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[33] **Japan**

[31] **43/62233, 44/8039 and 44/4134**

[50] Field of Search..... 307/10, 11,
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[54] **REFRIGERATOR UNIT USED FOR A FREIGHT CONTAINER**
13 Claims, 11 Drawing Figs.

[52] U.S. Cl..... **307/9,**
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[51] Int. Cl..... **H02g 3/00**

ABSTRACT: A refrigerator unit used for a freight container which may be operated at various places where the line voltages of available power are different, for example, 200 v. class and 400 v. class, said unit comprising electric loads rated for the dual voltages, switches for selecting appropriate power input terminals or relays for detecting the voltage of the connected power line, switches for changing connections of the electric loads so as to match the rated voltage of said loads with the power voltage, the above switches and relays being all interconnected to ensure safe operation.

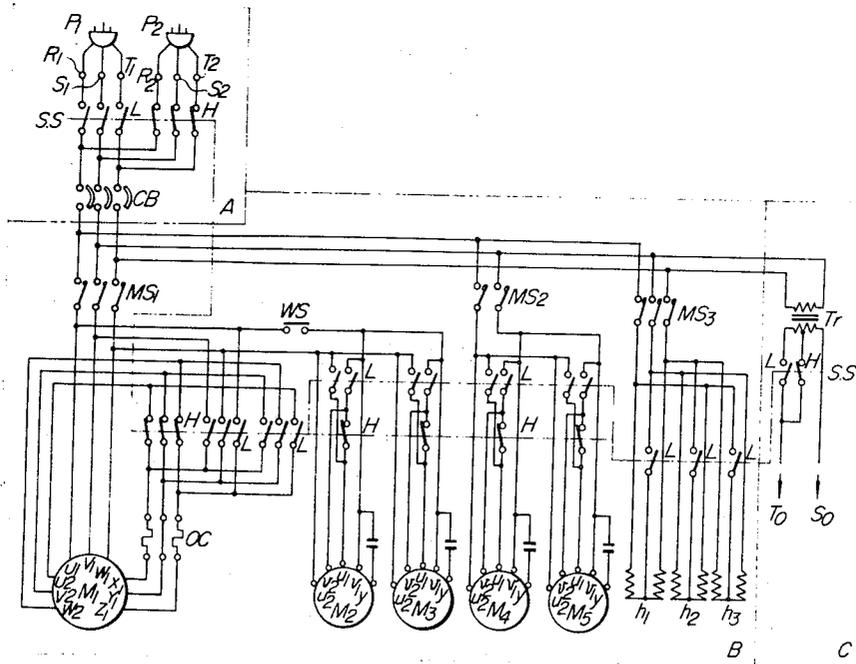
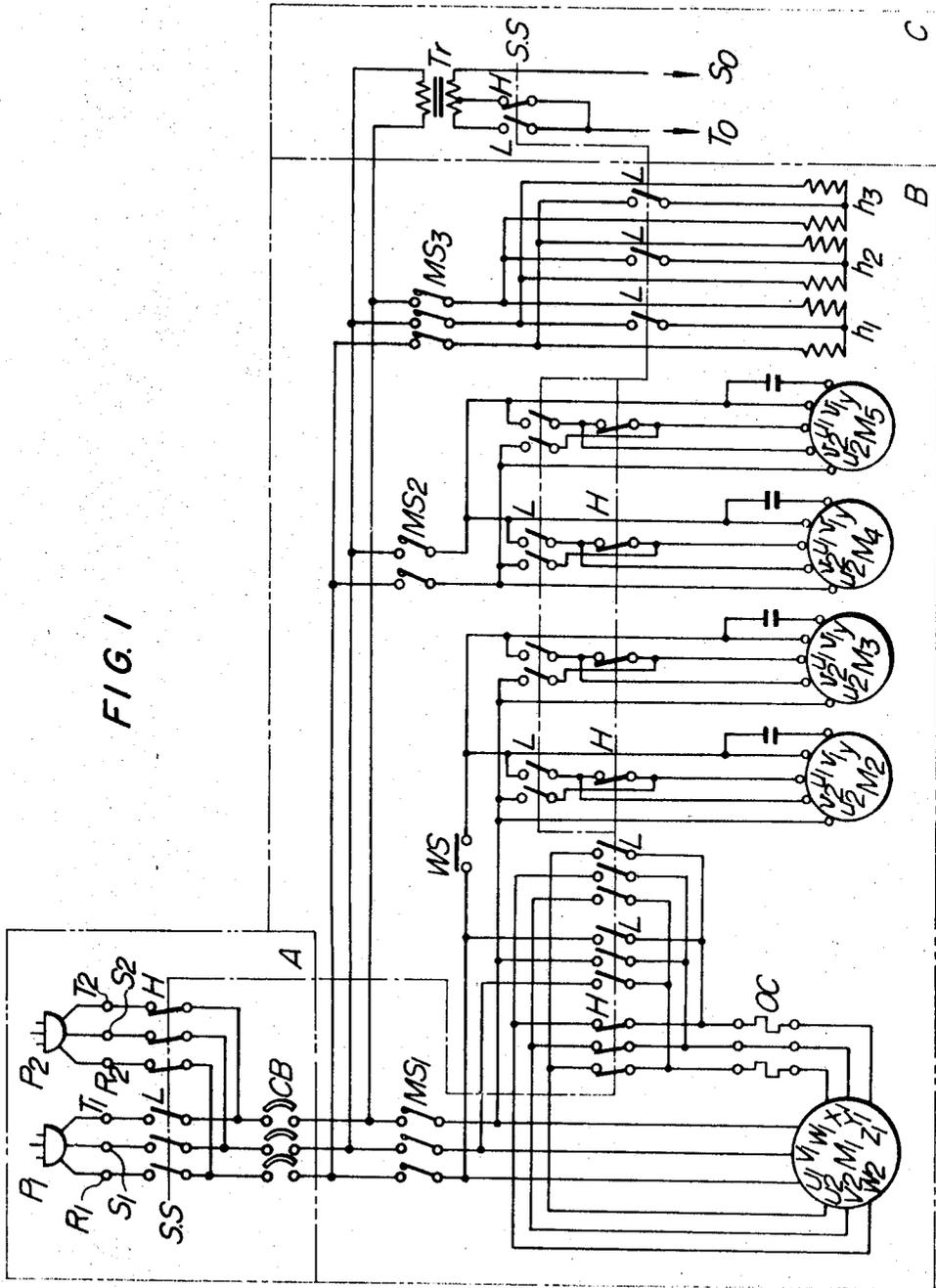


