

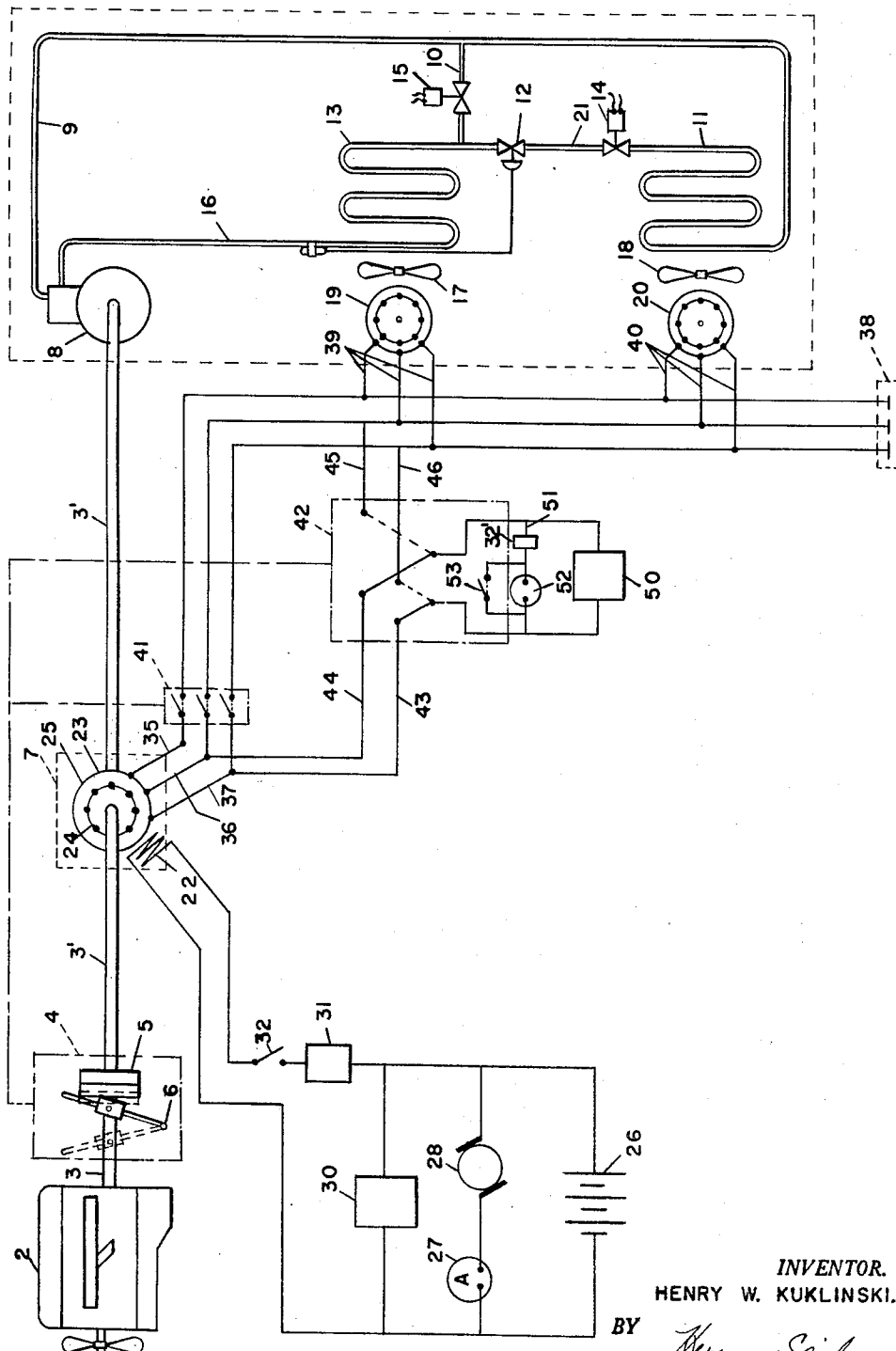
Oct. 6, 1959

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2,907,182

TRANSPORTATION REFRIGERATION SYSTEM

Filed Oct. 15, 1956



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2,907,182

TRANSPORTATION REFRIGERATION SYSTEM

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Application October 15, 1956, Serial No. 616,078

1 Claim. (Cl. 62—158)

This invention relates to refrigeration systems and more particularly to refrigeration systems for use in transportation units such as railway cars and trucks for cooling the storage compartments thereof.

