

(19)



(11)

EP 3 604 190 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:

08.01.2025 Bulletin 2025/02

(21) Application number: **17901590.4**

(22) Date of filing: **17.11.2017**

(51) International Patent Classification (IPC):

B66B 1/24 (2006.01) B66B 1/18 (2006.01)

(52) Cooperative Patent Classification (CPC):

B66B 1/18; B66B 1/2458

(86) International application number:

PCT/JP2017/041390

(87) International publication number:

WO 2018/173363 (27.09.2018 Gazette 2018/39)

(54) **ELEVATOR MANAGEMENT SYSTEM, AND METHOD FOR MANAGING ELEVATOR**

AUFZUGSVERWALTUNGSSYSTEM UND VERFAHREN ZUR VERWALTUNG EINES AUFZUGS

SYSTÈME DE GESTION D'ASCENSEUR ET PROCÉDÉ DE GESTION D'ASCENSEUR

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **23.03.2017 JP 2017058235**

(43) Date of publication of application:

05.02.2020 Bulletin 2020/06

(73) Proprietor: **Hitachi, Ltd.**

Tokyo 100-8280 (JP)

(72) Inventors:

- **NAYA, Hidemitsu**
Tokyo 100-8280 (JP)
- **HOSHINO, Takamichi**
Tokyo 100-8280 (JP)

- **HATORI, Takahiro**
Tokyo 100-8280 (JP)

(74) Representative: **MERH-IP Matias Erny Reichl**

Hoffmann
Patentanwälte PartG mbB
Paul-Heyse-Straße 29
80336 München (DE)

(56) References cited:

CN-A- 106 315 319 GB-A- 2 245 997
GB-A- 2 246 214 JP-A- 2011 057 325
JP-A- 2011 057 325 JP-A- 2012 180 185
JP-A- 2014 152 032 JP-A- H0 428 680
JP-A- H06 329 352 US-A- 5 767 461

- **DATABASE WPI Week 201124, Derwent World**
Patents Index; AN 2011-D07512

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

TECHNICAL FIELD

[0001] The present invention relates to an elevator management system and an elevator management method and relates to, for example, an elevator management system for managing a plurality of cages, which operate between a plurality of floors, as a group.

BACKGROUND ART

[0002] Conventionally, this type of elevator management system moves cages between the lowest floor and the highest floor so that the distances between the plurality of cages in a gravity direction become equal. However, when some cages are delayed as many passengers get into and out of the cages, the plurality of cages cannot be operated uniformly and this may result in the occurrence of situations, for example, where the plurality of cages stop at the same floor at the same timing and waiting time at other floors become long.

[0003] So, PTL 1 proposes an invention for controlling an elevator management system so that cage waiting time at each floor becomes uniform in order to enhance cage operation efficiency. While this invention is premised on repetitive operation of each of the plurality of cages between the lowest floor and the highest floor, the invention is designed so that the positions and moving directions of the cages after a specified amount of time are set and the cages are operated in accordance with the set positions and moving directions. PTL 2 discloses an elevator control apparatus which uses a neural net to evaluate the car delay which would result from allocation of a hall call to each car. The apparatus includes an input data conversion unit for convening traffic data, including a position of the car, a direction of a movement and calls to be responded, into data that can be used as input data to the neural net. The neural net includes an input layer for taking in the input data, an output layer for outputting the estimated travel time, and an intermediate layer provided between said input and output layers and in which weighting factors are applied in combining signals from the nodes of the input layer and in distributing signals to the output nodes. The weighting factors are variable through a learning process which compares estimated and actual travel times. Different sets of weighting factors may be applied at different times of the day or under different detected conditions of passenger traffic.

[0004] PTL 3 discloses an elevator management system according to the preamble of claim 1 and an elevator management method according to the preamble of claim 6.

CITATION LIST

PATENT LITERATURE

[0005]

PTL 1: Japanese Patent No. 4139819

PTL 2: GB 2 246 214 A

PTL 3: JP 2011 057325 A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] The problem of the conventional elevator management system is that the operation of the cages may become wasteful. Therefore, the present invention aims at proposing an elevator management system and elevator management method for efficiently operating the cages.

MEANS TO SOLVE THE PROBLEMS

[0007] In order to solve the above-described problem, the present invention provides an elevator management system according to claim 1.

[0008] Furthermore, the present invention provides an elevator management method according to claim 6.

ADVANTAGEOUS EFFECTS OF THE INVENTION

[0009] The elevator management system and the elevator management method for operating the cages efficiently can be implemented according to the present invention.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

Fig. 1 is a block diagram illustrating the configuration of an elevator management system according to this embodiment;

Fig. 2 is a schematic diagram illustrating a main part of a schematic structure of an elevator apparatus according to this embodiment;

Fig. 3 is a diagram illustrating operation routes for the elevator apparatus according to this embodiment;

Fig. 4 is a conceptual diagram for explaining learning according to this embodiment;

Fig. 5 is a conceptual diagram illustrating the configuration of an operation data table according to this embodiment;

Fig. 6 is a conceptual diagram illustrating the configuration of a learning data table according to this embodiment;

Fig. 7 is a flowchart illustrating a processing sequence for operation data storage processing;

Fig. 8 is a flowchart illustrating a processing sequence for operation data learning processing;

Fig. 9 is a flowchart illustrating a processing sequence for operation route determination processing;

Fig. 10 is a flowchart illustrating a processing sequence for operation instruction processing;

Fig. 11 is a flowchart illustrating a processing sequence for operation route correction processing during operation;

Fig. 12 is a flowchart illustrating a processing sequence for operation route correction processing while a door is open;

Fig. 13 is a block diagram illustrating the configuration of an elevator management system according to another embodiment;

Fig. 14 is a block diagram illustrating the configuration of an elevator management system according to another embodiment;

Fig. 15 is a block diagram illustrating the configuration of an elevator management system according to another embodiment; and

Fig. 16 is a block diagram illustrating the configuration of an elevator management system according to another embodiment.

DESCRIPTION OF EMBODIMENTS

[0011] (1) Configuration of Elevator Management System According to This Embodiment Referring to Fig. 1, the reference numeral 1 represents an elevator management system according to this embodiment. This elevator management system 1 is configured by including a management server 2 for managing a plurality of elevators 3. The management server 2 and the plurality of elevators 3 are connected via a communication path 19 such as an intranet.

[0012] The management server 2 is a management apparatus that acquires operation data of each elevator 3 via a receiving circuit, learns the operation status of each elevator 3 from the acquired operation data, and manages the operation of each elevator 3 by outputting management information via an output circuit. The management server 2 is configured by including a CPU (Central Processing Unit) 4, an auxiliary storage apparatus 5, and a memory 6.

[0013] The CPU 4 is a processor (controller) that controls the operation of the entire management server 2. The auxiliary storage apparatus 5 is composed of, for example, large-capacity nonvolatile storage devices such as hard disk drives and SSDs (Solid State Drives) and is used to store programs and data for a long period of time. Some of storage areas provided by this auxiliary storage apparatus 5 are used as an operation data table TB10 and a learning data table TB20 described later.

[0014] The memory 6 is composed of, for example, a volatile semiconductor memory, is also used as a work memory for the CPU 4, and includes an operation storage

module 7, an operation learning module 8, a route determination module 9, and a route instruction module 10. Incidentally, the memory 6 may accumulate and record the operation data as appropriate.

[0015] Each elevator 3 operates to lift and lower a cage 12 in a hoistway installed in a building between boarding places provided respectively at floor levels of, for example, a first floor to a seventh floor as illustrated in Fig. 2.

[0016] This cage 12 is attached to one end side of a primary rope 13, to the other end side of which a counterbalancing weight 14 is attached. Furthermore, the primary rope 13 is wound around a hoist 15. The hoist 15 is a hoisting mechanism for driving the cage 12 to lift and lower it and is installed together with a control apparatus for controlling hoisting operation of the cage 12 (hereinafter referred to as an elevator control apparatus) 11 in a machine room provided above the hoistway.

[0017] The elevator control apparatus 11 (Fig. 1) is a computer apparatus for controlling the operation of the cage 12 and controls the hoist 15 to lift and lower the cage 12 in response to a passenger's operation (cage call information) of a call button 16 (Fig. 2) provided at a boarding place.

[0018] The elevator 3 is inefficient because it is difficult for the elevator 3 to judge in which time slot and through which route the cage 12 does not have to operate; however, the elevator 3 is normally operated in such a manner that the cage 12 can be operated from the highest floor to the lowest floor. According to the present invention, the elevator management system 1 is equipped with a learning function in order to make the above-described judgment.

[0019] Next, the learning function mounted in the management server 2 of the elevator management system 1 will be explained. Incidentally, the learning function performs, for example, deep learning.

[0020] The learning function of the elevator management system 1 learns an operation tendency by predicting the operation status of the call button 16 and a destination floor designating button of each cage 12 a specified amount of time later (for example, 5 minutes later as a cycle for the cage 12 to make one run along a traveling route) after accepting the cage call information of each floor level and/or the operation of the destination floor designating button of each cage 12 (destination floor designating information).

[0021] Fig. 3 illustrates an example of the learning function. Arithmetic operation are performed by applying weighting to between neurons (circles in Fig. 3) in adjacent layers (columns in Fig. 3). Regarding this learning function, after an array of as many dimensions as the number of inputs to the call button 16 of each floor level and the destination floor designating button of each cage 12 is input, the management server 2 performs specified arithmetic operations in a plurality of hidden layers and an output layer. Incidentally, there is one input layer for a floor level where the input is performed; and there is one output layer for a floor level where the output is per-

formed. Also, a plurality of hidden layers exist between the input layer and the output layer.

[0022] Then, as a result of the arithmetic operations, the management server 2 outputs an array of as many dimensions as the number of inputs to the call button 16 at each floor level and the destination floor designating button of each cage 12. Incidentally, a specified arithmetic operation(s) in the hidden layers is, for example, an arithmetic operation(s) using activation functions such as a Sigmoid function, a hyperbolic tangent function, and a ramp function. Furthermore, a specified arithmetic operation(s) in the output layer is, for example, an arithmetic operation(s) using a Softmax function and so on.

[0023] Referring to Fig. 3, when the cage 12 moving up is called at the 1st floor and the cage 12 moving up and the cage 12 moving down are called at the 2nd floor, the management server 2 predicts how the cage 12 will be called in the next cycle, according to this learning function.

[0024] In this case, the management server 2 predicts that the cage 12 moving up will be called at the 2nd floor and the cage 12 moving down will be called at the 4th floor in the next cycle.

