daytime functions off the motor of the truck and will now be described. In day operation, the plug 232 is not plugged into an external source of electricity. It is seen that the contacts 94 and 96; 106 and 108; 110, 114 and 116 are closed. It is seen that the electric clutch 22 may or may not be activated. In the situation where it is necessary to drive both of the compressors 12, the electric clutch 22 is activated. In the situation where it is not necessary to drive only one of the compressors 12, the electric clutch 22 is not activated. More particularly, tracing lead 160, it is seen that the same makes a closed circuit through closed contacts 114 and 116, and lead 158 connects with contact 114 and makes contact with terminal 152. Lead 150 interconnects terminal 152 with contact 148. In day operation the contacts 148 and 144 open and close with respect to each other; but, due to the open contacts 118 and 120, the contacts 148 and 144 are in effect dead contacts. Also, the contact 152 through lead 154 connects with motor 36 in the condenser 14. The operation of the motor 44 in the evaporation unit 16 is run off the battery 130 in the ignition system for the motor of the truck. More particularly, it is seen that lead 136 interconnects motor 44 with contact 96. Contacts 96 and 94 are closed. Lead 122 connects contact 94 with control switch 124. The switch 126 connects with the battery 130 through a fuse 134 and lead 128. In day operation, it is seen that the ignition system of the truck engine is connected with lead 190. The lead 190 connects with the battery 130 by means of contacts 108 and 106, which are closed in day operation, the lead 188, the switch 186 and the lead 184 which connects with the lead 128 and the battery 130. Of importance in this matter is the fact that the ignition system for the truck engine must pass through contacts 106 and 108 in the master relay 92. The activation of the electric clutch 22 is determined by the switching means in evaporation unit 16 and in the low-temperature unit 50.

When the temperature in the very-cold-unit 50 is too high the bellows switch 206 closes the contacts 210 and 212. This activates the relay coil 216 so that the contacts 144 and 148 are closed. More particularly, the contact 212 connects by means of lead 214 with the relay coil 216 and the ground 218. Also, the contact 210 by means of the lead 208 connects with the switch 192 of the evaporator unit 16 and by lead 220 with the switch 194, and by lead 230, fuse 134 and lead 128 to the battery 130. With the relay coil 216 activated the contacts 148 and 144 are closed. The contact 144 connects with lead 142 which in turn connects with the contact 100. The contact 100 connects with lead 140 which in turn connects with contact 96. The lead 136 connects with contact 96 and

leads to motor 44 in the evaporator unit 16. As is seen from the above, with the temperature in the cold unit being too high the electric clutch 22 is activated so that both of the compressors 12 compress the refrigerant and drives it through the coils 52. With the temperature of the cold unit being sufficiently low the bellows 206 is contracted and contacts 210 and 212 are bridged. Under these conditions with the temperature in the evaporator unit 16 being too high, the switch 192 is activated by means of the fluid in the coil 198. With the closing of the switch 192 and also the closing of the switch 194 power is supplied from the battery 130, through 128 and 320, switch 194 and 220, switch 192 and 208, and the lead 226 to the solenoid valve 90. Also, 210 and 212 being bridged, power is supplied through lead 214 to coil 216 to close relay 146. By closing relay 146 there is activated the electric fan motor 36 and the electric clutch 22 in daytime operation as previously explained; or, electric motor 36 and electric motor 10 for nighttime operation. This gives refrigeration in evaporator 16. As is recalled the motor 44 runs continuously.

As previously stated, in daytime operation, the motor 10 does not function as a motor, but as an arbor or shaft. In order to do this, without burning out the motor, it is necessary to have the field coils for the windings in an open circuit. As is seen, the windings, in the motor 10 connect by means of leads 164, 180, 166 and 182 with open contacts in the main relay 92. More particularly, lead 164 connects with contact 104 which is open in daytime operation. Lead 182 connects with contact 110. The contacts 110 and 112 are open in daytime operation. The lead 166 connects with contact 118 which is open in daytime operation. From experience, it has been found that it is necessary to have these field windings open in order not to burn the windings in the motor 10.

