(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 604 190 A1

(12) EUROPEAN PATENT APPLICATION

published in accordance with Art. 153(4) EPC

(43) Date of publication:
05.02.2020 Bulletin 2020/06

(21) Application number: **17901590.4**

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

(51) Int Cl.:
B66B 1/18 *(2006.01)*

(86) International application number:
PCT/JP2017/041390

(87) International publication number:
WO 2018/173363 (27.09.2018 Gazette 2018/39)

(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
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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

(71) Applicant: **Hitachi, Ltd.**
Tokyo 100-8280 (JP)

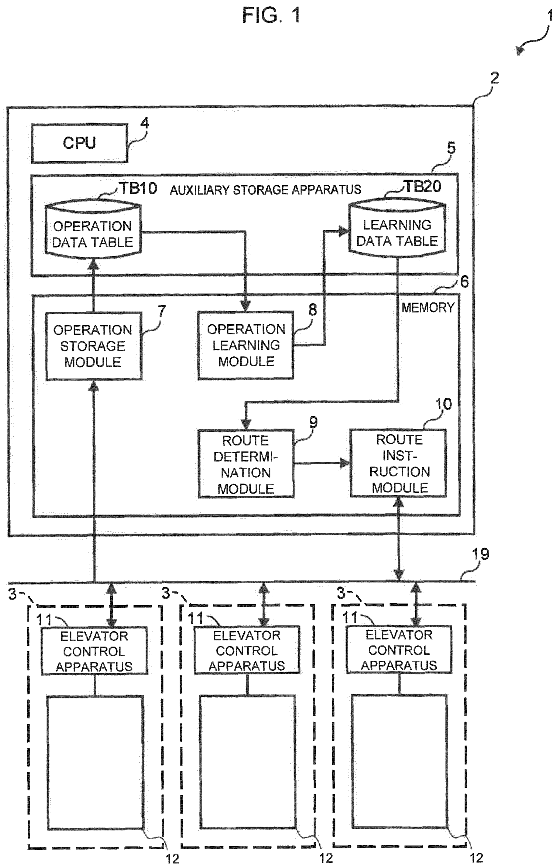
(72) Inventors:
- **NAYA, Hidemitsu**
  Tokyo 100-8280 (JP)
- **HOSHINO, Takamichi**
  Tokyo 100-8280 (JP)
- **HATORI, Takahiro**
  Tokyo 100-8280 (JP)

(74) Representative: **MERH-IP Matias Erny Reichl Hoffmann**
Patentanwälte PartG mbB
Paul-Heyse-Strasse 29
80336 München (DE)

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

(57) An elevator management system and elevator management method for efficiently operating cages are proposed. An elevator management system for managing an elevator equipped with a control apparatus for operating a cage or cages across a plurality of floors is designed so that the elevator management system includes a management apparatus for managing the control apparatus, wherein the management apparatus includes: a receiving circuit that receives destination floor designating information and cage call information; a memory that accumulates and records the information received by the receiving circuit; a controller that learns an operation tendency of the cages based on the information recorded in the memory; and an output circuit that outputs management information to the control apparatus; and wherein the controller: predicts 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; and forms the management information on the basis of a result of the prediction of the specified amount of time later so as to limit a range of operation floors of the cages; and wherein the control apparatus controls operation of the cages on the basis of the management information.

FIG. 1



EP 3 604 190 A1

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.

CITATION LIST

PATENT LITERATURE

[0004] PTL 1: Japanese Patent No. 4139819

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] 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

[0006] In order to solve the above-described problem, the present invention provides an elevator management system for managing an elevator equipped with a control apparatus for operating a cage(s) across a plurality of floors, wherein the elevator management system includes a management apparatus for managing the control apparatus; wherein the management apparatus includes: a receiving circuit that receives destination floor designating information and cage call information; a memory that accumulates and records the information received by the receiving circuit; a controller that learns an operation tendency of the cages based on the information recorded in the memory; an output circuit that outputs management information to the control apparatus; wherein the controller: predicts 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; and forms the management information on the basis of a result of the prediction of the specified amount of time later so as to limit a range of operation floors of the cages; and wherein the control apparatus controls operation of the cages on the basis of the management information.

[0007] Furthermore, the present invention provides an elevator management method for managing a control apparatus for operating a cage or cages of an elevator across a plurality of floors by using a management apparatus, wherein the management apparatus: receives destination floor designating information and cage call information; accumulates and records the information received by a receiving circuit; learns an operation tendency of the cages based on the received information; outputs management information as a learning result to the control apparatus; 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; 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; and causes the control apparatus to control operation of the cages on the basis of the management information.

ADVANTAGEOUS EFFECTS OF THE INVENTION

[0008] 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

[0009]

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

[0010] (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.

[0011] 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.

[0012] 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.

[0013] 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.

[0014] 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.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] 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).

[0020] 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 performed. Also, a plurality of hidden layers exist between the input layer and the output layer.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] Incidentally, referring to Fig. 3, "○" represents a case where the button is pressed; and "×" 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.

[0025] 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.

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] Incidentally, when the operation route of the cage 12 does not have to be corrected, the route instruction 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.

[0034] 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, "○", "×", "↑", "↓", and "→" in Fig. 5 have the same meanings as those in Fig. 3.

[0035] 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, "○", "×", "↑", "↓", and "→" in Fig. 6 have the same meanings as those in Fig. 3.

(2) Various Kinds of Processing by Management Server

[0036] 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."

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] Practically, the operation learning module 8 starts the operation data learning processing, for example, at a set time of the year every year.

[0042] 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.

[0043] 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.

[0044] Practically, after the operation data learning processing terminates, the route determination module 9 starts the operation route determination processing illustrated in this Fig. 9.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] 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.

[0057] 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

[0058] 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.

[0059] 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

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] 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.

[0066] 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.

[0067] 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).

[0068] 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.

[0069] 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.

[0070] 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.

[0071] 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.

[0072] 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

[0073]

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 for managing an elevator equipped with a control apparatus for operating a cage across a plurality of floors,
the elevator management system comprising a management apparatus for managing the control apparatus,
wherein the management apparatus includes:

a receiving circuit that receives destination floor designating information and cage call information;
a memory that accumulates and records the information received by the receiving circuit;
a controller that learns an operation tendency of the cages based on the information recorded in the memory; and
an output circuit that outputs management information to the control apparatus; wherein the controller:

predicts 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; and

forms the management information on the basis of a result of the prediction of the specified amount of time later so as to limit a range of operation floors of the cages; and
wherein the control apparatus controls operation of the cages on the basis of the management information.

2. The elevator management system according to claim 1,
wherein the control apparatus determines a floor to be reached on the basis of the prediction of the cage call information and the destination floor designating information and inverts a traveling direction of the cage upon reaching the determined floor.