[0025] Incidentally, referring to Fig. 3, "o" represents a case where the button is pressed; and "x" represents a case where the button is not pressed. Furthermore, regarding each floor level, "↑" represents a button when calling the cage 12 moving up at the boarding place; "↓" represents a button when calling the cage 12 moving down at the boarding place; and "→" represents a button when a passenger is getting off from the cage 12 at the relevant floor. Incidentally, since Fig. 3 illustrates an example of the case where there is only one cage 12, there is one row of "→" for each floor; however, there may be a plurality of cages 12.

[0026] In the case of the prediction in Fig. 3, the management server 2 predicts, by means of deep learning, that the cage 12 will not be called from the 4th floor to the 7th floor during a period of time required for the cage 12 to make one run along the route. The management server 2 issues an instruction to the elevator control apparatus 11 to operate the cage 12 along an operation route with the 4th floor as a destination floor as indicated with a solid line in Fig. 4. Specifically speaking, the management server 2 issues an instruction to the elevator control apparatus 11 to invert a traveling direction of the cage 12 after waiting time for a passenger(s) to get on and/or off the cage 12 at the 4th floor. Incidentally, a broken line in Fig. 4 indicates a conventional operation route and the cage reaches to the 7th floor which is the highest floor according to the conventional operation.

[0027] As means for implementing the above-described learning function, as illustrated in Fig. 1, the memory 6 of the management server 2 stores the operation storage module 7, the operation learning module 8, the route determination module 9, and the route instruction module 10 and the auxiliary storage apparatus 5 of the management server 2 stores the operation data table

TB10 and the learning data table TB20.

[0028] The operation storage module 7 is a program having a function that acquires the operation data from the elevator control apparatus 11 of each elevator 3, for example, every day and stores the acquired operation data in the operation data table TB10.

[0029] The operation learning module 8 is a program that performs learning as illustrated in Fig. 3 on the basis of the operation data acquired from the operation data table TB10, for example, for one year every year and changes, for example, necessary values for learning such as a weight value as illustrated in Fig. 3. Furthermore, the operation learning module 8 records the status of the call button 16 at each floor level and the status of the destination floor designating button of each cage 12 which are calculated as a learning result (the learning result) in the learning data table TB20. Incidentally, the learning result is calculated for each combination of the status of the call button 16 at each arbitrary floor level and the status of the destination floor designating button of each cage 12.

[0030] The route determination module 9 is a program that acquires the learning result from the learning data table TB20 and determines the operation route of the cage 12. The route determination module 9 derives a route which can be omitted and along which the cage 12 does not have to be operated, from each learning result and determines a route which does not pass through the above-mentioned route, as a shortened route, to be the operation route of the cage 12.

[0031] For example, in a case of the learning result as illustrated in an input row and an output row in Fig. 6, the route determination module 9 recognizes that it is unnecessary to pass through the 2nd floor to the 7th floor regarding either the input row or the output row.

[0032] Accordingly, the route determination module 9 determines the shortened route, which does not pass through the 2nd floor to the 7th floor, as the operation route of the cage 12. Incidentally, if there is no route which can be omitted, the route determination module 9 determines the normal route along which the cage 12 moves between the lowest floor and the highest floor, as the operation route of the cage 12.

[0033] The route instruction module 10 is a program that corrects the operation route determined by the route determination module 9 according to the position, traveling direction, etc. of each cage which are given from the elevator control apparatus 11 of each elevator 3. For example, when the call button 16 is pressed within the operation route where the cage 12 has not passed through yet during the operation of the cage 12, or when something which has not occurred yet is predicted while the door for the cage 12 is open, the operation route of the cage 12 is corrected and this corrected operation route is transmitted as the management information to the elevator control apparatus 11 of the elevator 3.

[0034] Incidentally, when the operation route of the cage 12 does not have to be corrected, the route instruc-

tion module 10 transmits the operation route determined by the route determination module 9, without any change, to the elevator control apparatus 11 of the elevator 3. Furthermore, the route instruction module 10 determines one or more cages 12 to be operated from among the plurality of cages 12 according to the operation route determined by the route determination module 9.

[0035] The operation data table TB10 stores, as illustrated in Fig. 5, the status of the call button 16 at each floor level (the cage call information) and the status of the destination floor designating button of each cage 12 (the destination floor designating information) as the operation data every 5 minutes (time required to make one run along the route). Incidentally, "o", "x", "↑", "↓", and "→" in Fig. 5 have the same meanings as those in Fig. 3.

[0036] Similarly, the learning data table TB20 stores, as illustrated in Fig. 6, the status of the call button 16 at each arbitrary floor level and the status of the destination floor designating button of each cage 12 as inputs and the status of the call button 16 at each floor level and the status of the destination floor designating button of each cage 12 five minutes later (time required to make one run along the route) as outputs. Incidentally, "o", "x", "↑", "↓", and "→" in Fig. 6 have the same meanings as those in Fig. 3.

(2) Various Kinds of Processing by Management Server

[0037] Next, various kinds of processing executed by the above-described management server 2 will be explained. Incidentally, a processing subject of the various kinds of processing will be hereinafter explained as a "program"; however, it is needless to say that practically the CPU 4 executes the processing based on the "program."

[0038] Fig. 7 illustrates a processing sequence for operation data acquisition processing executed by the operation storage module 7. The operation storage module 7 acquires the operation data from the elevator control apparatus 11 of each elevator 3 according to the processing sequence illustrated in this Fig. 6.

[0039] Practically, the operation storage module 7 starts the operation data acquisition processing illustrated in this Fig. 7, for example, at a set time every day.

[0040] Then, the operation storage module 7 firstly acquires the operation data for one day from the elevator control apparatus 11 of each elevator 3 (S11). Subsequently, the operation storage module 7 stores the operation data for one day in the operation data table TB10 (S12) and terminates the operation data acquisition processing.

[0041] Fig. 8 illustrates a processing sequence for operation data learning processing executed by the operation learning module 8. The operation learning module 8 learns the status of the call button 16 at each floor level and the status of the destination floor designating button of each cage 12 five minutes later (time required to make one run along the route) (the learning result) with

respect to the status of the call button 16 at each arbitrary floor level and the status of the destination floor designating button of each cage 12 in accordance with the processing sequence illustrated in this Fig. 8 based on the operation data acquired from the operation data table TB10.

[0042] Practically, the operation learning module 8 starts the operation data learning processing, for example, at a set time of the year every year.

[0043] Then, the operation learning module 8 firstly acquires the operation data for one year from the operation data table TB10 and learns based on the acquired operation data (S15). Subsequently, the operation learning module 8 stores the learning result as learning data in the learning data table TB20 (S16) and terminates the operation data learning processing.

[0044] Fig. 9 illustrates a processing sequence for operation route determination processing executed by the route determination module 9. The route determination module 9 determines the operation route of the cage 12 in accordance with the processing sequence illustrated in this Fig. 9.

[0045] Practically, after the operation data learning processing terminates, the route determination module 9 starts the operation route determination processing illustrated in this Fig. 9.

[0046] Then, the route determination module 9 firstly acquires the learning data from the learning data table TB20 (S21). Subsequently, the route determination module 9 judges whether or not there is any route which can be omitted, with respect to each learning result (S22). When a negative result is obtained in this judgment, the route determination module 9 transmits the normal route as the operation route to the route instruction module 10 and terminates the operation data learning processing.

[0047] On the other hand, when an affirmative result is obtained in the judgment of step S22 because there is a route which can be omitted, the route determination module 9 generates a shortened route by omitting that route (S23), transmits the shortened route to the route instruction module 10, and terminates the operation data learning processing.

[0048] Fig. 10 illustrates a processing sequence for operation instruction processing executed by the route instruction module 10. The route instruction module 10 designates the operation route to the cage 12 in accordance with the processing sequence illustrated in this Fig. 10.

[0049] Practically, after receiving the passenger's operation on the call button 16 from the elevator control apparatus 11 of the elevator 3, the route instruction module 10 starts the operation route correction processing during operation as illustrated in this Fig. 10.

[0050] Then, the route instruction module 10 firstly determines the cage 12 to be operated (S25). Subsequently, the route instruction module 10: transmits the operation route to the elevator control apparatus 11 which controls the relevant cage 12 (S26); and terminates the

operation instruction processing. Then, the elevator control apparatus 11 which has received the operation route operates the cage 12 in accordance with this operation route.

[0051] Fig. 11 illustrates a processing sequence for operation route correction processing during operation, which is executed by the route instruction module 10. The route instruction module 10 corrects the operation route of the cage 12 in accordance with the processing sequence illustrated in this Fig. 11.

[0052] Practically, after the operation instruction processing terminates and the route instruction module 10 receives the passenger's operation on the call button 16 at a boarding place within the operation route of the cage 12, whose operation is designated by this operation instruction processing, from the elevator control apparatus 11, the route instruction module 10 starts the operation route correction processing during operation as illustrated in this Fig. 11.

[0053] Then, the route instruction module 10 firstly acquires the position and traveling direction of the cage 12 from each elevator control apparatus 11 and judges whether there is any cage 12 approaching to the relevant boarding place or not (S31). When an affirmative result is obtained in this judgment because there is a cage 12 approaching to that boarding place, the route instruction module 10 terminates the operation route correction processing during operation. Since this approaching cage 12 stops at the relevant boarding place, the control by the management server 2 becomes no longer necessary.

[0054] On the other hand, when a negative result is obtained in the judgment of step S31 because there is no cage 12 approaching, the route instruction module 10 selects a cage 12 closest to the boarding place (S32). Subsequently, the route instruction module 10: transmits an instruction to the elevator control apparatus 11, which controls the selected cage 12, to invert the traveling direction of the relevant cage 12 (S33); and terminates the operation route correction processing during operation.

[0055] Fig. 12 illustrates a processing sequence for operation route correction processing executed by the route instruction module 10 while the door is open. The route instruction module 10 corrects the operation route of the cage 12 in accordance with the processing sequence illustrated in this Fig. 12.

[0056] Practically, after the operation instruction processing terminates and the route instruction module 10 receives a button pressing operation, which has not occurred yet with respect to the cage 12 (and which should have occurred according to the prediction based on the learning result), from the elevator control apparatus 11 while the door of the cage 12 which has been designated to operate according to this operation instruction processing is opened (hereinafter referred to as door-opened time), the route instruction module 10 starts the operation route correction processing while the door

is open as illustrated in this Fig. 12.