In night operation the plug 232 is connected to a suitable source of electricity such as 220 volts A.C. One lead 238 connects with terminal 240. A lead 326 connects with the relay coil 242 of the relay 92. The relay coil 242 also connects with the terminal 244. With the energization of the coil 242 the contacts 94 and 96 are opened; contacts 98 and 100 are closed; contacts 102 and 104 are closed; contacts 106 and 108 are opened; contacts 110 and 112 are closed; contacts 114 and 116 are opened; and, contacts 118 and 120 are closed. The contact 244 by means of lead 260 connects with the other side of the source of electricity. The terminal 240 also connects with the primary coil 248 of the transformer 250. The primary coil 248 by means of the lead 246 connects with terminal 244. The terminal 244 by means of lead 263 connects with contact 102. Contacts 102 and 104 are closed. Contact 104 by means of lead 164 connects with the winding of the motor 10. The lead 180 of the motor 10 connects with the capacitor 181. This capacitor connects with contact 324 in relay 172. The contacts 324 and 174 are closed by power supplied to motor 10 through motor induction relay 170. Contact 174 connects by means of lead 176 with contact 112. The contacts 112 and 110 are closed. The contact 110 connects with the lead wire 182 which in turn leads to the windings of the motor 10. Also, the windings in the motor by means of lead 166 connect with the contact 118. The contacts 118 and 120 are closed. The contact 120 connects by means of lead wire 258 with contact 256. Contacts 256 and 254 are closed. As previously explained, the contact 254 connects by means of lead 252 with the terminal 240. The terminal 240, by means of lead 241, connects with the primary 248 of the transformer 250. The lead 166 connects with the contact 118. It is seen that the lead 168 connects with the lead 166 and, also, connects with the relay coil holding 170 and the contact 174. Contact 174, by means of the lead 176, connects with the contact 112.

The electric clutch 22 is de-activated during night operation. More particularly, it is seen that lead 160 connects

with the contact 116. The contacts 116 and 114 are open, and thereby the electric clutch 22 is deactivated.

The secondary coil 262 of the transformer 250 connects with lead 274. It is seen that there are provided silicon rectifiers 272 and 270 for the coil 262. The lead 274 connects with a contact 98. The contacts 98 and 100 are closed. The contact 100 connects with the lead 142 which connects with the contact 144 of the relay 146. Contacts 144 and 148 are closed; the contact 148, by means of lead 150, connects with contact 114. The contacts 114 and 116 are open. As previously explained, the contact 116 by means of lead 160, connects with the control for the electric clutch 22. Also, the contact 152, by means of lead 154, connects with the electric motor 36 in the condenser unit 14.

The contacts 98 and 100, as previously explained, are closed. The contact 100 by means of lead 140 connects with contact 96. The contact 96, by means of lead 136, connects with the electric motor in the evaporation unit 16.

The control for the cold unit 50 is as follows. It is assumed that the temperature in the cold unit 50 is too high. Therefore, the bellows 206 have expanded, and the contacts 210 and 212 are closed. It is seen that the contact 210 is connected by means of lead 226 with the valve 90. Valve 90 opens to allow refrigerant to flow. The contact 210 also connects by means of lead 208 with the temperature control 192 in the evaporation unit 16. The temperature control 192, by means of lead 220, connects with the de-icing control 194. Control 194, by means of lead 230, connects with the fuse 134, the lead 128, and the battery 130 of the truck.

When the temperature of the unit 50 reaches the desired point, the bellows 206 is contracted, and the contacts 224 and 212 are closed. Therefore, no energy reaches the valve 90, and the valve is closed so as to prevent the flow of refrigerant.

The circuitry for the evaporator unit 16 when the temperature is too high has been explained. Also, the circuitry for the evaporator unit when the temperature is at the desired point has been explained. In addition, the circuits for the cold unit 50 have been explained for a desired low temperature and for too high a temperature.

Finally, as previously stated, in night operation, contacts 106 and 108 are open and, therefore, there is no power supply to the ignition system and spark plugs of the truck engine. More particularly, the lead 190 connects with the ignition system in the engine. With the contacts 106 and 108 broken there is no power to the ignition system as the circuit between the system and the truck battery is open. This is a safety precaution to prelude an operator from starting the truck and driving the truck while the same is plugged into an external source of electricity.

