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

(11) EP 1 623 902 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
08.02.2006 Bulletin 2006/06

(21) Application number: **04730074.4**

(22) Date of filing: **28.04.2004**

(51) Int Cl.:
B61D 19/00 *(1968.09)* ***B61D 17/20*** *(1968.09)*
B61D 23/02 *(1968.09)*

(86) International application number:
PCT/JP2004/006187

(87) International publication number:
WO 2004/098972 (18.11.2004 Gazette 2004/47)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR

(30) Priority: **07.05.2003 JP 2003128815**

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(54) CAR EMERGENCY EXIT DEVICE

(57) An emergency exit apparatus 1 is equipped in a car 130 for use in evacuation by exiting from the car 130 or by moving between the cars 130. The emergency exit device 1 is suitable for use with a railway vehicle, particularly an automatically operated train on which staff such as a driver or conductor does not ride. The emergency exit apparatus 1 includes an emergency exit 150, an emergency exit door system 2, auxiliary equipment 3, and a control system 4 configured to control these components. When a passenger operates an unlock switch 41 provided inside the car 130, a train information management system (TIMS) receives a signal, and controls the door system 2 or the auxiliary equipment 3 based on the signal.

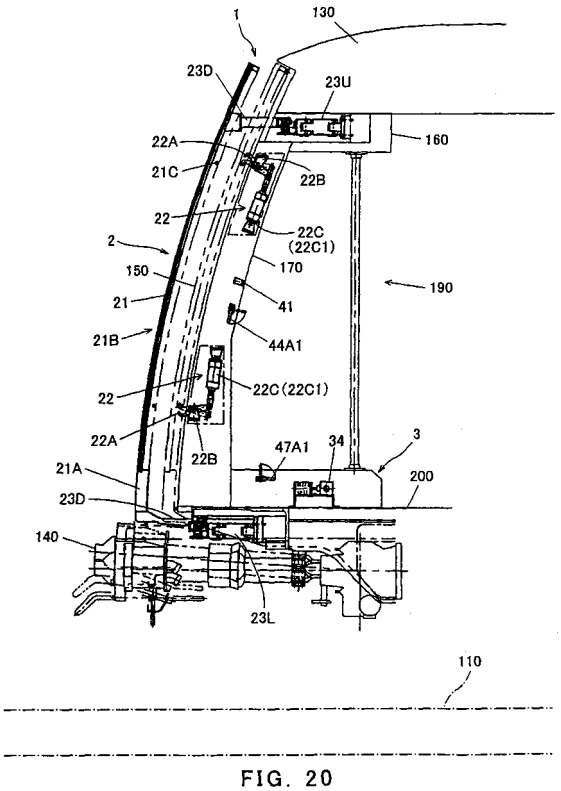

FIG. 20

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention is directed to providing an emergency exit apparatus equipped in a vehicle composed of a single car or multi coupled cars and configured to allow passengers to escape from the vehicle or move between the cars of train, in unusual case during travel. Particularly, the present invention is directed to providing an apparatus suitably applied to a railway vehicle configured to be automatically operated in an unattended state without a driver or a conductor thereon.

[0002] Initially, definitions of terms employed in this description will be briefly described.

(Terms)

[0003]

Means: Generic term of a method, a construction, a system, a device, etc, for achieving a predetermined object;
Method: General term of a series of procedure. Manual operation is conducted by person and operation is performed by means;
Evacuation: Safety keeping activity including escape from car or move between cars;
Unusual: Not usual;
Emergency: Condition in which safety can be secured at that time point but emergency may transition to urgency;
Urgency: Condition in which safety cannot be secured unless any prompt safety measures are taken;
Vehicle:Carriage consisting of car or cars traveling with persons carried thereon;
Train: Movable body in operation composed of vehicle;
Stop: Stop of vehicle or train at predetermined point;
Suspend: Stop of vehicle or train at point other than predetermined point;
Operation control center: Site which manages and controls operation or traffic of trains;
Information: Meaningful content such as state or instruction, finally communicated to persons;
Signal: Information or content of control converted to correspond to transmission means;
Lock: Lock and fix;
Unlock: Unlock and unfix;
Unlock switch: Switch attached in the vicinity of emergency exit to unlock door;
Unlock signal: Instruction generated by operating unlock switch to unlock door;
Fix signal: Instruction selected for move between cars to fix ladder to floor;
Location information: Information indicating location within train where unlock switch has been operated;
Coupling information: Information indicating whether or not coupler is in coupled state;
Velocity information: Information indicating velocity of train;
Velocity zero: Information indicating that train velocity is zero, i.e., train is stopped or suspended state;
Public address equipment: General term of on-vehicle equipment except for emergency communication equipment, equipped beyond the scope of emergency exit apparatus, capable of outputting information to passengers in form of voice, and configured to send information from on-vehicle equipment or operation control center through communication means;
Indication equipment: General term of on-vehicle equipment capable of outputting visual information to passengers, equipped beyond the scope of emergency exit apparatus and configured to send information from on-vehicle equipment or operation control center through communication means;
Emergency communication equipment: One type of on-vehicle equipment which is equipped beyond the scope of emergency exit apparatus for use in conversation between passengers in train and staff in operation control center in such a manner that passengers report situation to staff in operation control center and staff announces instruction to passengers and configured to send information through communication means;
Visual communication equipment: Device, for example, CCTV, equipped beyond the scope of emergency exit apparatus on car side or on the ground to mainly transmit visual information between train and operation control center and configured to send information through communication means;
Communication means: Device, for example, train radio, equipped beyond the scope of emergency exit apparatus on car side and above ground and configured to transmit information such as signal, voice, image, etc, between train and operation control center;
Indication means: Means located in operation control center and configured to inform staff of operation condition information or car state information; and
Control means: Means located in operation control center and configured to give instruction or perform control for train or vehicle.

[0004] Next, definitions of components used in detailed description of the present invention will be described below.

(Definition of Components)

[0005]

Emergency exit apparatus: Total system including emergency exit, door system, auxiliary equipment, and control system;

Emergency exit: Opening not available in usual state, serving as entrance and exit;
Door system: Main component including door, lock mechanism, and opening and closing mechanism;
Door: Door including frame, glass window, and lock arm receiver and configured to close emergency exit;
Lock mechanism: Device including lock arm, drive mechanism, etc and configured to lock door;
Lock arm: Device mounted on car body side and configured to engage with lock arm receiver mounted to door;
Drive mechanism: Drive device for lock arm, including air cylinder, solenoid reciprocation mechanism, etc;
Opening and closing mechanism: Opening and closing device for door, including support base, input and output link, lateral movement mechanism, coupling arm, movement limit system for these, etc;
Lateral movement mechanism: Device including linear guide, etc, and configured to move door in lateral direction of car;
Movement limit mechanism: Limit device of movement track of door, including track plate or track groove, and roller;
Auxiliary equipment: Main component equipped for use with emergency exit, including ladder, ladder cover, apron, and fix mechanism;
Fix mechanism: Anti-protrusion device for ladder, including press member, wedge, operation mechanism, etc;
Operation mechanism: Operation device for press member, including air cylinder, solenoid reciprocation mechanism, etc;
Control system: Main component including unlock switch, coupling detection mechanism, unlock control mechanism, backup unlock mechanism, door open detection mechanism, fix control mechanism, auxiliary fix mechanism, fix detection mechanism, and TIMS, and configured to control door system or auxiliary equipment;
Unlock switch: First device operated by passenger to open door in operation of emergency exit apparatus;
Coupling detection mechanism: Device including limit switch and configured to detect coupled state;
Unlock control mechanism: Unlock control device of lock mechanism, including electromagnetic valve or contactor;
Backup unlock mechanism: Backup device against failure of unlock control mechanism, including cock of air circuit or cable of solenoid connection;
Door open detection mechanism: Device including limit switch, and configured to detect opening of door;
Fix control mechanism: Fix control device for fix mechanism, including electromagnetic valve or contactor;
Backup fix mechanism: Backup device against failure of fix control mechanism, including cock of air circuit or cable of solenoid connection;
Fix detection mechanism: Device including limit switch and configured to detect fix of ladder; and
TIMS: Train information management system equipped in train and having function required for management and control of emergency exit apparatus.

[0006] The device of this type in the conventional car includes an emergency exit apparatus operated from inside or outside the car.

[0007] Atypical example of this is an emergency exit apparatus equipped in a rear portion of a bus. By manually operating unlock handle attached to a door of an emergency exit, the door can be opened manually, and passengers can escape therefrom. In the vehicle traveling independently as a single piece, such as bus, passengers need not move from car from which they should escape to another car.

[0008] On the other hand, in a train composed of coupled cars, such as railway vehicle, passages are typically provided between the cars to allow passengers to freely move between them. In addition, emergency exit apparatuses are equipped on end portions of front and rear cars of the train to allow passengers to escape from the vehicle.

[0009] In these vehicles, a train conductor operates an unlock handle of the emergency exit apparatus from inside the car and sets a ladder equipped as auxiliary equipment on the floor to allow passengers to escape from the train to a track outside the train through the ladder.

[0010] In the case of a train which is not equipped with emergency exit apparatuses at both end portions of the cars, such a method is not employed. Since the train is equipped with only entrances and exits provided on side portions thereof, through which passengers usually get on and off the train, they are used for evacuation. In any case, in the train on which the passengers can move between cars, the passengers escape from the cars substantially without any problem.

[0011] However, in the case of a train composed of plural trains equipped with emergency exit apparatuses between which the passengers do not usually move at both end portions of cars and traveling with the both end portions of the cars facing each other, some devices should be made to deal with evacuation.

[0012] Specifically, some devices should be made for passengers to move between cars urgently when trains with different destinations are traveling in a coupled state, or for passengers to move to and be accommodated in an assistance train coupled to a train under a failure condition.

[0013] A progressive one of emergency exit apparatuses applicable to the railway vehicle is registered as Japanese Patent No. 1992083 or EP Patent No. 0259886. These emergency devices are devised according to their embodiments so that a rear surface of a door

of an emergency exit can be utilized as a ramp to allow passengers to escape from a car, or a door is laterally moved to ensure an emergency exit to allow passengers to move between coupled cars.

[0014] However, these emergency exit apparatuses are not equipped with normal windows, and the emergency exit apparatus equipped at the front car of the train blocks the passengers' front view within the car. Thus, these emergency exit apparatuses have shortcomings and cannot provide desired service for passengers.

[0015] Train operation of a guideway such as railway vehicle includes train operation conducted by/with driver and train operation without driver. In general, the former is called attended train operation (train operation by/with driver) and the latter is called unattended train operation.

[0016] In the vehicle of the attended train operation, passenger cabin is not substantially affected by a large emergency exit apparatus because of the presence of a conductor cabin, and complicated operation for evacuation of the passengers is performed by an expert conductor without substantial difficulty.

[0017] On the other hand, in the vehicle of the unattended train operation, since a passenger cabin occupies a whole part of the interior of the car because of the absence of the conductor cabin, the large emergency exit apparatus undesirably narrows a space of the passenger cabin, and blocks the front view.

[0018] Further, in the vehicle of the unattended train operation, it is necessary for the passengers to perform the whole operation from preparation to completion of evacuation even through they are not familiar with such operation. For this reason, it is desirable to configure the emergency exit apparatus of the vehicle of the unattended train operation as follows as compared to that of the attended train operation:

- Operation of the emergency exit apparatus is simpler so that the passengers do not make mistake. If possible, the operation is desirably automatic.
- The emergency exit apparatus operates better than the conventional emergency exit apparatus.
- Failure of the automated part can be dealt with.
- Passengers passing through the emergency exit per unit of time can be increased.
- No large space is required and sufficient front view is ensured.
- The emergency exit apparatus intended for the vehicle of the unattended train operation is directly applicable to the vehicle of the attended train operation. The above requirements are desirably met in the vehicle of the attended train operation as well as the vehicle of the unattended train operation of the present invention.

SUMMARY OF THE INVENTION

[0019] Accordingly, the present invention is directed to providing a means capable of meeting requirements for an emergency exit apparatus equipped in a vehicle of unattended operation and of meeting the requirements which have not been solved in the prior art apparatus. The present invention is not limited to guideway vehicle of unattended operation, but applied to a train of attended operation or unguided vehicle driven independently as a single car without any problem. The present invention is intended to improve safety in evacuation of passengers.

[0020] An emergency exit apparatus of the present invention comprises an emergency exit; a door system; auxiliary equipment; and a control system, wherein the emergency exit is provided at an end portion of a car, the door system includes a door openably mounted to the emergency exit, a lock mechanism configured to lock and unlock the door relative to a car body of the car, and an opening and closing mechanism configured to mount the door to the car body and to allow the door to be opened outward without interference with the car body, the auxiliary equipment includes a ladder, a ladder cover, an apron, and a fix mechanism configured to unfix the ladder when the apron is not used and to fix the ladder when the apron is used, and the control system includes an unlock switch configured to generate an unlock signal, a coupling detection mechanism configured to detect coupling or uncoupling between cars, an unlock control mechanism configured to place the lock mechanism at an unlock position, a backup unlock mechanism, a door open detection mechanism configured to detect opening of the door, a fix control mechanism configured to fix the ladder in unfixed state by the fix mechanism, a backup fix mechanism, a fix detection mechanism configured to detect fix of the ladder, and a train information management system configured to manage and control the above equipment and the above mechanisms.

[0021] Preferably, in the emergency exit apparatus, the lock mechanism forming a part of the door system includes a lock arm and a drive mechanism, and the lock arm has a support member around which the lock arm is pivotable, and is structured such that an engagement portion engageable with a lock arm receiver is provided at one end thereof and an opposite end thereof is coupled to the drive mechanism by a pin to allow the door to be locked and unlocked by an operation of the drive mechanism using the lock arm receiver.

[0022] Preferably, in the emergency exit apparatus, the opening and closing mechanism forming a part of the door system includes a support base, an input and output link, a lateral movement mechanism, and a coupling arm, or includes the support base, the input and output link, the lateral movement mechanism, the coupling arm, and an operation limit mechanism, the support base is mounted to the car body to support the door by elements of the opening and closing mechanism other than the support base and coupled to the lateral movement mechanism by two sets of pins provided at both ends of the input and output link to allow the lateral movement mechanism to pivot, and the lateral movement mechanism is structured to have plural layers in which a lower layer thereof is

coupled to the input and output link and an upper layer thereof is coupled to the coupling arm to allow the plural layers of the lateral movement mechanism to move relative to each other, the coupling arm is configured to couple the upper layer of the lateral movement mechanism to the door, and to couple one end of the operation limit mechanism to the support base and an opposite end of the operation limit mechanism to the upper layer of the lateral movement mechanism.

[0023] Preferably, in the emergency exit device, the auxiliary equipment includes the ladder, the ladder cover, the apron, and the fix mechanism, the ladder is mounted on a passage of the emergency exit by a mechanism which is configured to support and guide right and left sides of the ladder and is capable of being unfixed and fixed by the fix mechanism mounted in the vicinity of the ladder, and the ladder cover is provided to cover the ladder, and the apron is mounted on the ladder cover such that the apron is rotatable around a hinge to be extended outside the car.

[0024] Preferably, in the emergency exit apparatus, the control system includes the unlock switch, the coupling detection mechanism, the unlock control mechanism, the backup unlock mechanism, the door open detection mechanism, the fix control mechanism, the backup fix mechanism, the fix detection mechanism, and the train information management system, the unlock switch is configured to generate the unlock signal and to send the unlock signal to the train information management system, the coupling detection mechanism is configured to generate coupling information and to send the coupling information to the train information management system, the unlock control mechanism is configured to receive the unlock signal through the train information management system and to perform control to cause the lock mechanism to be placed at an unlock position, the backup unlock mechanism is configured to be manually operated to cause the lock mechanism to be placed at the unlock position or a lock position, the door open detection mechanism is configured to generate door open information and to send the door open information to the train information management system, the fix control mechanism is configured to receive a fix signal or an unfix signal generated in the train information management system and to perform control to cause the fix mechanism to be placed at a fix position or an unfix position, the backup fix mechanism is configured to be manually operated to cause the fix mechanism to be placed at the fix position or the unfix position, the fix detection mechanism is configured to send fix information or unfix information of the ladder to the train information management system, and the train information management system is configured to receive at least the unlock signal, velocity information, the coupling information, the door open information, the fix information or the unfix information, and a control signal, and configured to send at least the unlock signal, a public address signal or an indication signal, an emergency brake signal, the fix signal or the unfix signal which are instruction signals, and state information including location information.

[0025] Subsequently, an evacuation method in emergency associated with a car of an unattended operation will be described in conjunction with the emergency exit apparatus of the present invention.

(Evacuation method in emergency)

[0026] Assume that an emergency occurs in an automated train of unattended operation during travel. The procedure of evacuation which is assumed to be optimal is as follows.

I. Report of emergency by passenger

[0027] When an emergency occurs, a passenger behaves and each mechanism and equipment operates as follows.

- The passenger operates a switch of emergency communication equipment provided within each car. The emergency communication equipment is provided beside door of each car through which the passengers get on and off the train.
- When the passenger operates the switch of the emergency communication equipment, the information is sent to an operation control center configured to manage and control operation of the train through communication means, etc.

II. Action of staff in operation control center

[0028] Receiving the information, the staff in the operation control center acts as follows.

- The staff in the operation control center opens a communication line to converse with the passenger which has operated the switch of the emergency communication equipment to know the reason and cause.
- After that, the staff in the operation control center announces instructions for actions to be taken to the passengers on the train according to a predetermined procedure of a procedure manual or according to circumstances without the procedure manual.
- When the emergency exit should be used, the staff announces this to all the passengers. Depending on the case, the staff limits behavior of the passenger to avoid prompt escape from the car.
- The staff in the operation control center switches the communication line to emergency communication equipment at an appropriate position if necessary.

III. Manual operation for unlocking door by passenger (operation of emergency exit apparatus by passenger)

[0029] In order to use the emergency exit, the passen-

ger acts as follows according to the announced instruction, and each mechanism and equipment operates.

- The passenger approaches to the emergency exit and operates the unlock switch of the emergency exit which is positioned beside the emergency exit.
- Upon the operation of the unlock switch, the unlock signal is generated, and train information management system (TIMS) equipped in any of the cars forming the train detects and recognizes the unlock signal, and causes either one of or both of public address equipment and indication equipment to announce and display operation method and evacuation method.
- After recognizing the unlock signal, the TIMS causes the train to immediately apply an emergency brake.
- Simultaneously, the TIMS specifies a location where the unlock signal has been generated, and checks coupling information at the location.

[0030] The coupling information is meant to indicate whether or not a coupler at the location of each emergency exit is coupled or uncoupled. At a location of the coupled state, move between the cars is selected, while at a location of the uncoupled state, escape from the car is selected.

- Further, the TIMS checks velocity information of the train, and waits to output the unlock signal until the velocity becomes zero. Thereby, the door is kept locked until the train is suspended. When the train is suspended, the velocity information is velocity zero, and therefore, the TIMS immediately sends the unlock signal to a lock control mechanism at the location of the door to be unlocked.
- Receiving the unlock signal, the lock control mechanism immediately places the lock mechanism at an unlock position.
- When the passenger operates the unlock switch, the resulting generated, processed and output information are sent to the operation control center through the communication means, etc.

IV. Action of staff in operation control center

[0031] In the operation control center, the staff acts as follows based on the information sent through the communication means, etc.

- When the location information indicates an end portion of a train set, i.e., the location of uncoupled state, the corresponding car is considered as a target, while when the location information indicates an intermediate portion of the train set, i.e., at the location of the coupled state, the corresponding car and an opposite car are considered as targets.
- The staff switches the emergency communication equipment to that nearest to the location where the unlock signal has been generated. If visual communication equipment is equipped, the staff switches the corresponding circuit to that at the location to enable the action from the operation control center. These switching may be performed automatically or manually by the staff in the operation control center.
- With reference to audio information from the emergency communication equipment or visual information from the visual communication equipment, the staff in the operation control center announces instructions according to the predetermined procedure to the passengers. The staff causes the passengers to operate the emergency exit apparatus according to the instructions and guides them.

Brief Description of the Drawings

[0032]

Fig. 1 is a longitudinal sectional view showing a method of operation performed by a passenger on a car who is going to move to an opposite car, and a condition in which the passenger has operated an unlock switch;
Fig. 2 is a longitudinal sectional view showing a condition in which the passenger has pushed an emergency exit door outside the car;
Fig. 3 is a longitudinal sectional view showing a condition in which the passenger lifts up and rotates an apron to extend out the apron outside the car;
Fig. 4 is a longitudinal sectional view showing a condition in which the passenger opens an emergency exit door of the opposite car;
Fig. 5 is a plan view of auxiliary equipment which allows the passenger to move between cars;
Fig. 6 is a longitudinal sectional view of Fig. 5;
Fig. 7 is a longitudinal sectional view showing a method of operation performed by the passenger which is going to escape from the car, and a condition in which the passenger has operated an unlock switch;
Fig. 8 is a longitudinal sectional view showing a condition in which the passenger has pushed the door outside the car;
Fig. 9 is a longitudinal sectional view showing a condition in which the passenger is going to kick a ladder outside the car;
Fig. 10 is a longitudinal sectional view showing a condition in which the ladder is set in an emergency exit;
Fig. 11 is a plan view showing a condition in which the passenger can escape from the car;
Fig. 12 is a longitudinal sectional view of Fig. 11;
Fig. 13 is a flowchart showing a series of operation steps and actions in a case where the passengers move between cars under the condition in which all functions are proper;
Fig. 14 is a flowchart showing a series of operation steps and actions in a case where the passengers

escape from the car under the condition in which all functions are proper;
Fig. 15 is a flowchart showing a series of operation steps and actions at a location where failure occurs in an unlock control mechanism;
Fig. 16 is a flowchart showing a series of operation steps and actions at a location where failure occurs in a fix control mechanism;
Fig. 17 is a flowchart showing a series of operation steps and actions under the condition in which failure occurs in the TIMS;
Fig. 18 is a flowchart showing a series of operation steps and actions under the condition in which failure occurs in the emergency communication equipment or the communication means;
Fig. 19 is a flowchart showing a series of operation steps and actions during and after evacuation performed by the assistance staff outside of the car;
Fig. 20 is a longitudinal sectional view of an embodiment of a car which is cut along the center of car body;
Fig. 21(a) is a longitudinal sectional view of an embodiment in the vicinity of a center of the car and Fig. 21(b) is an enlarged view of a portion represented by "Z";
Fig. 22 is a transverse sectional view of an embodiment of an upper opening and closing mechanism and its surroundings;
Fig. 23 is a transverse sectional view of an embodiment of a center of a door in a vertical direction and its surroundings;
Fig. 24(a) is a transverse sectional view of a portion located slightly above a floor, and Figs. 24(b) and 24(c) are enlarged views of a portion represented by Z in Fig. 24(a);
Fig. 25 is a transverse sectional view of an embodiment of a lower opening and closing mechanism and its surroundings;
Fig. 26 is a front view of an embodiment of an emergency exit of a car;
Fig. 27 is a block diagram showing a control system of an emergency exit apparatus and its associated configuration;
Fig. 28 is a block diagram showing the control system of the emergency exit apparatus and its associated configuration;
Fig. 29 is a piping diagram showing a state in which lock and unfix are performed in an embodiment comprising spring air cylinders;
Fig. 30 is a piping diagram showing a state in which unlock and fix are performed in an embodiment comprising the spring air cylinders;
Fig. 31 is a piping diagram showing a state in which unlock and fix are performed from inside the car in the event of a failure of the embodiment in Fig. 29;
Fig. 32 is a piping diagram showing a state in which unlock and fix are performed from outside the car in the event of a failure of the embodiment in Fig. 29;
Fig. 33 is a piping diagram showing a state in which lock and unfix are performed in an embodiment comprising two-chamber air cylinders;
Fig. 34 is a piping diagram showing a state in which unlock and fix are performed in an embodiment comprising two-chamber air cylinders;
Fig. 35 is a connection diagram showing a state in which unlock and fix are performed in an embodiment comprising spring solenoid reciprocation mechanism; and
Fig. 36 is a connection diagram showing a state in which unlock and fix are performed in an embodiment comprising non-spring solenoid reciprocation mechanism.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0033] Best mode for carrying out the invention will be described with reference to the attached drawings.