3. The elevator management system according to claim 1,
wherein an operation route of each of the cages is determined by predicting the cage call information and the destination floor designating information about each of the cages until an amount of time required for one operation of each of the cages 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 cage and a current moving direction of the cage.

5. The elevator management system according to claim 1,
wherein door opening time of the cage 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 system for managing an elevator, comprising:

a first server apparatus that records an operation status of each of cages including destination floor designating information of each cage and cage call information given from each floor and learns the operation status; and
a second server apparatus that predicts the cage call given from each floor on the basis of the learning,
wherein operation of each cage is controlled by a control apparatus; and
wherein the control apparatus determines an operation route of each cage by excluding a floor regarding which it is predicted based on the prediction of the cage call by the second server apparatus that the cage call will not occur.

7. An elevator management method for managing a control apparatus for operating a cage or cages of an elevator across a plurality of floors by using a management apparatus,
wherein the management apparatus:

receives destination floor designating information and cage call information;
accumulates and records the received information;
learns an operation tendency of the cages based on the received information;
outputs management information as a learning result to the control apparatus;
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;
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; and
causes the control apparatus to control operation of the cages on the basis of the management information.

FIG. 1

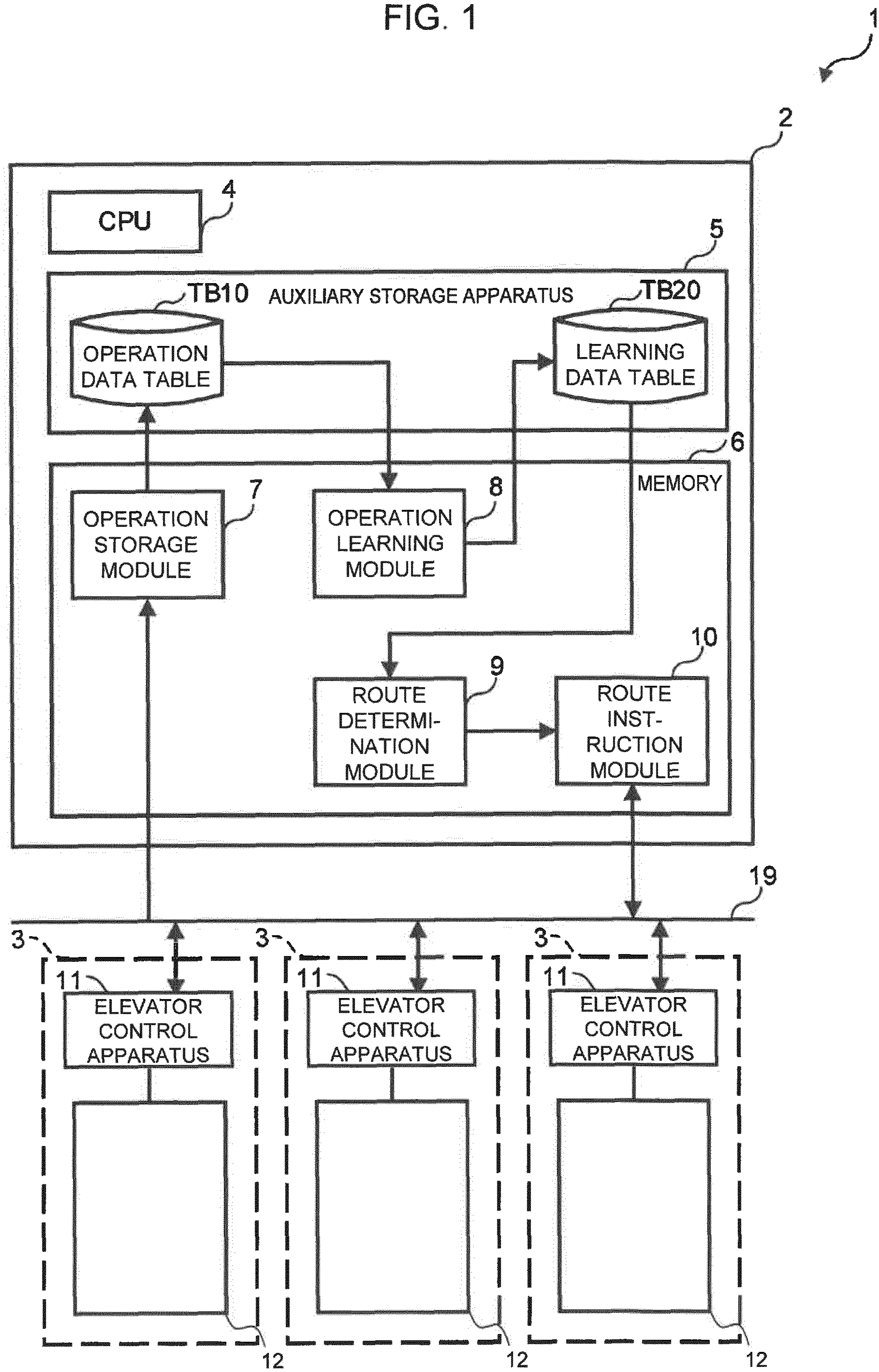

1
2
CPU
4
5
TB10
AUXILIARY STORAGE APPARATUS
TB20
OPERATION DATA TABLE
LEARNING DATA TABLE
6
MEMORY
7
OPERATION STORAGE MODULE
8
OPERATION LEARNING MODULE
10
9
ROUTE DETERMI-NATION MODULE
ROUTE INST-RUCTION MODULE
19
3
11
ELEVATOR CONTROL APPARATUS
12