Refrigerated railway cars are becoming more and more important in our present mode of living considering the increased number of items which find their way to the consumer in the frozen or chilled state. Not only is the railway car used as a conveyance but increasingly it is also serving as a convenient storage place. In small communities it is found that keeping a railway car in the siding and using it as a warehouse obviates the need of a special building and also avoids necessary and costly handling between the railway yard, warehouse and the consumer. Also in many cases the railway cars are rolled into particular plants for a number of days and are used as cold storage rooms before the frozen goods are removed to be processed.

These railway cars may have specialized refrigeration systems of the type as illustrated in Patent No. 2,762,206 to Carlyle M. Ashley. The prime mover in these applications may be a gasoline engine or frequently a diesel engine directly connected to a suitable generator. The generator in turn is connected to a hermetic motor driven compressor. The purpose of this arrangement is to enable the compressor to be isolated from the remainder of the system so that it may be driven by another source of electrical power. This is an extremely necessary provision in view of the noise and exhaust characteristics of internal combustion engines. With respect to the noise problem, considering the presence of a large number of railway cars in a plant, it is easily appreciated that the din made by these machines would seriously hamper the efficiency of people working within the plant. Small communities likewise take a dim view of having the noise of a large number of diesel engines continuously disturbing the tranquility of their community. With respect to the exhaust problem created by the diesel engine, the operation of these machines in a plant is almost impossible. Not only does the odor of the diesel fumes form a health hazard to personnel operating therein, but it is possible that these sulphurous fumes might injure goods being processed therein. Communities likewise have ordinances forbidding the continuous exhaust of dangerous fumes.

Immediately recognizing the importance of the equipment used, it also becomes obvious that the machinery required is complex with its diesel engine, generator, motor and compressor setup tied in with a specialized and extensive refrigeration system as noted in our reference to the Ashley patent.

The chief object of the present invention is to provide a transportation refrigeration system requiring less components.

Another object of this invention is to provide a transportation refrigeration system which is more compact thereby requiring less space within the refrigerated space, thereby making more room for storage purposes.

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Another object of this invention is to provide a transportation refrigeration system having an electrical circuit in which an alternating current machine provides the dual function of an alternator and motor.

A still further object of the present invention is to provide a transportation refrigeration system having a component arrangement in which a compressor, diesel engine and an alternating current synchronous machine are arranged in tandem. Other objects of my invention will be perceived from the following description.

This invention relates to a transportation refrigeration system including a compressor, a condenser, expansion means, and an evaporator in a closed circuit, the compressor having its shaft coaxially connected to an alternating current synchronous machine, said synchronous machine being further connected in tandem to a diesel engine. The synchronous machine is provided with a stationary armature winding, a rotating field winding and having located adjacent the field winding suitable induction operation windings for alternating current motor operation. Operatively associated with the rotating field is a low voltage circuit including energy supply means and suitable control and safety devices for the system. The armature of the machine is provided with a suitable circuit operatively connected to the evaporator and condenser fans and also to a control circuit for actuating the various valves in the refrigeration system and for the motor control system wherein the synchronous machine operates as a motor. By manipulation of a clutch lever the diesel engine is disconnected from the alternating current machine thereby starting the alternating current machine as a motor by providing current from an outside source to the armature winding and, after a time delay during which time the motor operates inductively, the field winding is energized putting the machine on a synchronous motor operation. During operation as an alternator the armature is connected to the fan motors and also to the control circuit to supply current thereto while the low voltage circuit excites the rotating field.

The attached drawing illustrates a preferred embodiment of the present invention, in which the figure is a diagrammatic view of a railway refrigeration system provided with the necessary diesel engine, alternating current machine and suitable control circuits.

Referring to the drawings a diesel engine 2 having an output shaft 3 extending therefrom extends into a clutch assembly 4. This clutch assembly 4 consists of clutch elements 5 which are disengaged by a lever 6. Extending from this clutch assembly 4 is a shaft 3' which extends through an alternating current synchronous motor-alternator 7. The shaft further extends through the machine 7 to a compressor 8. Normally it is preferable that the diesel engine, alternating current synchronous motor-alternator and the compressor are in tandem to form a compact arrangement.

A refrigeration system includes a compressor 8 connected to a condenser 11 by line 9. A fan 18 driven by motor 20 is adapted to pass air through the condenser 11 in heat exchange relation with refrigerant passing there-through. Condenser 11 is connected to evaporator 13 by line 21. An expansion valve 12 is placed in line 21 to meter the flow of refrigerant to the evaporator. A fan 17 driven by motor 19 passes a medium to be cooled through evaporator 13 in heat exchange relation with refrigerant passing therethrough. The evaporator is connected to the compressor 8 by suction line 16. Preferably a hot gas line 10 connects discharge line 9 with the inlet to evaporator 13. Solenoid valve 15 is placed in line 10. A second solenoid valve 14 is placed in line 21. When it is desired to defrost evaporator 13, valve 14 is closed and valve 15 is opened to permit hot gaseous refrigerant to pass through the evaporator.