(Operation of emergency exit apparatus performed by passenger)

[0034] An operation of an emergency exit apparatus performed by a passenger, which is included in an evacuation method associated with an emergency exit apparatus of the present invention, will be described with reference to the drawings.

[0035] In principle, the emergency exit apparatus is operated by a passenger. The procedure of the operation varies between a portion of the emergency exit in coupled state and that in uncoupled state.

[0036] First of all, the procedure of the operation in the coupled state will be described.

(Move to Next Car)

[0037] Fig. 1 shows a configuration in which a passenger moves between cars. Emergency exit apparatuses 1 are respectively positioned at end portions of coupled cars 130. Usually, the passenger cannot move between the emergency exit apparatuses 1. In the configuration in Fig. 1, the operation procedure is as follows.

1) Coupled state

[0038] Fig. 1 shows a condition in which the passenger has operated an unlock switch 41 at an emergency exit 150. Upon the unlock switch 41 being operated, TIMS (train information management system) detects and recognizes an unlock signal and causes either one of or both of public address equipment and indication equipment to announce and display an operation method and an evacuation method for passengers.

[0039] The present invention is configured such that, to avoid the opening of a door 21 during travel of a train 120, an emergency brake is applied, upon the operation

of the unlock switch 41 during the travel of the train 120, thereby causing the train 120 to suspend after a while. After that, the TIMS confirms velocity zero, and unlocks the door 21.

[0040] On the other hand, if the unlock switch 41 is operated in a stopped state of the train 120, the door 21 is immediately unlocked under the velocity zero. In Fig. 1, movement of a lock mechanism 22 is shown in two ways, i.e., lock and unlock.

[0041] Upon the door 21 being unlocked, a force applied to close the door 21 is released, thereby allowing the door 21 to move slightly outward. This state is shown by the car 130 on the left side in Fig. 2. Upon the unlock of the door 21, the car 130 on the right side becomes in the same condition. It will be appreciated that, such a condition occurs only in the doors 21 at locations of the emergency exit apparatuses 1 in coupled state within the train 130, including a location where the unlock signal has been generated and an opposite location.

[0042] Fig. 2 shows a condition in which the passenger has pushed the door 21 outside the car 130. The door 21 is moved to be more distant from the car body of the car 130 by an operation of the opening and closing mechanism 23.

[0043] Since the door 21 moves distant from the car body and in the lateral direction, the passenger pushes the door 21 in the lateral direction in which the door 21 moves, thereby allowing the door 21 to be fully opened.

[0044] Fig. 3 shows a condition in which the passenger is going to lift up and rotate an apron 33 on a ladder cover 32 (see Fig. 6) covering a ladder 31 (see Fig. 6) installed on the floor to extend out the apron 33 outside the car 130.

[0045] Fig. 4 shows a condition in which the passenger walks on the extended-out apron 33 outside the car 130 and sees the door 21 of the opposite car 130 in front. Since the door 21 of the opposite car 130 is slightly distant from the car body as described above, the passenger draws the door 21 and moves the door 21 in the lateral direction to fully open the door 21.

[0046] After fully opening the door 21, the passenger extends out the apron 33 in the opposite car 130 toward the passenger, to allow the aprons 33 to be positioned between the cars 130.

[0047] Figs. 5 and 6 shows the train 120 in which the cars 130 are coupled to each other. The emergency exit apparatuses 1 are equipped at the end portions of the cars 130. Between the coupled cars 130, the passenger can move to the next car 130. More specifically, the doors 21 of the cars 130 are both fully opened and the aprons 33 are both extended out. The doors 21 move outward from the car bodies of the cars 130 and in the lateral direction to be opened. Under this condition, the passengers start to sequentially move to the opposite car 130. Fig. 5 shows that the emergency exits 150 are positioned to conform to each other in the lateral direction. This is because, opposite passages 190 are desirably arranged to extend in straight line shape to facilitate the evacuation of the passengers.

[0048] In railway vehicles recently manufactured, the emergency exits of this type are biased relative to the center of car bodies. The passengers can escape from the cars through such emergency exits but cannot walk straight to move between cars because the opposite passages 190 are not arranged to extend in straight line shape. For this reason, the cars 130 of this embodiment are more advantageous in terms of safety and time than the cars equipped with the biased emergency exits.

(Escape to Track)

[0049] Figs. 7 through 10 show a condition in which the passenger exits from the car. The emergency exit apparatus 1 is equipped at the end portion of the car 130, corresponding to a front portion or a rear portion of the train 120. The operation procedure in this case is as follows.

2) Uncoupled State

[0050] Fig. 7 shows that the passenger has operated the unlock switch 41 at the emergency exit 150. Upon the unlock switch 41 being operated, the TIMS detects and recognizes an unlock signal and causes either one or both of the public address equipment and the indication equipment to announce and display an operation method and an evacuation method for passengers.

[0051] The present invention is configured such that, the emergency brake is applied, upon the operation of the unlock switch 41 during travel of the train 120, thereby causing the train 120 to suspend after a while, for the reason described previously. After that, the TIMS confirms velocity zero, and unlocks the door 21. On the other hand, if the unlock switch 41 is operated in a stopped state of the train 120, the door 21 is immediately unlocked under the zero velocity. In Fig. 7, operation of the lock mechanism 22 is shown in two ways, i.e., lock and unlock.

[0052] Upon unlock of the door 21, a force applied to close the door 21 is released, thereby allowing the door 21 to move slightly outward. Although not shown in Fig. 7, the car 130 on the left side in Fig. 2 is in the same state.

[0053] It will be appreciated that, such a condition occurs only in the door 21 at a location of the emergency exit apparatus 1 in uncoupled state within the train 120, including a location where the unlock signal has been generated.

[0054] Fig. 8 shows a condition in which the passenger has pushed the door 21 outside the car 130. The door 21 is moved to be more distant from the car body the car 130 by the operation of the opening and closing mechanism 23. Since the door 21 moves distant from the car body and in the lateral direction, the passenger pushes the door 21 in the lateral direction in which the door 21 moves, thereby allowing the door 21 to be fully opened.

[0055] Fig. 9 shows a condition in which the passenger is going to kick a near side of the ladder cover 32 covering the ladder 31 installed on the floor outside the car with

the door 21 fully opened.

[0056] Fig. 10 shows a condition in which the ladder 31 and the ladder cover 32 kicked out by the passenger from the car 130 are automatically set by a gravitational force. In this case, the ladder cover 32 is separated from the ladder 31 and the ladder 31 which is retractable is extended and set between the emergency exit 150 and the track 110.

[0057] Figs. 11 and 12 show a condition in which the passenger can escape from the car 130 of the train 120 with the doors 21 fully open and the ladders 31 extended out. Under this condition, the passengers sequentially step down the ladders 31 outside the car 130. In the example shown in Fig. 11, the ladders 31 for use in escape are set between rails of straight track.

[0058] The passengers may escape from the car 130 on curved track. So, if the end portion of the car 130 is biased relative to the track 110 and an end portion of the ladder 31 contacts the rail or a fastening device thereof, this may negatively affect the evacuation of the passengers. Therefore, it is desirable to position the emergency exits 150 as close to the center of the car body as possible and arrange them to be laterally symmetric.

(Operation of emergency exit apparatus and action of staff)

[0059] Subsequently, how the emergency exit apparatus 1 and systems or mechanisms configuring the emergency exit apparatus 1 operate and staff in the operation control center takes actions, after the emergency exit apparatus 1 has been operated by the passenger, will be described.

(Move to Next Car)

1). Coupled State

[0060] Fig. 13 is a flowchart showing a series of operation steps and actions in a case where the passengers move between cars under the condition in which all the functions are proper. The emergency exit apparatus 1 and the associated operation are as follows.

(1) The passenger operates the unlock switch.
(2) The TIMS detects and recognizes the unlock signal, then causes either one of or both of the public address equipment and the indication equipment to announce and display an operation method and an evacuation method for passengers.
(3) The TIMS sends an emergency brake signal to a brake control system to cause the train 120 to apply an emergency brake.
(4) The TIMS specifies a location where the unlock signal has been generated and generates location information.
(5) The TIMS checks coupling information regarding the location based on the location information.
(6) In this case, the TIMS selects move mode to the next car and fix of the ladder.
(7) The TIMS sends a fix signal to fix control mechanisms of ladders at the location and an opposite location.
(8) Each fix control mechanism receives this signal.
(9) Each fix control mechanism causes the fix mechanism to operate to fix the ladder.
(10) Each fix detection mechanism detects fix of the ladder and generates fix information of the ladder.
(11) The TIMS detects each fix information and recognizes a fixed state of the ladder.
(12) The TIMS checks velocity information of the train.
(13) The TIMS waits to output the unlock signal until the velocity becomes zero.
(14) When the velocity becomes zero, the TIMS sends the unlock signal to the unlock control mechanism at the location of the door which is to be unlocked.
(15) The unlock control mechanism receives this signal.
(16) The unlock control mechanism places the lock mechanism at an unlock position.
(17) The door open detection mechanism detects the opening of the door and generates door open information.
(18) The TIMS detects the door open information and recognizes an open state of the door.
(19) The TIMS continues sending the above series of state information to the communication means of the train.

- The communication means relays the state information to the indication means of the operation control center.
- The indication means displays the information for the staff in the operation control center.
- Thereby, the staff in the operation control center recognizes other states of the emergency exit apparatus and takes actions. Specifically, the staff automatically or manually switches to the emergency communication equipment (or visual communication equipment if possible) which is located nearest the unlocked door, or opens communication line to recognize the conditions of the passengers or the emergency exit apparatus which cannot be recognized in the conventional emergency communication equipment (visual communication equipment) or the indication means.

(Escape to track)

2). Uncoupled State

[0061] Fig. 14 is a flowchart showing a series of operation steps and actions in a case where the passengers

escape from the car under the condition in which all functions are proper. The emergency exit apparatus 1 and the associated operation are as follows.

(1) The passenger operates the unlock switch.
(2) The TIMS detects and recognizes the unlock signal, then causes either one of and both of the public address equipment and the indication equipment to announce and display an operation method and an evacuation method for passengers.
(3) The TIMS sends an emergency brake signal to a brake control system to cause the train to apply an emergency brake.
(4) The TIMS specifies a location where the unlock signal has been generated and generates location information.
(5) The TIMS checks coupling information at the location based on the location information.
(6) In this case, the TIMS selects escape from the car and unfix of the ladder.
(7) The TIMS sends an unfix signal of the ladder to a fix control mechanism of ladder associated with the location or does not send the fix signal to the fix control mechanism.
(8) The fix control mechanism receives this signal.
(9) The fix control mechanism causes the fix mechanism to remain placed at an unfix position.
(10) The fix detection mechanism continues detecting the unfix of the ladder without generating the fix information
(11) The TIMS recognizes an unfixed state of the ladder without detecting the fix information.
(12) The TIMS checks velocity information of the train.
(13) The TIMS waits to output the unlock signal until the velocity becomes zero.
(14) When the velocity becomes zero, the TIMS sends an unlock signal to an unlock control mechanism at the location of the door which is to be unlocked.
(15) The unlock control mechanism receives this signal.
(16) The unlock control mechanism places the lock mechanism at an unlock position.
(17) The door open detection mechanism detects the opening of the door and generates the door open information.
(18) The TIMS detects the door open information and recognizes the door open state.
(19) The TIMS continues sending the above series of information to the communication means of the train.

- The communication means relays the state information to the indication means of the operation control center.
- The indication means displays the information for the staff in the operation control center.
- Thereby, the staff in the operation control center recognizes other states of the emergency exit apparatus and takes actions. Specifically, the staff automatically or manually switches to the emergency communication equipment (or visual communication equipment if possible) which is located nearest the unlocked door, or opens the communication line to recognize the conditions of the passengers or the emergency exit apparatus which cannot be recognized in the conventional emergency communication equipment (visual communication equipment) or the indication means.

(Failure location of unlock control mechanism)

3). Location where failure occur in unlock control mechanism

[0062] Fig. 15 is a flowchart showing a series of operation steps and actions at a location where failure occurs in the unlock control mechanism 33. The emergency exit apparatus 1 and the associated operation are as follows.

[0063] Since steps (1) through (14) in the procedure in Fig. 15 are identical to the steps (1) through (14) in the coupled state (Fig. 13) or uncoupled state (Fig. 14), they will not be further described.

(15) The unlock control mechanism cannot receive this signal.
(16) The unlock control mechanism cannot place the lock mechanism at an unlock position.
(17) The door open detection mechanism does not detect the opening of the door and does not generate the door open information.
(18) The TIMS monitors the door open information and generates failure information of this unlock control mechanism, because the TIMS does not detect the door open information even after an elapse of a predetermined time.
(19) The TIMS causes the public address equipment and the indication equipment of this car to announce manual unlock and display the procedure, respectively.
The passengers operate a backup unlock mechanism inside the car and places the lock mechanism at an unlock position to open the door based on the announcement and the display.
(20) The TIMS continues sending the above series of state information to the communication means of the train.

(Failure location of fix control mechanism)

4). Location where failure occurs in fix control mechanism

[0064] Fig. 16 is a flowchart showing a series of operation steps and actions at a location where failure occurs

in the fix control mechanism 46. The emergency exit apparatus 1 and the associated operation are as follows.

[0065] Since steps (1) through (7) in the procedure in Fig. 16 are identical to steps (1) through (7) of the coupled state (Fig. 13) or uncoupled state (Fig. 14), they will not be further described.

(8) The fix control mechanism cannot receive this signal.
(9) The fix control mechanism cannot fix the ladder by the fix mechanism.
(10) The fix detection mechanism does not detect the fix of the ladder and does not generate fix information.
(11) The TIMS monitors the fix information and generates failure information of the fix control mechanism, because the TIMS does not detect the fix information even after an elapse of a predetermined time.
(12) The TIMS causes the public address equipment and the indication equipment of this car to announce manual fix of the ladder and display the procedure, respectively.
The passenger operates a backup fix mechanism inside the car to fix the ladder based on the announcement and the display.
Since the following steps (13) through (19) in the procedure in Fig. 16 are identical to the steps (12) through (18) in the coupled state (Fig. 13) or the uncoupled state (Fig. 14), they will not be further described.
(20) The TIMS continues sending the above series of state information to the communication means of the train.

(Failure of TIMS)

5). In the Event of Failure of TIMS

[0066] Fig. 17 is a flowchart showing a series of operation steps and actions under the condition in which failure occurs in the TIMS. The emergency exit apparatus 1 and the associated operation are as follows.

(1) The TIMS detects its failure by self-diagnostic function, generates TIMS failure information and sends it to the communication means of the train.
(2) The passenger operates the unlock switch.
(3) Upon detection of the failure, the TIMS continues to relay the input unlock signal to the communication means of the train.

- The communication means of the train relays this state information to the operation control center.
- The indication means in the operation control center displays this state information.
- The staff in the operation control center recognizes the situation, prepares a predetermined procedure manual and takes actions as follows.
- The staff causes the train to apply an emergency brake.
- The staff opens the communication line of the emergency exit apparatus.
- The staff calls the passengers to question them about the current situation and specifies the location where the unlock signal has been generated.
- The staff determines whether or not evacuation is necessary and decides the method.
  In the case of move to next car:

    - The staff operates the backup fix mechanisms inside the opposing cars and instructs the passengers to fix the ladders.

(4) The passengers operate the backup fix mechanisms inside the cars and fix the ladders according to the instruction from the staff.
(5) The fix detection mechanisms detect the fix of the ladders and generate fix information.
In the cases of move to the next car and the escape from the car:

- The staff confirms the suspension of the train.
- The staff explains and announces the method and procedure of the evacuation to the passengers.
- The staff instructs the passengers to place the lock mechanism at an unlock position by the operation of the backup unlock mechanism inside the car.

(6) The passengers operate the backup unlock mechanism inside the car and places the lock mechanism at an unlock position according to the instruction from the staff.
(7) The passengers open the unlocked door.
(8) The door open detection mechanism detects the opening of the door and generates the door open information.
(9) The TIMS in failure continues to relay the input state information to the communication means of the train.

(Failure of emergency communication equipment or communication means)

6). In the event of failure of emergency communication equipment or communication means

[0067] Fig. 18 is a flowchart showing a series of operation steps and actions under the condition in which failure occurs in the emergency communication equipment or the communication means. The emergency exit apparatus 1 and the associated operation are as follows.

[0068] In the event of the failure of the emergency communication equipment:

- The emergency communication equipment detects its failure by a self-diagnostic function, generates emergency communication equipment failure information and sends it to the TIMS.

(1) The TIMS continues to relay this state information to the communication means of the train.

- The communication means of the train relays this state information to the operation control center.
- The indication means of the operation control center displays this state information.
- The staff in the operation control section recognizes the situation. In the event of a failure of the communication means:
- The communication means detects its failure by a self-diagnostic function, generates communication means failure information and sends it to the operation control center.
- In the event of the failure of the communication means, the state information does not reach the indication means.
- The indication means monitors the state information and displays the failure information of the communication means, because the indication means does not detect the state information even after an elapse of a predetermined time.
- The staff in the operation control center recognizes the situation.

In the event of a failure of the emergency communication equipment or the communication means:

- The staff in the operation control center prepares a predetermined procedure manual and determines whether the train is stopped and accommodated in a station or the train is suspended between stations, based on this procedure manual and carries this.

When the train is suspended between the stations:

- The staff suspends the train by the emergency brake.
- The staff confirms that the train has been suspended between stations.
- The staff decides to dispatch the rescue train or assistance staff and calls them.

(2) The assistance staff arrives on the scene and places the lock mechanism of the emergency exit at an unlock position by the backup unlock mechanism equipped outside the car.
(3) The assistance staff opens the unclocked door.
(4) The assistance staff prepares for the evacuation.

- The assistance staff evacuates the passengers.

When the train is accommodated into the station:

- The staff keeps traveling the train and accommodates it in nearest station.
- The staff confirms that the train has been stopped in the station.
- The staff causes the passengers to evacuate according to instruction and guides them in an usual manner.

(Action from outside the car in evacuation)

7). Action by the assistance staff from outside the car in the case of evacuation of passengers

[0069] Fig. 19 is a flowchart showing a series of operations and actions during and after evacuation performed by the assistance staff outside the car. The emergency exit apparatus 1 and the associated operation are as follows.

- The assistance staff approaches to the train from outside.

[0070] In the case of the move to the next car:

(1) The assistance staff operates the backup fix mechanism of each of the opposing cars outside the car.
(2) Each backup fix mechanism fixes the ladder.
(3) Then, the assistance staff operates the backup unlock mechanism outside of each of the cars.
(4) Each backup unlock mechanism places the lock mechanism at an unlock position.
(5) The assistance staff opens each unlocked door.
(6) The assistance staff extends out each apron.

[0071] In the case of escape from the car:

(7) The assistance staff operates only the backup unlock mechanism outside the car.
(8) The backup unlock mechanism places the lock mechanism at an unlock position.
(9) The assistance staff opens the unlocked door.
(10) The assistance staff sets the ladder.
In the cases of the move to the next car and the escape from the car:
(11) The TIMS continues to relay this state information to the communication means of the train.

[0072] The communication means of the train relays this state information to the operation control center.
[0073] The assistance staff explains and announces the evacuation method to the passengers and guides

them.

(Action from outside the car after evacuation)

7). Action by the assistance staff from outside the car after evacuation of passengers

[0074] Fig. 19 is a flowchart showing a series of operation steps and actions during and after evacuation performed by the assistance staff outside the car. The emergency exit apparatus 1 and the associated operation are as follows.

[0075] In the case of the move to the next car:

(12) The assistance staff stores each apron.
(13) The assistance staff returns each backup fix mechanism outside the car to its original state.
(14) Each backup fix mechanism unfixes the ladder.

[0076] In the cases of the escape from the car:

(15) The assistance staff stores the ladder and the ladder cover.

[0077] In the cases of the move to the next car and the escape from the car:

(16) The assistance staff manually closes the door to return the door to unlocked state which was going to be opened.
(17) The assistance staff returns the backup unlock mechanism outside the car to its original state.
(18) The backup unlock mechanism locks the door.
(19) The TIMS continues to relay this state information to the communication means of the train.

- The communication means of the train relays this state information to the operation control center.

(Construction of emergency exit apparatus)

[0078] Figs. 20 through 26 show an embodiment of a construction of the emergency exit apparatus 1 for the unattended operation train, which allows the passengers to move between the cars 130 and to escape from the cars 130. In this embodiment, the door 21 is adapted to open outward. As a matter of course, the door 21 may be adapted to open inward or may be a sliding door. Nonetheless, of course, to give priority to the escape from the car 130 in the case of emergency, the rational structure is such that the door 21 is configured to open outward.

[0079] Fig. 20 is a longitudinal sectional view of the emergency exit apparatus 1 of the car 130, which is cut along the center of the car 130 in the longitudinal direction of the car 130. In Fig. 20, two-dotted line represents the state in which the door 21 is accommodated in the emergency exit 150 of the car body of the car 130, and solid line represents the state in which the door 21 moves distant from the car body.

[0080] An upper opening and closing mechanism 23U is accommodated in an upper portion of the car body, i.e., within a head jamb 160 of a ceiling, and a lower opening and closing mechanism 23L is accommodated in a lower portion of the car body, i.e., under the floor.

[0081] The door 21 is mounted by the upper and lower opening and closing mechanisms 23U and 23L at upper and lower positions, respectively. The door 21 is configured to open and close outward and in the lateral direction (direction perpendicular to the longitudinal direction of the car body) relative to the car body by the operations of the upper and lower opening and closing mechanisms 23U and 23L to be described later.

[0082] In this embodiment, since the doors 21 are provided at two positions, right and left positions (see Figs, 22 and 23), a center column 170 is provided at the center portion on the car body to receive the closed doors 21 (see Fig. 23). Within the center column 170, two sets of lock mechanisms 22 are accommodated in the upper and lower portions, respectively. Each lock mechanism 22 includes two lock arms 22A for the right and left doors 21 and a drive mechanism 22C, for example, including one air cylinder 22C. In this embodiment, the unlock switch 41 is equipped on the center column 170.

[0083] Fig. 21 is a longitudinal sectional view of the emergency exit apparatus 1 of the car 130. The doors 21 are provided at right and left positions relative to the center of the car body in the longitudinal direction of the car 130. Fig. 21 shows the left door 21 which is cut along the vicinity of the center. Also in Fig. 21, two-dotted line represents the state in which the door 21 is accommodated in the emergency exit 150 of the car body of the car 130, and solid line represents the state in which the door 21 moves distant from the car body.

[0084] In this embodiment, entrance and exit columns 180 are provided on right and left sides of the center column 170 (see Fig. 23), and two sets of the lock mechanisms 22 are provided at upper and lower portions within each entrance and exit column 180, respectively. The lock mechanisms 22 are configured like those of the center column 170, but includes one lock arm 22A. The drive mechanisms 22C provided on the entrance and exit columns 180 on the right and left sides of the center column 170 include air cylinders 22C.

[0085] By operating the drive mechanism 22C, the lock arm 22A connected to the drive mechanism 22C moves and its tip end disengages from and engage with the lock arm receiver 21C provided on the door 21 side, thereby causing the closed door 21 to be unlocked and locked.