FIG. 2

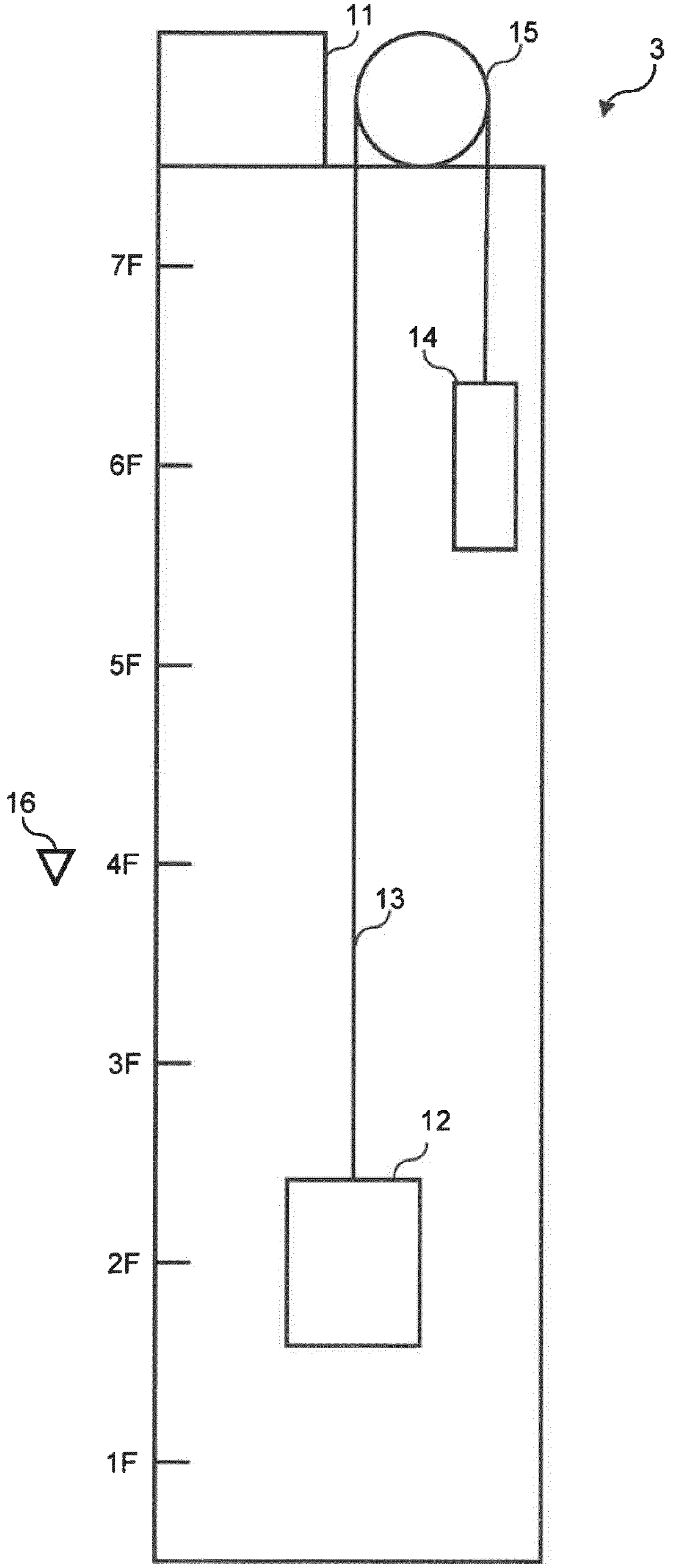
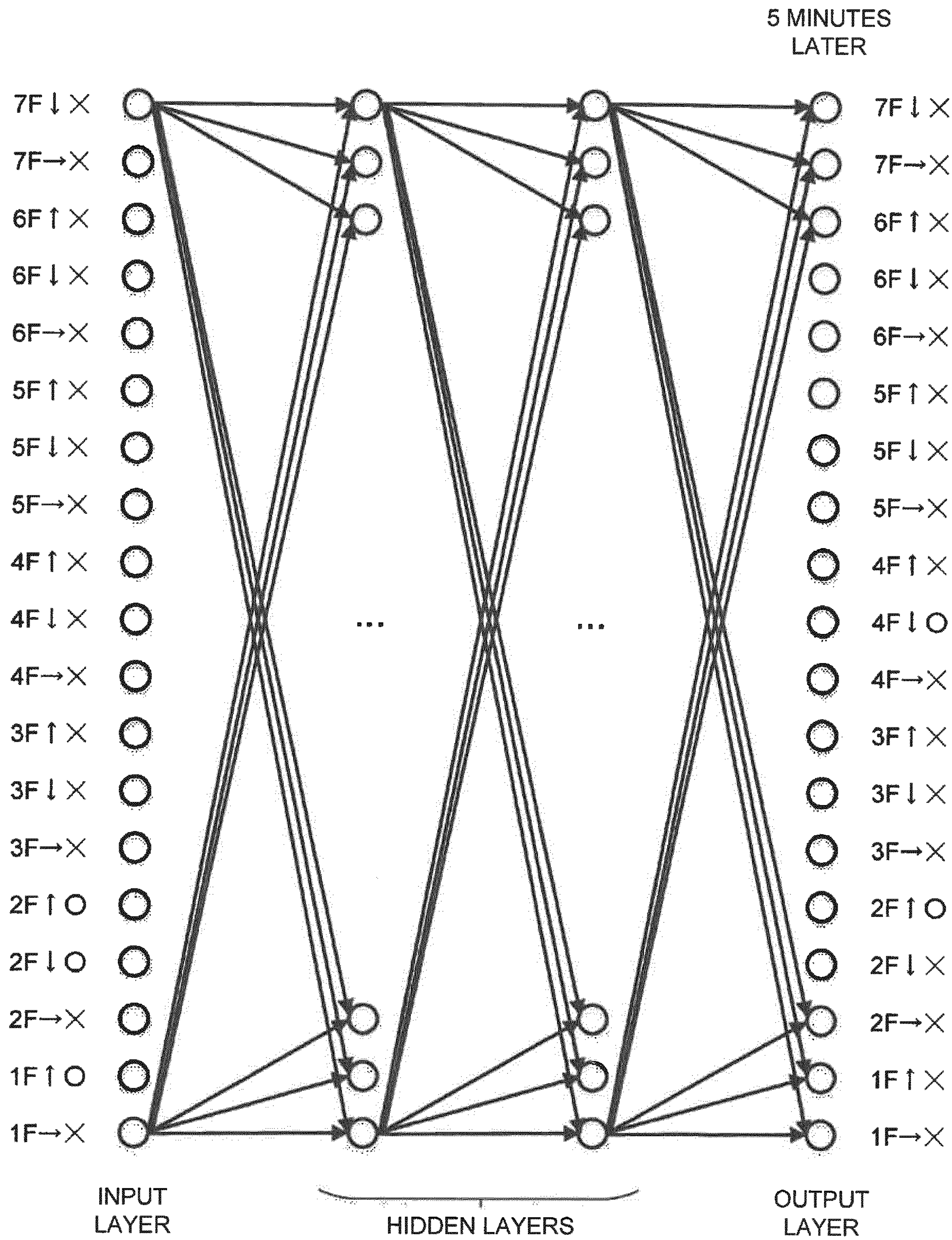


FIG. 3



5 MINUTES LATER
7F↓×
7F→×
6F↑×
6F↓×
6F→×
5F↑×
5F↓×
5F→×
4F↑×
4F↓×
4F→×
3F↑×
3F↓×
3F→×
2F↑○
2F↓○
2F→×
1F↑○
1F→×
...
...
7F↓×
7F→×
6F↑×
6F↓×
6F→×
5F↑×
5F↓×
5F→×
4F↑×
4F↓○
4F→×
3F↑×
3F↓×
3F→×
2F↑○
2F↓×
2F→×
1F↑×
1F→×
INPUT LAYER
HIDDEN LAYERS
OUTPUT LAYER