FIG. 1



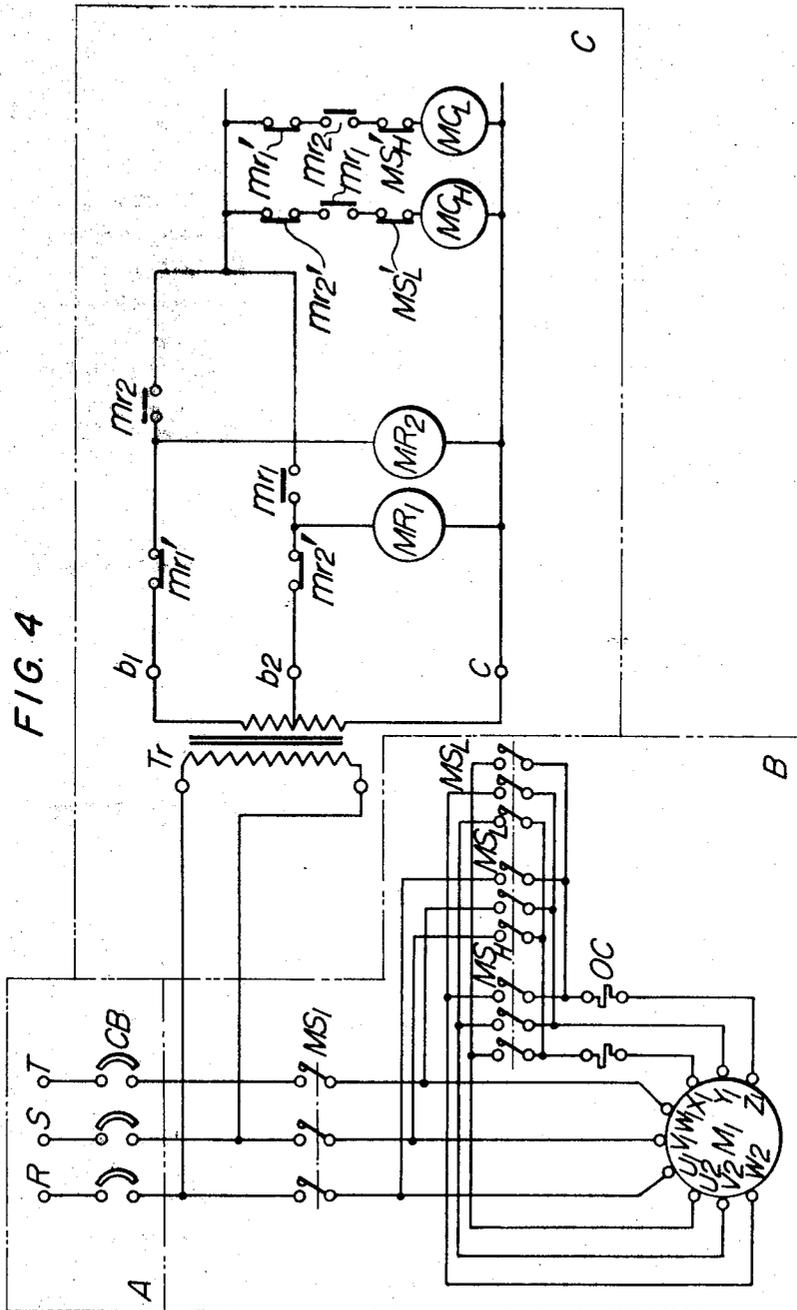
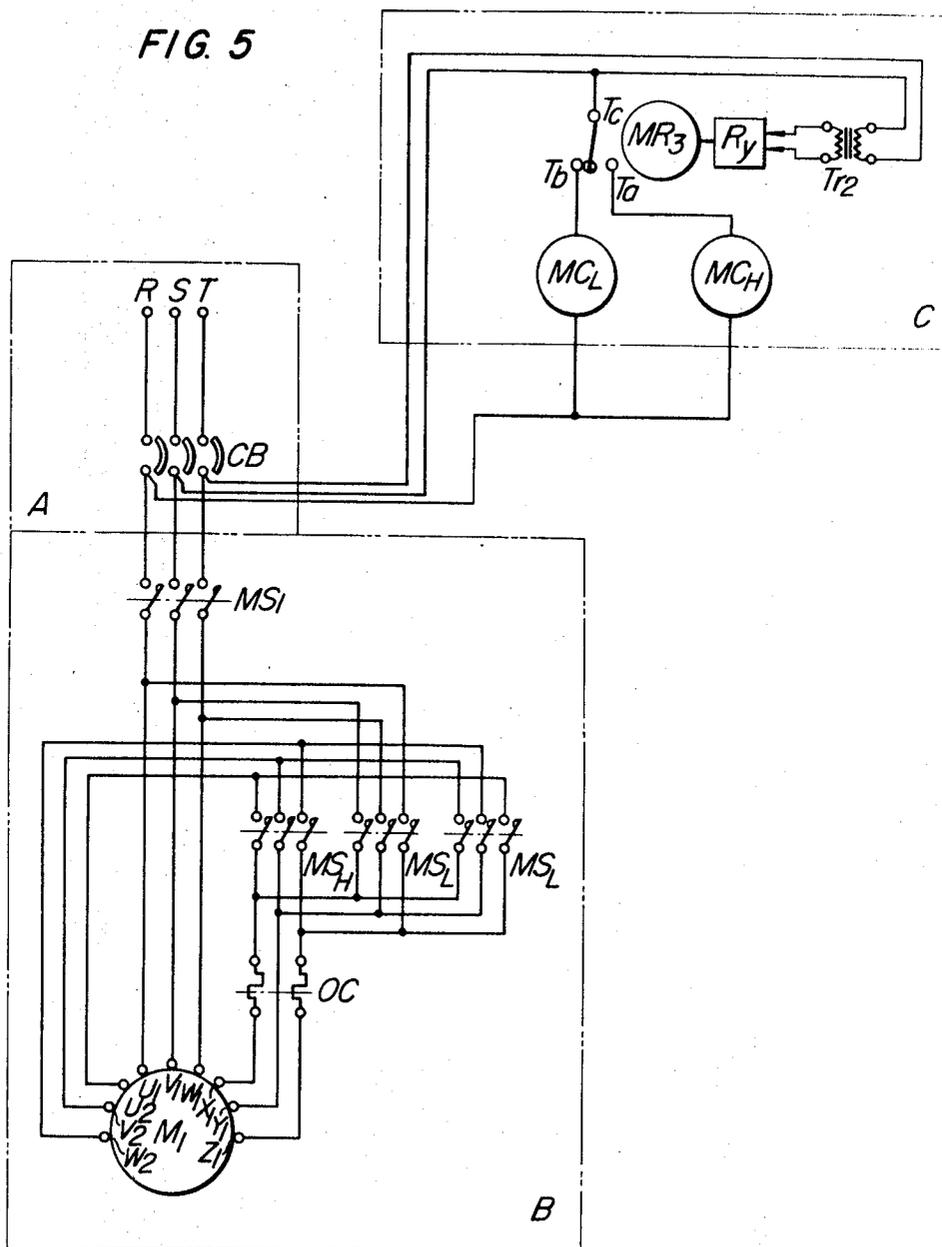
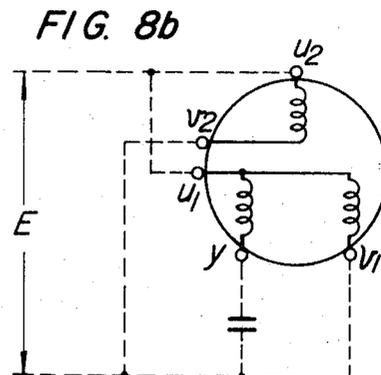
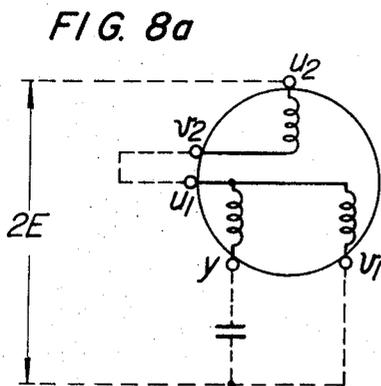