[0086] Fig. 22 is a transverse sectional view of the emergency exit apparatus 1 of the car 130, with the upper opening and closing mechanism 23U of the door 21 and its surroundings cut along a horizontal plane. In Fig. 22, the doors 21 and the upper opening and closing mechanisms 23U are provided laterally symmetric with respect

to the center of the car body in the longitudinal direction of the car 130.

[0087] The opening and closing mechanism 23 of this embodiment includes a support base 23A, an input and output link 23B, a lateral movement mechanism 23C, and a coupling arm 23D.

[0088] The support base 23A is a base portion mounted to a structure of the car body, and finally supports the whole of the upper opening and closing mechanism 23U. The input and output link 23B is a mechanism configured to allow the door 21 to be opened and closed without any interference. The input and output link 23B pulls the door 21 into a recess portion of an opening of the car body to close the door 21 and pulls the door 21 out to open the door 21 so as not to interference with the recess.

[0089] The lateral movement mechanism 23C serves to increase an opening width which is still insufficient only by an operation of the input and output link 23B, and to further move the pulled-out door 21 in the lateral direction to fully open the door 21. The coupling arm 23D transmits movement of the input and output link 23B and the lateral movement mechanism 23C to the door 21. Simultaneously, the coupling arm 23D limits the movement of the door 21 and operates along with the lower opening and closing mechanism 23L.

[0090] Fig. 23 is a transverse sectional view of the emergency exit apparatus 1 of the car 130, with the center of the door 2 in the vertical direction and its surroundings cut along the horizontal plane. As shown in Fig. 23, the center column 170 is disposed at the center of the car body and entrance and exit columns 180 are provided on right and left sides thereof. Fig. 23 shows the state in which the doors 21 are closed and the state in which the doors 21 are opened in the lateral direction.

[0091] In this embodiment, two sets of emergency exit apparatuses 1 are provided on right and left sides of the center of the car body, and two passages 190 are provided on right and left sides for the passengers to pass therethrough. Alternatively, one set of the emergency exit apparatus 1 may be provided and one passage 190 with increased opening dimension may be provided. In that case, the door 21 is opened to the left or to the right.

[0092] Figs. 24(a), 24(b), and 24(c) are transverse sectional views of the emergency exit apparatuses 1 of the car 130, in which a portion slightly located above the floor 200 of the car 130 is cut along a horizontal plane.

[0093] The lower lock mechanisms 22 are accommodated in the center column 170 and the entrance and exit columns 180. As in the case of the upper lock mechanisms 22, they are invisible from the passenger cabin of the car 130. The lock mechanisms 22 within the right and left entrance and exit columns 180 engage with and disengage from the lock arm receivers 21C located on outer positions of the right and left doors 21 and the lock mechanisms 22 within the center column 170 engage with and disengage from the unlock arm receiver 21C located on center (inner) positions of the doors 21.

[0094] In addition, a fix mechanism 34 to be described later is installed on the center line of the car body.

[0095] Fig. 25 is a transverse sectional view of the emergency exit apparatuses 1 of the car 130, with the lower opening and closing mechanisms 23L of the doors 21 and its surroundings cut along a horizontal plane. In the construction in Fig. 25, as in the construction in Fig. 22, the doors 21 and the lower opening and closing mechanisms 23L are disposed laterally symmetric relative to the center of the car body in the longitudinal direction of the car 130.

[0096] The opening and closing mechanism 23L of this embodiment includes the support base 23A, the input and output link 23B, the lateral movement mechanism 23C, and the coupling arm 23D, as in the above described opening and closing mechanism 23U, and further includes an operation limit mechanism 23E, which will be described later.

(Detail of systems and equipment configuring emergency exit apparatus)

[0097] The schematic construction of the emergency exit apparatus 1 has been described above. Further, with reference to Figs. 20 through 26, 27, 28, 29, 32, 33, 34, 35, and 36, the configurations or structures of the components will be described in detail.

(Door system)

[0098] As shown in Figs. 20 through 26, the door system 2 includes the doors 21, the lock mechanisms 22, and the opening and closing mechanism 23.

[0099] The door 21 is adapted to usually close the emergency exit 150 and open in evacuation as indicated by a two-dotted line in Fig. 26. The door 21 obtains strength by a peripheral frame 21A and is provided with a glass window 21B at the center portion to allow the passengers to see from inside the car 130. The lock arm receivers 21C are provided at four positions, upper and lower positions on both sides of the frame 21A and configured to engage with the lock arm 22A of the lock mechanism 22. Further, as shown in Fig. 21(a) and Fig. 21(b) which is an enlarged view of a portion represented by Z, the frame 21A is supported at upper and lower positions by coupling of the coupling arms 23D of the opening and closing mechanism 23. A clearance between the door 21 and the emergency exit 150 is sealed by a molded rubber or the like to inhibit entry of rain water or draft.

[0100] Such a seal member (not shown) mounted to the car body side functions under pressurized contact with the door 21. The force required for the pressurized contact is generated effectively in such a manner that the lock arm 22A is brought into engagement with and tightly mesh with the lock arm receiver 21C to cause the door 21 to be pulled toward the car body, thus completing lock.

[0101] The lock mechanism 22 is an important component, and includes the lock arm 22A, the drive mech-

anism 22C, etc. One lock arm 22A or a set of two lock arms 22A are pivotally mounted by pins around the support member 22B. An engagement portion engageable with the lock arm receiver 21C is formed at one end of the lock arm 22A and the other end thereof is coupled to an output shaft of the drive mechanism 22C by pin such that the lock state is usually maintained. While the air cylinders 22C1 or the solenoid reciprocation mechanism may be selected as the drive mechanism 22C, the air cylinders 22C1 are the simplest.

[0102] The drive mechanism 22C including the air cylinders 22C1 is constructed in two methods for the safety. One of the two methods is such that, as shown in Fig. 29, lock is accomplished by a force of the springs 22D mounted in the cylinders 22C1 and unlock is accomplished by supplying compressed air to push back the springs 22D. The other method is, as shown in Fig. 33, the compressed air is supplied to two chambers within cylinders 22C2 alternately so that lock and unlock are accomplished by an air pressure of the compressed air.

[0103] The former method may be incapable of unlocking the door 21 if there is a loss in air pressure, but can deal with this by multiplexing air sources. The latter method may cause the door 21 to be unlocked due to the loss in the air pressure. As a solution to this, the drive mechanism 22C of the lock mechanism 22 on the lower side may be directed downward as shown in Fig. 20 to produce a force of the weight of the piston and the piston rod, thus allowing the door 21 to be locked.

[0104] It is important that the locked door 21 can be reliably unlocked in emergency. The lock and unlock of the door 21 will be described later in association with the unlock control mechanism 43.

[0105] The drive mechanism 22C including the solenoid reciprocation mechanism 22C3 obtains the locking force by two methods.

[0106] One method is, as shown in Fig. 35, that lock springs 22D are incorporated into output shafts. The other method is, as shown in Fig. 36, that lock is accomplished by a fall of a contact of an unlock control contactor 43B forming an unlock control mechanism 43.

[0107] The former method requires to obtain an electric energy for unlocking the door 21. The latter method requires to obtain an electric energy for locking and unlocking the door 21.

[0108] As described above, it is important that the locked door 21 can be reliably unlocked in emergency. The lock and unlock of the door 21 will be described later in association with the unlock control mechanism 43 to be described later.

[0109] As described previously, the opening and closing mechanism 23 includes the support base 23A, the input and output link 23B, the lateral movement mechanism 23C, and the coupling arm 23D, or includes these elements and the operation limit mechanism 23E.

[0110] The former mechanism is mounted in an upper portion as shown in Fig. 22 and the latter mechanism is mounted in a lower portion as shown in Fig. 25. The support base 23A serves to mount the entire door 21 to the car body and to rigidly fix the upper and lower opening and closing mechanisms 23 to the car body.

[0111] The input and output link 23B serves to couple the support base 23A to the lateral movement mechanism 23C. The input and output link 23B permits a link movement in the shape of parallelogram by two sets of pins provided at both ends of the input and output links 23B. In such a construction, the door 21 is capable of being opened and closed so as not to interfere with the opening of the car body.

[0112] The lateral movement mechanism 23C is provided to increase a lateral movement of the door 21 which may be still insufficient only by the operation of the input and output link 23B. The lateral movement mechanism 23C is constructed by a slide mechanism having two or more layers, which is configured to move only in the two-dimensional direction.

[0113] As shown in Fig. 21(b), the lateral movement mechanism 23C is formed by a linear guide (manufactured by NSK. Ltd) 23C2 or the like. The lateral movement mechanism 23C of this embodiment has a two-layer structure, including a linear guide 23C2 structured such that two sets of bearings 23C4 slide on rail 23C3 equipped on a base 23C1 in a lower layer and a linear guide 23C2 structured such that one or two sets of bearings 23C4 slide on rail 23C3 equipped on the base 23C1 in an upper layer. The base 23C1 in the lower layer and the input and output link 23B are coupled to each other by pins. The base 23C1 in the upper layer is supported by the bearing 23C4 in the lower layer, and the bearing 23C4 in the upper layer and the coupling arm 23D are coupled to each other. In this manner, the door 21 is mounted to be openable and closable.

[0114] Since the lateral movement mechanism 23C is formed by plural layers of the linear guides 23C2, a required stroke is gained by the lateral movement mechanism 23C with a shorter stroke. If the stroke is insufficient, this can be well dealt with by providing an intermediate layer.

[0115] When the door 21 is mounted by the opening and closing mechanism 23, two sets of bearings 23C4 are provided per rail in each linear guide 23C2 of the upper opening and closing mechanism 23U, other than the upper layer linear guide so that the construction in the movement direction of the door 21 supported by the upper and lower opening and closing mechanisms 23U and 23L becomes stable. As a result, the door 21 can be opened in the lateral direction by a small force. Further, an opening keeping mechanism 23F is added to keep the door 21 opened so that the door 21 fully opened will not be closed by a gravitational force or the like. This is accomplished by mounting a commercially available spring catcher (not shown) between the coupling arm 23D and the support base 23A.

[0116] The operation limit mechanism 23E serves to limit the movement on the coupling arm 23D side within a predetermined movement track relative to the car body,

and includes the lower opening and closing mechanism 23L in this embodiment. The input and output link 23B and the lateral movement mechanism 23C individually limit the movement of the door 21, and allow the door 21 to freely move within a two-dimensional plane if these are combined with each other. The operation limit mechanism 23E limits the movement of the door 21 within a predetermined track to inhibit interference between the door 21 and the car body

[0117] The operation limit mechanism 23E includes a track plate or a track groove 23E1 provided on the support base 23A side and a roller 23E2 mounted on the lateral movement mechanism 23C side and configured to move along with the track plate or the track groove 23E1 or under limitation of these. Such a construction causes the door 21 to open and close to draw a movement track as shown in Fig. 25.

(Auxiliary Equipment)

[0118] Subsequently, auxiliary equipment 3 equipped in the emergency exit apparatus 1 will be described.

[0119] As shown in Fig. 21, the auxiliary equipment 3 includes the ladder 31, the ladder cover 32, the apron 33, and the fix mechanism 34 (see Fig. 20).

[0120] The ladder 31 is provided in collapsible state on the floor 200 which is the passage 190 of the emergency exit 150 as shown in Fig. 6. The specific structure of the ladder 31 may be a ladder 31 portion registered as Japanese Utility Model Application No. 2572728. Since the ladder 31 does not perform its function when placed on the floor 200, it is necessary to prepare a mechanism which supports and guides right and left sides of the ladder 31 to mount the ladder 31.

[0121] Since it is not easy for the passengers to walk on the ladder 31 during move between the cars 130, the ladder cover 32 is installed to allow the passengers to walk on the ladder cover 32 as well as to mount the apron 33. Thereby, the passengers easily move to the next car.

[0122] With the door 21 closed, the door 21 holds the ladder 31 and the ladder cover 32 within the car 130 to inhibit these from protruding outside. Further, the ladder 31 and the ladder cover 32 do not move inward inside the car 130. It is desired that, with the door 21 opened, the ladder 31 and the ladder cover 32 slide outside the car 130 by applying a certain force or more, for example, a force sufficient to kick the ladder 31 and the ladder cover 32 outside the car 130.

[0123] When the passenger exits from the car 130 as shown in Fig. 7, the passenger fully opens the door 21 and then kicks the ladder 31 and the ladder cover 32 outside the car 130 to set them.

[0124] One apron 33 is provided on a upper surface of the ladder cover 32 to correspond to each passage 190. Usually, as indicated by solid line in Fig. 6, the collapsible apron 33 is superposed on the ladder cover 32 inside the car 130. When the door 21 is fully opened, the apron 33 is rotated around a hinge 33A and extended out to protrude outside the car 130 as indicated by a two-dotted line in Fig. 6 and as shown in Fig. 5. To extend out the apron 33 outside the car 130, it is desirable to provide a handle or the like for the passenger to easily lift up the apron 33 from the ladder cover 32.

[0125] The fix mechanism 34 is an important component configured to fix the ladder 31 to inhibit the ladder 31 from protruding outside during the move between the cars 130, and includes an operation mechanism 34C, a wedge 34B attached to a tip end of an output shaft of the operation mechanism 24C, and a fix pin 34A1 mounted on a spring press member 34A movable by the wedge 34B, and usually keeps the ladder 31 unfixed.

[0126] Figs. 24(b) and 24(c) are embodiments of the fix mechanism 34. The fix mechanism 34 is mounted between the ladder covers 32 covering the right and left ladders 31. Fig. 24(b) shows a fixed state of the ladder cover 32 and Fig. 24(c) shows an unfixed state of the ladder cover 32.

[0127] The wedge 34B attached at the tip end of the output shaft of the operation mechanism 34C pushes the press member 34A having an inclined face, thereby causing a fix pin 34A 1 to be inserted into the ladder 31 from lateral side of the ladder cover 32 according to the movement amount of the press member 34A. Thus, the ladder 31 is fixed. The return spring 34D mounted on the press member 34A keeps the ladder 31 unfixed.

[0128] While the air cylinders 34C1 or the solenoid reciprocation mechanism may be selectively used as the operation mechanism 34C, the air cylinders 34C1 are the simplest.

[0129] As in the case of the drive mechanism 22C, the operation mechanism 34C including the air cylinders 34C1 is constructed in two methods for the safety. One method is, as shown in Fig. 29, such that the force of the springs mounted in the cylinders keep the ladder 31 unfixed and the compressed air is supplied to push the spring back to cause the ladder 31 to be fixed. The other method is, as shown in Figs. 33 and 34, such that the compressed air is supplied to two chambers within the cylinder alternately, and the air pressure causes the ladder 31 to be fixed or unfixed.

[0130] The former method may be incapable of fixing the ladder 31 if there is a loss in the air pressure, but can deal with this by multiplexing air sources. The latter method may cause the ladder 31 to be fixed due to the loss in the air pressure. As a solution to this, the return spring 34D is incorporated into the press member 34A to allow the ladder 31 to be unfixed.

[0131] It is important that the operation mechanism 34C can reliably fix the ladder 31 to inhibit the ladder 31 from protruding outside the car 130 during the move of the passengers between the cars 130. Unfix and fix of the ladder 31 will be described later in association with the fix control mechanism 46.

[0132] The operation mechanism 4C including the solenoid reciprocation mechanism is constructed in two methods as a means for ensuring the unfixed state of the

ladder 31. One method is, as shown in Fig. 35, such that the return spring 34D is incorporated into the output shaft. The other method is, as shown in Fig. 36, such that the contactor forming the fix control mechanism 46 is configured to switch between unfix and fix. The former method requires to obtain the electric energy for fixing the ladder 31 and the latter method requires to obtain the electric energy for unfixing and fixing the ladder 31.

[0133] As described above, it is important that the operation mechanism 34C can reliably fix the ladder 31 to inhibit the ladder 31 from protruding outside the car 130 during the move of the passengers between the cars 130. Unfix and fix of the ladder 31 will be described in detail in association with the fix control mechanism 46.

(Control system)

[0134] Subsequently, the control system 4 will be described. As shown in the block diagrams of Fig. 27 and 28, the control system 4 includes the unlock switch 41, the coupling detection mechanism 42, the unlock control mechanism 43, the backup unlock mechanism 44, the door open detection mechanism 45, the fix control mechanism 46, the backup fix mechanism 47, the fix detection mechanism 48, and the TIMS 49.

[0135] As shown in Fig. 27, the TIMS 49 detects and recognizes velocity information VEI, unlock signal ULS from the unlock switch 41, coupling information COI from the coupling detection mechanism 42, door open information DOI from the door open detection mechanism 45, fix information FXI (or unfix information UFI) from the fix detection mechanism 48.

[0136] The TIMS 49 sends an emergency brake signal EBS, a public address signal PAS, an indication signal IDS, the unlock signal ULS, the fix signal FXS (or unfix signal UFS), and state information STI, to braking equipment VBE, the public address equipment PAE, the indication equipment IDE, the unlock control mechanism 43, the fix control mechanism 46, and communication means RCM, respectively.

[0137] The TIMS is typically defined as being configured by a signal or multiple systems and equipped in the car 130 of the train 120 and having a function for collectively managing signals or information of the entire train 120. However, as shown in Fig. 28, the TIMS 49 is limited not to include this function but to have a function required to control the emergency exit apparatus 1. In the present invention, the TIMS 49 at least has the following functions:

- The TIMS 49 detects the unlock signal and specifies and recognizes the location where the unlock switch has been operated.
- The TIMS 49 detects the coupling information at the location where the unlock switch has been operated and selects an operation to be executed.
- The TIMS 49 selects fix or unfix of the ladder and sends the signal to the fix control mechanism of the ladder.
- The TIMS 49 causes the train to apply the emergency brake.
- The TIMS 49 checks velocity information of the train and detects velocity zero.
- The TIMS 49 waits to output the unlock signal until detecting the velocity zero, then sends the unlock signal to the unlock control mechanism.
- The TIMS 49 detects and recognizes the opening of the door.
- The TIMS 49 detects and recognizes the fix of the ladder.
- The TIMS 49 sends state information regarding the emergency exit apparatus to the communication means or relays the state information.
- The TIMS 41 receives the control signal regarding the emergency exit apparatus from the communication means or relays the control signal.

[0138] The unlock switch 41 is desirably of a press button type, provided with a protection cover, which is for use with fire alarm device. This type of switch remains unrestored once pressed, and is capable of keeping operated unless the train conductor operates it.

[0139] The coupling detection mechanism 42 is configured such that the limit switch (not shown) provided on an appropriate location of the coupler 140, for example, a coupler portion, detects the presence or absence of a coupling portion of the opposite coupler. It is appropriate to judge that the coupler 140 is coupled when the contactor of the limit switch is pushed back by the opposite coupler and that the coupler 140 is uncoupled when the contactor of the limit switch is at a free position.

[0140] The unlock control mechanism 43 is a generic term of electricity control and air control circuits, or electricity control and operation mechanisms, which are configured to receive the unlock signal ULS from the TIMS 49 and configured to cause the lock mechanism 22 to operate. Upon receiving the unlock signal ULS from the TIMS 49, the electromagnetic valve of the corresponding air control circuit or the contactor of the corresponding electricity control circuit operates.

[0141] The electromagnetic valve supplies the compressed air from the air source to the air cylinder, or the contactor supplies the electric energy from the power supply to the solenoid reciprocation mechanism, thereby allowing the lock mechanism 22 to be placed at unlock position with the above mechanism and to thereby allow the door 21 to be opened.

[0142] Fig. 29 is a first embodiment in which the drive mechanism 22C employs the air cylinders. The drive mechanism 22C is constructed such that upper and lower cylinders 22C1 are provided with lock springs 22D. Fig. 29 shows the lock mechanism 22 in an usual manner, placed at a lock position by the spring force, etc.

[0143] The air within each of the upper and lower cylinders 22C1 flows through an unlock control magnetic valve 43A and a three-way cock 44A which is the backup

unlock mechanism 44 inside the car 130, and is exhausted from a special three-way cock 44B which is the backup unlock mechanism 22 outside the car 130 as indicated by an arrow V in Fig. 29. As a result, the lock mechanism 22 locks the door 21 by the force of the lock springs 22D. Of course, the side where the lock springs 22D are stored communicates with atmosphere.

[0144] Fig. 30 shows the lock mechanism 22 placed at an unlock position by the unlock control mechanism 43, etc. Upon the unlock switch 41 being operated, the unlock control electromagnetic valve 43A which is the unlock control mechanism 43 receives the unlock signal ULS. The unlock control electromagnetic valve 43A switches, and under this condition, the compressed air is supplied from the air reservoir to an inside of each of the cylinders 22C1. The air pressure of the compressed air, which exceeds the force of the lock spring 22D, moves the piston, and thereby the lock arm 22A disengages from the lock arm receiver 21C, thus causing the door 21 to be unlocked. When the unlock control electromagnetic valve 43A does not receive the unlock signal ULS any more, it returns and the air cylinder 22C1 with the lock spring is placed at the lock position, as shown in Fig. 29.

[0145] Fig. 33 shows a second embodiment in which the drive mechanism 22C employs the air cylinders. The drive mechanism 22C includes two-chamber air cylinders 22C2 which are not equipped with the lock springs. Fig. 33 shows the lock mechanism 22 in a usual state, placed at a lock position by the compressed air within the second chambers of the cylinders 22C2, etc.

[0146] The air within a first chamber of each of the upper and lower air cylinders 22C2 flows through the unlock control magnetic valve 43A and the three-way cock 44A which is the backup unlock mechanism 44 inside the car 130, and is exhausted from the special three-way cock 44B which is the backup unlock mechanism outside the car 130 as indicated by an arrow V in Fig. 33. As a result, the lock mechanism 22 locks the door 21 by the air force within the second chambers.

[0147] It should be appreciated that the structure of an air passage of the unlock control electromagnetic valve 43A is different from that of the first embodiment.

[0148] Fig. 34 shows the lock mechanism 22 placed at the unlock position by the unlock control mechanism 43, etc. Upon the unlock switch 41 being operated, the unlock control electromagnetic valve 43A which is the unlock control mechanism 43 receives the unlock signal ULS. The unlock control electromagnetic valve 43A switches, and the compressed air is supplied from the air reservoir to an inside of the first chamber of each of the air cylinders 22C2. The air pressure of the compressed air causes the piston to move to cause the air to be exhausted from the second chambers. Thereby, the lock arm 22A disengages from the lock arm receiver 21C, thus causing the door 21 to be unlocked. When the unlock control electromagnetic valve 43A does not receive the unlock signal ULS any more, it returns, and the air cylinder 22C2 is placed at the lock position, as shown in Fig. 33.

[0149] Fig. 35 shows a third embodiment in which the drive mechanism 22C employs the solenoid reciprocation mechanism. The drive mechanism 22C is constructed such that the lock springs 22D are mounted on reciprocators of output shafts of solenoids 22C3. Fig. 35 shows the lock mechanism 22 placed at an unlock position by an unlock control contactor 43B which is the unlock control mechanism 43, etc.

[0150] When the unlock control contactor 43B is closed according to the unlock signal ULS, a current flows through coils of each of the upper and lower solenoids 22C3. Each solenoid 22C3 causes the reciprocator to operate by an electromagnetic force which exceeds the force exerted by the lock spring 22D, thereby causing the lock mechanism 22 to be placed at an unlock position. When the unlock control contactor 43B does not receive the unlock signal ULS any more and thereby is released, the electromagnetic force does not exist any more. Under this condition, each solenoid 22C3 is placed at the lock position by the force exerted by the lock spring 22D.