In FIGURE 3 there is illustrated the positioning of the refrigeration apparatus in a truck 330. It is seen that this truck 330 has a cold box or cold space 332. In conjunction with FIGURE 2, it is seen that there is a condenser unit 14, a motor 10, an electric clutch 22, a belt drive 322 for driving the compressor 12 from the engine 302. It is to be noted that there is a shaft 312 connecting with the pulley 318. The pulley 318 drives the belts 322. Also, there is a pulley 314 attached to the front of the shaft 312. In addition, there is a pulley 306 attached to the front end of the crankshaft of the engine 302. Belts 316 connect pulleys 304 and 314.

It is to be noted that the front lower part of the compartment 332, at least at one part, is recessed and there is provided a lower wall or floor 334 and a side wall 336. Also, it is to be noted that the evaporator unit 16 is mounted in the upper part of the chamber 332. Actually, the position of the evaporator unit 16 is of secondary importance. However, due to the tendency of cold air to settle toward the bottom of the container, it is more desirable to have the evaporator unit toward the upper part

of the chamber than toward the bottom part of the chamber.

The cold unit can be mounted at a desired position in the compartment **332**. The position will vary with the use to which the truck is to be placed.

In FIGURE 4 there is illustrated an evaporator unit **16** mounted on spaced-apart tracks **340**. These spaced-apart tracks **340** may run laterally across the chamber **332** or longitudinally across chamber **332**. Positioned in the tracks are two lateral members **342**. On the tracks, or between them, is mounted a connecting member **344**. The evaporator unit **16** may be connected to the connecting member **344** by means of a bolt **346**. The evaporator unit **16** may be pulled toward the cross member **344** so as to be rigidly positioned. It is to be realized that the unit **16** may be rotated around the bolt **346** so as to assume various positions in the chamber **332**. The unit **16** is connected to the condenser unit by means of flexible tubing.

From the above and also from experience, it is seen that there may be a number of different applications for this refrigeration system. More particularly, the system may be used in only daytime operation; and, therefore, there is no need for an electric motor, which would be used in nighttime operation only, as the compressor unit can be driven by the power take-off unit of the truck engine. There is no need to keep the box loaded at night as the box would be unloaded of its cold or frozen product. An example of this type of usage is in the fish and meat delivery trucks which are normally delivered only in the daytime.

In another operation, there may be used only the high temperature cold unit for maintaining a temperature of about 34° F. For instance, the apparatus may be used for both day and night operation. An example of such an operation is the delivering of milk, or other products which are kept near 34° F., both day and night. In this instance, it is not necessary to unload the truck at night and then reload the truck in the daytime.

In a third illustration there may be a straight low-temperature usage, both day and night. The low temperature usage, as is recalled, is in the range of 0° F. to −10° F. The low temperature usage is for frozen products, such as ice cream and other frozen goods. Again, it is not necessary to unload the frozen product at night and reload the product in the day time.

A fourth operation as that is illustrated in the above discussion where there is both a high temperature unit for maintaining a temperature of about 34° F. and a low-temperature unit for maintaining a temperature from 0° F. to −10° F., both day and night operation. In this instance, the product delivered may be a product such as milk maintained at about 34° F. and a frozen product such as ice cream which is maintained at a temperature from 0° F. to −10° F.

Although the circuitry has been defined as off the battery of the automotive vehicle or off the 220 volt A.C. single-phase source, it is to be realized that a three-phase A.C. source of electricity can be used. The refrigerant used in the above-described refrigeration apparatus may be one of many such as sulfur dioxide, CCl_2F_2 and $CHClF_2$. It is to be understood that other refrigerants may be used. The power plant for driving the refrigeration unit in the daytime may be a reciprocating engine such as a gasoline engine or a diesel engine, or a gas-turbine engine which is being used to an ever-increasing degree. Such engines are referred to as mechanical engines.