Referring to the alternating current synchronous machine 7, it is not necessary that this be a synchronous machine. Any suitable alternating current machine which has both motor and alternator characteristics may be utilized. However, it has been found that a synchronous machine has the most attractive size and operating characteristics for this particular purpose. It will be recalled that in alternating current machines of this type either the field or the armature may be rotated. In this particular embodiment a machine is used having a rotor 23 upon which is mounted the field winding 22. Also mounted upon this rotor 23 is a suitable set of induction windings 24. The machine also comprises stationary armature windings 25. The function of the aforementioned induction windings will be explained hereinafter.

The field windings 22 are connected to a suitable source of low voltage current such as a battery 26. Located in parallel with this battery 26 is a circuit comprising an ammeter 27 in series with a low voltage direct current generator 28. This generator 28 is attached by suitable means (not shown) to the shaft 3' for the purpose of recharging the battery 26 during operation.

Also located in parallel with this source of low voltage current are suitable controls 30. These controls receive and distribute low voltage current to carry out such functions as starting the diesel engine and controlling various safety devices on the engine such as the oil pressure pump. There is also located in series with the field winding 22 a safety control 31 for deenergizing the field winding in the event that one of the aforementioned safety devices indicate a hazardous operation. This safety control device is in series with a pair of contacts 32 which are normally controlled by a relay winding coil 32' located in another circuit to be described hereinafter.

The leads 35, 36 and 37 extend from the synchronous machine and terminate in the plug 38. It has been found that in operating synchronous machines of this type that three phase current is preferable. Two power takeoffs 39 and 40 extend from the leads 35, 36 and 37 to the evaporator fan motor 19 and the condenser fan motor 20. In the present embodiment these motors are indicated as three phase induction type motors. Again it will be recognized that other types of motors may be used and still be within the scope of the present invention.

Located in the lines 35, 36 and 37 adjacent the synchronous machine 7 is a suitable starting device 41 which is utilized to start the synchronous machine in motor operation in a well-known manner. However, this starting device 41 is operatively connected to the clutch control lever 6 and also to a gang switch 42 and shorting switch 53, the operation of which will be described hereinafter.

It is well-known that alternating current motors of the synchronous type require low voltage field excitation and high voltage armature field excitation. For this purpose a plug 38 is provided capable of being attached to another source of three phase high voltage current to energize the armature of the machine 7. Normally solenoid valves 14 and 15 and other control mechanisms in the refrigeration circuit are desired to be controlled by high voltage current. For this purpose, by means of the gang switch 42, two possible sources of current are available. A first source is through the leads 43 and 44 which are connected to two lead lines 36 and 37 extending from the alternating current machine 7. The purpose of this is to take single phase current from these lines when the machine 7 is acting as an alternator. When the machine is operating as a motor it is desirable to get single phase current from the three phase source 38, however, prior to the passage of the leads into the starting device 41. During motor operation the compressor will cycle rather than unload. This means the motor will operate intermittently and in order to supply a continuous source of energy to the controls 50 power should be drawn before the motor starting device 41. This is done by means of

lines 45 and 46 operating through the gang switch 42. This high voltage current taken through switch 42 is used in such functions as controlling the hot gas line and liquid line solenoid valves mentioned previously; also to power such devices as drain pan heaters, air switches and temperature responsive controls for the refrigeration system and also safety devices on the refrigerant compressor such as an oil pressure safety cut-out.

Another line 51 derives current from the gang switch 42. Located in this line is a relay winding 32' which is operatively connected to the contacts 32 in the previously mentioned low voltage circuit. In series with this relay winding is a time delay device, the function of which will be described hereinafter. A shorting switch 53 is provided to shunt out the effect of this time delay switch. This switch 53 is operatively connected to the gang switch 42 and also the clutch activating lever 6.

Referring to the drawing, the clutch assembly 4 and the gang switches 41 and 42 are connected and enveloped by dash-dot lines to indicate the operative association of these elements with one another. During diesel engine operation the clutch lever 6 and the switches which comprise the gang switches 41 and 42 are in the positions indicated with solid lines. During standby operation wherein current is supplied through the block 38, these same elements are in the positions shown in dotted lines.

