

APPARATUS FOR CONTROLLING AN ELEVATOR.

The present invention relates to an improved apparatus for computer control of an elevator.

In conventional elevator control apparatus electromagnetic devices and units such as
5 electromagnetic relays are mainly employed. Since electronic computers such as microcomputers have recently been developed, computers are also used for controlling elevators.

An elevator which is controlled by an electronic
10 computer has a number of advantages such as improved control performance, increased lifetime, energy saving and the like when compared with conventional elevators which employ electromagnetic relays. However, computer controlled elevators have a major drawback in that when
15 the computer malfunctions, the elevator cage generally becomes impossible to run, thereby causing passengers in the cage to be trapped in the cage.

The object of the present invention is to provide an elevator control apparatus in which the risk of
20 passengers becoming trapped is reduced.

The present invention resides in Apparatus for controlling the operation of an elevator cage which comprises:

a first electronic computer arranged to generate in
5 normal operation run commands and stop commands for said cage;

a second electronic computer arranged, in normal operation, to receive the run commands and the stop commands from said first computer and to generate a
10 command for controlling the speed of said cage;

a manual operating circuit capable of manual actuation for running said cage at low speed under manual control independently of the said computers;

defect detecting means for detecting a defect or
15 defects in said first or second computer when said first or second computers becomes or become defective;

the second computer being arranged to stop said cage at the nearest floor when a defect in said first computer is detected by said defect detecting means;
20 and

the first computer being arranged to actuate the manual operating circuit to run said cage at low speed to the nearest floor when a defect in said second computer is detected by said defect detecting means.

25 Thus a managing and a controlling electronic computer are provided, and the elevator cage is driven to the nearest floor by the controlling computer when

the managing computer malfunctions and the cage is driven to the nearest floor by the managing computer and the manual operating circuit when the controlling computer malfunctions, thereby allowing passengers in the cage to be safely rescued from the cage regardless of which computer malfunctions.

The apparatus can run the elevator cage to the nearest floor by manual operation even if both the controlling and managing computers malfunction.

10 The apparatus has a simple circuit configuration by employing a manual operating circuit for low speed automatic operation of the elevator cage when the second computer malfunctions, thereby eliminating the need for an exclusive operating circuit, effective only when
15 there is a malfunction.

In the accompanying drawings:-

Fig. 1 is a diagram showing the construction of an apparatus for controlling an elevator according to an embodiment of the present invention;

20 Fig. 2 is a circuit diagram of the apparatus;

Fig. 3 is a circuit diagram of a defect detector circuit of a second electronic computer in Fig. 1;

Fig. 4 is a waveform diagram showing input and output signals of Fig. 3;

Figs. 5A and 5B are flow charts of the operation of the program of the first and second electronic computers; and

Fig. 6 is a circuit diagram showing an example of a manual operating circuit and a manual pattern circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the invention will be described below in conjunction with Figs. 1 to 4.

In the drawings, reference character P denotes a positive electrode of a control power source, and N denotes a negative electrode of the power source. In Fig. 1, reference numeral 1 denotes a first electronic computer which generates a cage run instruction and a cage stop instruction to manage the service of an elevator cage 15 (to be described later), numeral 1A denotes a bus for its address and data, numeral 2 denotes a second electronic computer which calculates in accordance with instructions from the first computer 1 to generate a signal for controlling the speed of the cage 15, numeral 2A denotes its bus, numeral 3 denotes a transmission circuit which transmits and receives a signal between the computers 1 and 2, numeral 4 denotes a D/A converter which converts a digital signal inputted from the bus 2A into an analog signal, numeral 5 denotes a manual operating circuit for manually operating the cage 15, numeral 6 denotes a manual pattern circuit which generates a speed instruction at the manually operating time, numeral 7 denotes a defect detector circuit which detects a defect in the second computer 2, numeral 7a