[0151] Fig. 36 shows a fourth embodiment in which the drive mechanism 22C employs the solenoid reciprocation mechanism. The drive mechanism 22C includes solenoids 22C4 without lock springs. Fig. 36 shows the drive mechanism 22C placed at an unlock position by the unlock control contactor 43B which is the unlock control mechanism 43, etc. When the contact lifts up to cause the unlock control contactor 43B to be closed according to the unlock signal ULS, a current flows through each of the upper and lower solenoids 22C4 in a direction to unlock the door 21, and each solenoid 22C4 causes the reciprocator to operate by the electromagnetic force, thereby causing the lock mechanism 22 to be placed at an unlock position. When the unlock control contactor 43 does not receive the unlock signal ULS and is closed by the fall of the contact, the current flows in a reverse direction, and each solenoid 22C4 is placed at the lock position by the electromagnetic force.

[0152] When evacuation actions are carried out, the lock mechanism 22 cannot be placed at an unlock position if the unlock control mechanism 43 fails and thereby the unlock control electromagnetic valve 43A or the unlock control contactor 43B does not operate. The backup unlock mechanism 44 makes up for the failure of the unlock control mechanism 43.

[0153] Fig. 31 shows a first embodiment in which the drive mechanism 22C employs the air cylinders 22C1. In this embodiment, between the air reservoir and the unlock control electromagnetic valve 43A, the three-way cock 44A inside the car 130 and the special three-way cock 44B outside the car 130 are arranged in parallel. In addition, the three-way cock 44A and 44B are provided in series in an air exhaust passage from a fix control magnetic valve 43A. Fig. 31 shows the lock mechanism 22 placed at an unlock position by operating the three-way cock 44A which is the backup unlock mecha-

nism 44 inside the car 130, etc. By switching the three-way cock 44A, the compressed is supplied from the air reservoir to the inside of each of the cylinders 22C1 through the three-way cock 44A and the unlock control electromagnetic valve 43A. The air pressure of the compressed air exceeds the force of the lock spring 22D to cause the piston to move, thus causing the lock mechanism 22 to be placed at an unlock position. At this time, the three-way cock 44A blocks the passage leading to the special three-way cock 44B. When the three-way cock 44A is returned to its original state, the supplied compressed air is exhausted, and each cylinder 22C1 is placed at the lock position, as shown in Fig. 29.

[0154] Fig. 32 shows that the lock mechanism 22 is placed at an unlock position by operating the special three-way cock 44B which is the backup unlock mechanism 44 outside the car 130 in the embodiment (Fig. 31). By switching the special three-way cock 44B, the compressed air is supplied from the air reservoir to the inside of each of the cylinders 22C1 through the special three-way cock 44B, the three-way cock 44A and the unlock control electromagnetic valve 43A. The air pressure of the compressed air exceeds the force of the lock spring 22D to cause the piston in each of the cylinders 22C1 to move. Thereby, the lock mechanism 22 is placed at the unlock position.

[0155] At this time, the special three-way cock 44B blocks an air exhaust passage. When the special three-way cock 44B is returned to its original state, the supplied compressed air is exhausted, and each cylinder 22C1 is placed at the lock position, as shown in Fig. 29.

[0156] In this embodiment, when any of the backup unlock mechanisms 44 is operated, it is placed at the lock position by returning it to its original state. To close and lock the unlocked and opened door 21, the backup unlock mechanism 44 is returned with the door 21 closed and untightly fitted to seal rubber (not shown) attached to the car body. By doing so, the lock arm 22A of the lock mechanism 22 engages with the lock arm receiver 21C, and the force of the lock spring 22D of each cylinder 22C1 is applied to pull back and lock the door 21. Thus, the door 21 can be easily closed without manually pulling in the door 21.

[0157] Fig. 33 shows a second embodiment in which the drive mechanism 22C which employs the air cylinders. The construction of the backup unlock mechanism 44 of the drive mechanism 22C is identical to that of the embodiment in Fig. 31. By operating the three-way cock 44A which is the backup unlock mechanism 44 inside the car 130 under the failure condition of the unlock control mechanism 43, the air passage of this portion becomes the three-way cock 44A shown in Fig. 31. The compressed air is supplied from the air reservoir to the first chamber of each cylinder 22C2 through the three-way cock 44A and the unlock control electromagnetic valve 43A. Since a pressure-receiving area of the piston is larger in the first chamber side than in the second chamber side irrespective of the air pressure being equal, the piston moves toward the second chamber to place the lock mechanism 22 at an unlock position. At this time, the three-way cock 44A blocks the passage to the special three-way cock 44B. When the three-way cock 44A is returned to its original state, the compressed air is exhausted from the first chamber, and the air pressure within the second chamber leading to the air reservoir causes each cylinder 22C2 to be placed at the lock position, as shown in Fig. 33.

[0158] By operating the special three-way cock 44B which is the backup unlock mechanism 44 outside the car 130 in the same manner in the construction in Fig. 33, the air is supplied to the first chamber of each cylinder 22C2 through the special three-way cock 44B, the three-way cock 44A, and the unlock control electromagnetic valve 43A, thereby causing the lock mechanism 22 to be placed at an unlock position, as in the configuration in Fig. 32. At this time, the special three-way cock 44B blocks the air exhaust passage. When the special three-way cock 44B is returned to its original state, the compressed air is exhausted from the first chamber, and the air pressure within the second chamber leading to the air reservoir causes each cylinder 22C2 to be placed at the lock position, as shown in Fig. 33.

[0159] In this embodiment, also, when any of the backup unlock mechanisms 44 is operated, it is placed at a lock position by returning it to its original state. To close and lock the unlocked and opened door 21, the backup unlock mechanism 44 is returned with the door 21 closed and untightly fitted to the seal rubber provided on the car body. By doing so, the lock arm 22A of the lock mechanism 22 engages with the lock arm receiver 21C, and the air pressure within each cylinder 22C2 is applied to pull back and lock the door 21. Thus, the door 21 can be easily closed without manually pulling in the door 21, as in the first embodiment.

[0160] When the solenoid reciprocation mechanism is used as the drive mechanism 22C, the solenoids do not operate and hence cannot place the lock mechanism 22 at an unlock position if there is a loss of an electric power supply or a failure occurs in the unlock control mechanism 43.

[0161] Figs. 35 and 36 show examples which can solve such a problem, in which one ends of cables 44C are connected to unlock-side end portions of output shafts of solenoids 22C3 or 22C4, and opposite ends of the cables 44C are configured to be pulled together inside and outside the car 130.

[0162] The cables 44C which are the backup unlock mechanism 44 and the associated auxiliary equipment are structured such that the opposite ends thereof are located inside and outside the car 130 and one ends thereof are connected to output shafts of the solenoids 22C3 or 22C4. By pulling any of the opposite ends of the cables 44C, the output shafts of all the solenoids 22C3 or 22C4 are fixed at the unlock position by fixing members (not shown).

[0163] The door open detection mechanism 45 is con-

figured such that a limit switch (not shown) provided at an appropriate position of the door 21, for example, in the vicinity of the lower opening and closing mechanism 23L, detects the presence or absence of an inner face of the door 21 which may contact the limit switch.

[0164] Specifically, since the door 21 is opened when the lock arm 22A disengages from the lock arm receiver 21C and the door 21 moves distant from the car body of the car 130, it is appropriate to judge that the door 21 is open when the contact of the limit switch is at a free position, in order to detect the state of the door 21.

[0165] The fix control mechanism 46 is a generic term of electricity control and air control circuits, or electric control and operation mechanisms, which are configured to receive the fix signal FXS from the TIMS 49 and configured to cause the fix mechanism 34 to operate.

[0166] Upon receiving the fix signal FXS from the TIMS 49, the electromagnetic valve of the corresponding air control circuit or the contactor of the corresponding electricity control circuit operates. The electromagnetic valve supplies the compressed air from the air source to the air cylinder or the contactor supplies the electric energy from the power supply to the solenoid reciprocation mechanism, thereby allowing the fix control mechanism 46 to fix the ladder 31 by the fix mechanism 34.

[0167] Fig. 29 shows a first embodiment in which the fix mechanism 34 employs a air cylinder 34C1. The fix mechanism 34 is formed by mounting the return spring 34D in the air cylinder 34C1. Fig. 29 shows the fix mechanism 34 in an usual state, placed at an unfix position by the force of the return spring 34D, etc.

[0168] The air flows from the air cylinder 34C1 through the fix control electromagnetic valve 46A and the three-way cock 47A which is the backup fix mechanism 47 inside the car 130, and is exhausted from the special three-way cock 47B which is the backup fix mechanism 47 outside the car 130 as indicated by the arrow V in Fig. 29. Thus, the ladder 31 is unfixed by the force of the return spring 34D. As a matter of course, the side where the return spring 34D is stored communicates with atmosphere.

[0169] Fig. 30 shows the fix mechanism 34 placed at a fix position by the fix control mechanism 46, etc. When the fix control electromagnetic valve 46A receives the fix signal FXS, it switches, and the compressed air is supplied from the air reservoir to the inside of the cylinder 34C1. The air pressure of the compressed air, which exceeds the force of the return spring 34D, moves the piston to cause the wedge 34B in Fig. 24 to press the press member 34A, thereby causing the fix pin 34A 1 to fix the ladder 31. When the fix electromagnetic valve 46A does not receive the fix signal FXS any more, it returns, thus causing the air cylinder 34C1 to be placed at the unfix position, as shown in Fig. 29.

[0170] Fig. 33 shows a second embodiment in which the fix mechanism 34 employs an air cylinder 34C2. The fix mechanism 34 is formed by the two-chamber cylinder 34C2 which is not equipped with the return spring 34D. Fig. 33 shows the fix mechanism 34 in an usual state placed at an unfix position by the compressed air within the second chamber of the cylinder 34C2, etc.

[0171] The air flows from a first chamber of the air cylinder 34C2 through the fix control electromagnetic valve 46A and the three-way cock 47A which is the backup unlock mechanism 44 inside the car 130, and is exhausted from the special three-way cock 47B which is the backup fix mechanism 47 outside the car 130 as indicated by an arrow V in Fig. 33. As a result, the ladder 31 is unfixed by the air pressure within the second chamber.

[0172] Fig. 34 shows the fix mechanism 34 placed at the fix position by the fix control mechanism 46, etc. When the fix control electromagnetic valve 46A receives the fix signal FXS, it switches, and the compressed air is supplied from the air reservoir to the first chamber of the air cylinder 34C2. The air pressure of the compressed air causes the piston to move, thereby causing the air to be exhausted from the second chamber. Thereby, the wedge 34B in Fig. 24 presses the press member 34A to thereby cause the fix pin 34A1 to fix the ladder 31. When the fix control electromagnetic valve 46 does not receive the fix signal FXS any more, it returns, and the air cylinder 34C2 is placed at an unfix position again, as shown in Fig. 33.

[0173] Fig. 35 shows a third embodiment in which the fix mechanism 34 employs the solenoid reciprocation mechanism. The fix mechanism 34 is formed by mounting the return spring 34D on reciprocator of an output shaft of the solenoid 34C3. Fig. 35 shows the fix mechanism 34 placed at a fix position by a fix control contactor 46B which is the fix control mechanism 46, etc.

[0174] When the fix control contactor 46B is closed according to the fix signal FXS, a current flows through coils of the solenoid 34C3. The solenoid 34C3 causes the reciprocator to operate by an electromagnetic force which exceeds the force of the return spring 34D. Thereby, the wedge 34B in Fig. 24 presses the press member 34A, and thereby the fix pin 34A1 fixes the ladder 31. When the fix control contactor 46B does not receive the fix signal FXS any more, and is thereby released, the electromagnetic force does not exist any more, and the solenoid 34C3 is placed at the unfix position by the force of the return spring 34D.

[0175] Fig. 36 shows a fourth embodiment in which the fix mechanism 34 employs the solenoid reciprocation mechanism. The fix mechanism 34 is formed by solenoid reciprocation mechanism 34C4 which is not equipped with the return spring 34D. Fig. 36 shows the fix mechanism 34 placed at the fix position by the fix control contactor 46B which is the fix control mechanism 46, etc. When the contact lifts up to cause the fix control contactor 46B to be closed according to the fix signal FXS, a current flows through the solenoid 34C4 in a direction to fix the ladder 31. The solenoid reciprocation mechanism 34C4 causes the reciprocator to operate by the electromagnetic force. Thereby, the wedge 34B in Fig. 24 presses the press member 34A, and thereby the fix pin 34A1 fixes

the ladder 31. When the fix control contactor 46B does not receive the fix signal FXS any more and is closed by the fall of the contact, a current flows in a reverse direction. The solenoid reciprocation mechanism 34C4 is placed at the unfix position again by the electromagnetic force.

[0176] When evacuation actions are carried out, the ladder 31 cannot be fixed if the fix control mechanism 46 fails and the fix control electromagnetic valve 46A or the fix control contactor 46B does not operate. The backup fix mechanism 47 makes up for the failure of the fix control mechanism 46.

[0177] Fig. 31 shows a first embodiment in which the operation mechanism 34C employs the air cylinder 34C1. In this embodiment, between the air reservoir and the fix control electromagnetic valve 46A, the three-way cock 47A inside the car 130 and the special three-way cock 47B outside the car 130 are arranged in parallel. In addition, the three-way cock 47A and 47B are provided in series in an air exhaust passage from the fix control electromagnetic valve 46A. Fig. 31 shows the lock mechanism 22 in the state in which the ladder 31 is fixed by operating the three-way cock 47A which is the backup fix mechanism 47 inside the car 130, etc.

[0178] By switching the three-way cock 47A, the compressed is supplied from the air reservoir to the inside of the cylinder 34C1 through the three-way cock 47A and the fix control electromagnetic valve 46A. The air pressure of the compressed air, which exceeds the force of the return spring 34D, moves the piston of the air cylinder 34C1 to press the wedge 34B, which presses the press member 34A, and thereby the fix pin 34A1 fixes the ladder 31. At this time, the three-way cock 47A blocks the passage leading to the special three-way cock 47B. When the three-way cock 47A is returned to its original state, the supplied compressed air is exhausted, and the cylinder 34C1 is placed at the unfix position, as shown in Fig. 29.

[0179] Fig. 32 shows the state in which the ladder 31 is fixed by operating the special three-way cock 47B which is the backup fix mechanism 47 outside the car 130, in the embodiment (Fig. 31). By switching the special three-way cock 47B, the compressed air is supplied from the air reservoir to the inside of the air cylinder 34C1 through the special three-way cock 47B, the three-way cock 47A, and the fix control electromagnetic valve 46A. The air pressure of the compressed air, which exceeds the force of the return spring 34D, moves the piston within the air cylinder 34C1 to thereby press the wedge 34B, which presses the press member 34A, thereby causing the fix pin 34A1 to fix the ladder 31. At this time, the special three-way cock 47B blocks the air exhaust passage. By returning the special three-way cock 47B to its original state, the compressed air is exhausted and the air cylinder 34C1 is placed at the unfix position, as shown in Fig. 29.

[0180] In this embodiment, also, when any of the backup fix mechanism 47 is operated, it is placed at the unfix position again by returning it to its original state.

[0181] The fixed ladder 31 is returned to unfixed state merely by returning the backup fix mechanism 47 to its original state.

[0182] Fig. 33 shows a second embodiment in which the operation mechanism 34C employs the air cylinder 34C2. By operating the three-way cock 47A which is the backup fix mechanism 47 inside the car 130 in the operation mechanism 34C, the compressed air is supplied from the air reservoir to the first chamber of the cylinder 34C2 through the three-way cock 47A and the fix control electromagnetic valve 46A.

[0183] Since a pressure-receiving area of the piston is larger in the first chamber side than in the second chamber side irrespective of the air pressure being equal, the piston moves toward the second chamber to press the wedge 34B, which presses the press member 34A, thus causing the fix pin 34A1 to fix the ladder 31. At this time, the three-way cock 47A blocks the passage to the special three-way cock 47B. When the three-way cock 47A is returned to its original state, the compressed air is exhausted from the first chamber, and the air pressure within the second chamber leading to the air reservoir causes each cylinder 34C2 to be placed at the unfix position, as shown in Fig. 33.

[0184] By operating the special three-way cock 47B which is the backup fix mechanism 47 outside the car 130 in the same manner in the construction in Fig. 33, the air is supplied to the first chamber of each air cylinder 34C2 through the special three-way cock 47B, the three-way cock 47A, and the fix control electromagnetic valve 46A, thus causing the ladder 31 to be fixed. At this time, the special three-way cock 47B blocks the air exhaust passage.

[0185] When the special three-way cock 47B is returned to its original state, the supplied compressed air is exhausted from the first chamber, and the air pressure within the second chamber leading to the air reservoir causes the cylinder 34C2 to be placed at the unfix position, as shown in Fig. 33.

[0186] In this embodiment, also, when any of the backup fix mechanisms 47 is operated, it is placed at the unfix position again by returning it to its original state.

[0187] The fixed ladder 31 is returned to unfixed state merely by returning the backup fix mechanism 47 to its original state.

[0188] When the solenoid reciprocation mechanism is used in the operation mechanism 34C, the solenoid does not operate if there is a loss in a power supply as well as a failure occurs in the fix control mechanism 46. As a result, the ladder 31 cannot be fixed.

[0189] Figs. 35 and 36 show examples which can solve such a problem, in which one ends of cables 47C are connected to fix-side end portions of output shaft of solenoid reciprocation mechanism 34C3 or 34C, and opposite ends of the cable 47C are configured to be pulled together inside and outside the car 130.

[0190] The cables 47C which are the backup fix mech-

anism 47 and the associated auxiliary equipment are structured such that the opposite ends thereof are located inside and outside the car 130 and the one ends thereof are connected to the output shafts of the solenoid 34C3 or 34C4. By pulling any of the opposite ends of the cable 44C, the output shafts of all the solenoids are fixed at the fix position by fixing members (not shown).

[0191] The fix detection mechanism 48 is configured such that a limit switch (not shown) attached to an appropriate position of the fix mechanism, for example, a position at the tip end of the air cylinder 34C1 which is opposite to the wedge 34B detects the presence/absence of the wedge 34B which may contact the limit switch.

[0192] In a strict sense, the ladder 31 is fixed when the wedge 34B presses the press member 34A and the fix pin 34A1 is inserted into the ladder 31. So, it is appropriate to detect the fixed state and the unfixed state in such a manner that the ladder 31 is fixed when the wedge 34B pushes back the contact of the limit switch and the ladder 31 is unfixed when the contact of the limit switch is at a free position.

[0193] It should be noted that the emergency exit apparatus 1 of the present invention is considered as follows.

1) Keep door locked based on detection of velocity

[0194] Upon the unlock switch 41 being operated, the TIMS 49 immediately causes the train 120 to apply the emergency brake. Wen the unlock switch 41 is operated during travel of the train 120, the TIMS 49 waits to transmit the unlock signal ULS, to keep the door 21 locked.

[0195] This function is achieved by a function of the TIMS 49 to check velocity information VEI. When the velocity information VEI is velocity zero, the TIMS 49 sends the unlock signal ULS to the unlock control mechanism 43.

[0196] Thereby, it becomes possible to inhibit the door 21 from opening during the travel of the train 120. In addition, evacuation actions are carried out in the suspended state of the train 120.

2) Keep lock mechanism placed at lock position

[0197] To allow the drive mechanism 22C of the lock mechanism 22 to keep lock force, and to deal with the unlock caused by the loss of the air pressure in the air cylinder, the lock force is kept by the lock spring mounted in the drive mechanism 22C or by the weight of the piston and the piston rod.

[0198] To inhibit the unlock caused by the loss of an energy of the solenoid reciprocation mechanism, the door 21 is locked when the contact of the contactor of the electricity control circuit falls.

3) Inhibit ladder from protruding outside during move between cars

[0199] While it is necessary to kick the ladder 31 outside the car 130 for enabling the escape from the car 130, it is necessary to fix the ladder 31 during the move between cars.

[0200] To this end, the TIMS49 is configured to detect the location where the door 21 should be opened is both end portions of the train 120, or an intermediate portion of the train 120. When detecting that the location is the intermediate portion, the TIMS 49 sends the fix signal FXS to the fix mechanism 34 before the door 21 is opened, to allow the passengers to move between the cars without any troubles.

4) Keep ladder unfixed

[0201] To allow the fix mechanism 34 to keep the ladder 31 unfixed, the return spring of the press member 34A usually keeps the ladder 31 unfixed.

5) Keep door opening.

[0202] Against the event that train 120 is suspended at a point of the track 110 which is inclined in the lateral direction, the door open keeping mechanism 23F is added to keep the door 21 fully opened.

6) Measurements to failure of TIMS

[0203] In the present invention, the TIMS 49 plays an important role. If the TIMS 49 is not functioning, "the door system 2 is opened from inside or outside the car 130" is required at minimum. To this end, the following function is added to the emergency exit apparatus 1:

> Against the event that the unlock signal ULS does not reach the unlock control mechanism 43, the backup unlock mechanism 44 is equipped to allow the drive mechanism 22C of the lock mechanism 22 to operate. These are located within the center column 170 within the car 130 or under the floor outside the car 130. By operating any of them, "unlock state" is accomplished, and by returning it to its original state, "lock state" is accomplished.

[0204] Against the event that the fix signal FXS of the ladder 31 does not reach the fix control mechanism 46, the backup fix mechanism 47 is equipped to allow the fix mechanism 34 of the ladder 31 to operate. These are located in the vicinity of the floor of the passage inside the car 130 or under the floor outside the car 130. By operating any of them, "fix state" is accomplished, and by returning it to its original state, "unfix state" is accomplished.

Industrial Applicability

[0205] In accordance with the system of the emergency exit apparatus of the present invention:

1) Since part of the procedure is automated, configuration without errors is embodied, as compared to the conventional apparatus which totally depends on the judgment and operation by persons.
2) In the event of a failure of the automated portion, means for ensuring minimum safety is achieved by manual operation of the passenger.
3) Passengers which can evacuate per unit of time can be doubled as compared to the conventional apparatus.
4) Front view of the train can be sufficiently gained without intricate structure or extra space.

[0206] Furthermore, in accordance with this emergency exit apparatus:

5) The evacuation action system for the unattended operation, which may be employed in the evacuation action system for the attended operation, can be applied to existing vehicle as well as newly manufactured.
6) The simpler and safer operation, which is required for the evacuation action in the vehicle for the unattended operation and has not been achieved in the conventional apparatus, becomes possible.
7) The escape from the end of the train or move between the cars at the intermediate position of the car is selected.
8) Since the emergency exits between which the passengers do not usually move are coupled to each other to be opposed to each other, two-coupled-train unattended operation, which has been conventionally unfeasible, becomes feasible.
9) The procedure for the evacuation action for the unattended operation is directly applicable to the procedure for the evacuation action for the attended operation.

Claims

1. An emergency exit apparatus comprising:

an emergency exit;
a door system;
auxiliary equipment; and
a control system, wherein
the emergency exit is provided at an end portion of a car,
the door system includes a door openably mounted to the emergency exit, a lock mechanism configured to lock and unlock the door relative to a car body of the car, and an opening and closing mechanism configured to mount the door to the car body and to allow the door to be opened outward without interference with the car body,
the auxiliary equipment includes a ladder, a ladder cover, an apron, and a fix mechanism configured to unfix the ladder when the apron is not used and to fix the ladder when the apron is used, and
the control system includes an unlock switch configured to generate an unlock signal, a coupling detection mechanism configured to detect coupling or uncoupling between cars, an unlock control mechanism configured to place the lock mechanism at an unlock position, a backup unlock mechanism, a door open detection mechanism configured to detect opening of the door, a fix control mechanism configured to fix the ladder in unfixed state by the fix mechanism, a backup fix mechanism, a fix detection mechanism configured to detect fix of the ladder, and a train information management system configured to manage and control the above equipment and the above mechanisms.