[0057] Then, the route instruction module 10 firstly judges whether or not time elapsed from the time when the button pressing operation should have occurred to this door-opened time is equal to or less than a specified value (S41). When the specified amount of time has passed and the route instruction module 10 judges that an error in the prediction based on the learning result cannot be corrected, and when a negative result is thereby obtained in this judgment, the route instruction module 10 terminates the operation route correction processing while the door is open.

[0058] On the other hand, when the specified amount of time has not passed and the route instruction module 10 judges that the error in the prediction based on the learning result can be corrected, and when an affirmative result is thereby obtained in the judgment of step S41, the route instruction module 10: transmits an instruction to the elevator control apparatus 11, which controls this cage 12, to extend the time to open the door (S42); and then terminates the operation route correction processing while the door is open.

(3) Advantageous Effects of This Embodiment

[0059] With the elevator management system 1 according to this embodiment as described above, the management server 2 issues the instruction to each elevator 3 to operate by omitting any route which can be omitted, by predicting, based on the learning data, how each elevator will operate in the next cycle.

[0060] Therefore, this elevator management system 1 makes it possible to apply the operation according to the status of use to the cage(s) 12 without any alterations or the like of programs and the cage(s) 12 can be operated efficiently.

(4) Other Embodiments

[0061] Incidentally, the aforementioned embodiment has described the case where the elevator management system 1 to which the present invention is applied is configured as illustrated in Fig. 1; however, the present invention is not limited to this example and a wide variety of other configurations can be applied as the configurations of these elevator management systems.

[0062] For example, as illustrated in Fig. 13, an elevator management system 20 may be configured to connect the management server 2 with each elevator 3 via a communication network 21 such as the Internet. In this case, the management server 2 is a cloud server or a server apparatus installed at a data center. The management server 2 is connected to the elevators 3 via the communication network 21, communication equipment 22, 23 such as a switching hub and a router, and a communication path 24 such as an intranet.

[0063] In the case of the configuration as illustrated in Fig. 1, an inside space of the hoistway of the elevators 3

or a machine room is assumed as a place to install the management server 2, but it is sometimes difficult to install large-capacity data storage devices capable of saving the operation data for one year and the server apparatus for implementing the deep learning at such a place. However, the elevator management system 20 can apply the present invention even in such a case by employing the configuration as illustrated in Fig. 13.

[0064] Furthermore, the elevator management system 20 is installed at, for example, another building operated with the same working hours or business hours by being connected to the outside via, for example, the Internet and can acquire the operation data of the elevators 3 which operate in similar manners. Accordingly, the elevator management system 20 can acquire many pieces of operation data for learning and enhance the accuracy of learning.

[0065] Furthermore, as the elevator management system 20 is connected to the outside via, for example, the Internet and uses weather data and operation information of public transportation facilities as information for learning, it can enhance the accuracy of learning.

[0066] Furthermore, regarding an elevator management system 30 as illustrated in Fig. 14, a cloud server 35 for calculating learning data may be connected to a management server 31, which is a server apparatus, and each elevator 3 via the communication network 21 and communication equipment 37, 39 such as a switching hub and a router. Incidentally, the cloud server 35 is composed of a cloud server, a data center, and so on.

[0067] As a result of employing the configuration illustrated in Fig. 14, processing mainly focused on the operation data learning processing which requires transfer of the operation data with heavy load and learning processing can be executed by the cloud server 35 with high performance; and processing mainly focused on the operation instruction processing which requires frequent communication with the elevators 3 and for which any delay in the communication would be fatal can be executed by the management server 31.

[0068] Accordingly, the elevator management system 30 can reduce any influence caused by the delay in the communication and can be installed also in a relatively limited installment space. Incidentally, the acquisition of the learning data by a learning data acquisition module 34 and the operation instruction to the relevant elevator 3 can be implemented promptly by installing the management server 31 in a DMZ (demilitarized zone).

[0069] Furthermore, regarding an elevator management system 50 as illustrated in Fig. 15, communication via the communication equipment 37 (Fig. 14) such as the switching hub and the router becomes no longer necessary by providing a management server 51, which is a server apparatus, with a communication module 54. Therefore, the present invention can be applied even in a case where the switching hub, the router, and so on cannot be used due to the environment where the switching hub, the router, and so on are not installed, or due to

some security reason. Incidentally, the configuration in Fig. 15 can return to the conventional operation of the elevators 3 simply by removing the management server 51.

[0070] Furthermore, when it is difficult to download the learning data via the communication network, an auxiliary storage apparatus 63 such as an SD card in which learning data TB30 is recorded may be connected to an elevator management system 60 as illustrated in Fig. 16. The auxiliary storage apparatus 63 updates the learning data TB 30 when a customer engineer who periodically performs maintenance and inspection of the elevators 3 performs carrying maintenance or performs inspection. The learning data TB30 is created by copying the learning data TB20. Incidentally, the configuration in Fig. 16 can return to the conventional operation of the elevators 3 simply by removing a management server 61 which is a server apparatus.

[0071] Furthermore, the aforementioned embodiment has described the case where the deep learning is used as a learning means; however, the present invention is not limited to this example and a statistic means such as regression analysis may be used and machine learning other than the deep learning may be used.

[0072] Furthermore, the aforementioned embodiment has described the case where the pressed state of the call button 16 at each floor level and the destination floor designating button of each cage 12 after one run along the route is predicted based only on the pressed state of the call button 16 at each floor level and the destination floor designating button of each cage 12; however, the present invention is not limited to this example and season information such as spring, summer, fall, and winter, year information such as a year when the Olympics will be held or a leap year, time slot information such as morning, noon, and night, and so on may be reflected.

[0073] Furthermore, the aforementioned embodiment has described the case where no consideration is paid to local information within the building; however, the present invention is not limited to this example and the location information such as information about the use of meeting rooms in the building may be acquired through the communication path 19 and be reflected in the prediction result.

REFERENCE SIGNS LIST

[0074]

- 1, 20, 30, 50, 60: elevator management system
- 2, 31, 51, 61: management server
- 3: elevator
- 4, 32, 52, 62: CPU
- 5, 63: auxiliary storage apparatus
- 6, 33, 36, 53, 64: memory
- 7: operation storage module
- 8: operation learning module
- 9: route determination module

10: route instruction module
 11: elevator control apparatus
 12: cage
 13: primary rope
 14: counterbalancing weight
 15: hoist
 16: call button
 19, 24, 38, 40: communication path
 21: communication network
 22, 23, 37, 39: communication equipment
 35: cloud server

Claims

1. An elevator management system (1, 20, 30, 50, 60) for managing a plurality of elevators (3) each equipped with a control apparatus (11) for operating a cage (12) across a plurality of floors, the elevator management system (1, 20, 30, 50, 60) comprising a management apparatus (2) for managing the control apparatuses (11), wherein the management apparatus (2) includes:

a receiving circuit configured to receive destination floor designating information and cage call information, the destination floor designating information being a status of a destination floor designating button of each cage (12) and the cage call information being a status of a call button (16) at each floor;

an operation data table (TB10) configured to store the cage call information and the destination floor designating information as operation data every time a cage makes one run along a travelling route;

a memory (6, 33, 36, 53, 64) configured to accumulate and record the information received by the receiving circuit;

a controller (4, 32, 52, 62) configured to learn an operation tendency of the cages (12) based on the information recorded in the memory (6, 33, 36, 53, 64); and

an output circuit configured to output management information to each control apparatus (11); **characterized in that** the controller (4, 32, 52, 62):

is configured to predict the destination floor designating information and the cage call information a specified amount of time later from the information received by the receiving circuit on the basis of a result of the learning, the specified amount of time being the time needed by a cage to make one run along the travelling route; and to form the management information on the basis of a result of the prediction of the

specified amount of time period later so as to limit a range of operation floors of the cages (12); and

in that the control apparatuses (11) are configured to control operation of the cages (12) on the basis of the management information.

2. The elevator management system according to claim 1, wherein a control apparatus (11) is configured to determine a floor to be reached on the basis of the prediction of the cage call information and the destination floor designating information and to invert a traveling direction of a cage (12) upon reaching the determined floor.

3. The elevator management system according to claim 1, wherein an operation route of each of the cages (12) is determined by predicting the cage call information and the destination floor designating information about each of the cages (12) until an amount of time required for one operation of each of the cages (12) elapses from a present point in time.

4. The elevator management system according to claim 1, wherein when a cage call or destination floor designation which is not predicted occurs after the prediction of the cage call information and the destination floor designating information, an operation route is modified based on a current position of the cages (12) and a current moving direction of the cages (12).

5. The elevator management system according to claim 1, wherein door opening time of a cage (12) is adjusted on the basis of a difference between occurrence time of a cage call and destination floor designation based on the prediction of the cage call information and the destination floor designating information and occurrence time of the cage call and the destination floor designation.

6. An elevator management method for managing a plurality of elevators (3) each equipped with a control apparatus (11) for operating a cage (12) across a plurality of floors by using a management apparatus (2), wherein the management apparatus (2):

receives destination floor designating information and cage call information, the destination floor designating information being a status of a destination floor designating button of each cage (12), and the cage call information being a status of a call button (16) at each floor; stores the cage call information and the destina-

tion floor designating information as operation data in an operation data table (TB10) every time a cage makes one run along a travelling route;
 accumulates and records the received information; learns an operation tendency of the cages (12) based on the received information; outputs management information as a learning result to each control apparatus (11);
 the method **characterized in that** the management apparatus (2) predicts the destination floor designating information and the cage call information a specified amount of time later from the received information on the basis of the learning result, the specified amount of time being the time needed by a cage to make one run along the travelling route;
 forms the management information on the basis of a result of the prediction so as to limit a range of operation floors of the cages (12); and causes the control apparatuses (11) to control operation of the cages (12) on the basis of the management information.