FIG. 4

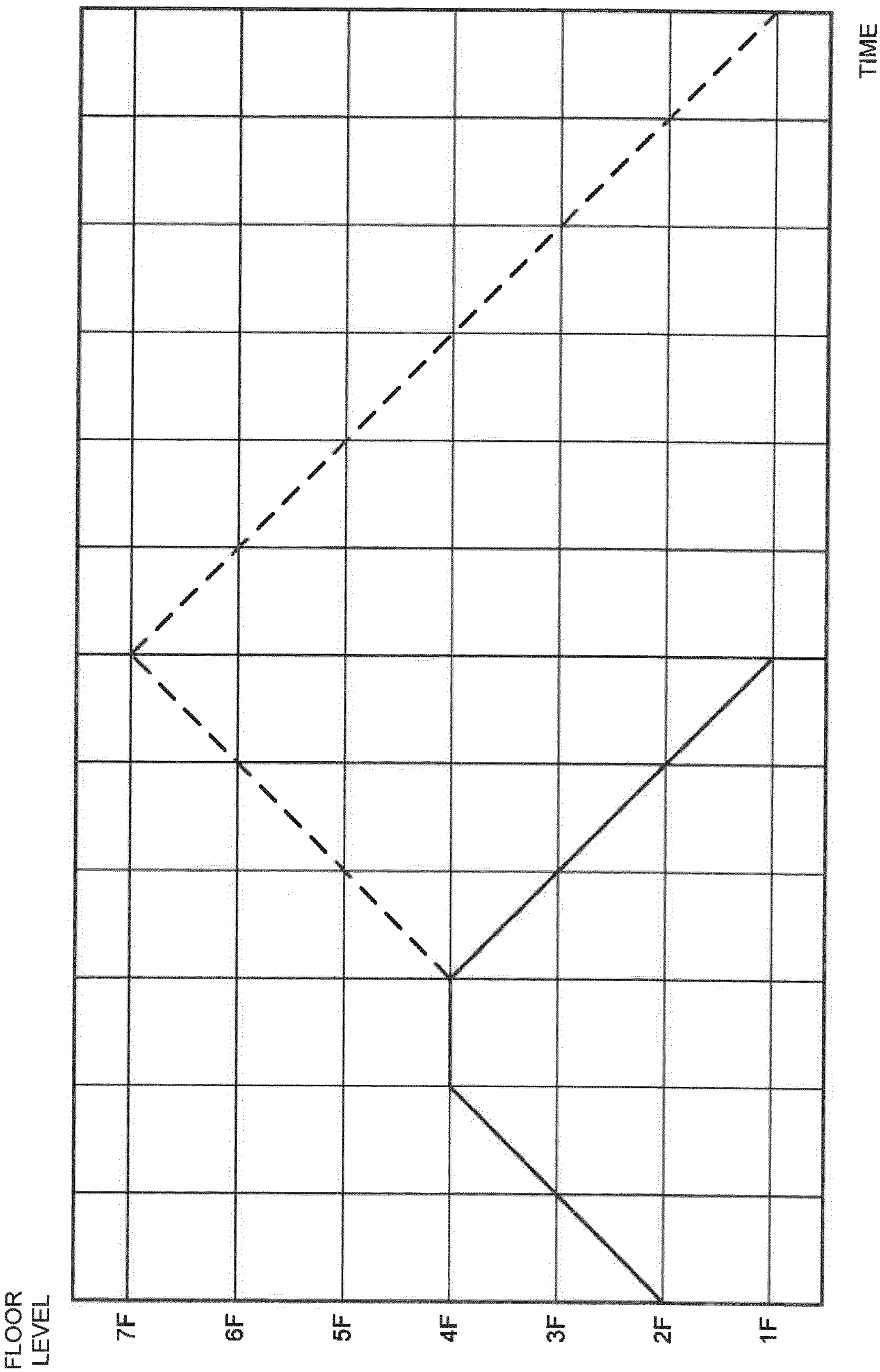


FIG. 5

TB10

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→
INPUT	O	×	O	O	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
OUTPUT	O	×	×	O	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×