2. The emergency exit apparatus according to Claim 1, wherein the lock mechanism forming a part of the door system includes a lock arm and a drive mechanism, and
the lock arm has a support member around which the lock arm is pivotable, and is structured such that an engagement portion engageable with a lock arm receiver is provided at one end thereof and an opposite end thereof is coupled to the drive mechanism by a pin to allow the door to be locked and unlocked by an operation of the drive mechanism using the lock arm receiver.

3. The emergency exit apparatus according to claim 1, wherein
the opening and closing mechanism forming a part of the door system includes a support base, an input and output link, a lateral movement mechanism, and a coupling arm, or includes the support base, the input and output link, the lateral movement mechanism, the coupling arm, and an operation limit mechanism,
the support base is mounted to the car body to support the door by elements of the opening and closing mechanism other than the support base and coupled to the lateral movement mechanism by two sets of pins provided at both ends of the input and output link to allow the lateral movement mechanism to pivot, and
the lateral movement mechanism is structured to have plural layers in which a lower layer thereof is coupled to the input and output link and an upper layer thereof is coupled to the coupling arm to allow

the plural layers of the lateral movement mechanism to move relative to each other,
the coupling arm is configured to couple the upper layer of the lateral movement mechanism to the door, and to couple one end of the operation limit mechanism to the support base and an opposite end of the operation limit mechanism to the upper layer of the lateral movement mechanism.

4. The emergency exit apparatus according to Claim 1, wherein the auxiliary equipment includes the ladder, the ladder cover, the apron, and the fix mechanism,
the ladder is mounted on a passage of the emergency exit by a mechanism which is configured to support and guide right and left sides of the ladder and is capable of being unfixed and fixed by the fix mechanism mounted in the vicinity of the ladder, and
the ladder cover is provided to cover the ladder, and
the apron is mounted on the ladder cover such that the apron is rotatable around a hinge to be extended outside the car.

5. The emergency exit apparatus according to claim 1, wherein
the control system includes the unlock switch, the coupling detection mechanism, the unlock control mechanism, the backup unlock mechanism, the door open detection mechanism, the fix control mechanism, the backup fix mechanism, the fix detection mechanism, and the train information management system,
the unlock switch is configured to generate the unlock signal and to send the unlock signal to the train information management system,
the coupling detection mechanism is configured to generate coupling information and to send the coupling information to the train information management system,
the unlock control mechanism is configured to receive the unlock signal through the train information management system and to perform control to cause the lock mechanism to be placed at an unlock position,
the backup unlock mechanism is configured to be manually operated to cause the lock mechanism to be placed at the unlock position or a lock position,
the door open detection mechanism is configured to generate door open information and to send the door open information to the train information management system,
the fix control mechanism is configured to receive a fix signal or an unfix signal generated in the train information management system and to perform control to cause the fix mechanism to be placed at a fix position or an unfix position,
the backup fix mechanism is configured to be manually operated to cause the fix mechanism to be placed at the fix position or the unfix position,
the fix detection mechanism is configured to send fix information or unfix information of the ladder to the train information management system, and
the train information management system is configured to receive at least the unlock signal, velocity information, the coupling information, the door open information, the fix information or the unfix information, and a control signal, and configured to send at least the unlock signal, a public address signal or an indication signal, an emergency brake signal, the fix signal or the unfix signal which are instruction signals, and state information including location information.