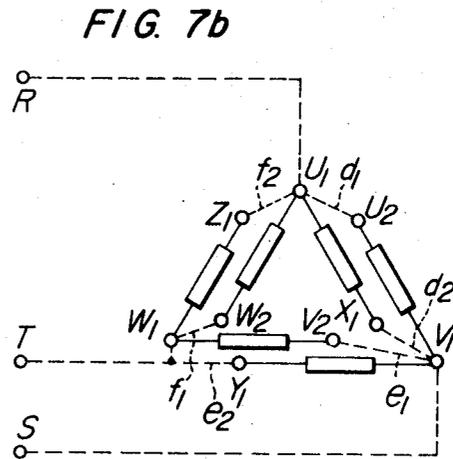
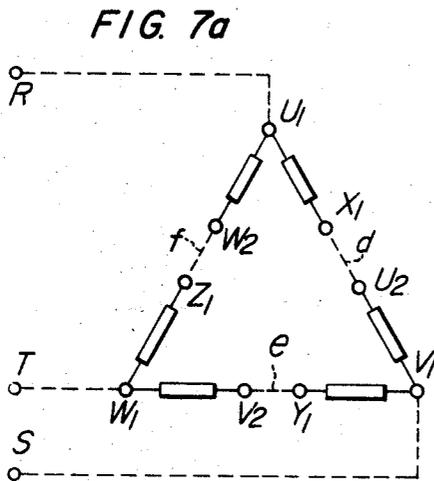
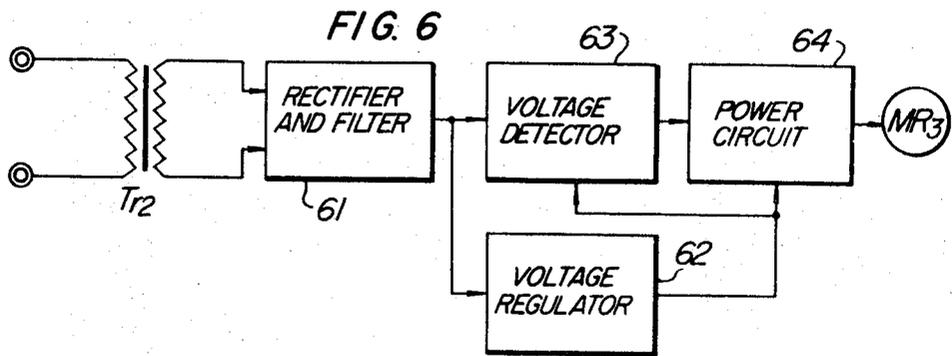
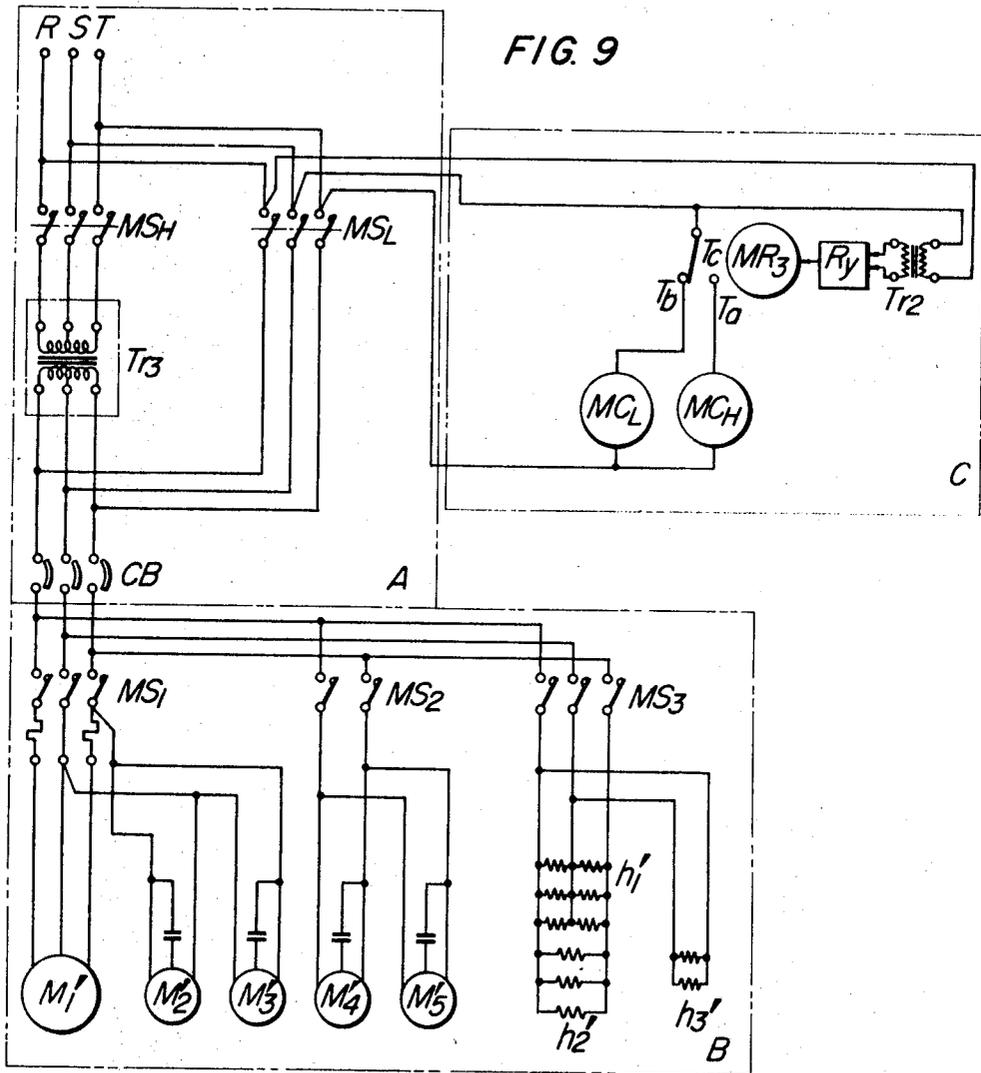


