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"EMERGENCY DRIVE DEVICE FOR AN A.C. ELEVATOR"

This invention relates to an improved driving device whereby an elevator driven by an alternating current motor may be driven in an emergency such as during a power supply interruption.

5 Usually, in the case of a power supply interruption at the power source for an elevator, the elevator is continued to be driven by a switchover from that power source to an emergency power source. Fig. 1 shows a drive device which is used at the
10 time of power supply interruption, wherein the motor for driving the elevator car is an induction motor and is driven by an a.c. supply of a variable frequency.

 In the drawing, there is shown a three-phase power source, and a converter 2 for converting a.c.
15 power having a constant frequency into a.c. power having a variable frequency, as will be hereafter described. Also shown is an emergency power source such as an accumulator 3 and an emergency inverter 4 for converting the d.c. supply from the emergency
20 power source into a three-phase a.c. supply of constant frequency. A normal operation contact 5 is connected to the converter 2 and turned "on" and "off" during normal operation and at the time of a power supply interruption of the three-phase a.c. source 1,
25 respectively. A supply interruption contact 6 is

connected to the emergency converter 4 and turned "on" and "off" at the time of supply interruption and at the time of normal operation, respectively. A three-phase induction motor 7 is connected to both the contacts 5, 6. A winch driven by the motor 7 has a drive sleeve 8 around which there is wound a main cable 9. A car 10 and a balance weight 11 are coupled to the respective ends of the main cable 9.

During normal operation, the contact 5 is closed, so that the variable frequency alternating current is supplied to the motor 7 for controlling the speed of the car 10. During a supply interruption, the contact 5 is opened and the contact 6 is closed, so that alternating current is supplied to the motor 7 from the emergency inverter 4 for driving the car 10.

This conventional device has however a drawback in that the drive means employed during supply interruption tend to be costly because of the provision of the emergency inverter 4.

This invention aims to obviate this drawback and provides an emergency drive system for an a.c. elevator wherein the inverter employed during normal operation is employed simultaneously during supply interruption for dispensing with the emergency inverter.

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According to the present invention, there is provided an a.c. elevator drive apparatus, comprising an a.c. motor for driving an elevator car, a rectifier for connection to an a.c. power supply, an inverter
5 connected on its input side to the rectifier output and on its output side to the motor and adapted to supply to the motor a.c. operating power of variable frequency, an emergency d.c. power source connected to the input side of the inverter for supplying power to the motor on
10 interruption of the a.c. power supply, inverter control means responsive to a.c. power supply interruption for controlling the inverter to provide from the emergency power source motor operating power such as to drive the elevator car at a reduced speed to the nearest floor.

15 The invention will be further described, by way of example only, with reference to the accompanying drawings.

In these drawings:-

Fig. 1 is a schematic view showing the conventional drive system for the a.c. elevator;

5 Fig. 2 is a circuit diagram showing an embodiment of the emergency drive system for the a.c. elevator according to the present invention;

Fig. 3 is a block diagram showing the control device used in the circuit of Fig. 2; and

10 Fig. 4 is a partial circuit diagram of a modified embodiment of the invention corresponding to a portion of Fig. 2.

Reference is made to Fig. 2 for illustrating an embodiment of the present invention.

15 Thus Fig. 2 shows driving contacts 13a, 13b and 13c connected to a power source 1 and turned on and off respectively at the time of travel and halt of the car 10. A rectifier 14 is formed by diodes 14a to 14f arranged as a three-phase full-wave rectifier circuit and having its input side connected
20 to contacts 13a, 13b and 13c. A smoothing capacitor 15 is connected across the output terminals of the rectifier 14. An inverter 16 comprises diodes 16a to 16f and transistors 16A to 16F and is used for converting a constant d.c. voltage into an a.c.
25 voltage of a desired magnitude and frequency. A reactor coil 17 is connected in one of the input lines

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of the inverter 16. A diode 18 is connected across both terminals of the reactor 17. A diode 19 is connected across input terminals of the inverter 16 with the same polarity as these input terminals, and is also connected in series with the emergency power source 3 and with the same polarity as the source 3. A current limiting resistor 20 is connected across both terminals of the diode 19. A speed command generator 21 issues a speed command signal V_p . A speed sensor 22 is coupled to the motor 7 and is designed to produce a speed signal V_t representative of the actual speed of the car 10. An adder 23 is provided for calculating an offset between the input command signals V_p and V_t . An inverter control circuit 24 is connected between the adder 23 and the input side of the inverter 16 and is designed to control the base terminals of the transistors 16A to 16F of the inverter 16 depending on the above offset signal.

The device of the present embodiment operates as follows:

When an elevator call is produced at the time of normal operation, the driving contacts 13a to 13c are closed, so that the rectifier 14 yields a d.c. output of a predetermined voltage. The control circuit 24 responds to the offset signal between the speed command signal V_p and the actual speed signal V_t to

control the transistors 16A to 16F so that an a.c. power of variable frequency is generated at the output side of the inverter 16. In this manner, the motor 7 is driven to cause the car 10 to travel.