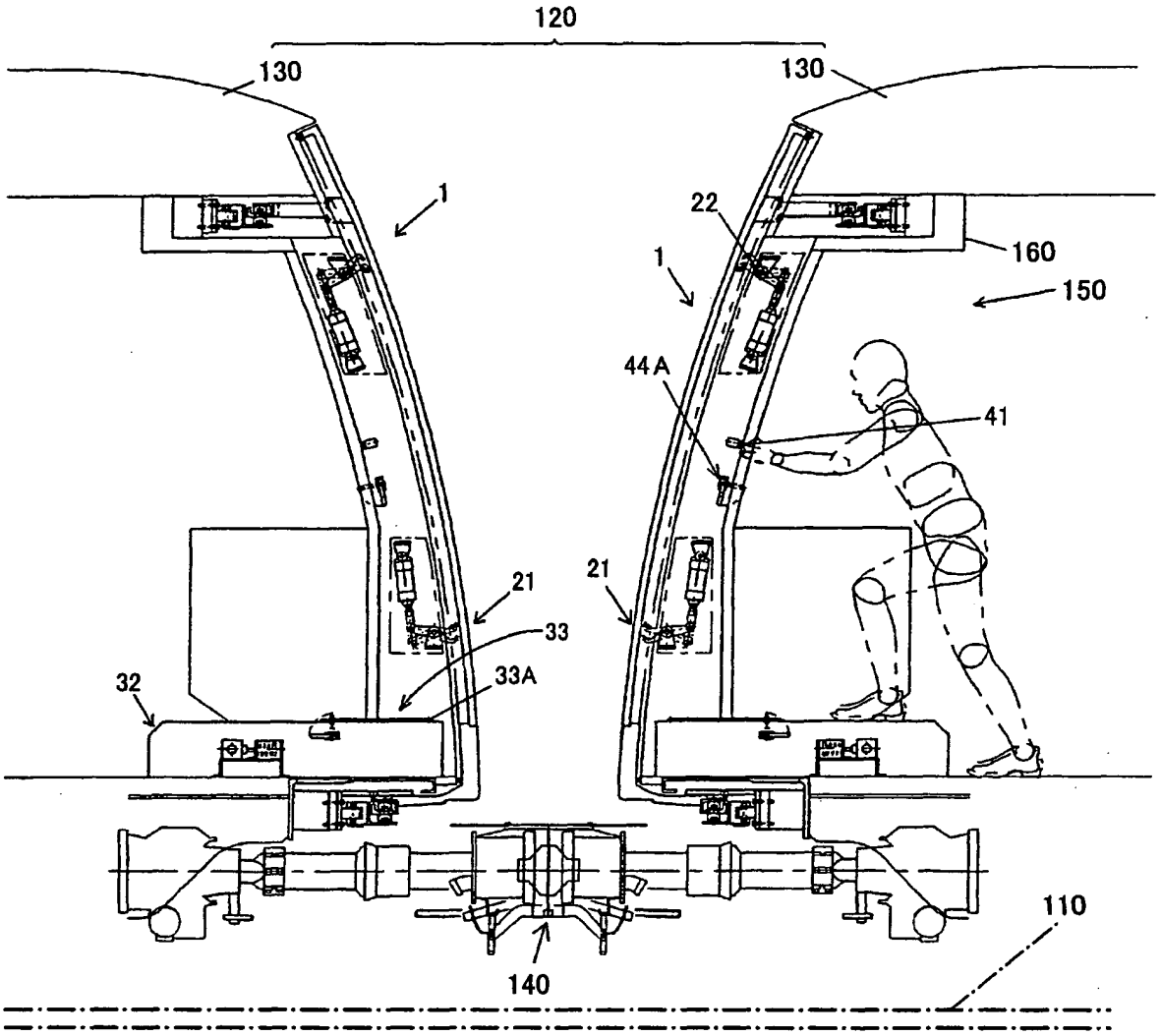


FIG. 1

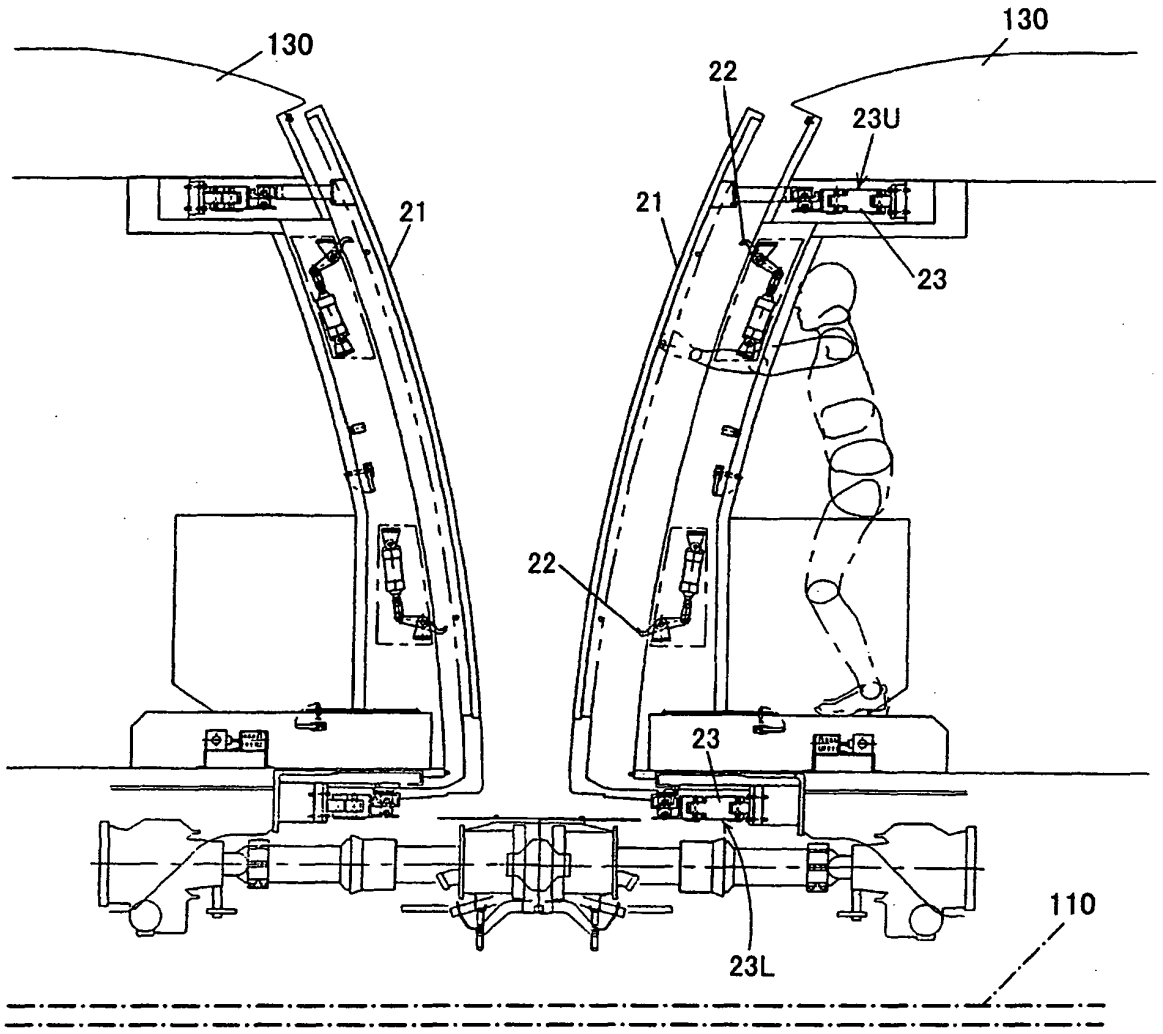


FIG. 2

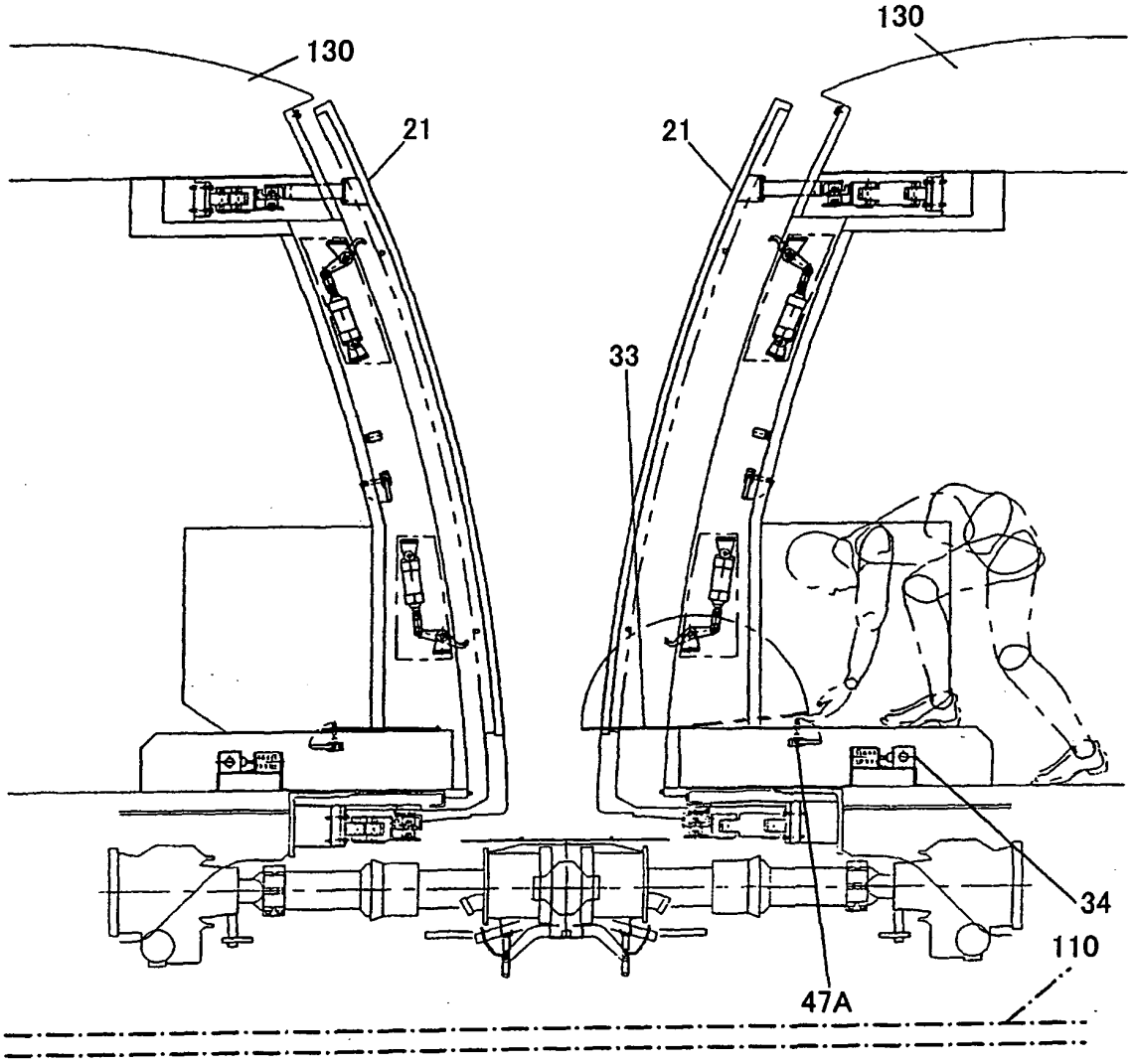


FIG. 3

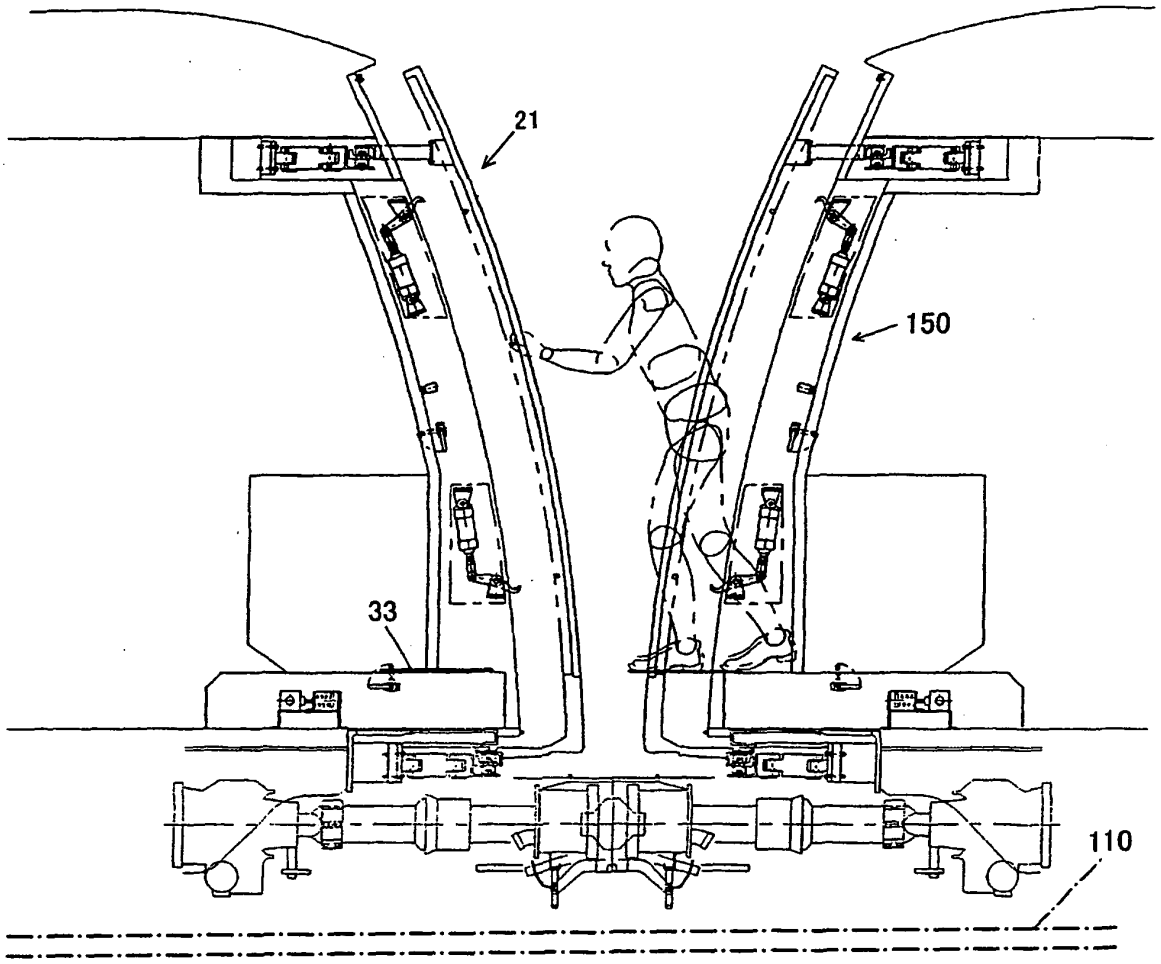


FIG. 4

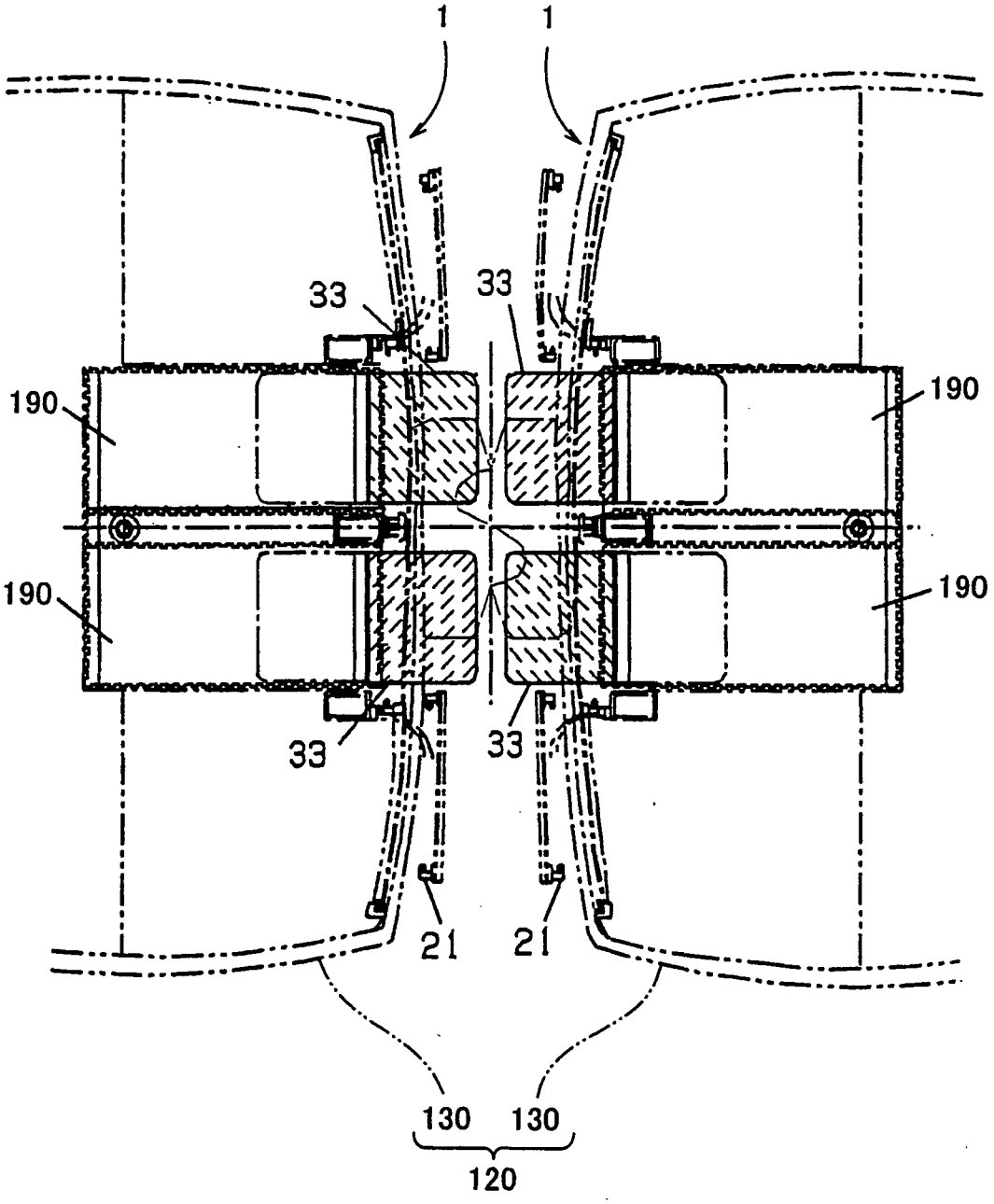


FIG. 5

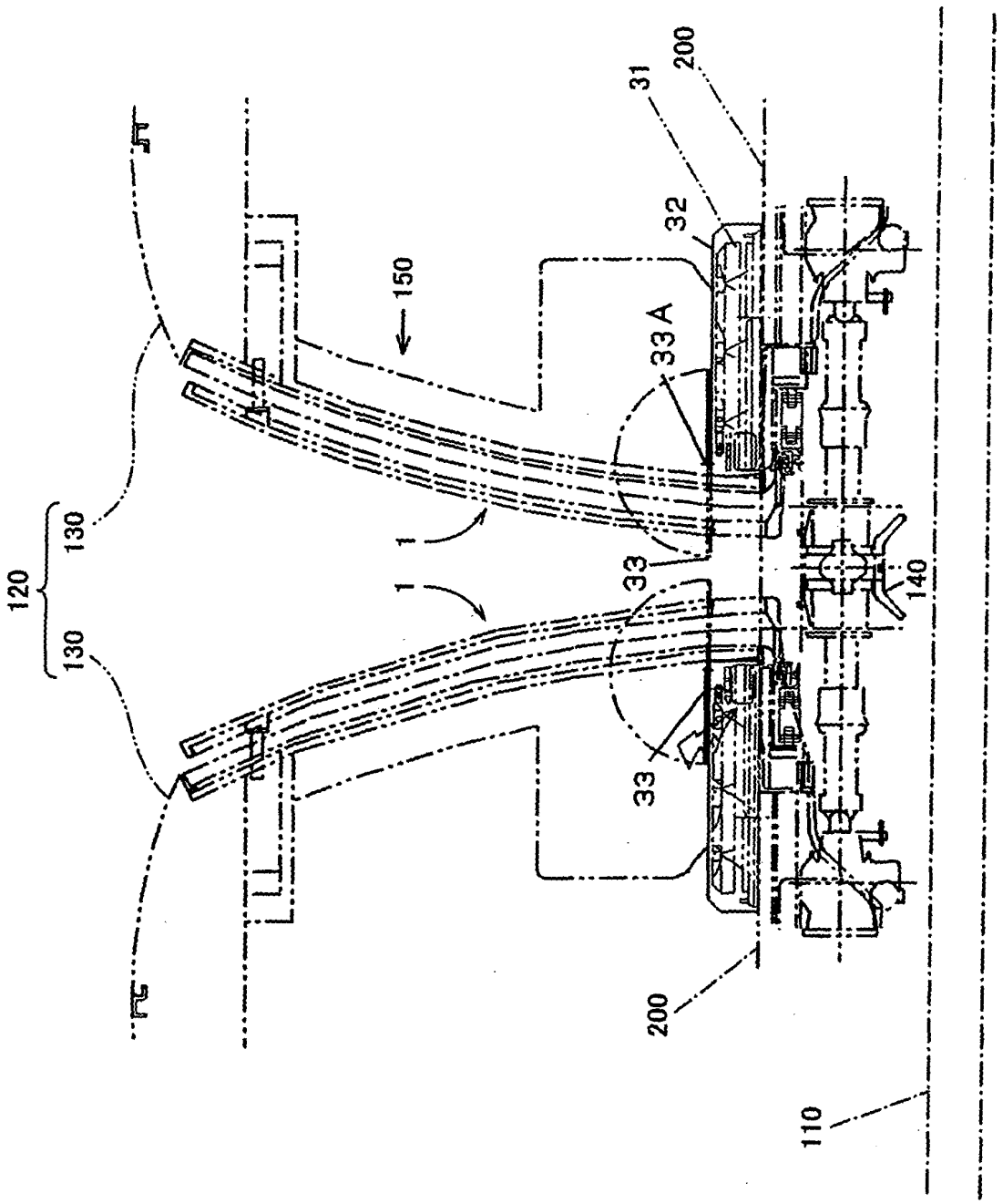


FIG. 6

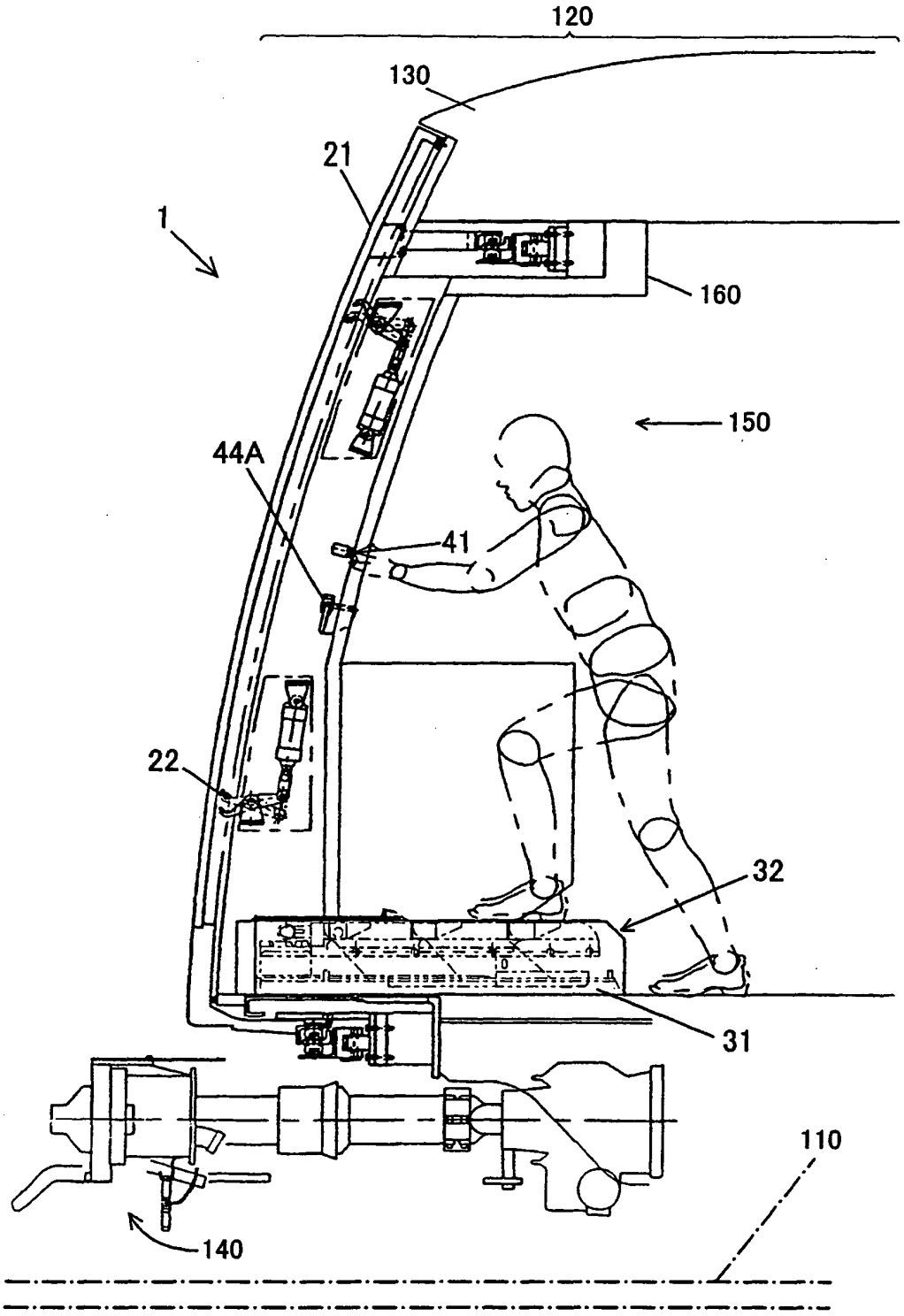


FIG. 7

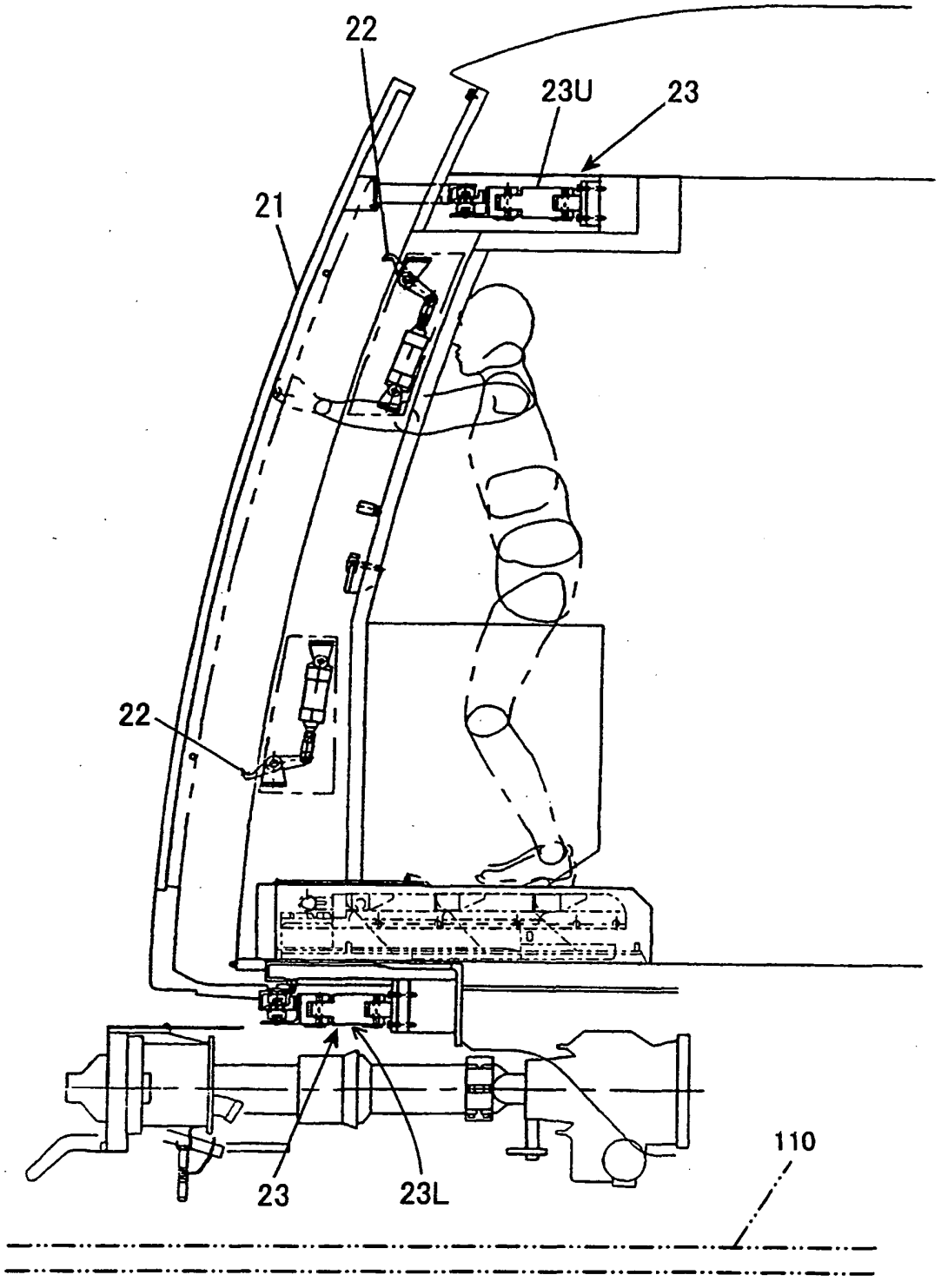


FIG. 8

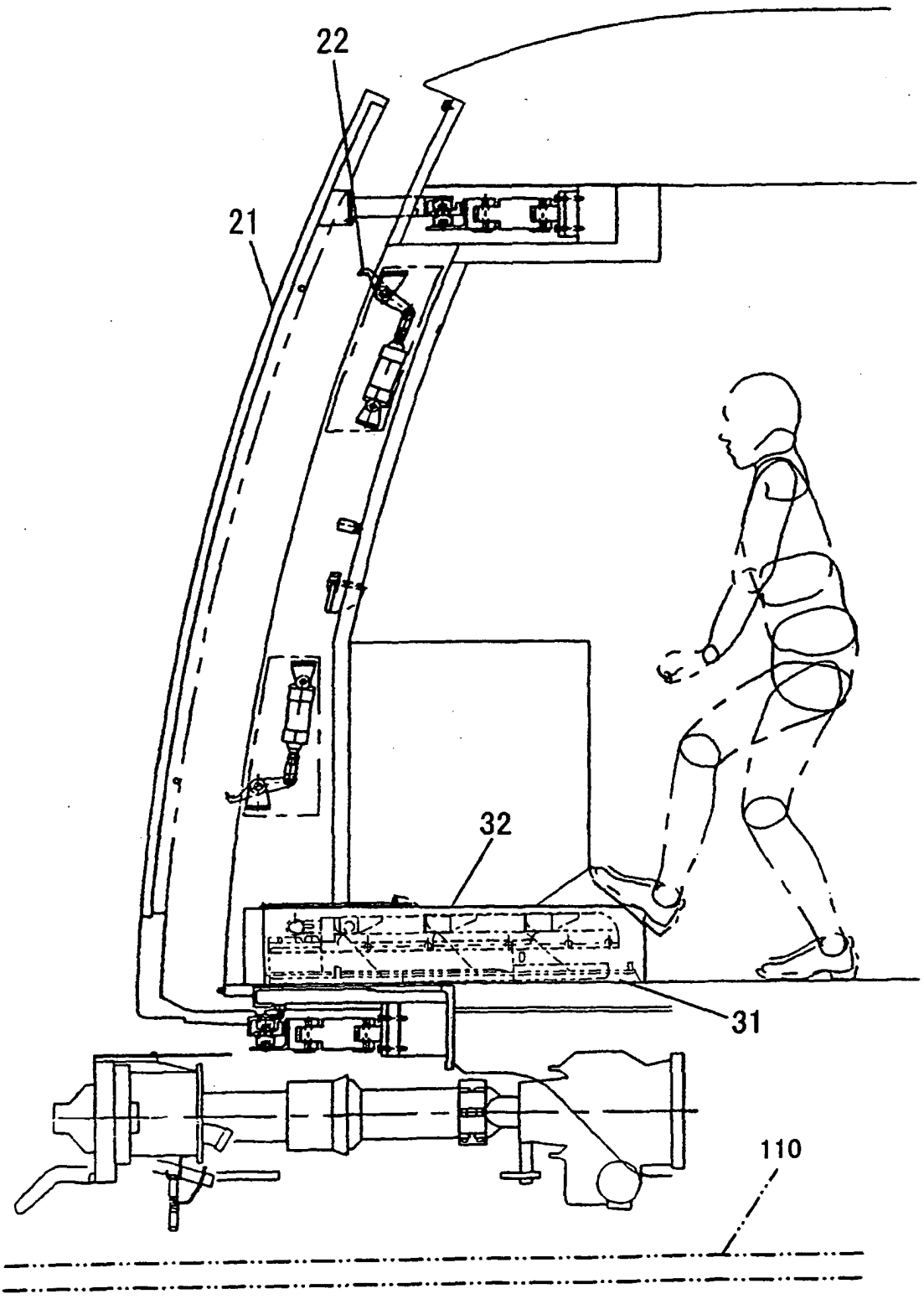


FIG. 9

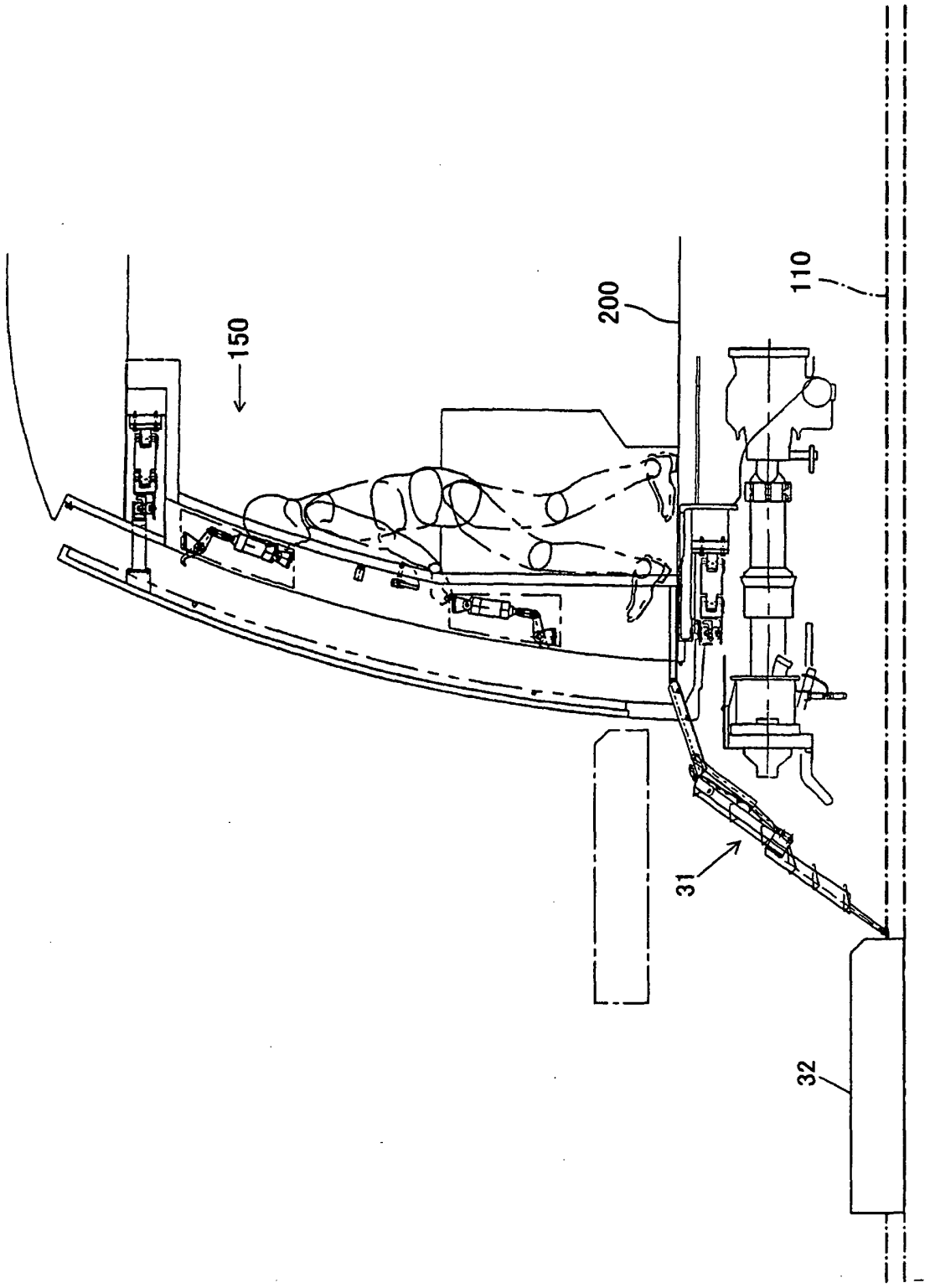


FIG. 10

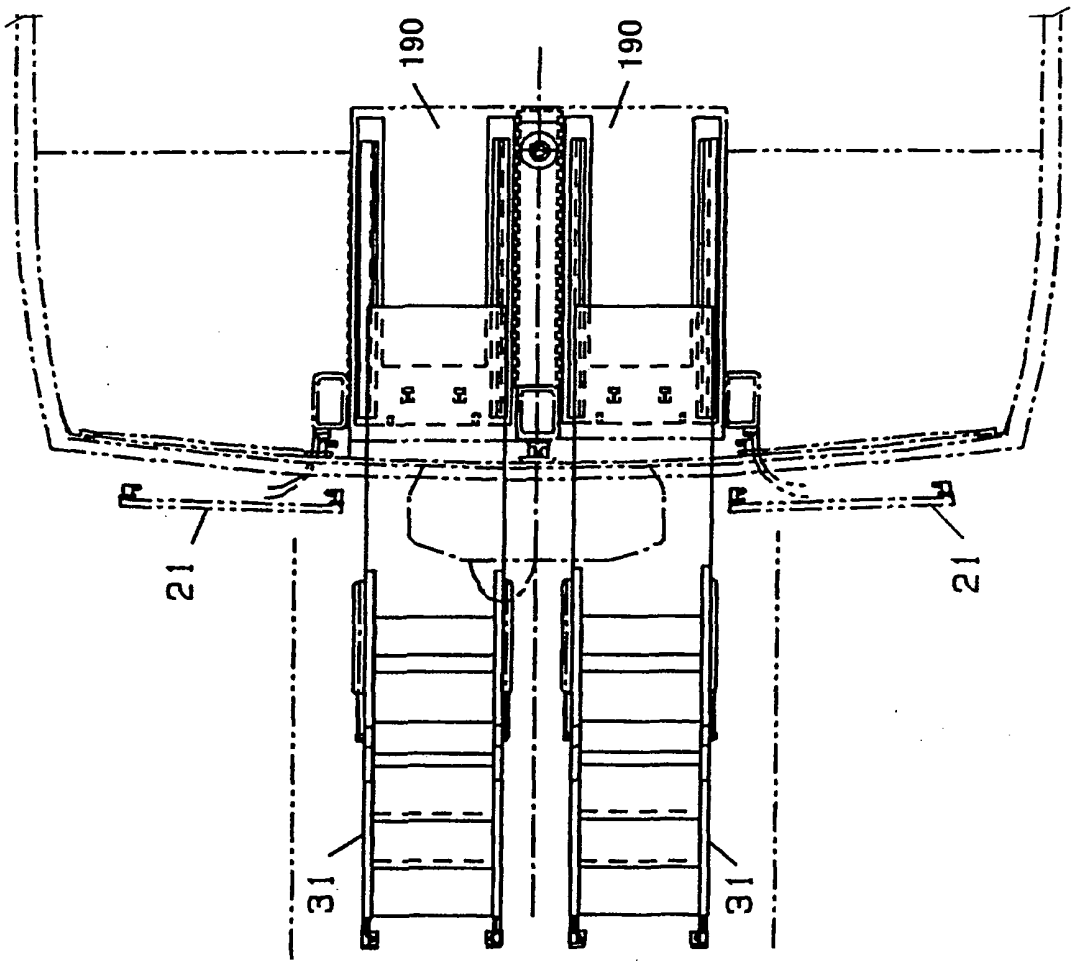


FIG. 11

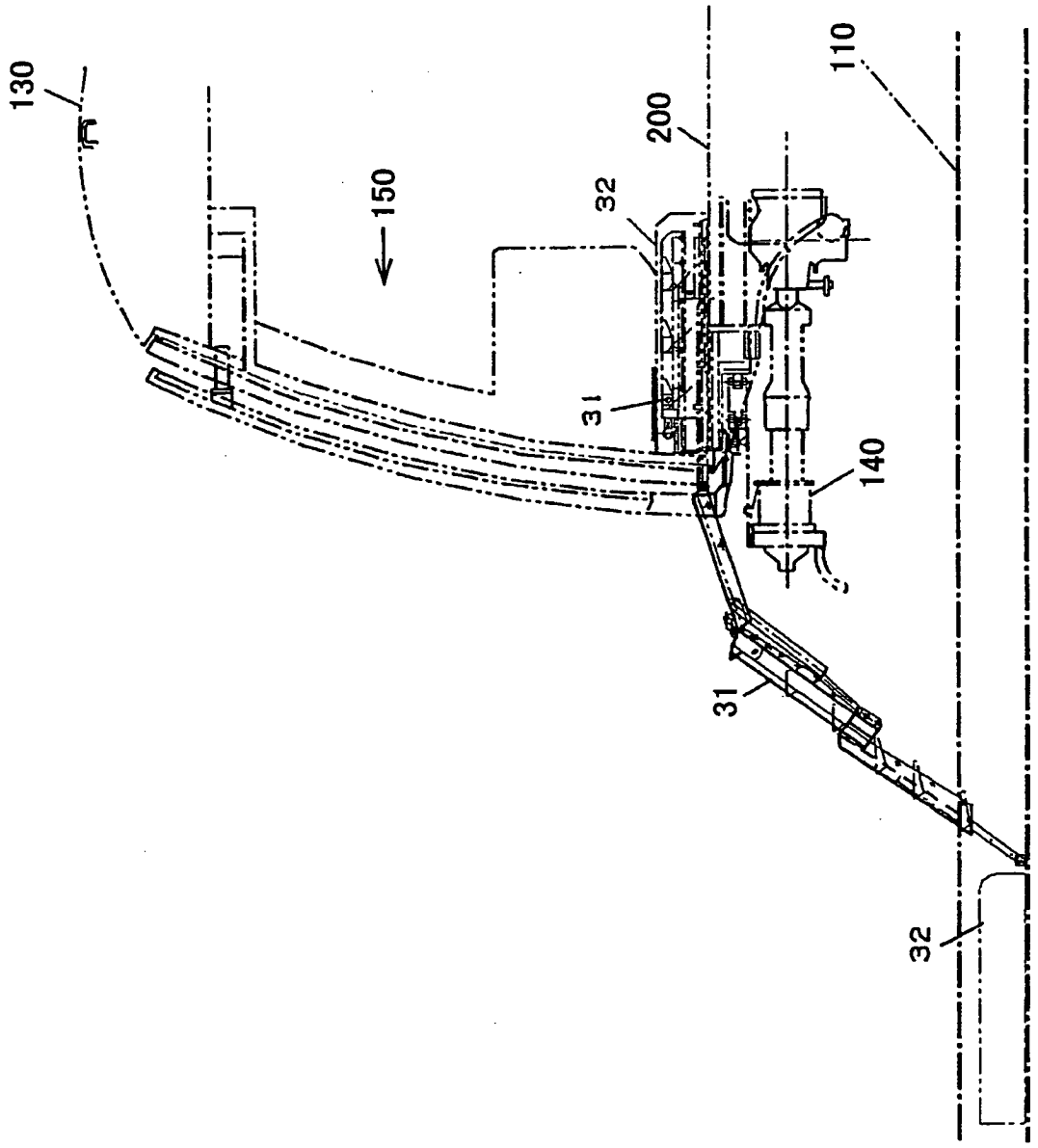


FIG. 12

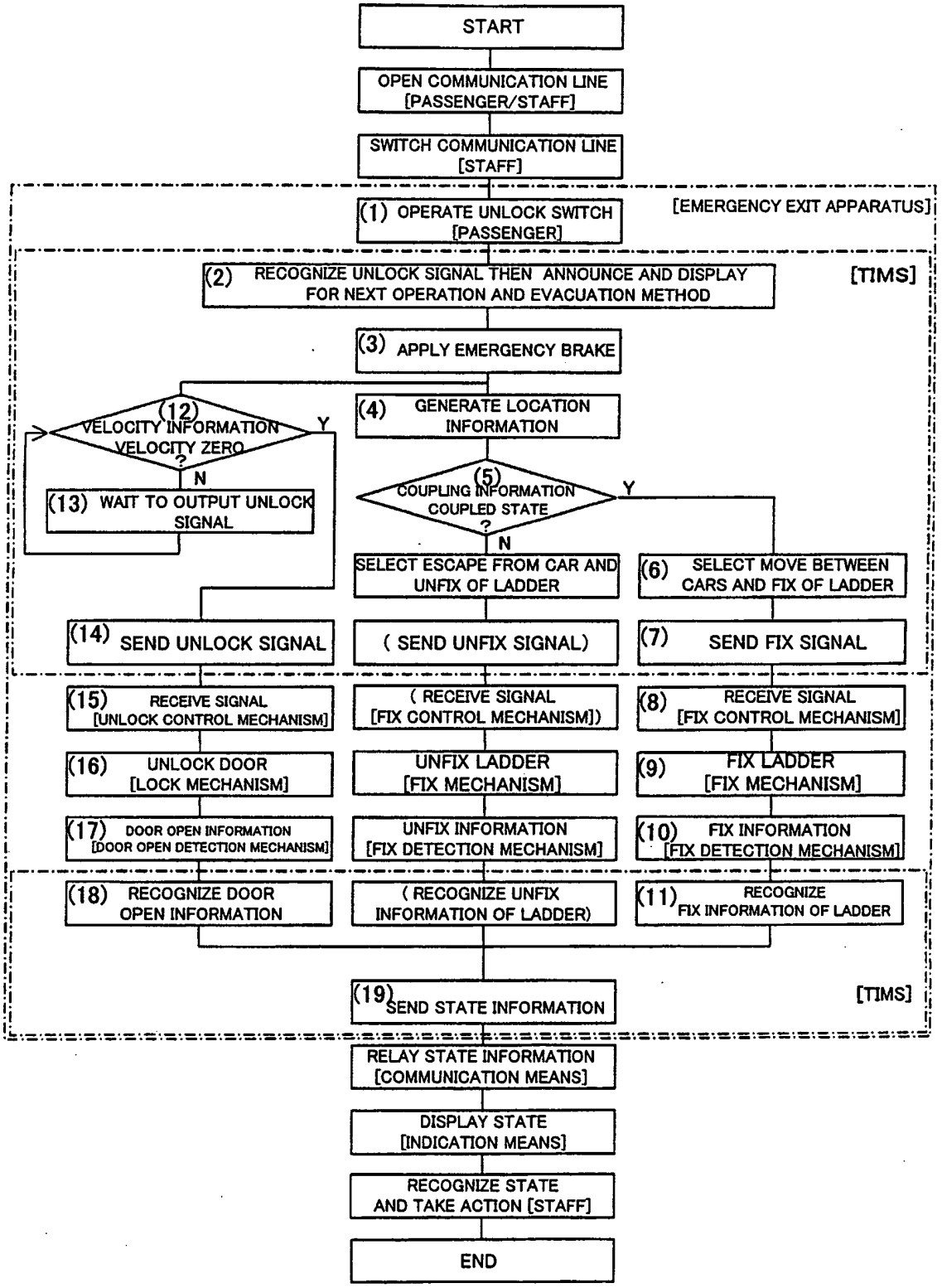

START
OPEN COMMUNICATION LINE [PASSENGER/STAFF]
SWITCH COMMUNICATION LINE [STAFF]
[EMERGENCY EXIT APPARATUS]
(1) OPERATE UNLOCK SWITCH [PASSENGER]
[TIMS]
(2) RECOGNIZE UNLOCK SIGNAL THEN ANNOUNCE AND DISPLAY FOR NEXT OPERATION AND EVACUATION METHOD
(3) APPLY EMERGENCY BRAKE
(4) GENERATE LOCATION INFORMATION
(12) VELOCITY INFORMATION VELOCITY ZERO ?
Y
N
(13) WAIT TO OUTPUT UNLOCK SIGNAL
(5) COUPLING INFORMATION COUPLED STATE ?
Y
N
SELECT ESCAPE FROM CAR AND UNFIX OF LADDER
(6) SELECT MOVE BETWEEN CARS AND FIX OF LADDER
(14) SEND UNLOCK SIGNAL
(SEND UNFIX SIGNAL)
(7) SEND FIX SIGNAL
(15) RECEIVE SIGNAL [UNLOCK CONTROL MECHANISM]
(RECEIVE SIGNAL [FIX CONTROL MECHANISM])
(8) RECEIVE SIGNAL [FIX CONTROL MECHANISM]
(16) UNLOCK DOOR [LOCK MECHANISM]
UNFIX LADDER [FIX MECHANISM]
(9) FIX LADDER [FIX MECHANISM]
(17) DOOR OPEN INFORMATION [DOOR OPEN DETECTION MECHANISM]
UNFIX INFORMATION [FIX DETECTION MECHANISM]
(10) FIX INFORMATION [FIX DETECTION MECHANISM]
(18) RECOGNIZE DOOR OPEN INFORMATION
(RECOGNIZE UNFIX INFORMATION OF LADDER)
(11) RECOGNIZE FIX INFORMATION OF LADDER
(19) SEND STATE INFORMATION
[TIMS]
RELAY STATE INFORMATION [COMMUNICATION MEANS]
DISPLAY STATE [INDICATION MEANS]
RECOGNIZE STATE AND TAKE ACTION [STAFF]
END

FIG. 13

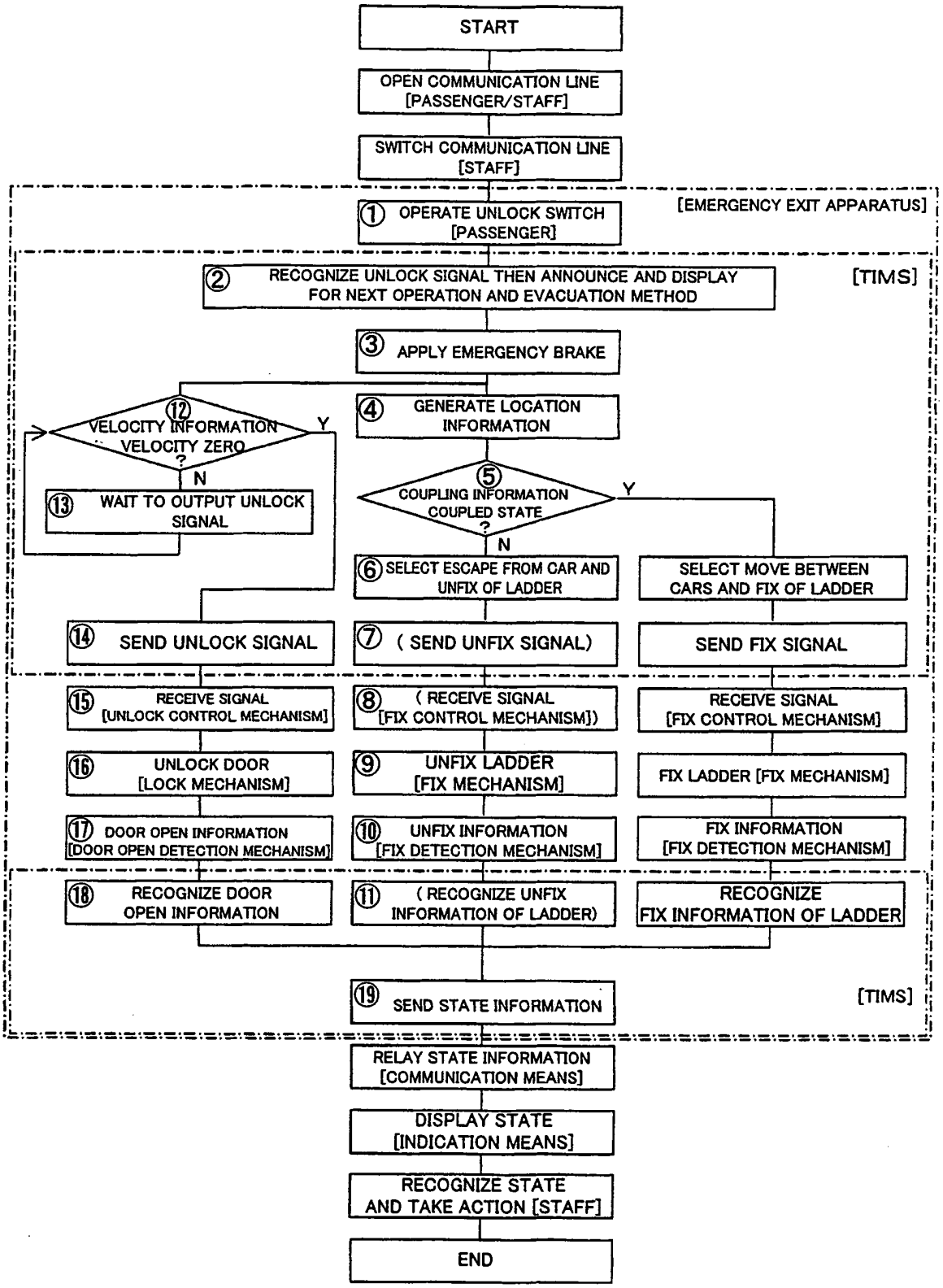

START
OPEN COMMUNICATION LINE [PASSENGER/STAFF]
SWITCH COMMUNICATION LINE [STAFF]
[EMERGENCY EXIT APPARATUS]
① OPERATE UNLOCK SWITCH [PASSENGER]
[TIMS]
② RECOGNIZE UNLOCK SIGNAL THEN ANNOUNCE AND DISPLAY FOR NEXT OPERATION AND EVACUATION METHOD
③ APPLY EMERGENCY BRAKE
④ GENERATE LOCATION INFORMATION
⑫ VELOCITY INFORMATION VELOCITY ZERO ?
Y
N
⑬ WAIT TO OUTPUT UNLOCK SIGNAL
⑤ COUPLING INFORMATION COUPLED STATE ?
Y
N
⑥ SELECT ESCAPE FROM CAR AND UNFIX OF LADDER
SELECT MOVE BETWEEN CARS AND FIX OF LADDER
⑭ SEND UNLOCK SIGNAL
⑦ (SEND UNFIX SIGNAL)
SEND FIX SIGNAL
⑮ RECEIVE SIGNAL [UNLOCK CONTROL MECHANISM]
⑧ (RECEIVE SIGNAL [FIX CONTROL MECHANISM])
RECEIVE SIGNAL [FIX CONTROL MECHANISM]
⑯ UNLOCK DOOR [LOCK MECHANISM]
⑨ UNFIX LADDER [FIX MECHANISM]
FIX LADDER [FIX MECHANISM]
⑰ DOOR OPEN INFORMATION [DOOR OPEN DETECTION MECHANISM]
⑩ UNFIX INFORMATION [FIX DETECTION MECHANISM]
FIX INFORMATION [FIX DETECTION MECHANISM]
⑱ RECOGNIZE DOOR OPEN INFORMATION
⑪ (RECOGNIZE UNFIX INFORMATION OF LADDER)
RECOGNIZE FIX INFORMATION OF LADDER
