

AC ELEVATOR CONTROL SYSTEM

1 This invention relates to a system for controlling an AC elevator car driven by a three-phase induction motor.

 The comfortableness of a ride and the accuracy
5 of landing at stopping floors are strictly demanded for elevator cars.

 An AC elevator control method satisfying such a demand by employment of a high-speed induction motor and a low-speed induction motor is proposed in,
10 for example, U.S. Patent No. 3,876,918. The proposed method is such that, depending on the error between the speed command signal and the speed feedback signal, the AC voltage applied to the high-speed induction motor is controlled when the elevator car is accelerated or running at the rated speed, while the DC
15 braking current supplied to the low-speed induction motor is controlled when the elevator car is decelerated. Therefore, according to this elevator control method, both of the motoring torque and the
20 braking torque can be controlled to satisfactorily control acceleration and deceleration of the elevator car.

 However, the proposed control method is defective in that the double-winding motor structure
25 is quite expensive and the application of DC braking

1 torque for the control of the deceleration of the
elevator car results in a great energy loss. Especially,
such a energy loss is very large and is not negligible
in the case of an elevator car which is repeatedly
5 started and stopped at a high frequency.

On the other hand, a method for controlling
an induction motor is widely known from, for example,
U.S. Patent No. 3,568,021 and U.S. Patent No. 3,940,669
each of which discloses the so-called inverter system
10 in which an inverter is employed for the control of
the frequency of an AC power supply voltage supplied to
an induction motor.

An application of such an inverter to an AC
elevator system is proposed in Japanese Patent
15 Application Laid-Open No. 137845/77 (laid open on
November 17, 1977). The proposal is such that,
depending on the elevator car speed command, the
voltage and frequency of AC power supplied to the
induction motor is progressively increased during
20 acceleration of the elevator car, while the AC voltage
and frequency are progressively decreased during
deceleration of the elevator car. According to the
proposed method, therefore, an induction motor of a
single winding structure can be employed, and the
25 power consumption can be saved since regenerative
braking is applied during deceleration of the elevator
car.

However, according to the so-called inverter

system it is necessary to control the large current supplied during acceleration of the elevator car, so that the capacity of the inverter used for the control exceeds necessarily the motor starting power requirement to such an extent that its value will become several
5 times as large as the rated capacity of the induction motor.

Consequently, the proposed method has been defective in that the inverter apparatus requires a very large capacity and is therefore expensive, and because of the above defect, the method has not yet been put into practical use.

10 Therefore, it is desirable to provide an improved AC elevator control system employing a three-phase induction motor, in which control elements of small capacity can be employed thereby saving the power consumption, whilst the number of necessary parts can be reduced thereby attaining the economization of the system.

15 According to the present invention there is provided an AC elevator control apparatus for use in an AC elevator system including a three-phase AC power source, a three-phase induction motor, and an elevator car and a counterweight suspended from the opposite ends of a rope trained around a rotatable member and driven by said induction
20 motor, said apparatus comprising: means for supplying AC power of the same frequency as said AC power source from said AC power source to said induction motor to control motoring torque thereof at least when said elevator car operates in an acceleration mode; and a power converting unit for supplying AC power of a frequency lower than that of said AC
25 power source to said induction motor to control motoring torque thereof at least when said elevator car operates in a deceleration mode.

In one preferred embodiment of the apparatus of the present invention there is provided a full-wave bridge circuit including a plurality of control elements connected at its AC terminals to the three-phase AC power source, the connections between the control
5 elements being suitably switched over to serve both the control of the motoring torque and the control of the braking torque, and that the full-wave bridge circuit is provided by a single-phase full-wave bridge a structure.

Other objects, features and advantages of the present inven-
10 tion will become apparent from the following detailed description of preferred embodiments thereof taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a block diagram of an embodiment of the AC elevator
15 control apparatus according to the present invention;

FIG. 2 is a graph showing torque characteristics of the three-
phase induction motor IM shown in FIG.1;

20 FIG. 3 is a graph showing a speed characteristic of the elevator car;

FIG. 4 is a graph showing other torque characteristics of
the induction motor IM;

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FIG. 5 is a circuit diagram of a preferred _____

1 embodiment of the AC elevator control apparatus according to the present invention;

FIG. 6 is a circuit diagram of another embodiment of the AC elevator control apparatus of the present
5 invention in which a transformer is connected between the induction motor and the power converter unit;