denotes its input signal, and numeral 7b denotes its output signal. Reference numerals 8A to 8I denote an input/output converter hereinafter termed "I/F" of the computers 1 and 2, numeral 9 denotes a motor controller as disclosed in 5 Frederic Owen Johnson et al. Japanese Patent 1,103,157 (Patent Publication 56-39152) "Converter Apparatus" (correspond to U.S. Serial No. 238916), numeral 10 denotes an armature of a hoisting DC motor controlled by the controller 9 (a field is omitted), numeral 11 denotes an 10 electromagnetic brake which restricts the armature 10 by the force of a spring (not shown) when a brake coil 11A is deenergized and which allows the armature 10 to rotate when the brake coil 11A is energized, numeral 12 denotes a tachometer generator which is directly coupled to the 15 armature 10 and which generates a speed signal, numeral 13 denotes a sheave which is driven by the armature 10 for operating a hoisting machine, numeral 14 denotes a main cable which is laid over the sheave 13, numeral 15 denotes an elevator cage which is coupled to one end of the cable 14, 20 numeral 16 denotes a balance weight which is similarly coupled to the other end of the cable 14, numeral 17 denotes a storied floor, numeral 18 denotes an induction plate for detecting a door zone (a zone ^{within which it is possible to} ~~capable of opening and closing~~ a hall door) installed in a hoistway corresponding to the 25 floor 17, numeral 19 denotes a door zone detector which is provided on the cage 15 and which generates an output when it is adjacent to the plate 18, numeral 20 denotes calling signals such as a cage calling, a hall calling and the like, numeral 21 denotes an automatic and manual operation change- 30 over switch, numeral 22 denotes an upward button provided

in the cage 15, numeral 24 denotes an automatic operation relay with normal-open contacts 24a, 24b and normal-closed contacts 24c, 24d, numeral 25 denotes a high-speed-operation relay which includes normal-open contacts 25a, 26b and normal-closed contacts 25c, 25d, numeral 26 denotes a defect detecting relay of the second computer 2 which includes normal-open contacts 26a to 26c, numeral 27 denotes a brake releasing contactor which includes normal-open contacts 27a, 27b, numeral 28 denotes a defect detecting relay of the first computer 1 which includes normal-open contact 28a and normal-closed contact 28b, and numeral 29 a door control relay which generates a door opening instruction when the relay 29 is energized and generates a door closing instruction when the relay 29 is deenergized.

In Fig. 3, reference numeral 71 denotes a monostable element which produces a high output "H" for a predetermined period of time when an input signal 7a goes high "H" and which is retriggerable, numeral 72, 73 denotes resistors, and numeral 74 denotes a transistor. In Figs. 5A and 5B, reference numerals 31 to 34 denote the operating sequence of the second computer 2.

The operation of this embodiment of the invention will be described here below.

25 A. Manual Operation

When the changeover switch 21 is opened for check and maintenance purposes or the like of the elevator, the automatic operation relay 24 is deenergized, its contacts 24a and 24b are opened, and its contacts 24c and 24d are closed. Since the high speed operation relay 25 is deenergized by the opening of the contact 24a and its contact 25c is closed, the manual pattern circuit 6 is connected to the motor controller 9, and its contact 25d is closed to connect the manual operating circuit 5 to the brake releasing contactor 27.

When a maintenance operator depresses the upward button 22, the manual operating circuit 5 is operated in a circuit of the P-22-24c-5. Thus, the brake releasing contactor 27 is energized, its contacts 27a and 27b are closed. Then, the brake coil 11A is energized, and the electromagnetic brake 11 is released. Thus, the restriction of the armature 10 is released, and the armature 10 is rotated in an upward elevation direction of the elevator cage 15 in accordance with the output of the manual pattern circuit 6. In this manner, the cage 15 is moved upwardly. When the operator releases his finger from the upward button 22, the operation of the manual operating circuit 5 is stopped, and the manual pattern circuit 6 does not generate an output. Simultaneously, the brake releasing contactor 27 is deenergized and its contacts 27a and 27b are opened. Therefore, the brake coil 11A is deenergized, and the brake 11 restricts the armature 10. Thus, the cage 15 is stopped.

In case the downward button 23 is depressed, the manual operating circuit 5 is operated in a circuit of the P-23-24d-5, and the armature 10 is rotated similarly to the above-described operation to downwardly convey the cage 15. Thus, the cage 15 is moved downwardly.