⋮

FIG. 7

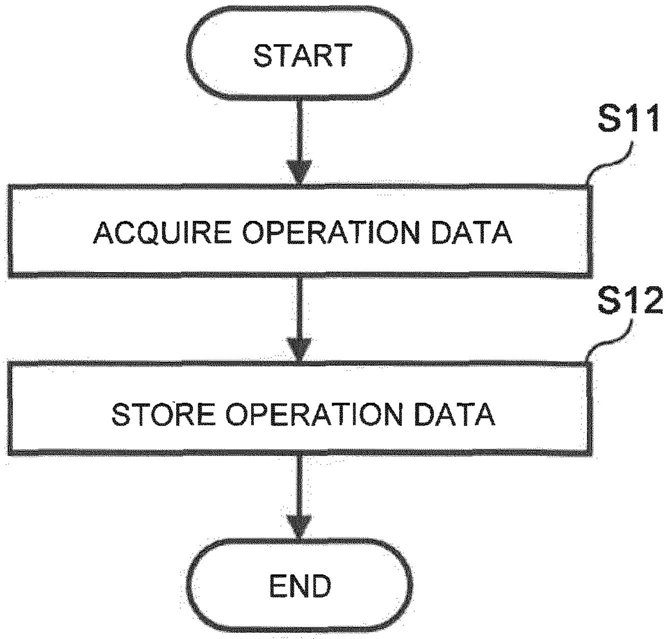

START
S11
ACQUIRE OPERATION DATA
S12
STORE OPERATION DATA
END

FIG. 8

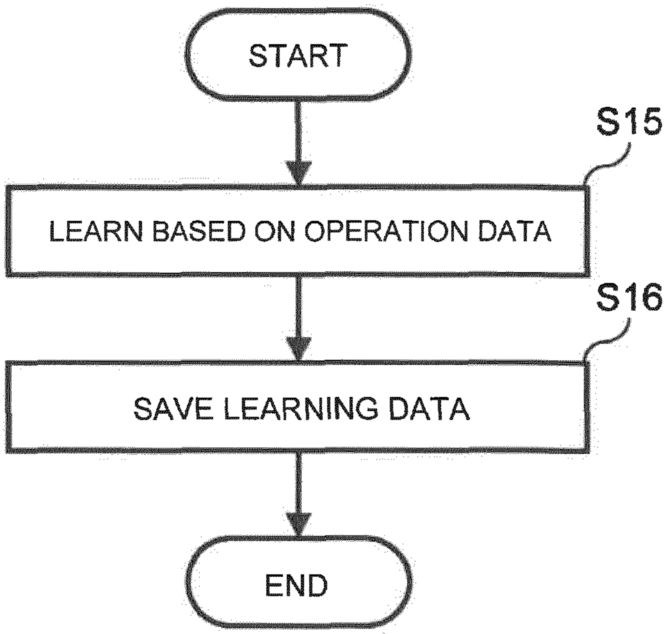

START
S15
LEARN BASED ON OPERATION DATA
S16
SAVE LEARNING DATA
END

FIG. 9

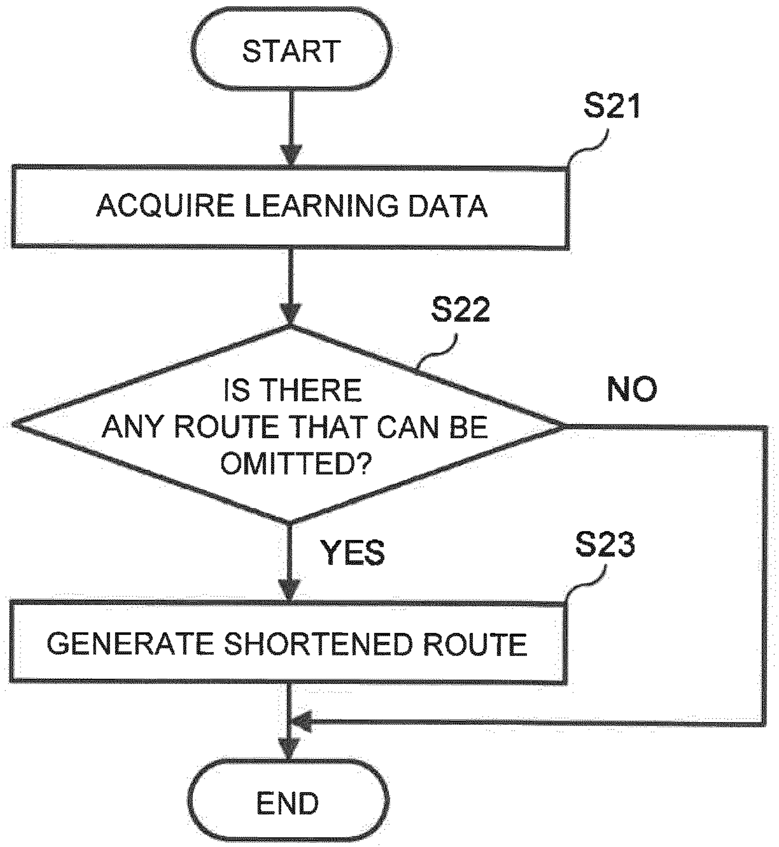

START
S21
ACQUIRE LEARNING DATA
S22
IS THERE ANY ROUTE THAT CAN BE OMITTED?
NO
YES
S23
GENERATE SHORTENED ROUTE
END

FIG.10

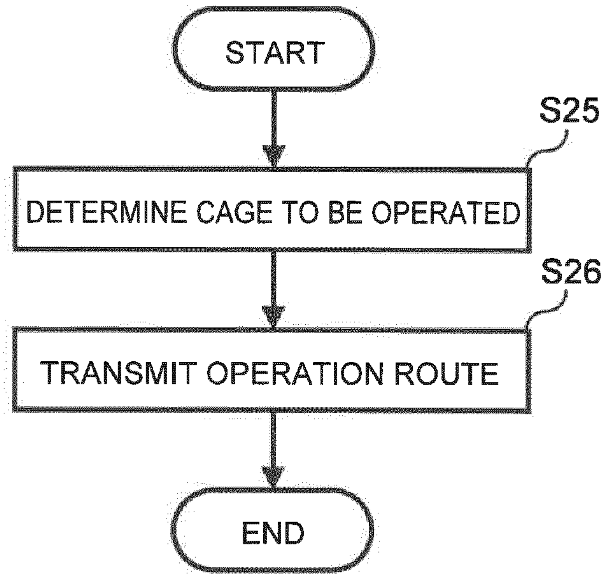

START
S25
DETERMINE CAGE TO BE OPERATED
S26
TRANSMIT OPERATION ROUTE
END

FIG.11

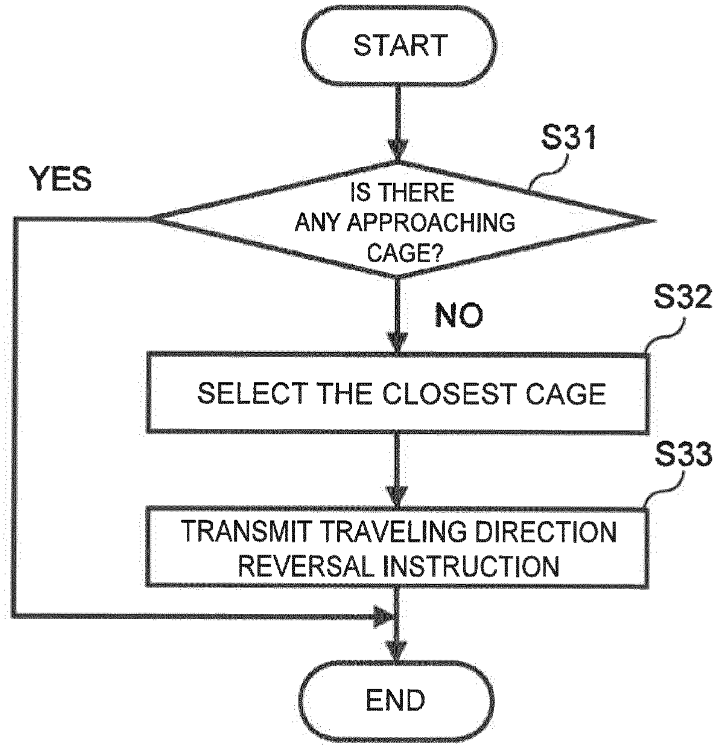

START
S31
YES
IS THERE
ANY APPROACHING
CAGE?
NO
S32
SELECT THE CLOSEST CAGE
S33
TRANSMIT TRAVELING DIRECTION
REVERSAL INSTRUCTION
END