Patentansprüche

1. Aufzugverwaltungssystem (1, 20, 30, 50, 60) zum Verwalten einer Vielzahl von Aufzügen (3), die jeweils mit einer Steuervorrichtung (11) zum Betreiben einer Kabine (12) über eine Vielzahl von Stockwerken ausgestattet sind, wobei das Aufzugverwaltungssystem (1, 20, 30, 50, 60) eine Verwaltungsvorrichtung (2) zum Verwalten der Steuervorrichtungen (11) umfasst, wobei die Verwaltungsvorrichtung (2) Folgendes umfasst:

eine Empfangsschaltung, die konfiguriert ist, um Zielstockwerkbezeichnungsinformationen und Kabinenrufinformationen zu empfangen, wobei die Zielstockwerkbezeichnungsinformationen ein Status einer Zielstockwerkbezeichnungstaste jeder Kabine (12) sind und die Kabinenrufinformationen ein Status einer Ruftaste (16) in jedem Stockwerk sind;
 eine Betriebsdatentabelle (TB10), die konfiguriert ist, um die Kabinenrufinformationen und die Zielstockwerkbezeichnungsinformationen als Betriebsdaten jedes Mal zu speichern, wenn eine Kabine eine Fahrt entlang einer Fahrtroute ausführt;
 einen Speicher (6, 33, 36, 53, 64), der konfiguriert ist, um die von der Empfangsschaltung empfangenen Informationen zu akkumulieren und aufzuzeichnen;
 eine Steuerung (4, 32, 52, 62), die konfiguriert ist, um eine Betriebstendenz der Kabinen (12)

basierend auf den in dem Speicher (6, 33, 36, 53, 64) aufgezeichneten Informationen zu lernen; und
 eine Ausgabeschaltung, die konfiguriert ist, um Verwaltungsinformationen an jede Steuervorrichtung (11) auszugeben;
dadurch gekennzeichnet, dass die Steuerung (4, 32, 52, 62):

konfiguriert ist, um die Zielstockwerkbezeichnungsinformationen und die Kabinenrufinformationen eine spezifizierte Zeitdauer später aus den von der Empfangsschaltung empfangenen Informationen auf der Grundlage eines Ergebnisses des Lernens vorherzusagen, wobei die spezifizierte Zeitdauer die Zeit ist, die eine Kabine benötigt, um eine Fahrt entlang der Fahrtroute auszuführen; und
 die Verwaltungsinformationen auf der Grundlage eines Ergebnisses der Vorhersage der spezifizierten Zeitdauer später zu bilden, um einen Bereich von Betriebsstockwerken der Kabinen (12) zu begrenzen; und
 dass die Steuervorrichtungen (11) konfiguriert sind, um den Betrieb der Kabinen (12) auf der Grundlage der Verwaltungsinformationen zu steuern.

2. Aufzugverwaltungssystem nach Anspruch 1, wobei eine Steuervorrichtung (11) konfiguriert ist, um ein zu erreichendes Stockwerk auf der Grundlage der Vorhersage der Kabinenrufinformationen und der Zielstockwerkbezeichnungsinformationen zu bestimmen und eine Fahrtrichtung einer Kabine (12) bei Erreichen des bestimmten Stockwerks umzukehren.
3. Aufzugverwaltungssystem nach Anspruch 1, wobei eine Betriebsroute jeder der Kabinen (12) durch Vorhersagen der Kabinenrufinformationen und der Zielstockwerkbezeichnungsinformationen über jede der Kabinen (12) bestimmt wird, bis eine Zeitdauer, die für einen Betrieb jeder der Kabinen (12) erforderlich ist, ab einem gegenwärtigen Zeitpunkt verstreicht.
4. Aufzugverwaltungssystem nach Anspruch 1, wobei, wenn ein Kabinenruf oder eine Zielstockwerkbezeichnung, die nicht vorhergesagt wird, nach der Vorhersage der Kabinenrufinformationen und der Zielstockwerkbezeichnungsinformationen auftritt, eine Betriebsroute basierend auf einer aktuellen Position der Kabinen (12) und einer aktuellen Bewegungsrichtung der Kabinen (12) modifiziert wird.
5. Aufzugverwaltungssystem nach Anspruch 1,

wobei eine Türöffnungszeit einer Kabine (12) auf der Grundlage einer Differenz zwischen einer Auftrittszeit eines Kabinenrufs und einer Zielstockwerkbezeichnung basierend auf der Vorhersage der Kabinenrufinformationen und der Zielstockwerkbezeichnungsinformationen und einer Auftrittszeit des Kabinenrufs und der Zielstockwerkbezeichnung angepasst wird.

6. Aufzugverwaltungsverfahren zum Verwalten einer Vielzahl von Aufzügen (3), die jeweils mit einer Steuervorrichtung (11) zum Betreiben einer Kabine (12) über eine Vielzahl von Stockwerken ausgestattet sind, unter Verwendung einer Verwaltungsvorrichtung (2), wobei die Verwaltungsvorrichtung (2) Folgendes ausführt:

Empfangen von Zielstockwerkbezeichnungsinformationen und Kabinenrufinformationen, wobei die Zielstockwerkbezeichnungsinformationen ein Status einer Zielstockwerkbezeichnungstaste jeder Kabine (12) sind und die Kabinenrufinformationen ein Status einer Ruftaste (16) in jedem Stockwerk sind;
Speichern der Kabinenrufinformationen und der Zielstockwerkbezeichnungsinformationen als Betriebsdaten in einer Betriebsdatentabelle (TB10) jedes Mal, wenn eine Kabine eine Fahrt entlang einer Fahrtroute ausführt;
Akkumulieren und Aufzeichnen der empfangenen Informationen; Lernen einer Betriebstendenz der Kabinen (12) basierend auf den empfangenen Informationen;
Ausgeben von Verwaltungsinformationen als ein Lernergebnis an jede Steuervorrichtung (11);
wobei das Verfahren **dadurch gekennzeichnet ist, dass** die Verwaltungsvorrichtung (2) die Zielstockwerkbezeichnungsinformationen und die Kabinenrufinformationen eine spezifizierte Zeitdauer später aus den empfangenen Informationen auf der Grundlage des Lernergebnisses vorhersagt, wobei die spezifizierte Zeitdauer die Zeit ist, die eine Kabine benötigt, um eine Fahrt entlang der Fahrtroute auszuführen;
die Verwaltungsinformationen auf der Grundlage eines Ergebnisses der Vorhersage bildet, um einen Bereich von Betriebsstockwerken der Kabinen (12) zu begrenzen; und

die Steuervorrichtungen (11) veranlasst, den Betrieb der Kabinen (12) auf der Grundlage der Verwaltungsinformationen zu steuern.

Revendications

1. Système de gestion d'ascenseur (1, 20, 30, 50, 60) pour gérer une pluralité d'ascenseurs (3) équipés chacun d'un appareil de commande (11) pour faire fonctionner une cabine (12) sur une pluralité d'étages, le système de gestion d'ascenseur (1, 20, 30, 50, 60) comprenant un appareil de gestion (2) pour gérer les appareils de commande (11), dans lequel l'appareil de gestion (2) comprend :

un circuit de réception configuré pour recevoir des informations de désignation d'étage de destination et des informations d'appel de cabine, les informations de désignation d'étage de destination étant un état d'un bouton de désignation d'étage de destination de chaque cabine (12) et les informations d'appel de cabine étant un état d'un bouton d'appel (16) à chaque étage ;
une table de données de fonctionnement (TB10) configurée pour stocker les informations d'appel de cabine et les informations de désignation d'étage de destination en tant que données de fonctionnement chaque fois qu'une cabine effectue une course le long d'un itinéraire de déplacement ;
une mémoire (6, 33, 36, 53, 64) configurée pour accumuler et enregistrer les informations reçues par le circuit de réception ;
un dispositif de commande (4, 32, 52, 62) configuré pour apprendre une tendance de fonctionnement des cabines (12) sur la base des informations enregistrées dans la mémoire (6, 33, 36, 53, 64) ; et
un circuit de sortie configuré pour délivrer en sortie des informations de gestion à chaque appareil de commande (11) ;
caractérisé en ce que le dispositif de commande (4, 32, 52, 62) :

est configuré pour prédire les informations de désignation d'étage de destination et les informations d'appel de cabine une quantité spécifiée de temps plus tard à partir des informations reçues par le circuit de réception sur la base d'un résultat de l'apprentissage, la quantité spécifiée de temps étant le temps requis par une cabine pour effectuer une course le long de l'itinéraire de déplacement ; et
pour former les informations de gestion sur la base d'un résultat de la prédiction de la quantité spécifiée de temps plus tard de manière à limiter une plage d'étages de fonctionnement des cabines (12) ; et
en ce que les appareils de commande (11) sont configurés pour commander le fonc-

tionnement des cabines (12) sur la base des informations de gestion.

2. Système de gestion d'ascenseur selon la revendication 1,
dans lequel un appareil de commande (11) est configuré pour déterminer un étage à atteindre sur la base de la prédiction des informations d'appel de cabine et des informations de désignation d'étage de destination et pour inverser une direction de déplacement d'une cabine (12) lors de l'atteinte de l'étage déterminé. 5 10
3. Système de gestion d'ascenseur selon la revendication 1,
dans lequel un itinéraire de fonctionnement de chacune des cabines (12) est déterminé en prédisant les informations d'appel de cabine et les informations de désignation d'étage de destination concernant chacune des cabines (12) jusqu'à ce qu'une quantité de temps requise pour une opération de chacune des cabines (12) s'écoule à partir d'un instant présent. 15 20
4. Système de gestion d'ascenseur selon la revendication 1,
dans lequel lorsqu'un appel de cabine ou une désignation d'étage de destination qui n'est pas prédit se produit après la prédiction des informations d'appel de cabine et des informations de désignation d'étage de destination, un itinéraire de fonctionnement est modifié sur la base d'une position actuelle des cabines (12) et d'une direction de déplacement actuelle des cabines (12). 25 30
5. Système de gestion d'ascenseur selon la revendication 1,
dans lequel un temps d'ouverture de porte d'une cabine (12) est ajusté sur la base d'une différence entre un temps d'occurrence d'un appel de cabine et une désignation d'étage de destination sur la base de la prédiction des informations d'appel de cabine et des informations de désignation d'étage de destination et d'un temps d'occurrence de l'appel de cabine et de la désignation d'étage de destination. 35 40 45
6. Procédé de gestion d'ascenseur pour gérer une pluralité d'ascenseurs (3) équipés chacun d'un appareil de commande (11) pour faire fonctionner une cabine (12) sur une pluralité d'étages en utilisant un appareil de gestion (2), dans lequel l'appareil de gestion (2) : 50

reçoit des informations de désignation d'étage de destination et des informations d'appel de cabine, les informations de désignation d'étage de destination étant un état d'un bouton de désignation d'étage de destination de chaque cabine (12), et les informations d'appel de ca- 55

bine étant un état d'un bouton d'appel (16) à chaque étage ;
stocke les informations d'appel de cabine et les informations de désignation d'étage de destination en tant que données de fonctionnement dans une table de données de fonctionnement (TB10) chaque fois qu'une cabine effectue une course le long d'un itinéraire de déplacement ;
accumule et enregistre les informations reçues ;
apprend une tendance de fonctionnement des cabines (12) sur la base des informations reçues ;
délivre en sortie des informations de gestion en tant que résultat d'apprentissage à chaque appareil de commande (11) ;
le procédé étant **caractérisé en ce que** l'appareil de gestion (2) :

prédit les informations de désignation d'étage de destination et les informations d'appel de cabine une quantité spécifiée de temps plus tard à partir des informations reçues sur la base du résultat d'apprentissage, la quantité spécifiée de temps étant le temps requis par une cabine pour effectuer une course le long de l'itinéraire de déplacement ;
forme les informations de gestion sur la base d'un résultat de la prédiction de manière à limiter une plage d'étages de fonctionnement des cabines (12) ; et

amène les appareils de commande (11) à commander le fonctionnement des cabines (12) sur la base des informations de gestion.