B. Automatic Operation

When the changeover switch 21 is closed, the automatic operation relay 24 is energized, its contacts 24a and 24b are closed, and its contacts 24c and 24d are opened. In case the second computer 2 is normally operating, a pulse train 7a is periodically produced from the computer 2

as shown in Fig. 4. Therefore, the output of the monostable element 71 becomes "H", the transistor 74 is turned on causing its output signal 7b to be "L", the defect detecting relay 26 is energized, and its contacts 26a to 26c are closed. Thus, the high speed operation relay 25 is energized in the circuit of the P-24a-26a-25-N, its contacts 25a and 25b are closed, and its contacts 25c and 25d are closed. The D/A converter 4 is connected to the motor controller 9 by the closure of the contact 25a, and the I/F 8A is connected to the brake releasing contactor 27 by the closure of the contact 25b.

On the other hand, in case the first computer 1 is normally operated, a signal is periodically applied to the second computer 2 through the transmission circuit 3. The second computer 2 operates by this signal, as shown in Fig. 5B. More particularly, in step 31', whether or not the second computer 1 receives a signal from the first computer 2 is determined. When the second computer 2 receives the signal from the first computer 1, the operation of the I/F 8D is stopped in step 37'. Thus, the defect detecting relay 28 is deenergized, its contact 28a is opened, and its contact 28b is closed. The I/F 8F is connected to the door control relay 29 by the closure of the contact 28b, and the opening and closing operations of the door are performed by the first computer 1.

When a calling signal 20 is generated and is read by the first computer 1 through the I/F 8I, the computer 1 supplies a run command to the second computer 2 via the transmission circuit 3. Thus, the computer 2

generates an output through the I/F 8A, the brake releasing contactor 27 is energized, and the brake 11 is released as described before. The computer 2 supplies a digital speed instruction signal to the D/A converter 4. In this manner, the speed instruction signal is converted into an analog amount, and is applied to the motor controller 9 through the contact 25a. Thus, the armature 10 is precisely automatically controlled by the above-described speed instruction signal and by a speed signal from the tachometer generator 12, and the cage 15 is caused to run. When the cage 15 approaches the storied floor 17 from which the cage 15 is called, the first computer 1 generates a stop command, so that the second computer 2 generates a speed command for stopping the cage 15, and the cage 15 is decelerated and stopped at the floor 17. When the door zone detector 19 is adjacent to the induction plate 18, an output signal is generated. This output signal is read by the first computer 1 through the I/F 8H. Then, the computer 1 produces an output through the I/F 8F, the door control relay 29 is thus energized, and the door of the cage 15 is opened.

C. Second Computer 2 Becomes Defective During Automatic Operation

In case the second computer 2 becomes defective, the pulse train 7a is not generated, as shown in Fig. 4. Therefore, the output of the monostable element 71 becomes "L", its output signal 7b becomes "H", the defect detecting relay 26 is deenergized, and the contacts 26a to 26c are opened. When the contacts 26a is opened, the high speed

operation relay 25 is deenergized, its contact 25a is opened, and its contact 25c is closed. Accordingly, the motor controller 9 of the manual pattern circuit 6 is connected instead of the D/A converter 4. Since the

5 contact 25b is opened, the brake releasing contactor 27 is deenergized, the brake coil 11A is deenergized, the brake 11 is operated, and the cage 15 is abruptly stopped. When the contact 26b is opened, its signal is loaded to the first computer 1 through the I/F 8C, the defect of the

10 second computer 2 is detected, as shown in the step 31 of Fig. 5A. As a result, the first computer 1 generates an output through the I/F 8B, as shown in step 32, and the manual operating circuit 5 is operated through the contact 24b, as shown in step 33. Thus, the brake releasing

15 contactor 27 is energized, the manual pattern circuit 6 is operated, and the cage 15 is conveyed at a low speed in accordance with the output from the manual pattern circuit 6 in the same manner as in the manual operation. The running direction of the cage 15 in this case may be either in a

20 upward or downward direction, and an arbitrary direction may be programmed accordingly into the first computer 1. When the contact 26c further remains open, the defect detecting relay 28 is disconnected, and the operation of the door control relay 29 is effectively conducted via the

25 first computer 1.

When the cage 15 arrives at the nearest floor 17 and the door zone detector 19 is adjacent to the induction plate 18, as shown in step 34, the first computer 1 stops the I/F 8B to disconnect a command to the manual operating

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circuit 5. Thus, the cage 15 is stopped. Simultaneously, the computer 1 generates an output through the I/F 8F, the door control relay 29 is energized through the contact 28b, and the door of the cage 15 is opened. Therefore, passengers in the cage can be rescued.