FIG. 12

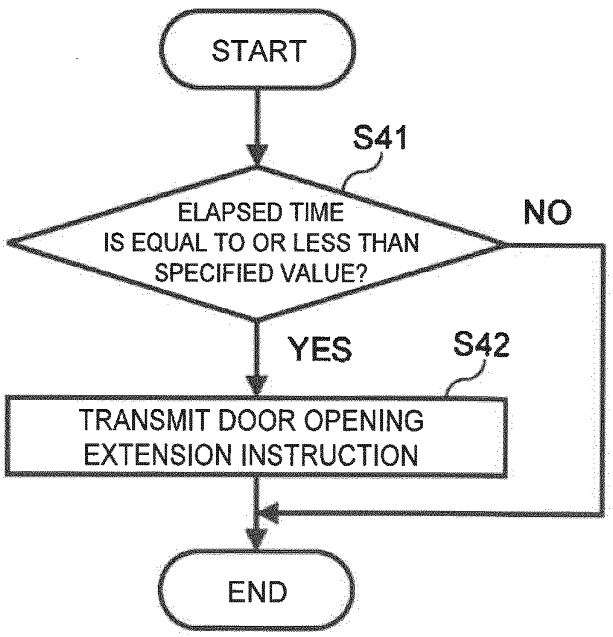

START
S41
ELAPSED TIME
IS EQUAL TO OR LESS THAN
SPECIFIED VALUE?
NO
YES
S42
TRANSMIT DOOR OPENING
EXTENSION INSTRUCTION
END

FIG.13

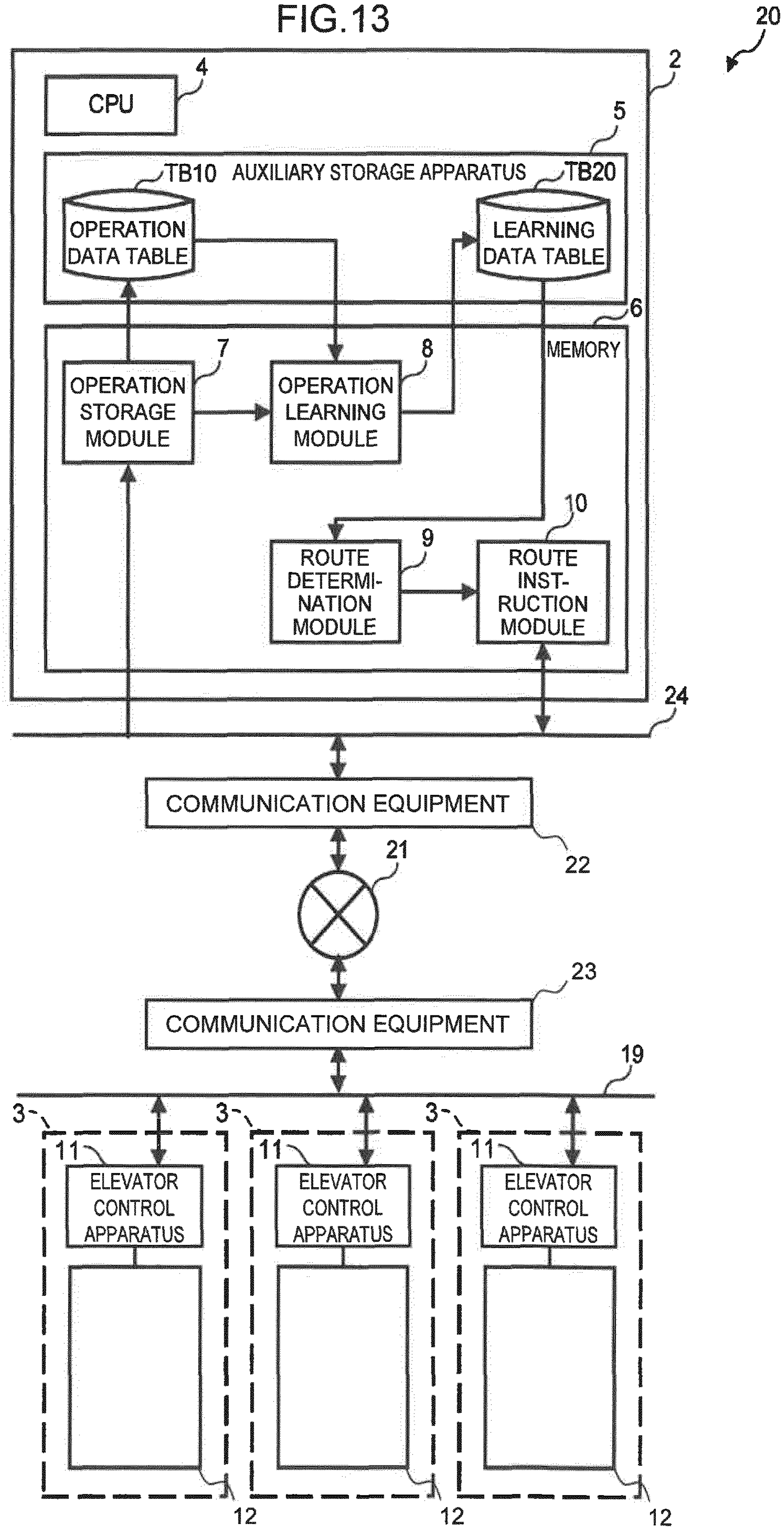

20
2
CPU
4
5
TB10
AUXILIARY STORAGE APPARATUS
TB20
OPERATION DATA TABLE
LEARNING DATA TABLE
6
MEMORY
7
8
OPERATION STORAGE MODULE
OPERATION LEARNING MODULE
10
9
ROUTE DETERMI-NATION MODULE
ROUTE INST-RUCTION MODULE
24
COMMUNICATION EQUIPMENT
22
21
23
COMMUNICATION EQUIPMENT
19
3
11
ELEVATOR CONTROL APPARATUS
3
11
ELEVATOR CONTROL APPARATUS
3
11
ELEVATOR CONTROL APPARATUS
12
12
12