FIG. 5







REFRIGERATOR UNIT USED FOR A FREIGHT CONTAINER

This invention relates to a refrigerator unit used for a freight container, particularly to the electric system of such a refrigerator unit which is adapted for use in places of different line voltage.

A freight container, in this specification, means an enclosed and thermally insulated box equipped, or adapted to be equipped, with a refrigerator including for example a compressor, condenser, expansion valve and a cooler as well as electric motors and heaters, which is used for transporting perishable goods, being carried on board a lorry or ship.

Such a container, as is natural from its object of use, is often transported to various countries of the world by land as well as by sea, or periodically transferred between two places. Unfortunately, however, the line voltage of power distribution systems are not the same throughout the world. It differs with countries, areas within a country, ships, railroads and even between firms. The line voltages are generally divided into two categories, 200 v. class and 400 v. class. On the other hand, conventional refrigerated containers are generally rated for a single class of voltage. This has been hindering refrigerated containers from being conveniently used in a larger sphere. In certain cases, it has been necessary to install a special power unit to accommodate refrigerated containers.

The main object of this invention is to provide a refrigerator unit for a freight container which can be easily and safely operated with either of the line voltages of the above-mentioned two voltage classes.

In order to achieve the above object, the refrigerator unit of this invention comprises electric motors constructed so as to be adaptable to either of the two classes of line voltages by simply changing the electric connections of said motor, a first means which contributes to discriminate said two classes of line voltages, a second means for changing said electric connections of said motors, and a third means for interlocking said first means with said second means so as to match the rated voltage of said motors with the voltage of the power line with which said refrigerator unit is connected.

More specifically, in one aspect of this invention, the refrigerator unit includes dual-rated electric motors and heaters, and switches for selecting connections of said electric apparatuses, power supply circuits and control circuits according to the class of line voltage, said switches being mutually interlocked so that no danger will occur even if a wrong power switch is turned on or the power cable has been connected with a wrong power outlet, and moreover the refrigerator unit is provided with two power connectors of different types, each to be connected with the respective power source of the different voltage classes, in order to minimize the probability of misconnection.

In another modification of this invention, the above-mentioned switches are further interlocked with electromagnetic contactors through which the loads are controlled, to prevent the switches from dealing with heavy current at the start and stop of the motors.

In still another modification of this invention, the refrigerator unit is provided with a transformer which is inserted into the power line or bypassed by means of a switch depending on the class of the line voltage, so that the unit can be operated with either of the line voltages.

In a further modified type of this invention, the refrigerator unit includes an automatic switching device in the control circuit, which detects the class of the line voltage and makes appropriate connections of the electric apparatuses or loads according to the voltage class, it being only necessary for the operator to connect the unit with the power source.

In a still further modification of this invention, the refrigerator unit includes current detecting elements for protecting a motor from overload, which are connected in a manner that the same detecting elements are equally effective for an operation under either of two classes of line voltage.

Other objects and features of this invention will be clarified in the following description given in connection with embodiments of the invention and with reference to the accompanying drawings, in which;

FIG. 1 is a connection diagram of an embodiment of this invention in which the switching of the electric connections are performed with manual switches;

FIG. 2 is a connection diagram of an embodiment of a simpler type of the refrigerator unit of this invention, of which the manual switches can be integrated into a compact cam switch;

FIG. 3 is a diagram showing the operational sequence of the cam switch which may be used in the embodiment shown in FIG. 2;

FIG. 4 is a connection diagram of an automatic type of embodiment of this invention;

FIG. 5 is a connection diagram of another automatic type of embodiment of this invention;

FIG. 6 is a block diagram of the static voltage relay which is used in the embodiment shown in FIG. 5;

FIGS. 7a and 7b are connection diagrams of windings in a dual-rated three-phase induction motor used in this invention, FIG. 7a being for use with a 400 v. class line voltage and FIG. 7b for use with a 200 v. class voltage;

FIGS. 8a and 8b are connection diagrams of windings in a dual-rated single-phase induction motor used in this invention, FIG. 8a being for the use in a 400 v. system and FIG. 8b for the use in 200 v. system; and

FIG. 9 is a connection diagram of an embodiment of this invention in which a transformer is used for adapting the loads to the line voltage of the different voltage classes.