FIG. 1

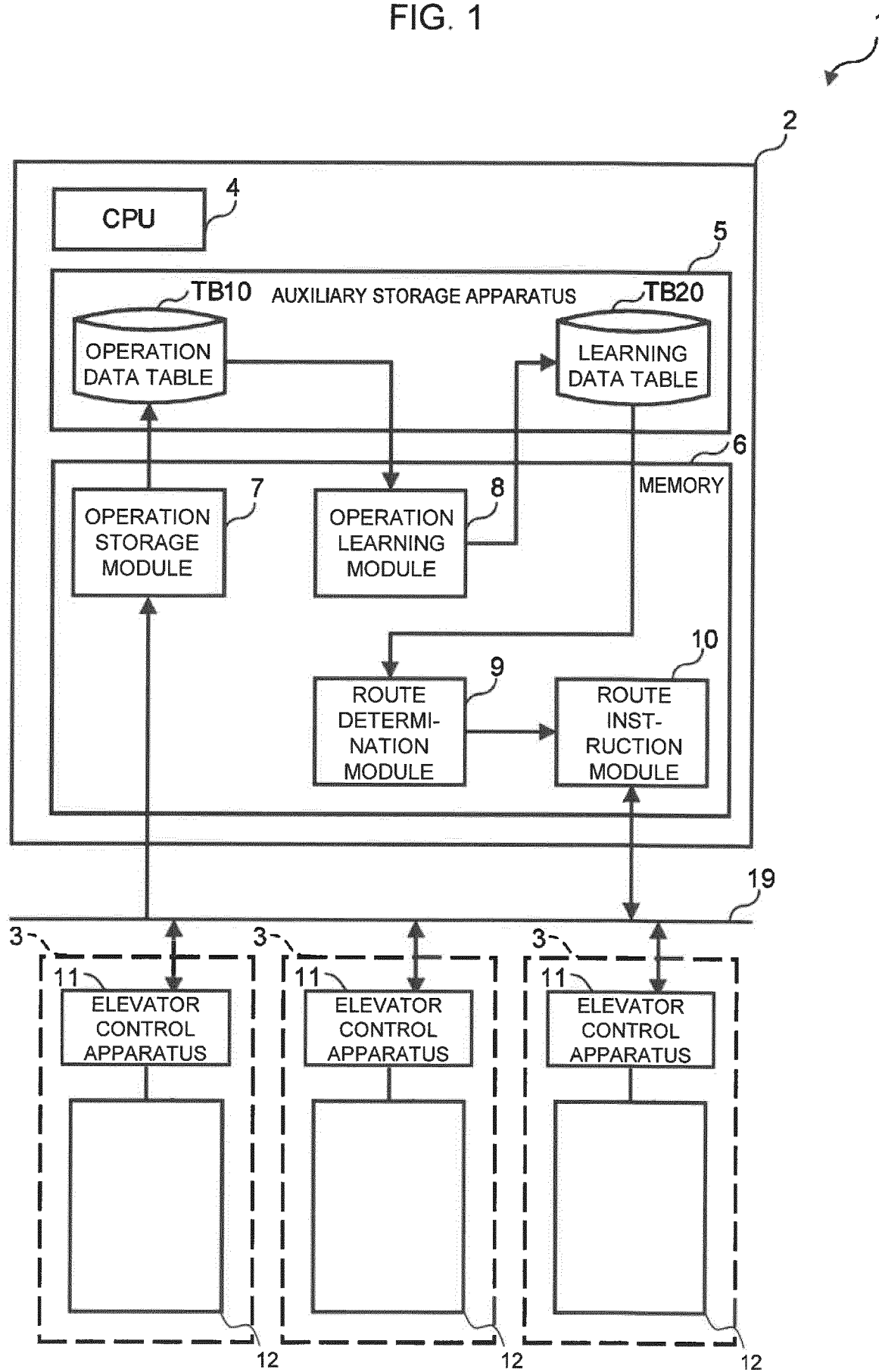


FIG. 2

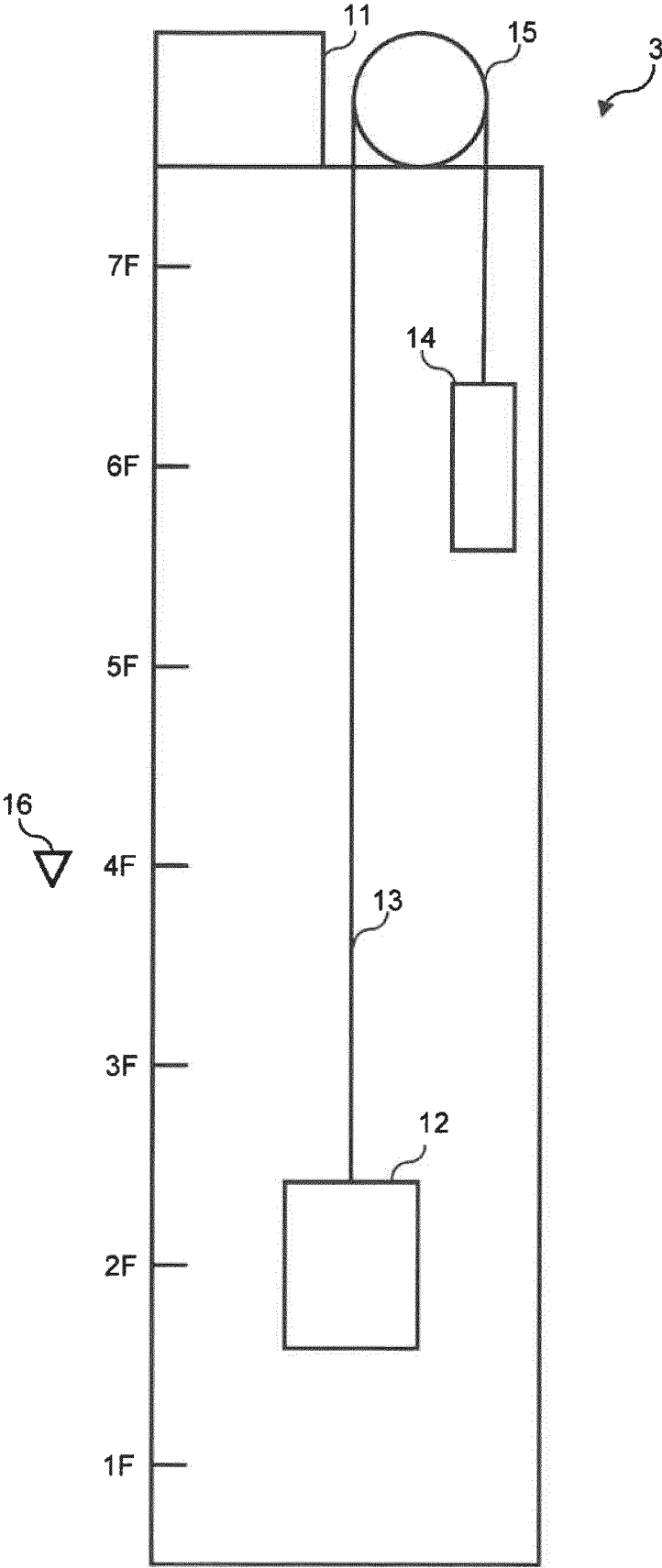


FIG. 3

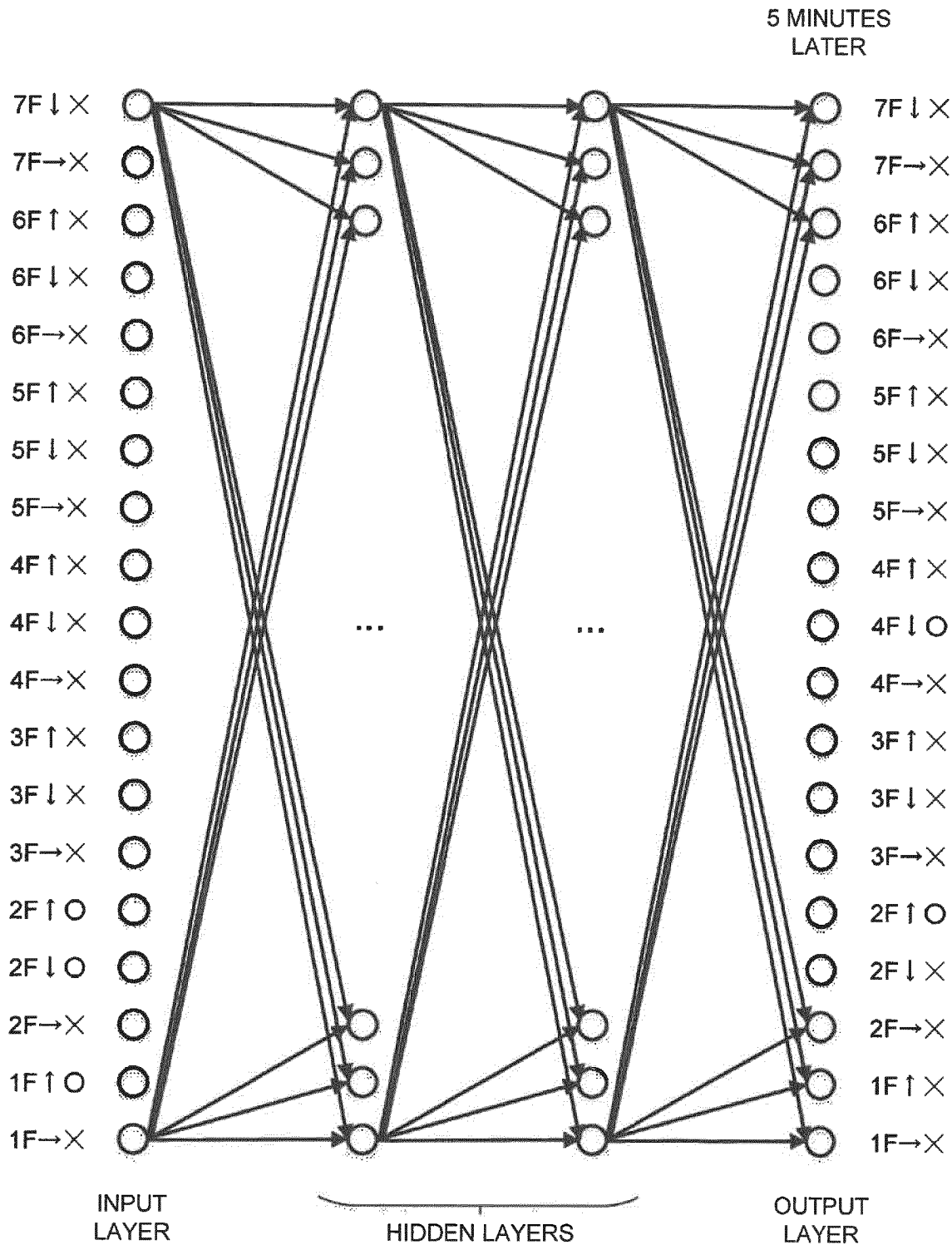


FIG. 4

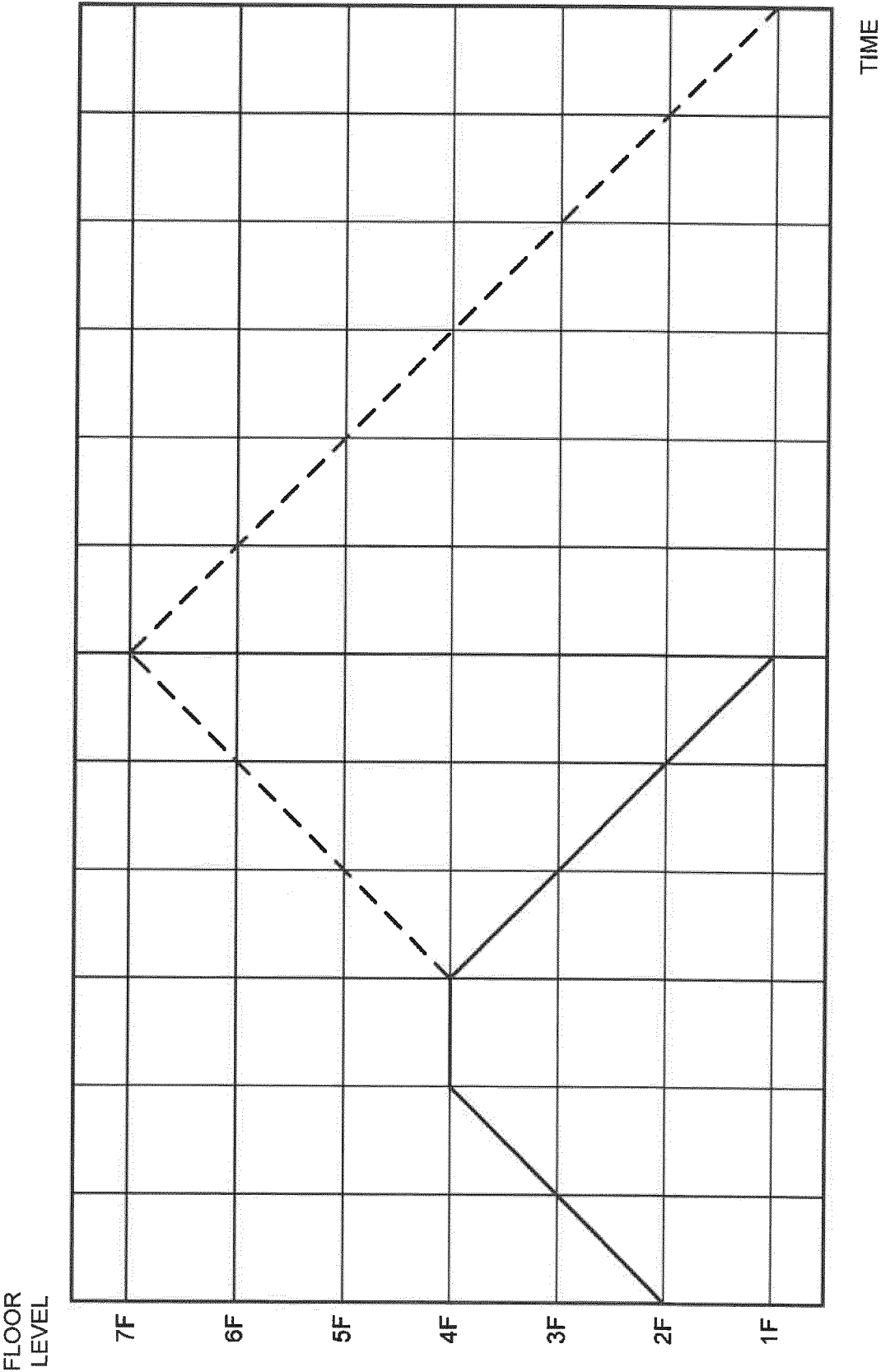


FIG. 5

IB10

BUTTON TIME	1F ↑	1F →	2F ↓	2F ↑	2F →	3F ↓	3F ↑	3F →	4F ↓	4F ↑	4F →	5F ↓	5F ↑	5F →	6F ↓	6F ↑	6F →	7F ↓	7F →
0:00	○	×	○	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
0:05	○	×	×	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
0:10	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
0:15	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	○	×
0:20	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
0:25	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
0:30	○	×	○	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×

⋮

FIG. 6

TB20

BUTTON INPUT/ OUTPUT	1F↑	1F→	2F↓	2F↑	2F→	3F↓	3F↑	3F→	4F↓	4F↑	4F→	5F↓	5F↑	5F→	6F↓	6F↑	6F→	7F↓	7F→
	O	X	O	O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
INPUT	O	X	O	O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OUTPUT	O	X	X	O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
⋮																			