FIG. 7 is a circuit diagram of still another embodiment of the AC elevator control apparatus of the present invention in which the motoring torque control
10 unit and the power converter unit include parts common to each other;

FIG. 8 is a circuit diagram of yet another embodiment of the AC elevator control apparatus of the present invention in which bidirectional control
15 elements are used in the power converter unit shown in FIG. 7;

FIG. 9 is a circuit diagram of a further embodiment of the AC elevator control apparatus of the present invention in which single-phase circuits are
20 used to constitute the power converter unit;

FIG. 10 is a graph showing the torque characteristics of the induction motor IM to illustrate the operation of the apparatus shown in FIG. 9;
and

25 FIG. 11 is a circuit diagram of a still further embodiment of the AC elevator control apparatus of the present invention in which single-phase circuits are used to constitute only the forward

1 converter of the power converter unit.

Referring now to FIG. 1 which is a block diagram of an embodiment of the AC elevator control apparatus according to the present invention, an elevator car CA
5 a counterweight CW are suspended from the opposite ends respectively of a rope RP trained around a traction sheave S. A three-phase induction motor IM, an electromagnetic brake unit MB and a tachometer generator TG are coupled to the sheave S. Therefore, the elevator car
10 CA is driven to run up and down by controlling the three-phase induction motor IM.

A three-phase AC power source U, V, W is connected to a motoring torque control unit VR through main contactors 11 for up movement and main contactors 12
15 for down movement. By closing either the main contactors 11 or 12, the AC power to be supplied to the motoring torque control unit VR is caused to have its phase rotation direction corresponding to the desired run direction of the elevator car CA. The output from this
20 motoring torque control unit VR is supplied to the induction motor IM through main contactors 13 for motoring purpose which are closed when the elevator car CA is accelerated and when the elevator car CA runs at its rated speed. The AC power from the three-phase AC
25 power source U, V, W is also supplied to a power converter unit PC, and the output from this power converter unit PC is supplied to the induction motor IM through main contactors 14 for deceleration purpose

- 1 which are closed when the elevator car CA is decelerated.

The speed signal appearing from the tachometer generator TG is fed back to a speed control unit SC. This speed control unit SC includes a speed pattern generator PG and a speed comparator CP. The signal
5 indicative of the speed error between the speed pattern signal and the speed feedback signal is applied from the speed comparator CP to phase shifters PS1 and PS2 which control the motoring torque control unit VR and
10 the power converter unit PC respectively so as to cancel the speed error.

As described later, the power converter unit PC in the embodiment of the present invention is composed of a forward converter for deriving DC power
15 from the AC power supplied from the AC power source and a reverse converter or inverter for converting the DC power into low-frequency AC power.

In the AC elevator control apparatus having the structure described above, the primary voltage is
20 controlled by the motoring torque control unit VR when the elevator car CA is accelerated and when the elevator car CA runs at its rated speed, so that the induction motor IM is controlled according to the output signal from the speed pattern generator PG
25 thereby accelerating the elevator car CA or running the elevator car CA at the rated speed.

When the elevator car CA is to be decelerated, the main contactors 13 for acceleration purpose are

- 1 opened and the main contactors 14 for deceleration
purpose are closed. Consequently, the low-frequency AC
power is supplied from the inverter of the power
converter unit PC to the induction motor IM.
- 5 The frequency of the low-frequency AC power
supplied from the inverter of the power converter
unit PC is selected to be $1/5$ to $1/10$ of that of the
AC power source U, V, W. (Then, the characteristic
will be analogous to that of a two-speed elevator
10 system employing a multipole induction motor in which
the number of poles is five to ten times as many as
that of the induction motor IM.) When the low-
frequency AC power having such a frequency is supplied
from the inverter of the power converter unit PC to
15 the induction motor IM, the state of regenerative
braking occurs in the induction motor IM thereby
causing deceleration of the elevator car CA while
recovering the energy produced as a result of regenera-
tive braking. FIG. 2 shows the relation between the
20 torque T and the slip S in such a case.

Suppose now that the elevator car CA runs
upward in a full-loaded condition loaded with a heavy
load as shown by the load torque line L1, then, the
elevator car CA continues to run upward at a constant
25 speed given by the intersection between the load
torque line L1 and the torque curve τ_1 of the
induction motor IM. At the point of commencement of
deceleration, the torque curve τ_1 of the induction

1 motor IM is changed over to the torque curve τ_3 , with
the result that the torque of the induction motor IM
changes now along the torque curve τ_3 , and the elevator
car CA is decelerated due to application of the
5 regenerative braking torque until the speed is reduced
to the level of the synchronous speed n_f determined
by the frequency of the low-frequency AC power supplied
from the inverter of the power converter unit PC.
The kinetic energy of the proportion corresponding to
10 $1 - (\frac{n_f}{n_0})^2$ is converted into the electrical energy by
the power generating characteristic of the motor,
and the electrical energy is returned to the power
source. The symbol "no" represents the synchronous
speed determined by the frequency of the AC power
15 source U, V, W.