In the above drawings, it should be noted that the motors shown in FIGS. 1, 2, 4 and 5 have been assumed to have the connections as shown in FIGS. 7a and 7b, and that single-phase motors and heaters are not shown in FIGS. 4 and 5 just for simplification of the explanation. Also, in FIG. 2, heaters are omitted for the same reason.

Throughout the drawings, the whole connection diagram of the refrigerator unit is divided into three sections, that is, input section, load section and control section, respectively being indicated by characters A, B and C. Generally, characters R, S, T indicate power input terminals; particularly R_1 , S_1 , T_1 being such terminals which are to be connected with 200 v. class power lines, while R_2 , S_2 , T_2 are for 400 v. class power lines.

Referring to FIG. 1, P_1 and P_2 indicate plugs connected with the input terminals R_1 , S_1 , T_1 and R_2 , S_2 , T_2 respectively through appropriate cables. Plugs P_1 and P_2 have respectively different formations so as not to allow misconnection. That is to say, plug P_1 is adapted only to a 200 v. receptacle, while plug P_2 only to a 400 v. receptacle. Reference character CB indicate a circuit breaker. The refrigerator includes a compressor, a condenser, an expansion valve and a cooler which constitute the known refrigerating cycle. In other words, the electric load includes a compressor motor M_1 , fan motors M_2 and M_3 for the condenser, and fan motors M_4 and M_5 for the cooler. The compressor motor M_1 is a dual-voltage three-phase induction motor and has delta-connected stator windings. Each branch of the delta consists of two windings which are to be connected in series for use in 400 v. lines as shown in FIG. 7a or connected in parallel for use in 200 v. lines as shown in FIG. 7b. The fan motors M_2 , M_3 , M_4 and M_5 are single-phase induction motors. For 400 v. operation, windings of the single-phase motor may be connected as shown in FIG. 8a. That is, the main coil (u_1-v_1) is connected in parallel with the series connection of the auxiliary coil (u_1-y) and a capacitor, and an additional coil (u_2-v_2) is connected in series with the above parallel connection. For 200 v. operation, the connection should be as shown in FIG. 8b, the additional coil also being connected in parallel with the above-mentioned parallel connection. Electromagnetic contactors MS_1 controls the compressor motor M_1 and the condenser motors M_2 and M_3 ; while electromagnetic contactor MS_2 controls the fan motors M_4 and M_5 of the cooler. Reference character WS indicates a water switch. The refrigerator unit further in-

cludes a heater h_1 for defrosting the cooling coils and heating air, a second heater h_2 for a drain pan and a third heater h_3 for a drain tube. These heaters h_1, h_2, h_3 also are prepared for connection to either of 200 v. and 400 v. lines. An electromagnetic contactor MS_3 controls the heater load.

Reference character SS indicates a gang switch such as a multistage cam switch or a rotary switch, which is manually operated. The switch traversed by a dot-and-dash line in the Figure are all included in this gang switch SS, of which switch contacts indicated with H are ones to be closed in the 400 v. operation, whereas those marked with L are closed in the 200 v. operation, interlock means being provided lest a H contact and a L contact should be closed at the same time. A transformer Tr is provided for supplying a control circuit with electric power. The secondary winding of the transformer Tr is provided with a midtap. In operation with a 200 v. source, the switch contact L is closed to connect one of the output terminals T_0 and S_0 of the transformer with one end of the secondary winding; while in the operation with a 400 v. source, the midtap is connected with said one of the output terminals through the switch contact H. Thus, under either line voltage, the same voltage 24 v. appears across the output terminals T_0 and S_0 to which is connected the control circuit of the electromagnetic contactors.

Operation of the above-described control system will be explained hereunder. Assuming that a 400 v. power line is now available, the input terminals R_2, S_2, T_2 are connected with the power line or the input plug P_2 is inserted to a mating power receptacle after the gang switch SS is turned so as to close the H contacts, and then the circuit breaker CB is closed, which is followed by closing the electromagnetic contactors MS_1, MS_2, MS_3 through adequate control means (not shown). Thus, a 400 v. power is applied to the loads which have all been prepared for operation under 400 v. In this case, if it happens that the gang switch SS is mistakenly turned to make the L contacts, thereby changing the connections in the loads to a 200 v. rating, none of the electric apparatuses will be damaged, since the 400 v. input also is cut off by the gang switch SS itself (H contacts in A section).

Next, assuming that a 200 v. power is available, the input terminals R_1, S_1, T_1 or the input plug P_1 is connected with the power line, after the gang switch SS is turned so as to close the L contacts. Then the circuit breaker CB and the electromagnetic contactors MS_1, MS_2, MS_3 are closed in the same manner as in the previous case. Thus, the operation will start, 200 v. power being applied to the load adapted for the same voltage. If the gang switch SS is mistakenly operated to make the H contacts, no damage will occur as the power input is also cut off by the same gang switch SS.

Further, by using the power plugs P_1 and P_2 which have electrodes of different formations from each other and mate only with the proper receptacles, any damage or fault due to a misconnection of the power or a misoperation of the switches is absolutely eliminated.

Now, another embodiment of this invention will be described hereunder with reference to FIGS. 2 and 3. The control system shown in FIG. 2 is substantially the same as that shown in FIG. 1, except that some of the single-phase motors and the heaters are omitted in FIG. 2 in order to simplify the description of the operation of the gang switch in connection with FIG. 3. A transformer Tr_1 for supplying electric power to the control circuits of the electromagnetic contactors MS_1, MS_2 is provided with a midtap in the primary winding. In 400 v. operation, the power lines should be connected across both ends of the primary winding; while in 200 v. operation the power lines should be connected to the midtap and one end of the primary winding, so that a constant 24 v. secondary voltage is always maintained between the terminals R_0 and S_0 . It will be understood that this dual voltage arrangement can be made in the secondary side of the transformer as in the first embodiment.

The switch contacts L_1-L_6 and H_1-H_4 are incorporated into a single cam switch. The arrangement of the contacts are

shown in FIG. 3. In FIGS. 2 and 3, L_1 and H_1 indicate contacts for selecting the power input between a 200 v. line and a 400 v. line; L_2, L_3 and H_2 contacts for changing connection of the windings of the compressor motor M_1 ; L_4, L_5 and H_3 for changing connection of the windings of a single-phase motor M_2 ; and L_6 and H_4 for selecting the primary terminal of the transformer Tr_1 .