FIG. 7

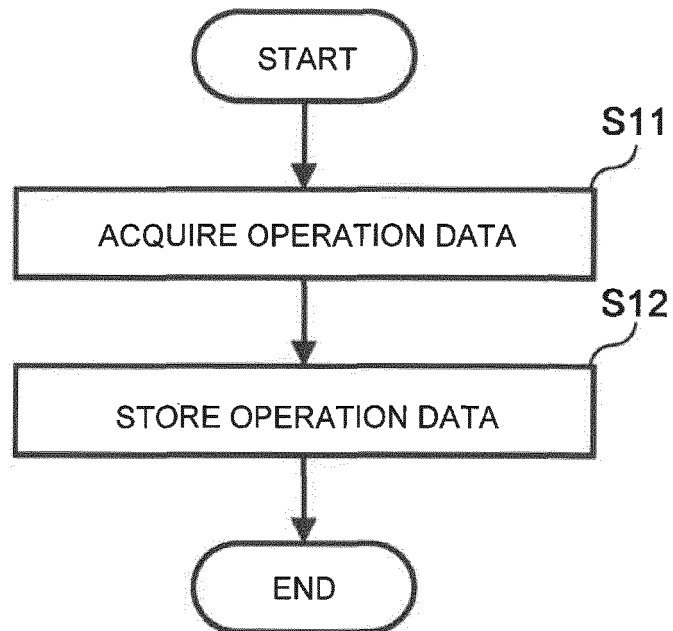


FIG. 8

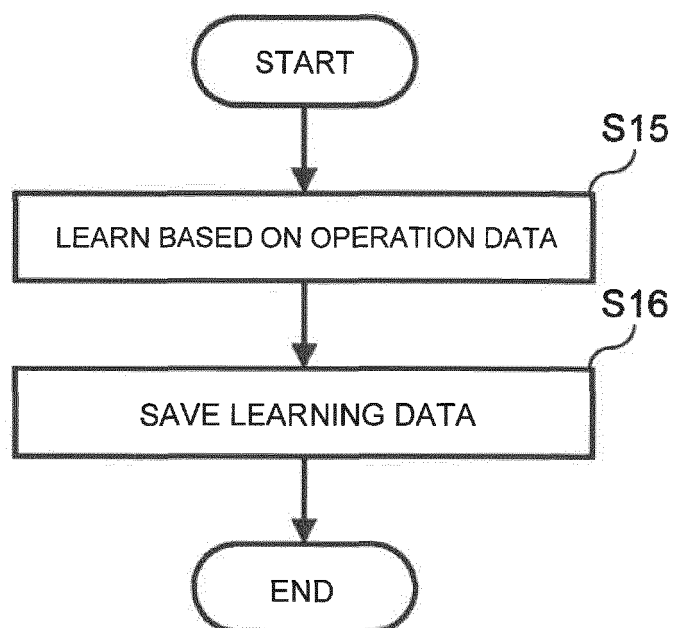


FIG. 9

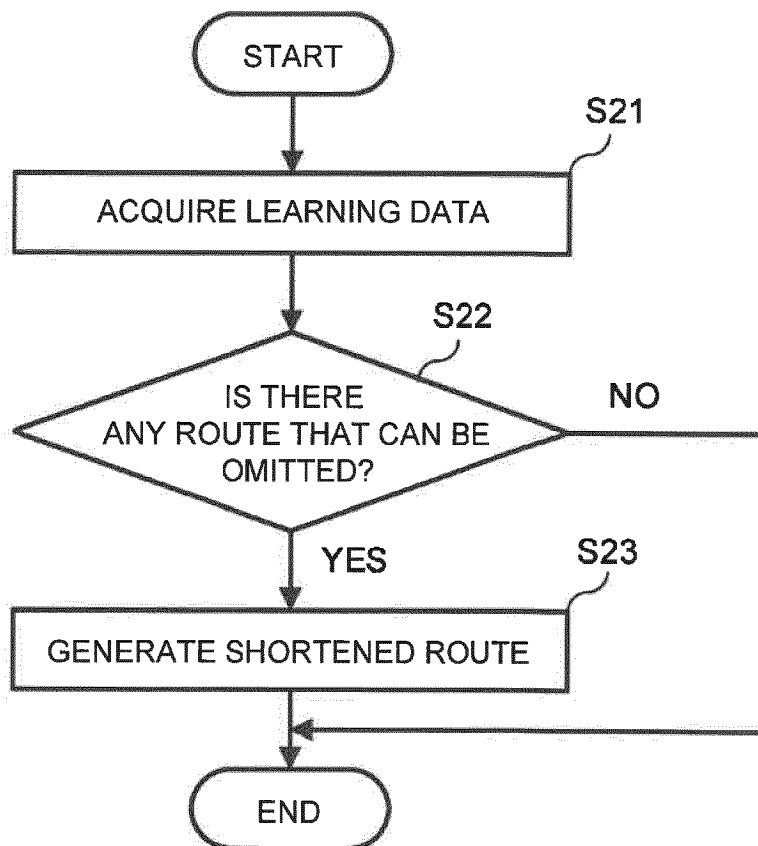


FIG. 10

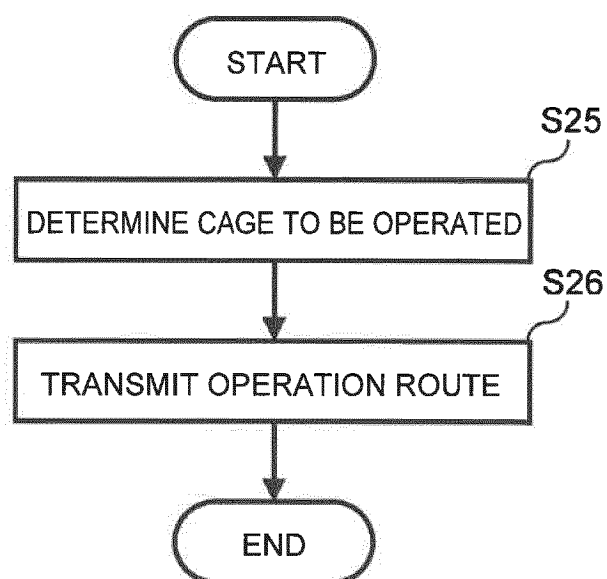


FIG. 11

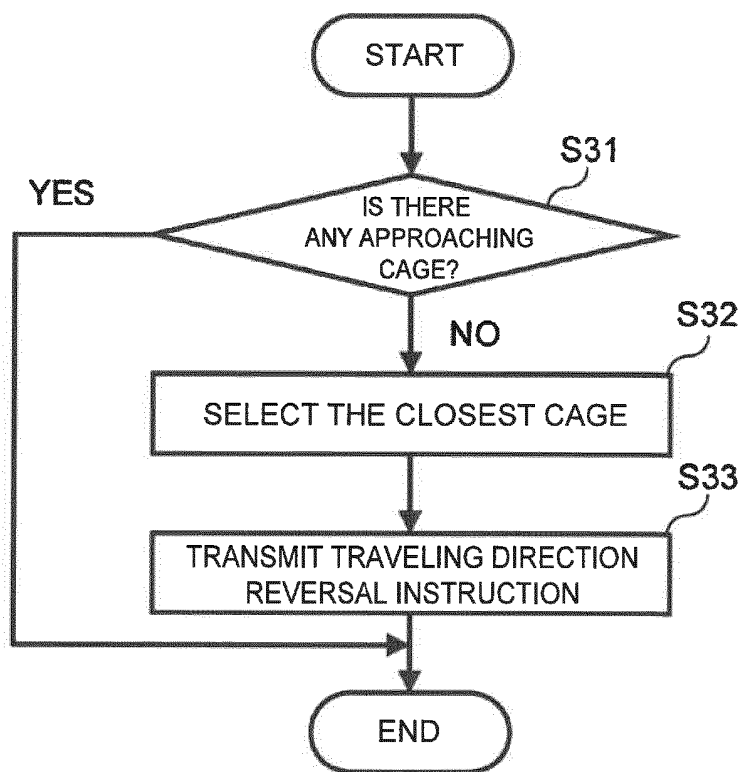


FIG. 12

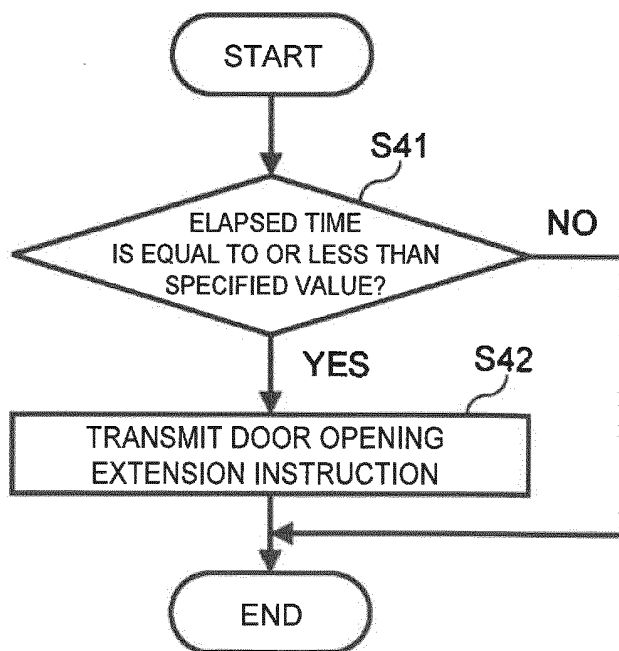


FIG.13