After the elevator car CA is decelerated in
the manner described above, the elevator car CA runs
stably at the point of balance P1 (or P2) between the
torque characteristic τ_3 determined by the power
20 converter unit PC and the loaded condition L1 (or L2)
at that time. Then, at the position of final stop,
the power supply is turned off by opening the main
contactors 11 (or 12), and, at the same time, the
elevator car CA is brought to a stop by the electro-
25 magnetic brake unit MB. Thus, an operation
characteristic curve as shown in FIG. 3 is obtained.
In the curve, the range B - D - E is controlled by
the inverter. The operation characteristic shown in

FIG. 3 is generally analogous to that exhibited by drive by the conventional two-speed motor. However, in the case of drive by the conventional two-speed motor, the speed ratio of 1/3 to 1/6 is a limit due to the manufactural limitation on the motor and from the aspect of the cost of the motor. In contrast, the speed ratio can be reduced to about 1/10 according to the present invention, so that the accuracy of floor landing and the stop shock alleviation which are important factors for the elevator car operation can be greatly improved. Further, the kinetic energy can be substantially completely regenerated since the kinetic energy of the elevator car CA during deceleration is proportional to the second power of the speed. In other words, when $\frac{nf}{no} = 0.1$, the kinetic energy of quantity $E = 1 - 0.1^2 = 0.99$ can be utilized for regeneration.

Alternatively, the DC braking technique disclosed in USP 3,876,918 cited hereinbefore can also be utilized so as to bring the elevator car CA to a stop at a point G while maintaining the deceleration between the points B and D, as shown by the dotted line DG in FIG. 3. The relation between the torque T and the slip S in this case is as shown in FIG. 4. Referring to FIG. 4, the elevator car CA is decelerated along the regenerative braking torque curve τ_3 representing the low-frequency torque characteristic from the high synchronous speed. (In this case too,

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1 the speed control unit SC shown in FIG. 1 carries out
the speed feedback control by comparing the speed
feedback signal with the speed pattern signal.) Then,
at a speed in the vicinity of the synchronous speed
5 nf determined by the output frequency of the inverter
of the power converter unit PC, switch-over from the
regenerative braking torque curve τ_3 to the DC braking
torque curve τ_d takes place. As soon as the elevator
car CA is stopped at the floor landing level, the
10 electromagnetic brake unit MB is energized and kept
in the energized state.

The DC braking torque τ_d approaches the
value of zero at the speed which is nearly zero.
Therefore, at the vicinity of this speed zero point,
15 the control may be made by using the electromagnetic
brake unit MB without resorting to the DC braking
torque τ_d . The range D-F in FIG. 3 is preferably as
short as possible. This may be attained by detecting
the load of the elevator car CA on the basis of the
20 level of the motor current in the running condition
of the elevator car CA or the level of the braking
current in the decelerating condition and controlling
the timing of energization of and the braking force
of the electromagnetic brake unit MB, so that the
25 curve of deceleration due to the application of the
braking force by the electromagnetic brake unit MB
may become a linear extension of the deceleration
curve up to that time. This manner of control can be

- 1 achieved relatively simply and inexpensively.

It will be understood from the above description of the embodiment that the motoring torque control unit VR controls the motoring torque applied for
5 accelerating the elevator car CA, and the power converter unit PC supplies the AC power of a frequency lower than that of the AC power source, to the induction motor IM for controlling the deceleration of the elevator car CA. Therefore, not only the desired
10 power saving can be achieved by the regeneration of power during deceleration of the elevator car CA as described above, but also the equipment capacity of the power converter unit PC can be reduced for the reasons which will be described presently.

- 15 In this embodiment, the power converter unit PC is merely required for providing an AC power output of a frequency lower than that of the AC power source. On the other hand, as is commonly known, the equipment cost of the power converter unit PC can be reduced
20 in proportion to its output frequency. Therefore, when the output frequency of the power converter unit PC is selected so as to reduce the synchronous speed of the induction motor IM to be about 1/10 of the rated speed of the elevator car CA, its equipment
25 cost can be reduced to about 1/10 of that of the case in which the power converter unit PC is solely relied upon for the control of acceleration and deceleration of the elevator car CA.