In the case where 200 v. power is available, the cam switch SS is turned to the position of notch No. 1 after the power plug P_1 is fitted to a mating power outlet. Thus, the contacts L_1-L_6 are closed and H_1-H_4 are opened, thereby supplying 200 v. power to the loads that are adapted for the same voltage. When the available power is 400 v. the cam switch SS is turned to notch No. 4 after the plug P_2 is fitted to a 400 v. power outlet. This time the contacts H_1-H_4 are closed and L_1-L_6 are opened, and the 400 v. power is supplied to the motors M_1, M_2 and the transformer Tr_1 which are all adapted to receive 400 v. power. The cam switch SS is provided with locking indents at the positions of notches No. 1 and No. 4, but such a locking means is not provided at the other positions, No. 2, No. 3 and the neutral point 0. The contacts of the switch SS are disposed in such a manner that in turning the switch SS by means of a lever from the notch No. 1 to notch No. 4 through notches No. 2, 0, No. 3, the contact L_6 is opened immediately after the switch lever departs from the notch No. 1, while the other L contacts are opened only after the lever passes the notch No. 2. Further, the contacts H_1-H_3 are closed at the position of the notch No. 3, but the contact H_4 is closed only after the lever reaches the notch No. 4. In a reverse operation, similarly, only the contact H_4 is opened when the lever leaves the notch No. 4 and the other contacts H_1-H_3 are opened after the notch No. 3 is passed. Further, the contacts L_1-L_5 are closed at the notch No. 2, whereas the contact L_6 is closed only after the lever reaches the notch No. 1. It should be noted that the switch SS is constructed in a manner that the lever cannot be turned from the notch No. 1 directly to No. 4 not passing the notches No. 2, 0, No. 3, and vice versa.

By the above-described structure of the cam switch SS is ensured safety in the operation relating to the selection of power voltage. Further, the current interrupting capacity of the contacts in the cam switch can be greatly reduced, which results in such a switch of being constructed a much smaller size and having a longer life. That is, if the lever of the cam switch happens to be turned during operation of the refrigerator unit, the contact H_4 (or L_6) is opened prior to opening of the other contacts H_1-H_3 (or L_1-L_5), and therefore the electromagnetic contactors MS_1, MS_2 which are designed to properly handle the respective load currents and which are energized from the transformer Tr_1 are opened prior to opening of the contacts H_1-H_3 (or L_1-L_5). Moreover, in starting the refrigerator unit, the contacts H_1-H_3 (or L_1-L_5) will always be closed prior to closing of the electromagnetic contactors. Thus, the contacts of the cam switch SS are assuredly exempted from dealing with heavy currents during the starting and the stopping periods of the operation. It should be noted, however, that it is usual practice in starting the refrigerator unit to energize the electromagnetic contactors MS_1, MS_2 manually by a pushbutton or automatically after the cam switch SS is set at the notch No. 1 or No. 4. Further, it should be understood that the cam switch SS may be remotely operated by means of a pilot motor incorporated therein. Other merits with this embodiment are the same as those described in connection with the previous embodiment.

Still another embodiment of this invention will be described with reference to FIG. 4. In this third embodiment, the switching of the connections is achieved automatically using electromagnetic contactors which are mutually interlocked in the operation. A transformer Tr which supplies control power is provided a center tap b_2 in the secondary winding. The transforming ratio of the transformer is such that if 400 v. is applied to the primary winding, 48 v. appears between both end b_1 and c of the secondary winding, while 24 v. appears

between the end c and the center terminal b_2 . Between terminals b_2 and c is connected a quick-acting auxiliary relay MR_1 which is rated for 24 v. Another auxiliary relay MR_2 of slow-acting type is connected between the terminals b_1 and c . The latter relay MR_2 also is rated for 24 v., but it can be operated at 48 v. for a short time. Switch contacts indicated by MS_H are make-contacts of an electromagnetic contactor whose coil is indicated by MC_H , and switch contacts marked with MS_L are actuated by coil MC_L . On the other hand, contacts MS_H' and MS_L' are break-contacts, i.e., normally closed contacts respectively associated with coils MC_H and MC_L . Further, contacts mr_1 and mr_2 are normally open contacts of the relays MR_1 and MR_2 respectively, and contacts mr_1' and mr_2' are normally-closed contacts of the relays.

Operation of this embodiment will be described hereunder. Assuming that the input terminal R, S, T are connected with three-phase 400 v. power lines and that circuit breaker CB is closed, voltage of 400 v. is applied to the transformer Tr and a voltage of 48 v. appears between terminals b_1 and c while 24 v. appears between b_2 and c . Accordingly, 24 v. is applied to the relay MR_1 and 48 v. to the relay MR_2 . Though both relays start to operate at the same time, the relay MR_1 acts faster than the other. It should be restated here that the relay MR_1 is of a quick-acting type whereas the relay MR_2 is a slow-acting relay. Therefore, a normally-closed contact mr_1' of the relay MR_1 cut off the power to the relay MR_2 before the latter can make any significant move. Thus, only the relay MR_1 is actuated, while the relay MR_2 remains unenergized. Accordingly, the coil MC_H of the electromagnetic contactor is energized through two normally-open contacts mr_1 and two normally-closed contacts mr_2' to close contacts MS_H and to open the contact MS_H' connected in series with coil MC_L . Meanwhile, the inactivity of the electromagnetic contactor MC_L is ensured by two normally-closed contacts mr_1' of the relay MR_1 and a normally-closed contact MS_H' of the contactor MC_H , and therefore the contacts MS_L remain open. Thus, the compressor motor M_1 is prepared for operation under 400 v., and upon closing electromagnetic contactor MS_1 , the motor M_1 will start safely.

If the line voltage is 200 v., that voltage is applied to the transformer Tr upon closing the circuit breaker CB. In the secondary side of the transformer, 24 v. and 12 v. will appear between terminals b_1 and c , and between terminals b_2 and c , respectively. Therefore, 12 v. is applied to the relay MR_1 and 24 v. to the relay MR_2 . As the relay MR_1 is designed to operate under 24 v. optimum voltage, it will not operate now with a voltage as low as 12 v. Thus, only the relay MR_2 is actuated, and the coil MC_L of the contactor is energized to close the contacts MS_L , while the coil MC_H is prevented from being energized, thereby to keep the contacts MS_H opened, in a similar manner as previously described. Therefore, the motor M_1 is adapted for 200 v. operation and will start safely upon closing the contactor MS_1 .