As described above, when the second computer 2 becomes defective, the cage 15 is automatically run at a low speed to the nearest floor by the first computer 1 and the manual operating circuit 5.

10 D. First Computer Becomes Defective During Automatic Operation

In case the first computer 1 becomes defective, a signal from the transmission circuit 3 to the second computer 2 does not appear for a relatively long period of time. Thus, the second computer 2 is operated, as shown in Fig. 5B. More particularly, as shown in step 31', the fact that the above-described signal is not received is detected, and the I/F 8D is operated as shown in step 32'. Since the contact 26c is closed at this time, the defect detecting relay 28 is energized, the contact 28a is closed, and the contact 28b is opened. Then, the I/F 8E is connected to the door control relay 29 by the closure of the contact 28a, and the opening and closing operations of the door of the cage 15 can be carried out by the second computer 2.

25 Then, the second computer 2 generates a stop command to be generated from the first computer 1 as shown in step 33' of Fig. 5B. The cage 15 thus arrives at the nearest floor 17, the door zone detector 19 generates an output signal. In step 35', this signal is inputted to the second computer 2

through the I/F 8G. Then, as shown in step 36', the computer 2 generates an output through the I/F 8E, and energizes the door ^{control} relay 29 through the contact 28a. Therefore, the door of the cage 15 is opened, and the passengers in the cage 15 can be rescued.

In this manner, when the first computer 1 becomes defective, the cage 15 is conveyed to the nearest floor by the second computer 2.

Even for the case where both the first and second computers 1 and 2 become defective, the switch 21 is opened, so that the cage 15 can be conveyed by the manual operation with the upward button 12 or the downward button 23, thereby readily returning to the normal operation.

Fig. 6 illustrates the internal constructions of the manual operating circuit 5 and the manual pattern circuit 6.

Reference numerals 51 to 54 denote transistors, numerals 55 and 56 denote inverters, numerals 57 and 58 denote NAND gates, numerals R511 to R513, R521 to R523, R531, R532. R611 to R613, R621, R622, R631, R632, R651, R652, R661 to R664 denote resistors, numeral D531 denotes a diode, numerals 61 to 63 denote transistors, numeral 64 to 66 denote operational amplifiers, numeral C611 denotes a capacitor, and Vcc denotes a power source for the logic circuit.

Operation of this embodiment of Fig. 6 will be described below as exemplified in the case that a maintenance operator depresses the downward button 23 at the manual operating time.

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When the downward button 23 is depressed, a circuit of P-23-24d-R511-51 is formed, the transistor 51 is thereby conductive and a signal to the NAND gate 57 becomes "L". Thus, the output of the NAND gate 57 becomes "H", the output of the inverter 55 becomes "L", the output of the NAND gate 58 becomes "H", the diode D531 becomes non-conductive, and the transistors 53 and 54, which are connected in a Darlington manner become conductive. In this manner, the manual operating circuit 5 is operated, and the brake releasing contactor 27 is energized.

The "H" output of the NAND gate 58 is inverted to "L" by the inverter 56, a current from the power source Vcc is allowed to flow through the diode D611, the transistor 61 thus goes into a non-conductive state, and the capacitor C611 starts charging through the resistor R613. The operational amplifier 64 serves as a voltage follower. In other words, the amplifier 64 operates as an amplifier having a gain of 1 and having a high input impedance and a low output impedance. Therefore, the voltage on the output of the operational amplifier 64 increases with the charging of the capacitor C611.

On the other hand, the transistor 62 becomes non-conductive due to the output "L" of the inverter 55. Since the downward button 23 is now depressed and the upward button 22 is not depressed, the transistor 52 is non-conductive, causing the transistor 63 to be conductive and the input to the operational amplifier 65 is short-circuited causing its output to become zero.

The output of the operational amplifier 64 is applied to the operational amplifier 66 through the resistors R661 and R662. Since the operational amplifier 66 is an inverting amplifier, a negative polarity instruction pattern is generated, and the elevator is operated in accordance with this pattern.

In case the upward button 22 is depressed, the output of the inverter 55 becomes "H", the transistor 62 is conductive, and the transistor 63 is off. In this manner, the output of the operational amplifier 64 is inverted in polarity by the operational amplifier 66. Accordingly, this output is again inverted in polarity by the operational amplifier 6 to generate a positive polarity manual pattern, and the motor is driven in accordance with this positive polarity manual pattern.