1 Further, the use of the power converter unit
PC for the sole purpose of deceleration control provides
such an additional advantage that the output of the
inverter can be reduced by the amount corresponding to
5 two times the loss of torque due to the losses occurring
in the mechanical system of the elevator (for example,
the gear loss in the hoist and the friction loss in the
guide shoes guiding the cage), compared with the case
in which the power converter unit PC is used for both
10 of acceleration control and deceleration control.

Further, the power converter unit PC in this
embodiment need not carry out frequency control
continuously over a wide frequency range. Therefore,
the phase shifter PS_2 connected to the power converter
15 unit PC can be made simpler in circuitry and more
economical than the conventional one which is con-
nected to the conventional power converter unit
designed to carry out frequency control continuously
over a wide frequency range. Thus, when, for example,
20 the elevator car CA is to be controlled in the manner
described with reference to FIGs. 2 and 3, the power
converter unit PC is merely required to be capable
of controlling the AC output to have a predetermined
frequency. On the other hand, when the elevator car
25 CA is to be controlled in the manner described with
reference to FIG. 4 in which the DC braking torque
 τ_d is applied for stopping the elevator car CA, the
power converter unit PC is merely required to be

- 1 capable of controlling the AC output at zero frequency.

In the above description, the AC output frequency of the power converter unit PC is selected to be constant. However, a plurality of frequencies lower than that of the AC power source may be generated from the power converter unit PC, and the output frequency may be successively switched over to lower ones depending on the elevator car position or the motor speed. Although the structure of the phase shifter PS_2 becomes complex in such a case, while the deceleration control can be improved, the circuitry of the phase shifter PS_2 is still simpler than that connected to the conventional power converter unit designed to continuously carry out the frequency control over a wide frequency range.

The above description has referred to the use of the power converter unit PC for the deceleration control. It is necessary to run the elevator car CA at a low speed in the case of, for example, maintenance and inspection of the elevator car CA. When such a low speed run is required, the elevator car CA is to be run at the low speed determined by the output frequency of the power converter unit PC. When the low speed above described is too slow for the maintenance and inspection purpose, a plurality of frequencies as described above may be prepared, and a suitable one of them may be utilized.

FIG. 5 is a circuit diagram of a preferred

1 embodiment of the elevator control apparatus of the present invention.

In the embodiment shown in FIG. 5, the
motoring torque control unit VR includes two pairs of
5 anti-parallel-connected thyristors 21 to 24, and the
power converter unit PC is composed of a forward
converter including thyristors 31 to 36 and an inverter
including thyristors 41 to 46. The power converter
unit PC is connected at its AC input terminals to the
10 AC power source U, V, W through a transformer T.

The above arrangement provides such advantages that
the breakdown voltage level of the thyristors 31 to 36
composing the forward converter can be decreased and
the radio interference against the power source can be
15 alleviated by the reactance of the transformer T.

In this embodiment, the fact that three-
phase AC power of a low frequency can be obtained by
inversion of DC power by the inverter is utilized so
that a rescue run of the elevator car CA can be made
20 in the event of power failure. Referring to FIG. 5,
an emergency switch-over contactor 15D (not shown),
which is normally turned off, is turned on upon
detection of interruption of power supplied from the
AC power source U, V, W. Thus, the contacts 15Db and
25 15Da of the contactor 15D are opened and closed
respectively thereby connecting a battery ED to the
inverter. Therefore, by controlling the thyristors
41 to 46 composing the inverter and supplying the

- 1 low-frequency AC power to the induction motor IM, the
elevator car CA can be brought to the nearest floor
while running at the low speed. Special means for
permitting the rescue run in the event of power failure
5 have been required in a conventional AC elevator
control system. In contrast, according to the embodi-
ment shown in FIG. 5, the rescue run can be simply
attained by the provision of the battery ED and the
contactor 15D.
- 10 In the final stage of deceleration of the
elevator car CA, the DC braking torque can be applied
by turning on the gate signal applied to the thyristors
42 and 45 only among those composing the inverter and
by turning off the gate signal applied to the remain-
15 ing thyristors. By so firing the selected thyristors
42 and 45, direct current flows through the windings u
and w of the induction motor IM to generate a DC
braking torque. The magnitude of this DC braking
torque can be controlled by controlling the gate
20 signal of the thyristors 31 to 36 composing the forward
converter on the basis of the error between the speed
command and the feedback speed.