Having presented my invention, what I claim is:

1. A cooling apparatus for operation on a mobile carrier and for operation off of both a mechanical engine and an electric motor, said apparatus comprising:

(a) a compressor;
(b) a condenser for a refrigerant;
(c) a refrigerant;

(d) means connecting the compressor and the condenser for the flow of refrigerant;
(e) a mechanical engine having a drive means;
(f) an electric motor having an output shaft;
(g) means connecting the mechanical engine and the electric motor;
(h) means connecting the electric motor and the compressor;
(i) a first evaporator for allowing the refrigerant to expand to realize a first cool temperature;
(j) means connecting the condenser and the first evaporator for the flow of refrigerant;
(k) a second evaporator for allowing the refrigerant to expand to realize a second cool temperature;
(l) means connecting the condenser and the second evaporator for the flow of refrigerant;
(m) means connecting the first evaporator with the compressor for the flow of refrigerant;
(n) means connecting the second evaporator with the compressor for the flow of refrigerant;
(o) means releasably connecting the mechanical engine and the electric motor;
(p) said second evaporator being at a lower temperature than the first evaporator;
(q) a first valve in the means connecting the first evaporator with the compressor;
(r) a first temperature sensitive means in the first evaporator for controlling the first valve for regulating the flow of refrigerant;
(s) means connecting the first valve and the first temperature sensitive means;
(t) a second valve in the means connecting the second evaporator with the compressor for the flow of refrigerant; and,
(u) said second valve preventing the flow of refrigerant from the compressor to the second evaporator.

2. A cooling apparatus for operation on a mobile carrier and for operation off of both a mechanical engine and an electric motor, said apparatus comprising:

(a) a compressor;
(b) a condenser for a refrigerant;
(c) means connecting the compressor and the condenser;
(d) a mechanical engine having a drive means;
(e) an electric motor having an output shaft;
(f) means connecting the mechanical engine and the electric motor;
(g) means connecting the electric motor and the compressor;
(h) a refrigerant;
(i) a first evaporator for allowing the refrigerant to expand to realize a first cool temperature;
(j) means connecting the condenser and the first evaporator;
(k) a second evaporator for allowing the refrigerant to expand to realize a second cool temperature;
(l) means connecting the condenser and the second evaporator;
(m) means connecting the first evaporator with the compressor;
(n) means connecting the second evaporator with the compressor;
(o) means releasably connecting the mechanical engine and the electric motor;
(p) said mechanical engine having an electrical system;
(q) with said mechanical engine running the compressor said electrical system being closed;
(r) with said electric motor running the compressor said electrical system being open;
(s) said second evaporator being at a lower temperature than the first evaporator;
(t) a first electrically controlled valve in the means connecting the first evaporator with the compressor;
(u) a first temperature sensitive means in the first

evaporator for controlling the first valve for regulating the flow of refrigerant;
(v) wiring means connecting the first valve and the first temperature sensitive means;
(w) a second temperature sensitive means in the second evaporator;
(x) a first electrical switching means;
(y) said first electrical switching means connecting with means for starting and stopping the electric motor;
(z) said first electrical switching means connecting with means releasably connecting the mechanical engine and the electric motor;
(aa) said second temperature sensitive means connecting with and controlling the first electrical switching means; and,
(bb) said first temperature sensitive means connecting with and controlling the first electrical switching means.