FIG.14

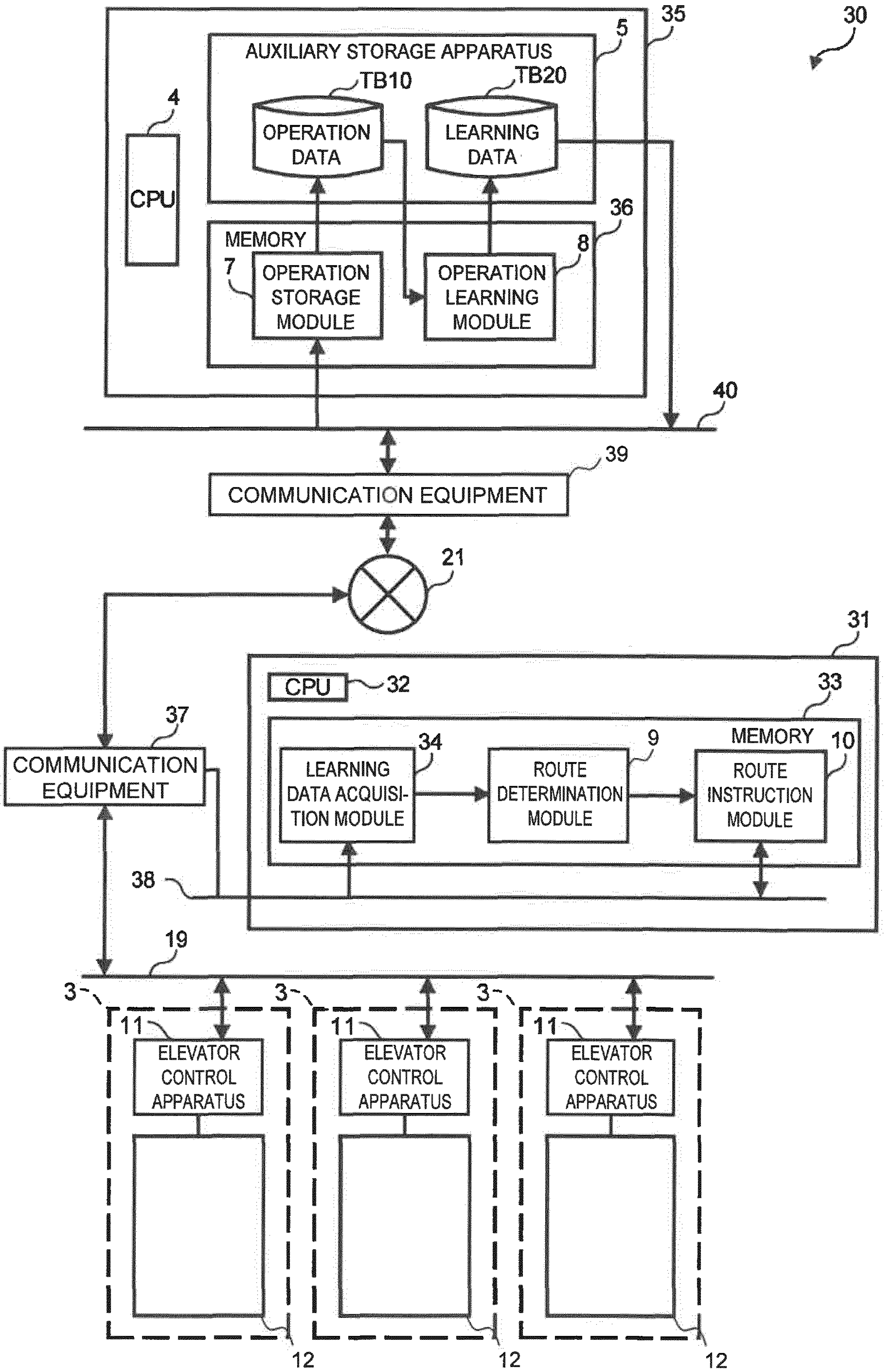

35
30
5
AUXILIARY STORAGE APPARATUS
TB10
TB20
4
OPERATION DATA
LEARNING DATA
CPU
36
MEMORY
8
7
OPERATION STORAGE MODULE
OPERATION LEARNING MODULE
40
39
COMMUNICATION EQUIPMENT
21
31
CPU
32
33
37
MEMORY
34
9
10
COMMUNICATION EQUIPMENT
LEARNING DATA ACQUISITION MODULE
ROUTE DETERMINATION MODULE
ROUTE INSTRUCTION MODULE
38
19
3
3
3
11
11
11
ELEVATOR CONTROL APPARATUS
ELEVATOR CONTROL APPARATUS
ELEVATOR CONTROL APPARATUS
12
12
12