⑲ SEND STATE INFORMATION
[TIMS]
RELAY STATE INFORMATION [COMMUNICATION MEANS]
DISPLAY STATE [INDICATION MEANS]
RECOGNIZE STATE AND TAKE ACTION [STAFF]
END

FIG. 14

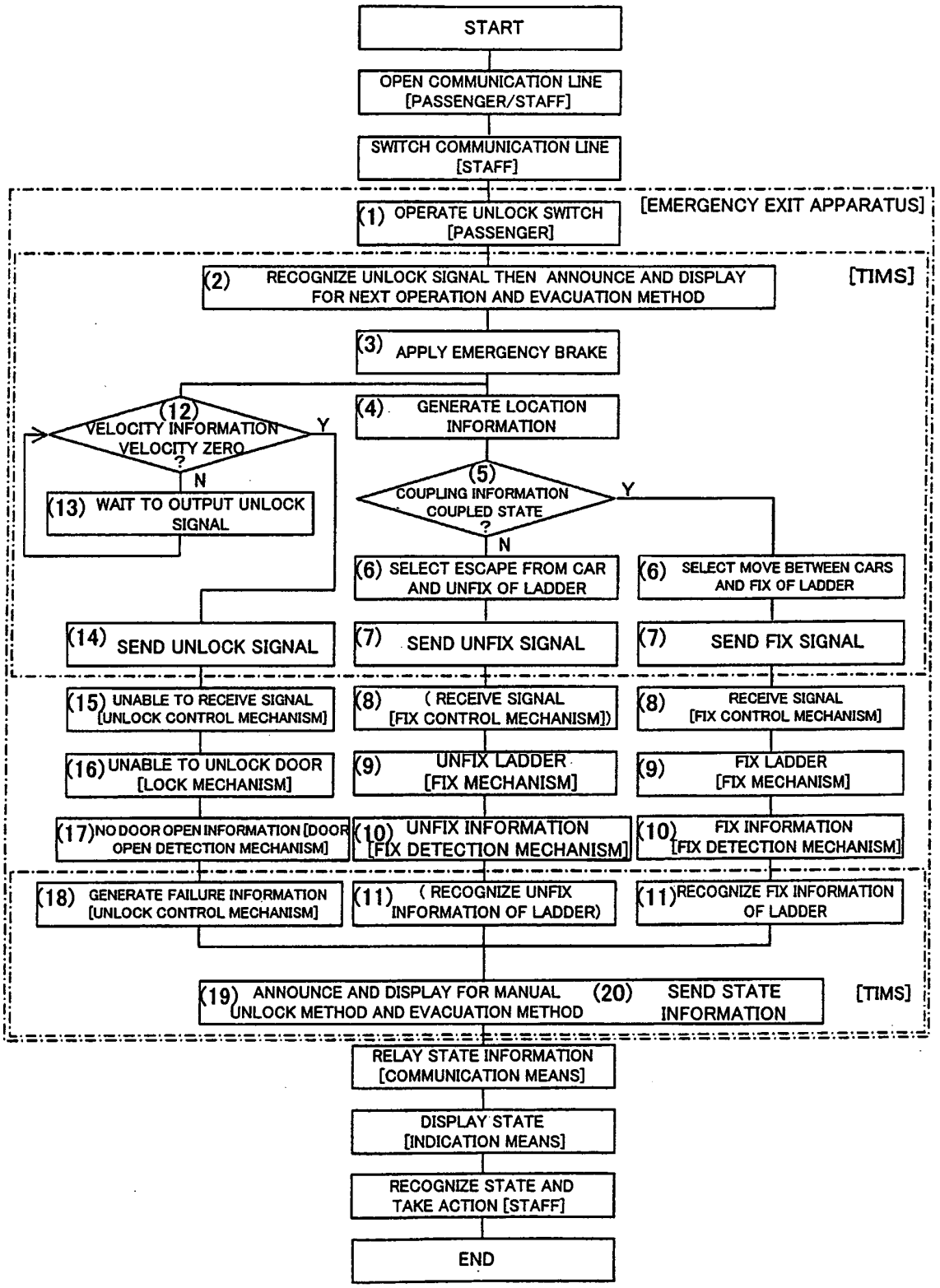

START
OPEN COMMUNICATION LINE [PASSENGER/STAFF]
SWITCH COMMUNICATION LINE [STAFF]
[EMERGENCY EXIT APPARATUS]
(1) OPERATE UNLOCK SWITCH [PASSENGER]
[TIMS]
(2) RECOGNIZE UNLOCK SIGNAL THEN ANNOUNCE AND DISPLAY FOR NEXT OPERATION AND EVACUATION METHOD
(3) APPLY EMERGENCY BRAKE
(4) GENERATE LOCATION INFORMATION
(12) VELOCITY INFORMATION VELOCITY ZERO ?
Y
N
(13) WAIT TO OUTPUT UNLOCK SIGNAL
(5) COUPLING INFORMATION COUPLED STATE ?
Y
N
(6) SELECT ESCAPE FROM CAR AND UNFIX OF LADDER
(6) SELECT MOVE BETWEEN CARS AND FIX OF LADDER
(14) SEND UNLOCK SIGNAL
(7) SEND UNFIX SIGNAL
(7) SEND FIX SIGNAL
(15) UNABLE TO RECEIVE SIGNAL [UNLOCK CONTROL MECHANISM]
(8) (RECEIVE SIGNAL [FIX CONTROL MECHANISM])
(8) RECEIVE SIGNAL [FIX CONTROL MECHANISM]
(16) UNABLE TO UNLOCK DOOR [LOCK MECHANISM]
(9) UNFIX LADDER [FIX MECHANISM]
(9) FIX LADDER [FIX MECHANISM]
(17) NO DOOR OPEN INFORMATION [DOOR OPEN DETECTION MECHANISM]
(10) UNFIX INFORMATION [FIX DETECTION MECHANISM]
(10) FIX INFORMATION [FIX DETECTION MECHANISM]
(18) GENERATE FAILURE INFORMATION [UNLOCK CONTROL MECHANISM]
(11) (RECOGNIZE UNFIX INFORMATION OF LADDER)
(11) RECOGNIZE FIX INFORMATION OF LADDER
(19) ANNOUNCE AND DISPLAY FOR MANUAL UNLOCK METHOD AND EVACUATION METHOD
(20) SEND STATE INFORMATION
[TIMS]
RELAY STATE INFORMATION [COMMUNICATION MEANS]
DISPLAY STATE [INDICATION MEANS]
RECOGNIZE STATE AND TAKE ACTION [STAFF]
END

FIG. 15

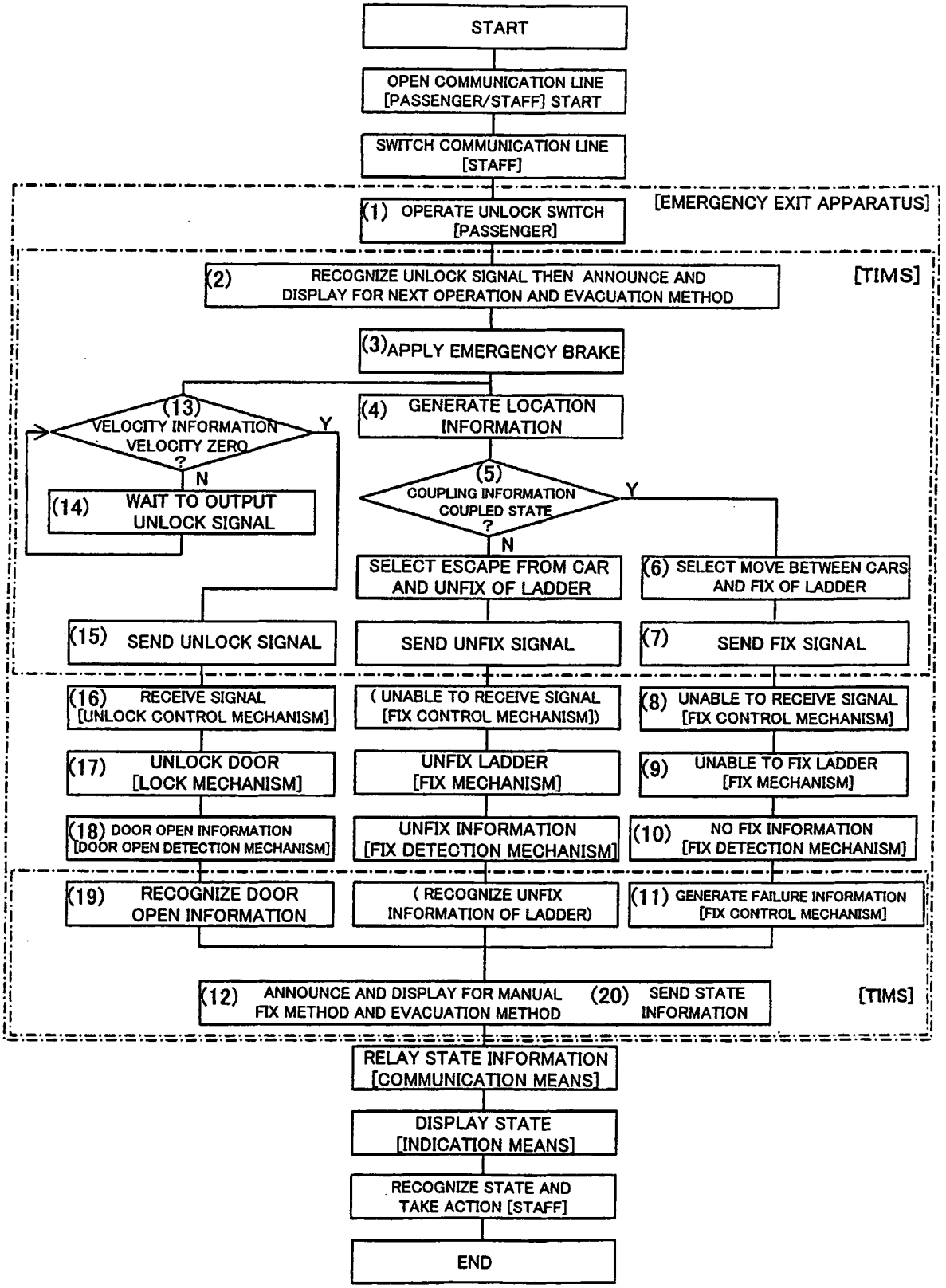

START
OPEN COMMUNICATION LINE [PASSENGER/STAFF] START
SWITCH COMMUNICATION LINE [STAFF]
[EMERGENCY EXIT APPARATUS]
(1) OPERATE UNLOCK SWITCH [PASSENGER]
[TIMS]
(2) RECOGNIZE UNLOCK SIGNAL THEN ANNOUNCE AND DISPLAY FOR NEXT OPERATION AND EVACUATION METHOD
(3) APPLY EMERGENCY BRAKE
(4) GENERATE LOCATION INFORMATION
(13) VELOCITY INFORMATION VELOCITY ZERO ?
Y
N
(14) WAIT TO OUTPUT UNLOCK SIGNAL
(5) COUPLING INFORMATION COUPLED STATE ?
Y
N
SELECT ESCAPE FROM CAR AND UNFIX OF LADDER
(6) SELECT MOVE BETWEEN CARS AND FIX OF LADDER
(15) SEND UNLOCK SIGNAL
SEND UNFIX SIGNAL
(7) SEND FIX SIGNAL
(16) RECEIVE SIGNAL [UNLOCK CONTROL MECHANISM]
(UNABLE TO RECEIVE SIGNAL [FIX CONTROL MECHANISM])
(8) UNABLE TO RECEIVE SIGNAL [FIX CONTROL MECHANISM]
(17) UNLOCK DOOR [LOCK MECHANISM]
UNFIX LADDER [FIX MECHANISM]
(9) UNABLE TO FIX LADDER [FIX MECHANISM]
(18) DOOR OPEN INFORMATION [DOOR OPEN DETECTION MECHANISM]
UNFIX INFORMATION [FIX DETECTION MECHANISM]
(10) NO FIX INFORMATION [FIX DETECTION MECHANISM]
(19) RECOGNIZE DOOR OPEN INFORMATION
(RECOGNIZE UNFIX INFORMATION OF LADDER)
(11) GENERATE FAILURE INFORMATION [FIX CONTROL MECHANISM]
(12) ANNOUNCE AND DISPLAY FOR MANUAL FIX METHOD AND EVACUATION METHOD
(20) SEND STATE INFORMATION
[TIMS]
RELAY STATE INFORMATION [COMMUNICATION MEANS]
DISPLAY STATE [INDICATION MEANS]
RECOGNIZE STATE AND TAKE ACTION [STAFF]
END