As described above, an automatic switching of the connections in the load according to the class of line voltage is made possible by utilizing a combination of two relays which have different operating characteristics.

In the above embodiment, two relays have been used for detecting line voltages. These relays can be replaced with a semiconductor static relay which will be described hereunder referring to FIGS. 5 and 6. In FIG. 5, reference character Tr_2 indicates a stepdown transformer, Ry a voltage relay of a static type and MR_3 an auxiliary relay with contacts Ta , Tb , Tc . The components of substantially the same functions as those shown in FIG. 4 are indicated by corresponding reference characters.

Assuming that the input terminals R, S, T are connected with 400 v. power lines and the circuit breaker CB is closed, that voltage is applied to the transformer Tr_2 and a predetermined appropriate voltage appears between two secondary terminals. The static relay Ry comprises, for example, a rectifying and filtering circuit, a voltage detecting circuit, a voltage regulating circuit and a driving circuit, as shown in FIG. 6. Es-

ential components of the above circuits are semiconductor elements such as silicon rectifiers, transistors and SCR. Output of the transformer Tr_2 is converted to a DC voltage through the rectifier and filter 61, and the DC-converted voltage is compared with a reference voltage from the voltage regulator 62, in the voltage detector 63. The resultant signal of the comparison indicating which voltage is higher, is applied to the power circuit 64, which in turn produces a constant output or no output depending on the level of the input voltage. The circuits of the relay are set so that said output is produced if the line voltage is in the 400 v. class but not if it is in the 200 V. class. The output from the static relay Ry energizes the auxiliary relay MR_3 to switch its movable contact T_r from the normally-closed position (T_b) to normally-opened position (T_a). Accordingly, the coil MC_H is energized to close the contacts MS_H and the coil MC_L remains inactive to keep the contacts MS_L opened. Thus, the motor M_1 is prepared for 400 v. operation, and if a pushbutton (not shown) is depressed to close the contactor MS_1 , it will start safely.

If the line voltage is 200 v., no output will be produced from the static relay Ry as mentioned above. Therefore, the movable contact T_r of the auxiliary relay MR_3 remains at the normally-closed position (T_b) and the coil MC_L of the contactor is energized to close the contacts MS_L . While, the contacts MS_H are kept open. The other operations of the system is the same as those in the preceding embodiment.

In the above embodiments, it will have been noted that overload detecting elements OC are connected among windings of the compressor motor M_1 in a particular manner. The conventional arrangement of overload detecting elements for a motor that is adaptable to two classes of line voltages, has been to connect two sets of such elements of different current ratings, each set for each line voltage, in series with a motor switch or breaker in two of the power lines or in all of three lines. With such an arrangement, however, the manufacturing cost involved in said elements as well as the space in the control box required for them are duplicated. Further, means for selecting either set of said two sets of elements according to the line voltage is required.

The above disadvantages have been overcome by the present invention. With the arrangement of this invention, a single set of overload detecting elements is equally effective to protect the motor in either operation under 200 v. or 400 v. Such overload detecting elements per se are known art such as various types of combinations of heating elements and temperature-sensitive bimetallic element or electromagnetic coils with plungers; and it will be needless to explain that such a detecting element, if an overload occurs, triggers a normally-closed contact in a control circuit of the electromagnetic contactor thereby to open the contactor and to stop the motor.

In FIGS. 7a and 7b, reference characters R, S, T indicate power input terminals; U_1 , U_2 , V_1 , V_2 , W_1 , W_2 , X_1 , Y_1 , Z_1 terminals of the component windings of the motor M_1 shown in FIGS. 1, 2, 4 and 5; and d , e , f , d_1 , e_1 , f_1 , d_2 , e_2 , f_2 conductors between windings. In the 400 v. operation of the motor M_1 , as shown in FIG. 7a, the overload detecting elements are connected in the portions d , e , f , or in either two of said three portions, in order to detect an overload current in the windings if it occurs. On the other hand, in a 200 v. operation when the windings are connected as shown in FIG. 7b, the same detecting elements with the same current rating are inserted in the portions d_1 (or d_2), e_1 (or e_2), f_1 (or f_2), or either two of said three portions, to protect the motor from the overload. Comparing the above two cases of the operation, the line currents to the motor are of course different, the current in the 200 v. operation being approximately twice as large as for the 400 v. operation. However, the current flowing through each of the six component windings are the same in both cases, because in a 200 v. operation the phase current (i.e. the current between lines) which is two-fold that of the 400 v. operation is divided between two component windings as is obvious from FIGS. 7a and 7b. Thus, the overload detecting elements of the same characteristics can be used with equal effectiveness in both

cases, if they are connected with the windings in a manner as described above. The above explanation has been given with regard to a delta-connected motor. However, it will be obvious that the same is applicable also to a star (Y)-connected motor.

Further, it will be noted that if the ratio of two anticipated line voltages is nearly $\sqrt{3}$, for example, if the power voltage available on board ship is 200 v., while it is 350 v. at the country of destination, a three-phase motor can be satisfactorily operated at both places simply by changing the connection of the component windings from a delta connection to a star (Y) connection. In such a case, if the overload detecting means are connected in series with the component windings as described in the preceding paragraphs, said detecting means will be equally effective in protecting the motor both in 200 v. and 400 v. operations, because the normal current flowing through each component winding is the same in both cases, though the line currents are different.

Thus, the above-described arrangement of the overload detecting means in the three-phase motor adds notable merit to the invention when used in association with the switching systems described in the above paragraphs.

Finally, still another embodiment of this invention will be described hereunder with reference to FIG. 9. The control system shown in FIG. 9 includes a stepdown transformer Tr_3 besides a small transformer Tr_2 for control circuits. The loads and other components whose functions are substantially the same as those in the preceding embodiments are indicated by corresponding reference characters. Further, in this embodiment, the control section C of the system is shown to be the same as that in FIG. 5. However, it should be noted that the motors $M_1', M_2', M_3', M_4', M_5'$ and the heaters h_1', h_2', h_3' are all rated for 200 v. and may not be provided with intermediate terminals, unlike in the preceding embodiments.