FIG. 6 shows another embodiment of the
present invention in which the transformer T is
25 inserted between the power converter unit PC and the
induction motor IM. In this case, contactors 16 are
required between the transformer T and the induction
motor IM so that current may not flow into the

1 transformer T when the elevator car CA is accelerated.

FIG. 7 shows still another embodiment of the present invention in which the motoring torque control unit VR and the power converter unit PC include
5 common thyristors. In this embodiment, the number of thyristors can be decreased although contactors 17 for motoring purpose and contactors 18 for deceleration purpose are additionally required. Referring to FIG. 7, the contactors 17 are turned on in the
10 motoring mode, and the anti-parallel circuits of thyristors 31, 32 and 33, 34 are inserted between the phases U, W of the AC power source and the windings u and w of the induction motor IM, thereby providing the same arrangement as that of the motoring torque
15 control unit VR shown in FIG. 5. The contactors 17 and 18 are turned off and on respectively in the deceleration mode, thereby providing the same arrangement as that of the power converter unit PC shown in FIG. 5.

20 In the embodiment shown in FIG. 7, the contactors 11 and 12 are connected to the induction motor IM at a position nearer to the motor IM than the contactors 17 so as to make unnecessary the switch-over of the gate circuits of the thyristors.

25 The method of inserting a transformer as shown in the FIG. 6 embodiment is suitable for application also to the arrangement of FIG. 7 in which the motoring torque control unit VR and the power

1 converter unit PC include thyristors common to each other, as described below.

FIG. 8 shows yet another embodiment of the present invention which is a modification of the embodiment shown in FIG. 7 in that the common thyristors 31 and 33 in the forward converter are replaced by bidirectional control elements FLS respectively. In the embodiment shown in FIG. 7, all of the four common thyristors 31 to 34 are required to have a capacity large enough to control the induction motor IM. In contrast, in the embodiment shown in FIG. 8, the bidirectional controlled elements FLS only are required to have a large capacity, and the remaining ten thyristors need not have a large capacity. Further, the number of the contactors 17 and 18 can be decreased.

FIGs. 9 and 11 show other embodiments of the present invention. In these embodiments, the power converter unit PC operates in the deceleration mode only so that the structure of the power converter unit PC can be simplified.

In the embodiment shown in FIG. 9, the power converter unit PC is entirely composed of single-phase circuits. Thus, this embodiment is featured by the fact that the regenerative braking torque is produced within the range of $S_L \leq 0$ on the low-frequency single-phase torque curve, as shown in FIG. 10. Although the magnitude of the regenerative

- 1 braking torque is less than that of the three-phase
torque curve shown by the dotted line, in FIG. 10, the
embodiment shown in FIG. 9 is economically greatly
advantageous, in comparison with the embodiment of
5 FIG. 5, in that the number of thyristors can be
decreased to eight from twelve, and, also, a trans-
former T of single-phase can be used in place of the
transformer T of three-phase.

The system shown in FIG. 9, in which the
10 single-phase torque can only be produced, is encountered
with such a problem that the starting torque cannot be
obtained, and the elevator car CA cannot be run at a
low speed under control of the power converter unit PC
only. However, this problem can be easily solved by
15 applying necessary starting torque under control of the
motoring torque control unit VR. Once started, the
elevator car CA can be driven to run at the low speed.

The embodiment shown in FIG. 11 is a modifi-
cation of the embodiment shown in FIG. 9 in that the
20 inverter only is composed of a three-phase bridge
circuit. Therefore, the elevator car CA can be run at
a low speed for the maintenance and inspection purpose
under control of the power converter unit PC only.

It is apparent to those skilled in the art
25 that suitable combinations of the aforementioned
embodiments can also exhibit corresponding effects.



CLAIMS:

1. An AC elevator control apparatus for use in an AC elevator system including a three-phase AC power source, a three-phase induction motor, and an elevator car and a counterweight suspended from the opposite
5 ends of a rope trained around a rotatable member and driven by said induction motor, said apparatus comprising:

 means for supplying AC power of the same frequency as said AC power source from said AC power source to said induction motor to control motoring torque thereof at least when said elevator car operates in an
10 acceleration mode; and

 a power converting unit for supplying AC power of a frequency lower than that of said AC power source to said induction motor to control motoring torque thereof at least when said elevator car operates in a deceleration mode.
- 15 2. An AC elevator control apparatus as claimed in Claim 1, wherein said motoring torque control means includes switch means for connecting said three-phase induction motor to said three-phase AC power supply in a direction of phase rotation corresponding to a desired running direction of the elevator car.
- 20 3. An AC elevator control apparatus as claimed in Claim 1, wherein said motoring torque control means includes anti-parallel-connected thyristors or bidirectional controlled elements inserted in at least one phase between said three-phase AC power source and said three-phase induction motor.
- 25 4. An AC elevator control apparatus as claimed in Claim 1, wherein said power converting unit is



constructed to supply AC power of a fixed predetermined low frequency.