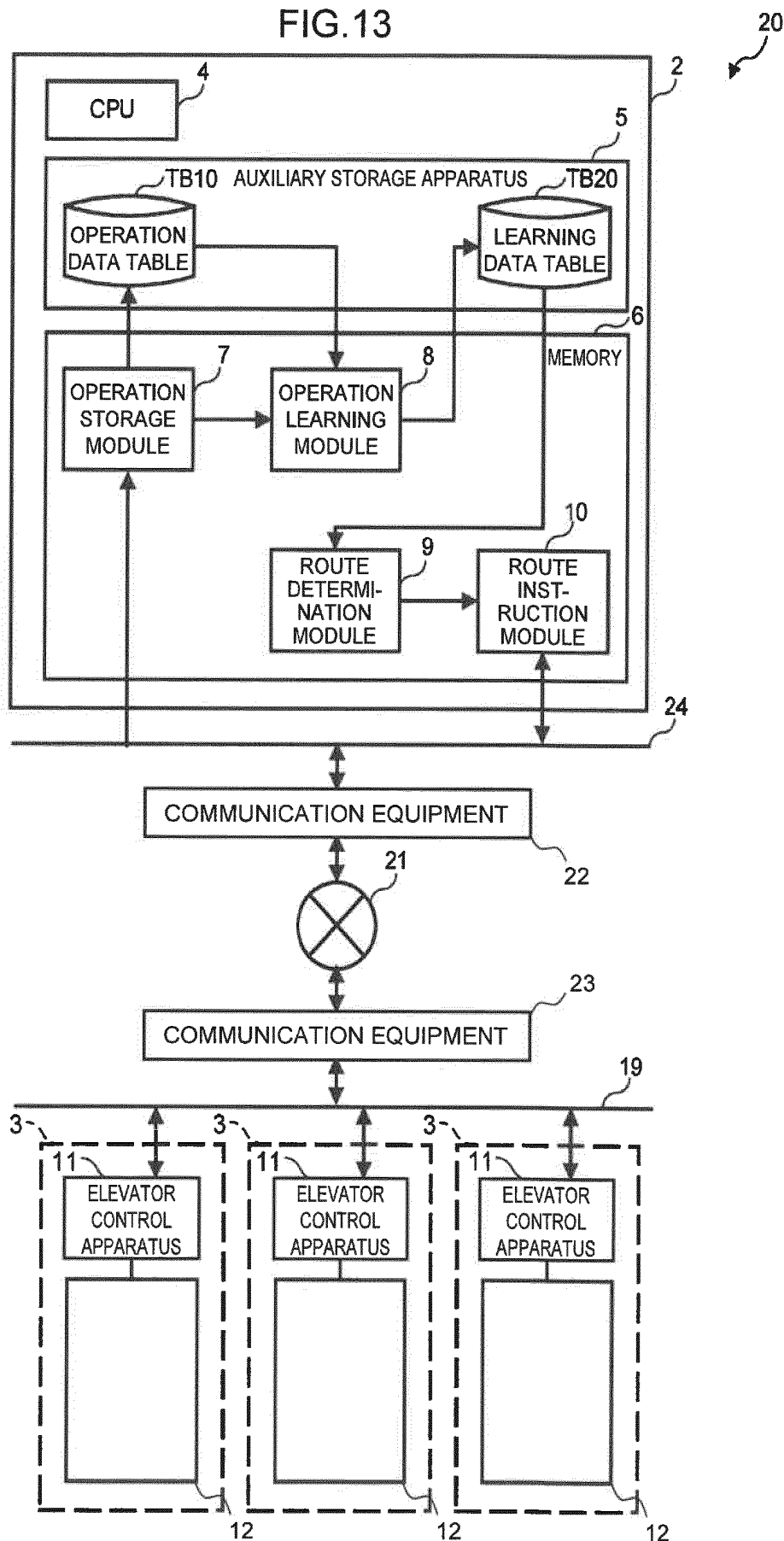


FIG.14

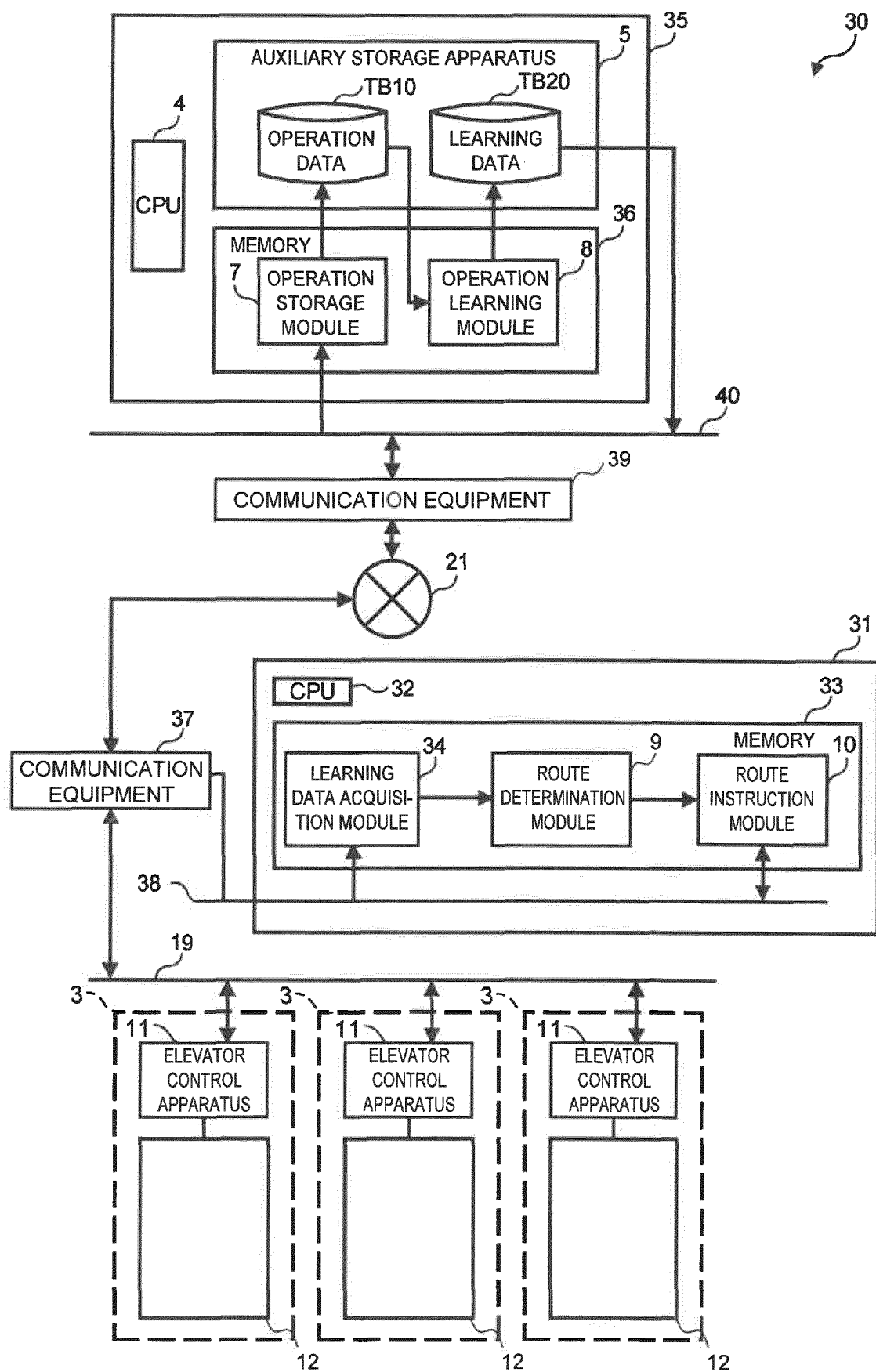


FIG.15

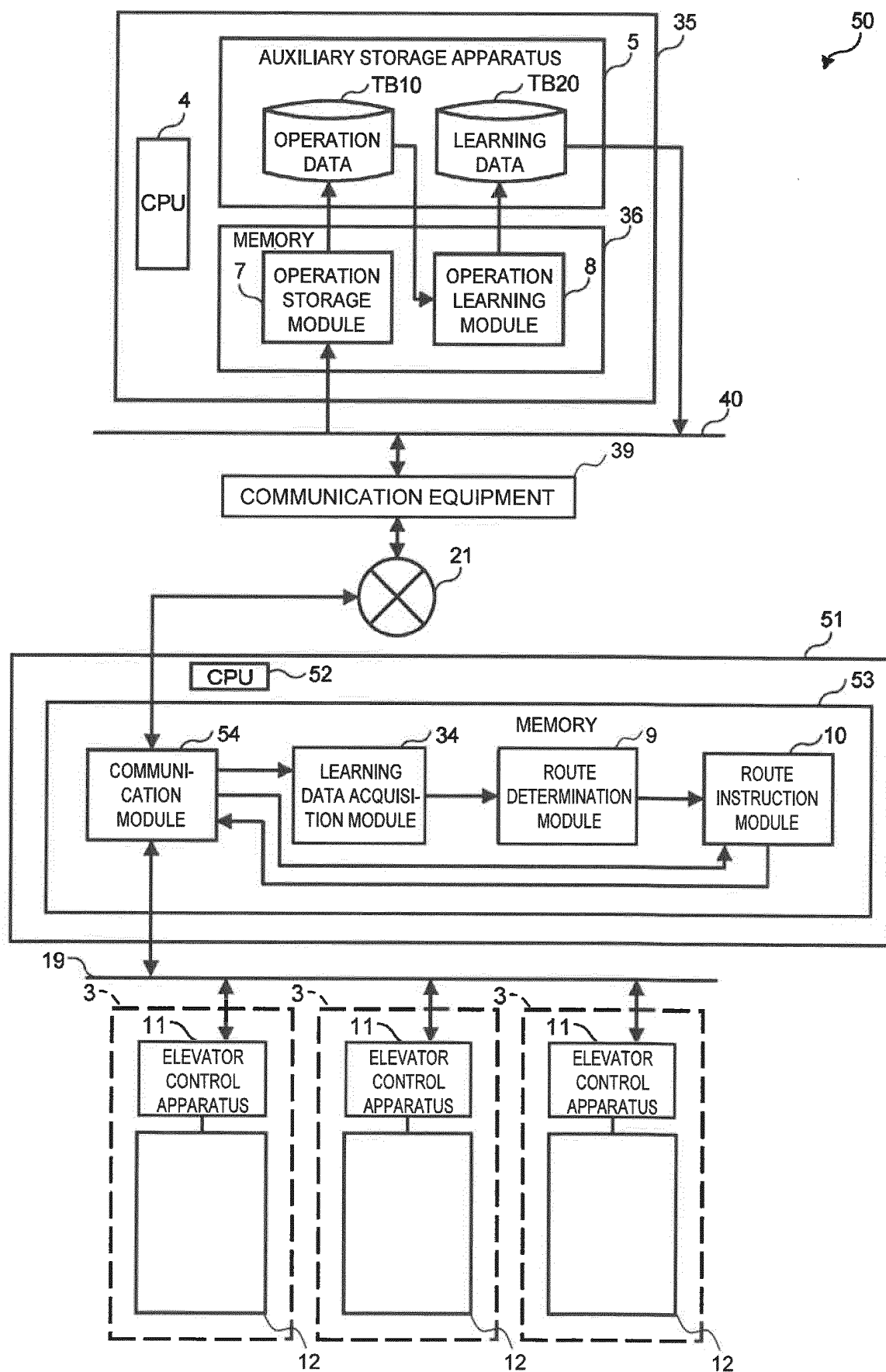
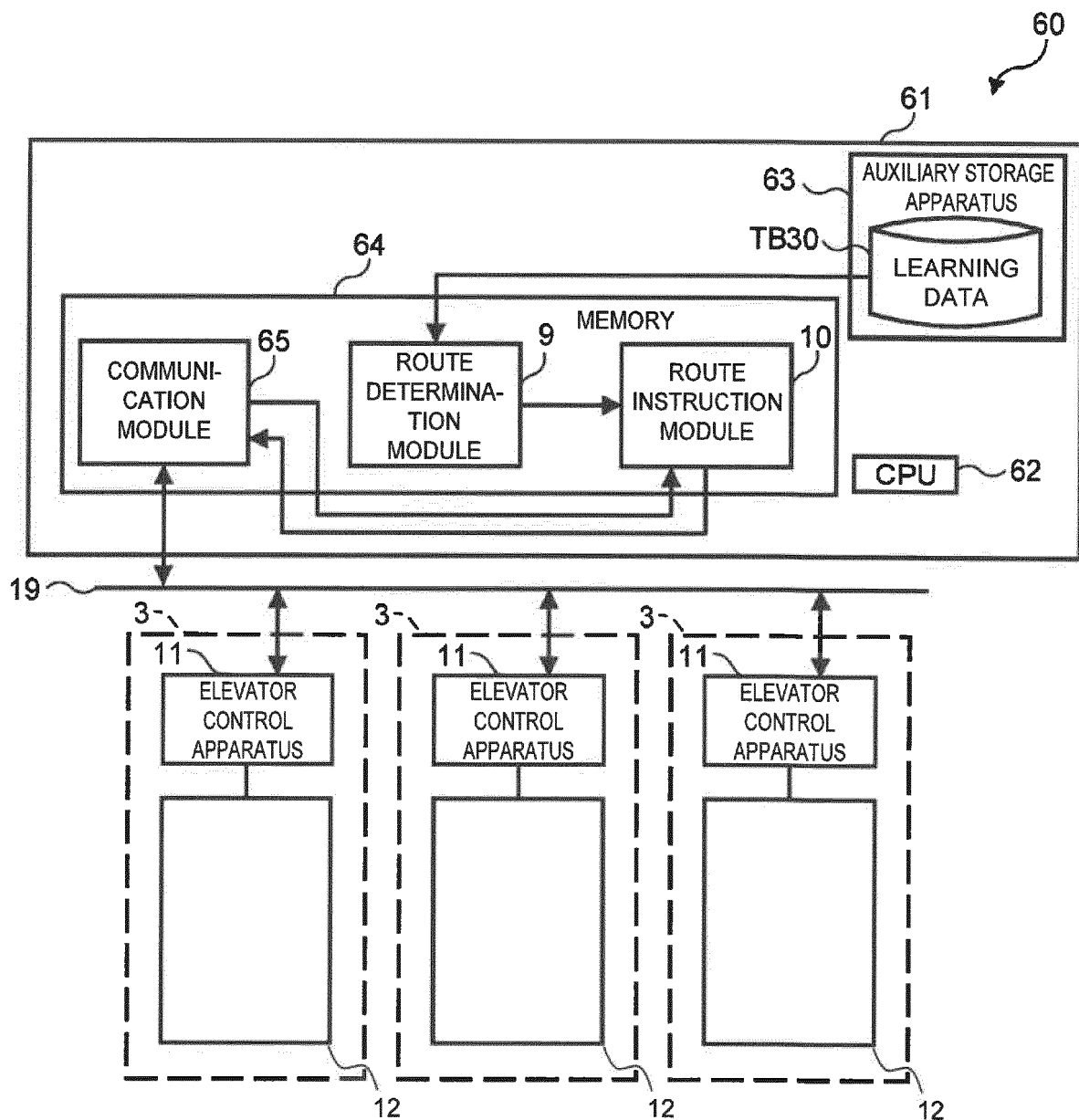


FIG.16



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 4139819 B [0005]
- GB 2246214 A [0005]
- JP 2011057325 A [0005]