In operation when the railway car is in transit the compressor of the refrigeration system is driven by the diesel engine 2. Power passes from the diesel engine through the shaft 3, and is transmitted through the clutch mechanism 4 through the shaft 3' to rotate the field of the synchronous machine 7 and also to actuate the compressor 8. The compressor 8 behaves in a well-known manner responding to various controls which may be provided thereon such as unloading devices and the various controls of the circuit respond to the demands of the controls in the refrigerated space. The diesel engine receives its electrical power requirements 30 from the battery 26. The field winding of the synchronous machine is energized by the battery. The switch 32 is closed because the shorting switch 53 in the high voltage system has energized the winding 32', therefore energization of the field is subject only to the safety control 31 which maintains safe operation of this portion of the synchronous machine. The plug 38 is not attached to any receptacle since the synchronous machine is now operating as an alternator. Therefore, a current having a high voltage is generated in the alternator and passed therefrom through the leads 35, 36 and 37. With the clutch engaged the starting device 41 closes the circuit to the induction motors 19 and 20 which drive the evaporator and condenser fans. Also in this position of the clutch lever the gang switch 42 derives its energy from the leads 43 and 44 thereby passing single phase electrical energy to the various control devices of the refrigeration system.

Upon coming into a plant or a railroad siding wherein diesel operation is no longer desirable, the diesel engine may be stopped and the clutch 4 disengaged thereby terminating any mechanical connection between the diesel engine and the synchronous machine and compressor. The plug 38 is thereupon attached to a receptacle connected to an external power source. Current is thereby supplied to the motors 19 and 20 through the leads 39 and 40. By disengaging the clutch lever 6 the gang switch 42 is moved so that current is supplied through leads 45 and 46 to the various control devices 50 of the refrigeration circuit. As the gang switch is passed to the lines 45 and 46 the shorting switch 53 is opened, thereby making the relay winding 32' subject to the time delay device 52. It will be recalled that this relay winding 32' is associated with the switch elements 32. The purpose of this association is as follows: Current passes through the plug 38 and drives the aforementioned fan motors. Current is also passed to the stationary armature of the synchronous machine 7 through the starting device 41. Because of

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the time delay mechanism in the single phase high voltage circuit the contacts 32 in the low voltage circuit will be open and the field of the machine 7 will not be energized. Initially, therefore, only high voltage current from the outside source will energize the armature which, in turn, will act upon the aforementioned induction winding 24. The synchronous machine will, therefore, start up as an induction motor. When the induction motor reaches substantially synchronous speed the time delay device 52 will energize the relay winding 32' closing the switch 32 in the low voltage circuit, thereby energizing the field winding 22 causing the rotor of the machine 7 to lock into synchronous relationship thereby changing the operation of the motor from induction operation to synchronous operation.

While the invention has been described in connection with railway and trailer installations it will be appreciated it is adapted for use with stationary installations. Considering the cumbersome relation of elements previously utilized to perform the same functions, by combining the motor and alternator in this manner in a tandem relationship with the compressor and the diesel engine, a more compact and economical unit is provided.

While I have described a preferred embodiment of the invention, it will be understood the invention is not limited thereto since it may be otherwise embodied within the scope of the following claim.

I claim:

In a railway refrigerator car having a storage space, a refrigeration system comprising a compressor, a condenser, expansion means and an evaporator placed in a closed circuit, said evaporator being in heat exchange relation with said storage space, a condenser fan having a motor associated with said condenser to pass air in heat exchange relation with refrigerant in said condenser, an evaporator fan having a motor to pass air in heat ex-

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change relation with refrigerant in said evaporator, an internal combustion engine, an alternating current synchronous machine having an exciter field and an armature, clutch means for connecting said internal combustion engine to said synchronous machine, means for connecting said synchronous machine to said compressor whereby under one set of refrigerating conditions said engine drives said compressor to provide refrigeration, low voltage supply means connected to said field whereby the rotation of the armature of the machine by the internal combustion engine generates a current in the armature, means for directing alternating current so generated to said condenser and evaporator fan motors while said engine drives said compressor, means connected to said clutch means which upon disengagement of said clutch permits operation of the synchronous machine as a motor whereby under a second set of refrigerating conditions said machine drives said compressor to provide refrigeration, means for directing alternating current to the armature of said machine whereby the machine starts as an induction motor, means for energizing the exciter field when the machine substantially reaches synchronous speed, and means for providing alternating current to drive the evaporator fan motor thus passing air to be cooled through the evaporator and to drive the condenser fan motor thus passing air in heat exchange relation with refrigerant in the condenser.

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