5. An AC elevator control apparatus as claimed in Claim 1, wherein said power converting unit is arranged to supply AC power of a plurality of predetermined different frequencies, and the AC power
5 of one of the plurality of predetermined frequencies corresponding to the position of the elevator car is selectable to be supplied to said induction motor.

6. An AC elevator control apparatus as claimed in Claim 1, wherein said power converting unit includes a converter for converting
10 the AC power supplied from said three-phase AC power source into DC power, and an inverter for converting said DC power into AC power at a frequency lower than that of said AC power source.

7. An AC elevator control apparatus as claimed in Claim 6, wherein said converter is arranged to convert AC power of selected single-
15 phase supplied from said three-phase AC power source into DC power, and said inverter is arranged to convert said DC power into single-phase AC power.

8. An AC elevator control apparatus as claimed in Claim 6, wherein said converter is arranged to convert AC power of a selected
20 single-phase supplied from said three-phase AC power source into DC power, and said inverter is arranged to convert said DC power into three-phase AC power.



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9. An AC elevator control apparatus as claimed in Claim 6, wherein said converter is constituted by a thyristor bridge circuit, and switch means are provided for inserting selected ones of the thyristors in said bridge circuit between said AC power source and said induction motor so as to control the motoring torque by said thyristors inserted between said AC power source and said induction motor.

10. An AC elevator control apparatus as claimed in Claim 9, wherein at least one of the thyristors constituting said bridge circuit is replaced by a bidirectional controlled element, and said bidirectional controlled element is inserted by said switch means between said AC power source and said induction motor.

11. An AC elevator control apparatus as claimed in Claim 6, wherein a transformer is connected between said AC power source and said converter.

12. An AC elevator control apparatus as claimed in Claim 6, wherein a transformer is connected between said inverter and said induction motor.

13. An AC elevator control apparatus for use in an AC elevator system including a three-phase AC power source, a three-phase induction motor, and an elevator car and a counterweight suspended from the opposite ends of a rope trained around a rotatable member and driven by said induction motor, said apparatus comprising:

a thyristor bridge circuit connected at its



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AC input terminals to said AC power source;

first switch means for acceleration purposes for short-circuiting terminals between DC sides of a selected one of the arms constituting said bridge circuit and connecting the short-circuited points to said induction motor when
5 said induction motor operates in a motoring mode;

an inverter connected at its AC output to said induction motor; and

second switch means for deceleration purposes for
10 connecting the DC side of said thyristor bridge circuit to the DC input of said inverter when said induction motor operates in a deceleration mode in response to the turning-off of said first switch means.

15 14. An AC elevator control apparatus for use in an AC elevator system including a three-phase power source, a three-phase induction motor, and an elevator car and a counterweight suspended from the opposite ends of a rope trained around a rotatable member and
20 driven by said induction motor, said apparatus comprising:

a full-wave bridge circuit connected at its AC input to said AC power source and including a bidirectional controlled element connected in at least
25 one of the arms thereof;

first switch means for acceleration purposes for connecting the DC output of said full-wave bridge circuit, which provides one end of said bidirectional



controlled element, to said induction motor when said induction motor operates in a motoring mode;

An inverter connected at its AC output to said induction motor; and

5 second switch means for deceleration purposes for connecting the DC output of said full-wave bridge circuit to the DC input of said inverter when said induction motor operates in a deceleration mode in response to the turning-off of said first switch means.

15. An AC elevator control apparatus as claimed in Claim 6,
10 wherein said converter is a forward converter for full-wave rectification of the AC power supplied from said AC power source; and

DC power supply means are connected to the DC input of said inverter.

16. An AC elevator control apparatus substantially as hereinbefore
15 described with reference to, and as illustrated in, Figures 1 to 4, or Figure 5; or Figure 6; or Figure 7; or Figure 8; or Figures 9 and 10; or Figures 9 and 10 as modified by Figure 11 of the accompanying drawings.

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