Assuming that input terminals R, S, T are connected with 400 v. power lines, the voltage relay Ry operates to actuate the auxiliary relay MR_3 and accordingly to energize the coil MC_H of the electromagnetic contactor. Therefore, contacts MS_H is closed which contacts MS_L is opened, and 400 v. power is applied to the 400 v./200 v. transformer Tr_3 which supplies the loads with 200 v. power. On the other hand, if the voltage of power system connected with the input terminals R, S, T is 200 v., then the voltage relay Ry will not operate and the movable contact T_c of the auxiliary relay MR_3 will remain at the normally-closed position, i.e., at the contact T_b . Therefore, the contacts MS_L are closed while the contacts MS_H are kept open. Thus, 200 v. power is supplied directly to the loads bypassing the transformer Tr_3 .

Though the above embodiment has been described as a combination of a transformer having a bypass means and a voltage detecting system shown in FIG. 5, it will be understood that combinations with other voltage detecting or selecting means are possible. Further, it will be obvious that the above arrangement is applicable to 400 v. loads provided that a 200 v./400 v. step-up transformer is used for the power transformer Tr_3 .

As described above, according to this invention, a refrigerated container can be used easily and safely at two places where available power is of different line voltages.

In the above embodiment, it has been assumed that the lower line voltage is 200 v. and the higher voltage is mostly 400 v. More generally, however, the lower voltage may be a voltage between 180 v. and 240 v., and any higher voltage ranging from 340 v. to 480 v. can be used for the refrigerator unit of this invention.

What we claim is:

1. A refrigerator unit for use in a freight container which may be commonly connected to available power lines of at least two classes of line voltage, said unit comprising:

at least one dual-rated electric motor constructed so as to be adaptable to either of two classes of line voltages by simply changing electric connections of said motor,

a first means which is connectable to electrical power lines for discriminating between said two classes of line voltages,

a second means for changing said electric connections of said motor, and

a third means for interlocking said first means with said second means so as to match the rated voltage of said motor with the voltage of said electrical lines with which said refrigerator unit may be connected.

2. A refrigerator unit as in claim 1, wherein:

said first means comprises two power input branches, each branch including a power plug of a particular formation which does not fit a receptacle prepared for the other plug and a switch is interlocked with a switch of the other branch so as to operate contrari-wise, and

said first means, second means and third means comprise a single gang switch.

3. A refrigerator unit as in claim 2, wherein:

said gang switch includes an additional pair of component switch means connected in a control circuit of an electromagnetic contactor for selecting a terminal which insures that the rated voltage of said contactor matches with the line voltage,

main contacts of said contactor being provided on the power side of said second means, and

said additional pair of switches being arranged in said gang switch in such a manner that each of said pair of switches is opened before or closed after the other component switches of the corresponding operation are opened or closed respectively.

4. A refrigerator unit as in claim 1, wherein:

said second means comprises a group of electromagnetic contactors,

said first means comprises a voltage detecting means connected with the power lines of the unit, and

said third means comprises an appropriate number of relays for controlling energization of exciting coils of said electromagnetic contactors according to the result of the detection by said first means.

5. A refrigerator unit as in claim 4, wherein said voltage detecting means comprises:

a transformer connected with the power lines of the unit for providing two classes of secondary voltages corresponding to said two classes of line voltages,

a quick-acting relay connected with lower voltage secondary terminals of said transformer for acting quickly when the refrigerator unit is connected with a power line of a higher voltage class but which will not act when the unit is connected with a power line of a lower voltage class, and

a slow-acting relay connected with higher voltage secondary terminals of said transformer for acting slowly whenever the refrigerator unit is connected with either power line, said quick-acting relay and said slow-acting relay being interlocked so as to prevent the opposite relay from operating when activated.

6. A refrigerator unit as defined in claim 4, wherein said voltage detecting means comprises a static voltage relay of a semiconductor type.

7. A refrigerator unit as in claim 1, wherein:

said electric motor comprises a three-phase motor of which each of three delta-connected windings or star-connected windings comprises two substantially equal component windings and,

said second means functions to change the connections of said component windings in each phase between series and parallel connections so that said refrigerator can be operated with either of two line voltages, one of which is substantially twice as high as the other voltage.

8. A refrigerator unit as in claim 1, wherein:

said electric motor comprises a three-phase, motor, and said second means functions to change the connections of phase windings of said motor between star connection and delta connection so that said refrigerator can be

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operated with either of two line voltages, one of which is substantially $\sqrt{3}$ times as high as the other voltage.

9. A refrigerator unit as in claim 7, wherein an overload detecting element is connected in series with one of said component windings in at least two phase windings.

10. A refrigerator unit as in claim 8, wherein an overload detecting element is connected in series with each of at least two phase windings.

11. A refrigerator unit used for a freight container, comprising electric loads whose rated voltage is equal to one of two classes of line voltages with either of which said refrigerator unit is to be operated, a first means as to contributes to select one of said two classes of line voltages, a transformer to whose secondary terminals are connected said electric loads and which is constructed so that the secondary voltage thereof is equal to the rated voltage of said loads and accordingly to said one of two line voltages when a voltage equal to the other of said two line voltages is applied to the primary windings thereof, a second means for disconnecting said transformer from the power circuit and making a circuit bypassing said transformer, and a third means for interlocking said first means with said second means so as to match the rated voltage of said load with the voltage of the power line with which said refrigerator unit is connected.

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12. A refrigerator unit for use in a freight container which may be connected to either of different electrical supply lines providing at least two classes of line voltages without any danger of mismatching electrical loads with available line voltages, said unit comprising:

at least one dual-rated electrical load which maybe operated at either of said two classes of line voltages by changing terminal connections thereto,

a first means for connecting said unit to available electrical power supply lines,

a second means connected between said first means and said load for changing said terminal connections, and

interlock means for preventing the energization of said load unless said terminal connections are proper for matching the load to the available class of line voltage.

13. A refrigerator unit as in claim 12 wherein:

said first means includes voltage detecting means for automatically determining the class of available line voltage connected thereto, and

said second means and said interlock means comprise electrically controlled switch means connected to said first means and automatically controlled thereby.

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