FIG.15

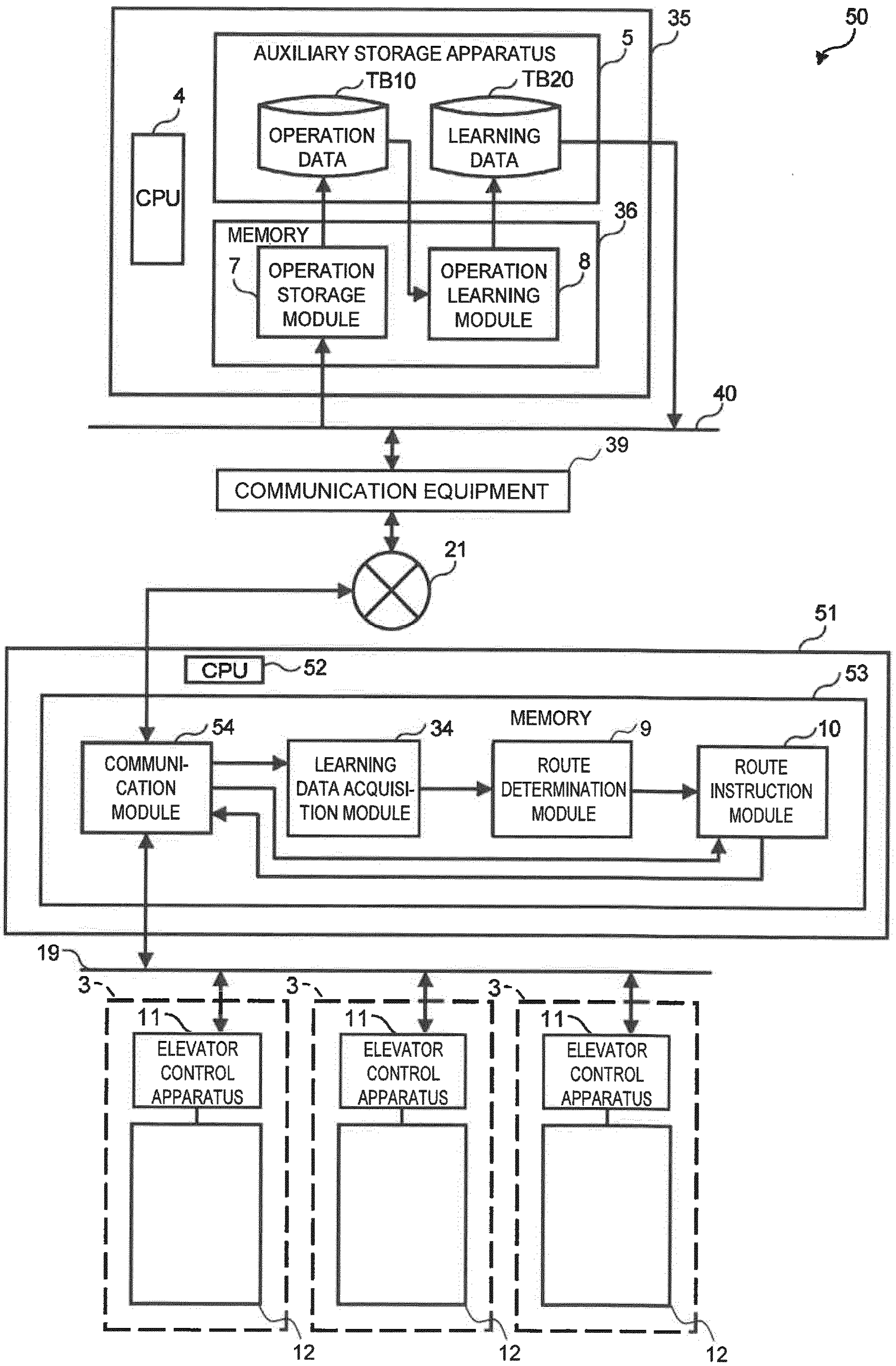
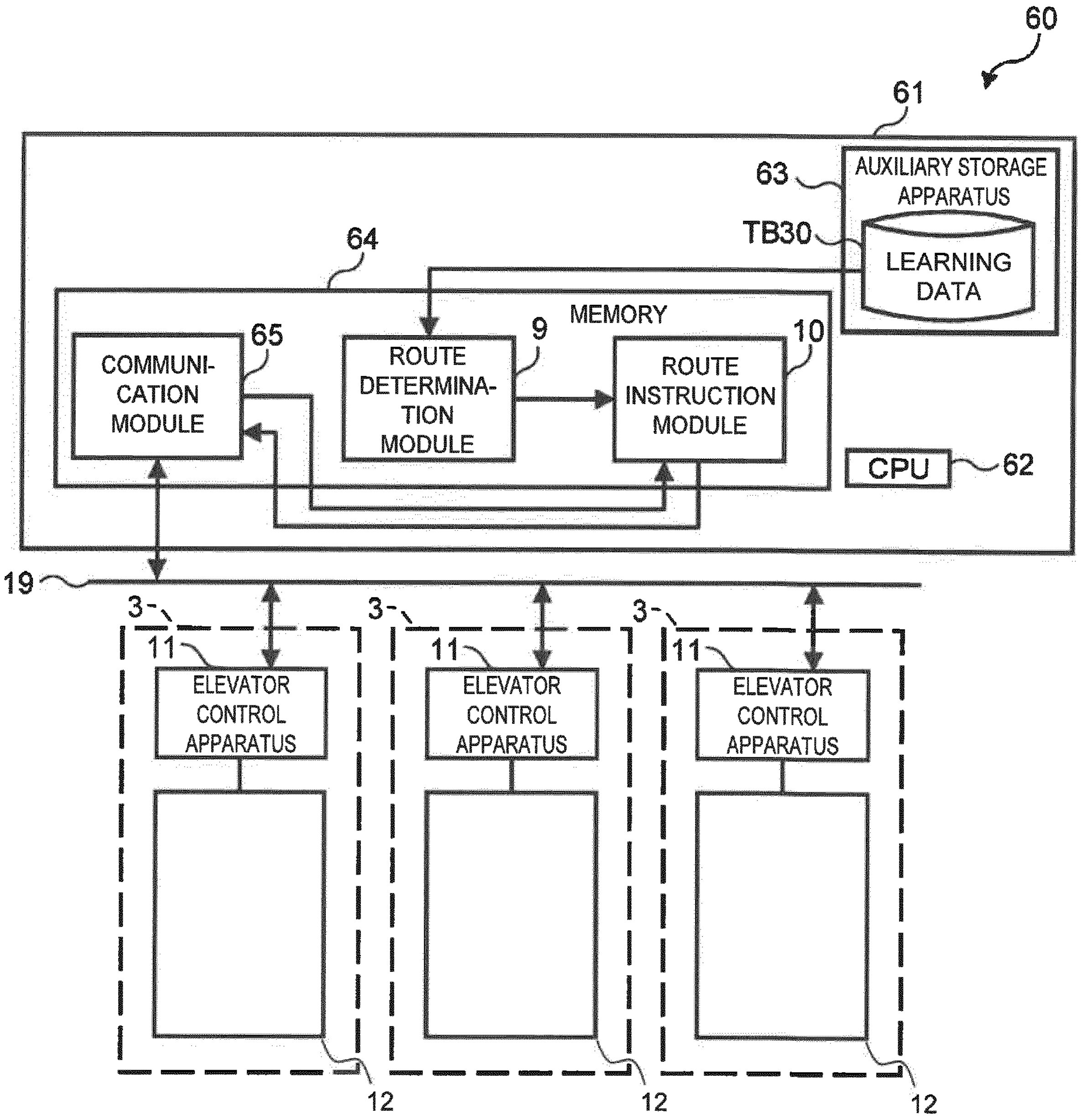

35
50
AUXILIARY STORAGE APPARATUS
5
TB10
TB20
4
OPERATION DATA
LEARNING DATA
CPU
36
MEMORY
7
OPERATION STORAGE MODULE
8
OPERATION LEARNING MODULE
40
39
COMMUNICATION EQUIPMENT
21
51
CPU
52
53
MEMORY
54
34
9
10
COMMUNI-CATION MODULE
LEARNING DATA ACQUISI-TION MODULE
ROUTE DETERMINATION MODULE
ROUTE INSTRUCTION MODULE
19
3
11
ELEVATOR CONTROL APPARATUS
12

FIG.16


60
61
63
AUXILIARY STORAGE APPARATUS
TB30
LEARNING DATA
64
MEMORY
65
COMMUNI-CATION MODULE
9
ROUTE DETERMINA-TION MODULE
10
ROUTE INSTRUCTION MODULE
CPU
62
19
3
11
ELEVATOR CONTROL APPARATUS
3
11
ELEVATOR CONTROL APPARATUS
3
11
ELEVATOR CONTROL APPARATUS
12
12
12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/041390

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. B66B1/18(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. B66B1/00-1/52, B66B3/00-3/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2011-057325 A (TOSHIBA ELEVATOR AND BUILDING SYSTEMS CORP.) 24 March 2011, paragraphs [0014]-[0096], fig. 1-11 (Family: none)	6 1-5, 7
A	JP 2012-180185 A (TOSHIBA ELEVATOR AND BUILDING SYSTEMS CORP.) 20 September 2012, paragraph [0016], fig. 1 & CN 102653366 A	1-7
A	JP 2014-152032 A (TOSHIBA ELEVATOR AND BUILDING SYSTEMS CORP.) 25 August 2014, paragraphs [0015], [0017], [0027], fig. 1 & CN 103979372 A	1-7
A	JP 06-329352 A (HITACHI, LTD.) 29 November 1994, paragraphs [0021]-[0024], [0036], [0047]-[0052], [0062], fig. 1, 3, 5 (Family: none)	1-7

☒ Further documents are listed in the continuation of Box C.   ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23.01.2018	06.02.2018
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/041390

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 04-028680 A (MITSUBISHI ELECTRIC CORP.) 31 January 1992, entire text, all drawings & US 5250766 A, entire text, all drawings & GB 2246210 A & CN 1056659 A	1-7

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

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 **[0004]**