3. A cooling apparatus for operation on a mobile carrier and for operation off of both a mechanical engine and an electric motor, said apparatus comprising:
(a) a compressor;
(b) a condenser for a refrigerant;
(c) a refrigerant;
(d) means connecting the compressor and the condenser for the flow of refrigerant;
(e) a mechanical engine having a drive means;
(f) an electric motor having an output shaft;
(g) means connecting the mechanical engine and the electric motor;
(h) means connecting the electric motor and the compressor;
(i) a first evaporator for allowing the refrigerant to expand to realize a first cool temperature;
(j) means connecting the condenser and the first evaporator for the flow of refrigerant;
(k) a second evaporator for allowing the refrigerant to expand to realize a second cool temperature;
(l) means connecting the condenser and the second evaporator for the flow of refrigerant;
(m) means connecting the first evaporator with the compressor for the flow of refrigerant;
(n) means connecting the second evaporator with the compressor for the flow of refrigerant;
(o) means releasably connecting the mechanical engine and the electric motor;
(p) said second evaporator being at a lower temperature than the first evaporator;
(q) a first valve in the means connecting the first evaporator with the compressor;
(r) a first temperature sensitive means in the first evaporator for controlling the first valve for regulating the flow of refrigerant;
(s) means connecting the first valve and the first temperature sensitive means;
(t) a second valve in the means connecting the second evaporator with the compressor for the flow of refrigerant;
(u) said second valve preventing the flow of refrigerant from the compressor to the second evaporator;
(v) said mechanical engine having an electrical system;
(w) with said mechanical engine running the compressor said electrical system being closed;
(x) with said electric motor running the compressor said electrical system being open;
(y) said first valve being an electrically controlled valve;
(z) a first electrical switching means;
(aa) said first electrical switching means connecting with means for starting and stopping the electric motor;
(bb) said means releasably connecting the mechanical engine and the electric motor being an electric clutch;
(cc) said first electrical switching means connecting with the electric clutch;
(dd) a second temperature sensitive means in the second evaporator;
(ee) said second temperature sensitive means connecting with and controlling the first electrical switching means; and,
(ff) said first temperature sensitive means connecting with and controlling the first electrical switching means.

4. A cooling apparatus for operation on a mobile carrier and for operation off of both a mechanical engine and an electric motor, said apparatus comprising:
(a) a compressor;
(b) a condenser for a refrigerant;
(c) a refrigerant;
(d) means connecting the compressor and the condenser for the flow of refrigerant;
(e) a mechanical engine having a drive means;
(f) an electric motor having an output shaft;
(g) means connecting the mechanical engine and the electric motor;
(h) means connecting the electric motor and the compressor;
(i) an evaporator for allowing the refrigerant to expand to realize a cool temperature;
(j) means connecting the condenser and the evaporator for the flow of refrigerant;
(k) means connecting the evaporator with the compressor for the flow of refrigerant;
(l) means releasably connecting the mechanical engine and the electric motor;
(m) a first valve in the means connecting the evaporator with the compressor;
(n) a first temperature sensitive means in the evaporator for controlling the valve for regulating the flow of refrigerant;
(o) means connecting the first valve and the first temperature sensitive means;
(p) said mechanical engine having an electrical system;
(q) with said mechanical engine running the compressor said electrical system being closed;
(r) with said electric motor running the compressor said electrical system being open;
(s) said valve being an electrically controlled valve;
(t) a first electrical switching means;
(u) said first electrical switching means connecting with means for starting and stopping the electric motor; and
(v) said first temperature sensitive means connecting with and controlling the first electrical switching means.

5. A cooling apparatus for operation on a mobile carrier and for operation off of both a mechanical engine and an electric motor, said apparatus comprising:
(a) a compressor;
(b) a condenser for a refrigerant;
(c) a refrigerant;
(d) means connecting the compressor and the condenser for the flow of refrigerant;
(e) a mechanical engine having a drive means;
(f) an electric motor having an output shaft;
(g) means connecting the mechanical engine and the electric motor;
(h) means connecting the electric motor and the compressor;
(i) an evaporator for allowing the refrigerant to expand to realize a cool temperature;
(j) means connecting the condenser and the evaporator for the flow of refrigerant;
(k) means connecting the evaporator with the compressor for the flow of refrigerant;
(l) means releasably connecting the mechanical engine and the electric motor;

(m) a valve in the means connecting the evaporator with the compressor for the flow of refrigerant;
(n) said valve preventing the flow of refrigerant from the compressor to the evaporator;
(o) a first electrical switching means;
(p) said mechanical engine having an electrical system;
(q) with said mechanical engine running the compressor said electrical system being closed;
(r) with said electric motor running the compressor said electrical system being open;
(s) said first electrical switching means connecting with means for starting and stopping the electric motor;
(t) a first temperature sensitive means in the evaporator; and,
(u) said first temperature sensitive means connecting

with and controlling the first electrical switching means.

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