In case the second computer 2 becomes defective, a signal which is applied from the first computer 1 through the contact 24b is inputted to the NAND gate 57, the cage 15 is conveyed at a low speed in the same manner described for the manual operation in a downward direction, and arrives at the nearest floor 17.

In the above described embodiment, the cage 15 travels downward. However, it is not intended to limit this invention to only a downward direction and the cage 15 could be made to move upward.

CLAIMS:

1. Apparatus for controlling the operation of an elevator cage which comprises:

a first electronic computer arranged to generate in normal operation run commands and stop commands for said cage;

a second electronic computer arranged, in normal operation, to receive the run commands and the stop commands from said first computer and to generate a command for controlling the speed of said cage;

a manual operating circuit capable of manual actuation for running said cage at low speed under manual control independently of the said computers;

defect detecting means for detecting a defect or defects in said first or second computer when said first or second computers becomes or become defective;

the second computer being arranged to stop said cage at the nearest floor when a defect in said first computer is detected by said defect detecting means; and

the first computer being arranged to actuate the manual operating circuit to run said cage at low speed to the nearest floor when a defect in said second computer is detected by said defect detecting means.



2. Apparatus as set forth in claim 1 wherein said defect detecting means comprises a first defect detector for detecting a defect in said first computer when said first computer stops supplying a signal to said second
5 computer.

3. Apparatus as set forth in claim 2 wherein said first defect detector comprises the second computer and detects a defect in said first computer by detecting the interruption of signals supplied from said first
10 computer.

4. Apparatus as set forth in claim 1, 2 or 3 wherein said defect detecting means comprises a second defect detector for detecting a defect in said second computer by detecting the presence or absence of an operation
15 signal generated in said second computer.

5. Apparatus as set forth in claim 4 wherein said second defect detector comprises a monostable element which is controlled by an operation signal generated in said second computer.

20 6. Apparatus as set forth in any preceding claim wherein said second computer is arranged to generate a stop command when a defect in said first computer is detected.



7. Apparatus as set forth in claim 6 wherein said second computer is arranged to generate a speed control signal for stopping said cage at the nearest floor when the stop command is generated.

5 8. Apparatus as set forth in claim 7 wherein said second computer is arranged to generate a command for opening the door of said cage when said cage arrives in a predetermined door opening and closing zone of the nearest floor.

10 9. Apparatus as set forth in any preceding claim wherein said first computer is arranged to supply an operation signal to said manual operating circuit when said defect detecting means detects a defect in said second computer, thereby causing said cage to run at a
15 low speed to the nearest floor.

10. Apparatus as set forth in claim 9 wherein said first computer stops supplying the operation signal to said manual operating circuit when said cage running at the low speed arrives at a predetermined door opening and
20 closing zone of the nearest floor.



11. Apparatus as set forth in claim 9 or 10 wherein said manual operating circuit is arranged to generate a signal for stopping the running of said cage when the input of the operation signal is interrupted.
- 5 12. Apparatus as set forth in claim 9, 10 or 11 wherein said first computer is arranged to generate a command for opening the door of said cage when said cage running at a low speed arrives at the door opening and closing zone of the nearest floor.
- 10 13. Apparatus as set forth in any preceding claim wherein said apparatus further comprises door opening and closing control means, which is controlled by said second computer when said first computer becomes defective and which is controlled by said first computer
15 when said second computer becomes defective.
14. Apparatus as set forth in any preceding claim wherein said apparatus further comprises a changeover switch for switching between fully manual operation and automatic computer-controlled operation.
- 20 15. Apparatus as set forth in claim 14 wherein when said changeover switch is switched to manual operation said elevator is operated by said manual operating circuit and is disconnected from said first and second computers.



16. Apparatus as set forth in any preceding claim
 wherein said apparatus further comprises a brake means
 for stopping the running of said cage wherein said brake
 means is driven to stop the running of said cage when
 5 said defect detecting means detects a defect in said
 second computer.

17. Apparatus as set forth in claim 16 wherein said
 brake means is connected to said manual operating
 circuit and is controlld thereby when a defect in said
 10 second computer is detected.

18. Elevator control apparatus substantially as herein
 described with reference to the accompanying drawings.