5 During supply interruption of the power source 1, the d.c. output from the rectifier 14 disappears, so that the emergency power source 3 is now operative to supply d.c. power to the inverter 16 through the diode 19. During supply interruption, the speed
10 command generator 21 issues a speed command signal V_p lower than that issued during normal operation. The control circuit 24 responds to this signal V_p to control the base electrodes of the transistors 16A to 16F for converting the direct current of the emergency
15 power source 3 into an alternating current of the predetermined frequency to drive the motor 47 to cause the car 10 to travel at a lower speed to the adjacent floor.

 When the car 10 travels down with a heavy load,
20 or up with a light load, the motor is driven with regenerative braking so that the power is returned to the electrical source. When the d.c. voltage has attained more than a predetermined magnitude at this time, the control device 24 operates to turn certain
25 of the transistors 16A to 16F "on" and "off". Direct

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current is now supplied to the motor 7 through diodes 16a, 164 for direct current braking of the motor 7. In this manner, the kinetic energy is not returned to the d.c. side, but is consumed at the rotor of the motor 7, and the power to be otherwise returned to the d.c. side is disposed of. Hence, the necessity for providing special devices for disposing of the turned power may be eliminated.

Fig. 3 shows a portion of the control circuit 24 designed to effect such direct current braking. Referring to Fig. 3, once the d.c. side voltage V_D exceeds a reference voltage V_R , a signal for commanding the issuance of a.c. voltage is interrupted from transistors by disconnecting a relay R so that the signal for commanding d.c. braking is supplied to the base electrodes of the transistors 16A, 16E to control the on/off operation of the transistors 16A and 16E.

Preferably, the transistors to be controlled in their on/off operations are not fixed but may be sequentially from one set to another set of transistors to make use of all of the transistors 16A to 16F thereby avoiding shortening of the service life by utilizing transistors.

The limiting resistor 20 through which the emergency power source 3 is charged and prepared for emergency operation, may be dispensed with if so desired.

5 Fig. 4 illustrates a modified embodiment of the invention.

 In this embodiment a supply interruption contact 26 is used in place of the diode 19 of Fig. 2 and is turned "on" and "off" at the time of
10 power supply interruption and at the time of normal operation, respectively. The remaining components are the same as those shown in Fig. 2.

 The contact 26 is turned "on" only during power supply interruption to supply the d.c. power
15 of the emergency power source 3 to the inverter 16.

 It may be contemplated that when the regenerative power is returned to the d.c. side, it flows through the contact 26 into the emergency power source 3, resulting in an elevated voltage at the terminal of
20 the emergency power source 3 and occasionally causing undesirable toxic gases or other effects undesirable in the emergency power source 3. However, this does not happen because the motor 7 is subjected to d.c. braking when the voltage at the d.c. side of the
25 inverter 16 exceeds a predetermined value, as mentioned above.

While the variable voltage variable frequency device of the pulse width modulation system has been shown and described, the present invention may also be applied to other types of variable voltage variable frequency devices.

Also, while the case of supply interruption has been shown and described, the present invention may be applied to the case where the elevator operation has been incapacitated by other accidents.

According to the present invention, as described above, since the emergency power source is connected across and with the same polarity as the input terminals of the inverter designed to supply a.c. power of a variable frequency to the a.c. motor, the inverter to be used for normal operation may also be used for emergency operation. Hence the necessity for providing an additional inverter for emergency is eliminated, resulting in reduced manufacture costs.

In addition, during regenerative braking of the motor, when the voltage at the d.c. side of the inverter exceeds a predetermined value, the motor is subjected to direct current braking by control elements included in the inverter. Hence, the regenerative power is not returned to the direct current side but is consumed in the motor thereby allowing special devices used for disposing of the regenerative power to be eliminated.



CLAIMS

1. An a.c. elevator drive apparatus, comprising an a.c. motor for driving an elevator car, a rectifier for connection to an a.c. power supply, an inverter connected on its input side to the rectifier output and
5 on its output side to the motor and adapted to supply to the motor a.c. operating power of variable frequency, an emergency d.c. power source connected to the input side of the inverter for supplying power to the motor on interruption of the a.c. power supply, inverter control
10 means responsive to a.c. power supply interruption for controlling the inverter to provide from the emergency power source motor operating power such as to drive the elevator car at a reduced speed to the nearest floor.
2. Apparatus as claimed in claim 1, wherein the voltage
15 value of the emergency power source is lower than the d.c. voltage across said inverter input during normal operation of the a.c. supply.
3. Apparatus as claimed in claim 2, wherein the emergency power source is connected with interrupting
20 means for interrupting the inflow of regenerative power from said motor when the elevator operates normally.

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4. Apparatus as claimed in claim 3, wherein said interrupting means comprises a diode connected in series with said emergency power source.

5. Apparatus as claimed in claim 3, wherein said
5 interrupting means comprises a contact connected in series with said emergency power source, said contact being open during normal operation and closed during power supply interruption.

6. Apparatus as claimed in claim 1, 2, 3, 4 or 5
10 operative with regenerative braking whereby power generated by the motor is returned to the a.c. supply through the inverter and rectifier, and further including braking control means responsive to the regenerative voltage and arranged to control elements of
15 the inverter in such a manner as to supply d.c. braking current through the inverter to the motor when the regenerative voltage exceeds a predetermined voltage, thereby to effect d.c. braking of the motor.