FIG. 16

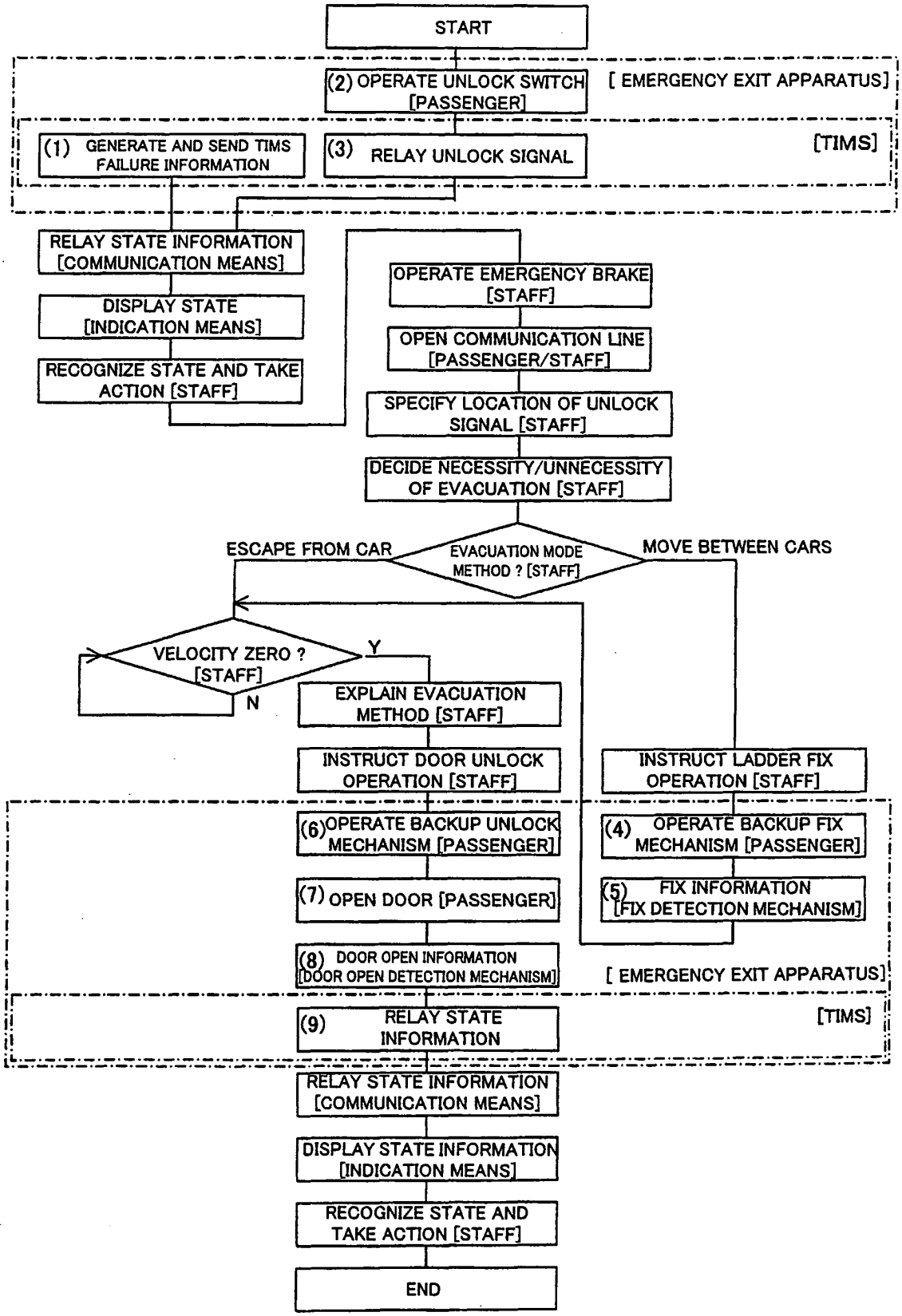

START
(2) OPERATE UNLOCK SWITCH [PASSENGER]
[EMERGENCY EXIT APPARATUS]
(1) GENERATE AND SEND TIMS FAILURE INFORMATION
(3) RELAY UNLOCK SIGNAL
[TIMS]
RELAY STATE INFORMATION [COMMUNICATION MEANS]
DISPLAY STATE [INDICATION MEANS]
RECOGNIZE STATE AND TAKE ACTION [STAFF]
OPERATE EMERGENCY BRAKE [STAFF]
OPEN COMMUNICATION LINE [PASSENGER/STAFF]
SPECIFY LOCATION OF UNLOCK SIGNAL [STAFF]
DECIDE NECESSITY/UNNECESSITY OF EVACUATION [STAFF]
ESCAPE FROM CAR
EVACUATION MODE METHOD ? [STAFF]
MOVE BETWEEN CARS
VELOCITY ZERO ? [STAFF]
Y
N
EXPLAIN EVACUATION METHOD [STAFF]
INSTRUCT DOOR UNLOCK OPERATION [STAFF]
INSTRUCT LADDER FIX OPERATION [STAFF]
(6) OPERATE BACKUP UNLOCK MECHANISM [PASSENGER]
(4) OPERATE BACKUP FIX MECHANISM [PASSENGER]
(7) OPEN DOOR [PASSENGER]
(5) FIX INFORMATION [FIX DETECTION MECHANISM]
(8) DOOR OPEN INFORMATION [DOOR OPEN DETECTION MECHANISM]
[EMERGENCY EXIT APPARATUS]
(9) RELAY STATE INFORMATION
[TIMS]
RELAY STATE INFORMATION [COMMUNICATION MEANS]
DISPLAY STATE INFORMATION [INDICATION MEANS]
RECOGNIZE STATE AND TAKE ACTION [STAFF]
END

FIG. 17

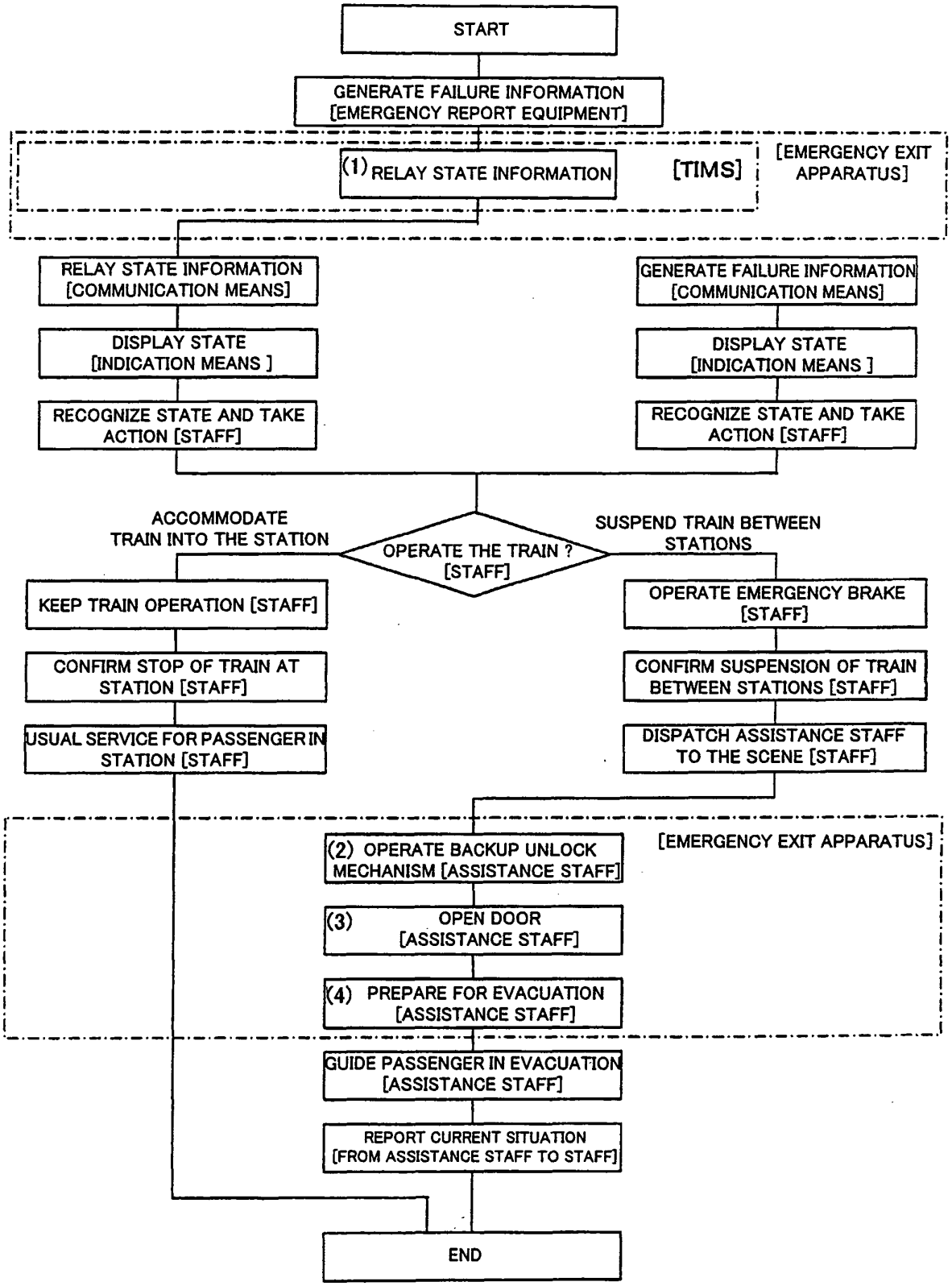

START
GENERATE FAILURE INFORMATION [EMERGENCY REPORT EQUIPMENT]
(1) RELAY STATE INFORMATION
[TIMS]
[EMERGENCY EXIT APPARATUS]
RELAY STATE INFORMATION [COMMUNICATION MEANS]
GENERATE FAILURE INFORMATION [COMMUNICATION MEANS]
DISPLAY STATE [INDICATION MEANS]
DISPLAY STATE [INDICATION MEANS]
RECOGNIZE STATE AND TAKE ACTION [STAFF]
RECOGNIZE STATE AND TAKE ACTION [STAFF]
ACCOMMODATE TRAIN INTO THE STATION
OPERATE THE TRAIN ? [STAFF]
SUSPEND TRAIN BETWEEN STATIONS
KEEP TRAIN OPERATION [STAFF]
OPERATE EMERGENCY BRAKE [STAFF]
CONFIRM STOP OF TRAIN AT STATION [STAFF]
CONFIRM SUSPENSION OF TRAIN BETWEEN STATIONS [STAFF]
USUAL SERVICE FOR PASSENGER IN STATION [STAFF]
DISPATCH ASSISTANCE STAFF TO THE SCENE [STAFF]
[EMERGENCY EXIT APPARATUS]
(2) OPERATE BACKUP UNLOCK MECHANISM [ASSISTANCE STAFF]
(3) OPEN DOOR [ASSISTANCE STAFF]
(4) PREPARE FOR EVACUATION [ASSISTANCE STAFF]
GUIDE PASSENGER IN EVACUATION [ASSISTANCE STAFF]
REPORT CURRENT SITUATION [FROM ASSISTANCE STAFF TO STAFF]
END

FIG. 18

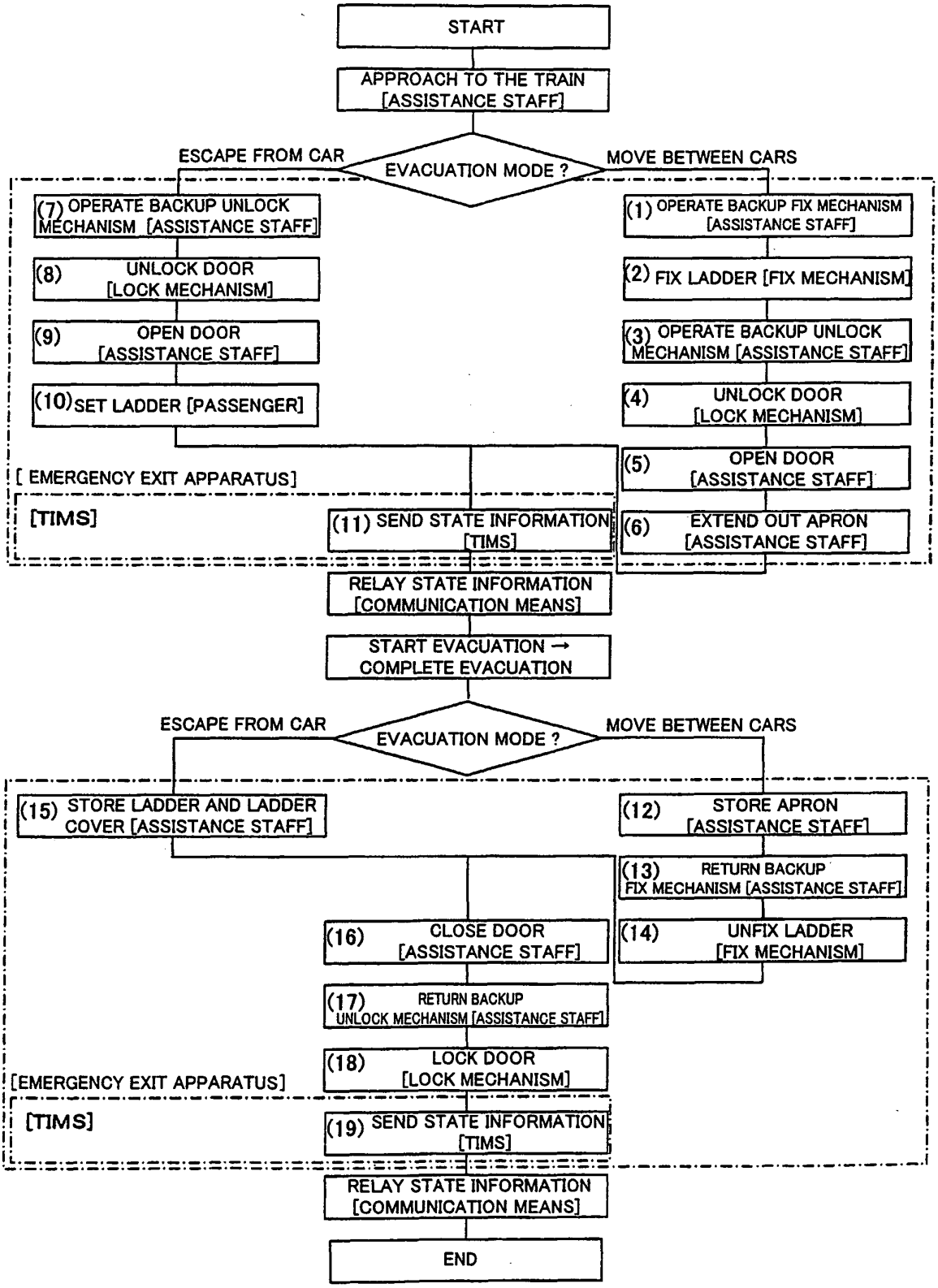

START
APPROACH TO THE TRAIN [ASSISTANCE STAFF]
ESCAPE FROM CAR
EVACUATION MODE ?
MOVE BETWEEN CARS
(7) OPERATE BACKUP UNLOCK MECHANISM [ASSISTANCE STAFF]
(8) UNLOCK DOOR [LOCK MECHANISM]
(9) OPEN DOOR [ASSISTANCE STAFF]
(10) SET LADDER [PASSENGER]
(1) OPERATE BACKUP FIX MECHANISM [ASSISTANCE STAFF]
(2) FIX LADDER [FIX MECHANISM]
(3) OPERATE BACKUP UNLOCK MECHANISM [ASSISTANCE STAFF]
(4) UNLOCK DOOR [LOCK MECHANISM]
(5) OPEN DOOR [ASSISTANCE STAFF]
[EMERGENCY EXIT APPARATUS]
[TIMS]
(11) SEND STATE INFORMATION [TIMS]
(6) EXTEND OUT APRON [ASSISTANCE STAFF]
RELAY STATE INFORMATION [COMMUNICATION MEANS]
START EVACUATION → COMPLETE EVACUATION
ESCAPE FROM CAR
EVACUATION MODE ?
MOVE BETWEEN CARS
(15) STORE LADDER AND LADDER COVER [ASSISTANCE STAFF]
(12) STORE APRON [ASSISTANCE STAFF]
(13) RETURN BACKUP FIX MECHANISM [ASSISTANCE STAFF]
(16) CLOSE DOOR [ASSISTANCE STAFF]
(14) UNFIX LADDER [FIX MECHANISM]
(17) RETURN BACKUP UNLOCK MECHANISM [ASSISTANCE STAFF]
(18) LOCK DOOR [LOCK MECHANISM]
[EMERGENCY EXIT APPARATUS]
[TIMS]
(19) SEND STATE INFORMATION [TIMS]
RELAY STATE INFORMATION [COMMUNICATION MEANS]
END

FIG. 19

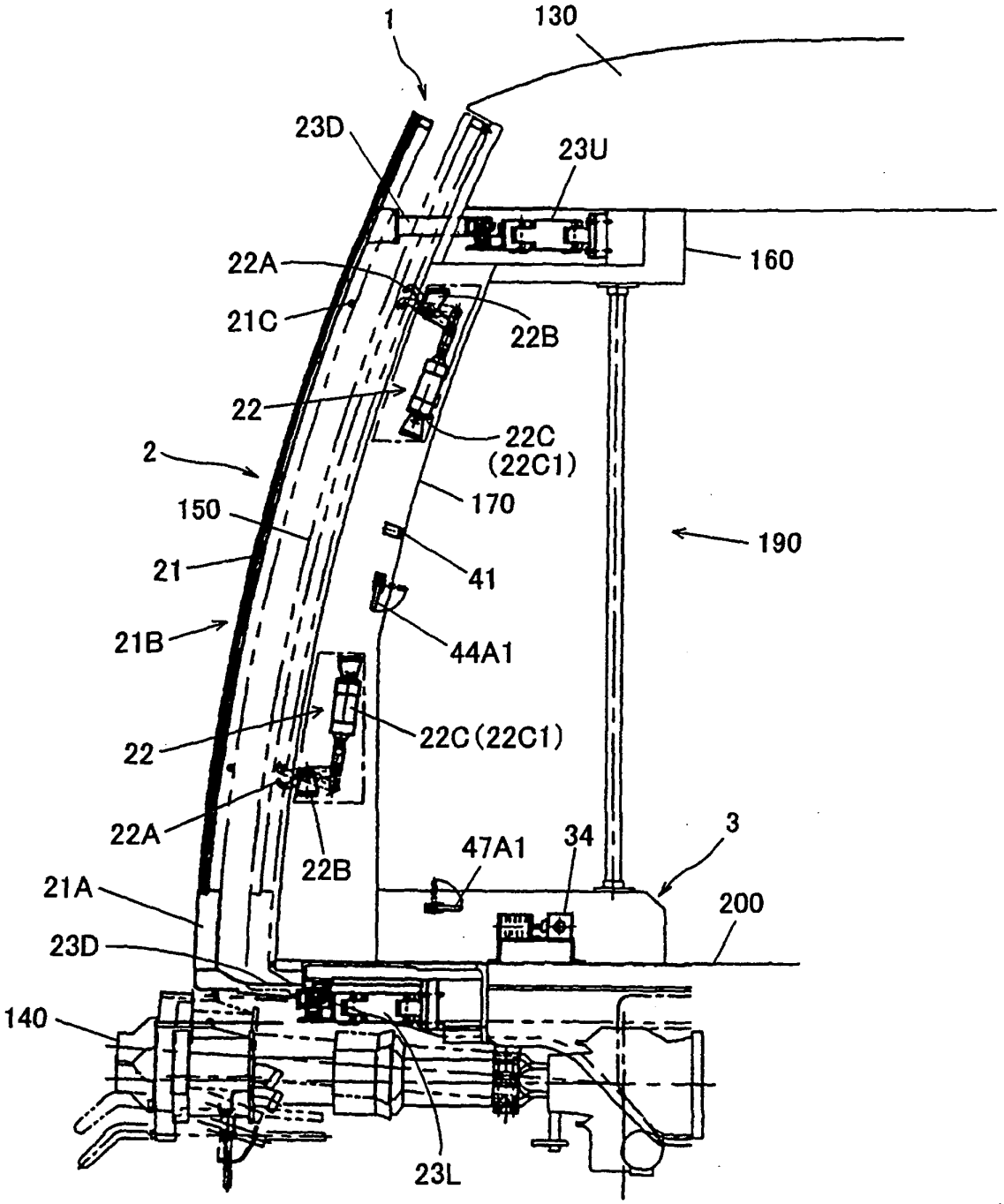
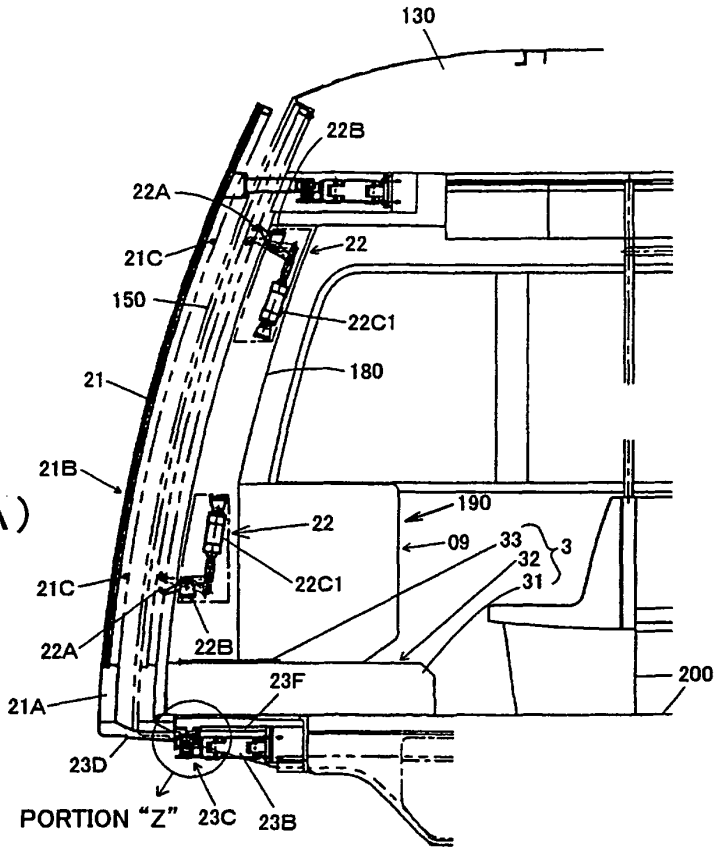

1
130
23D
23U
22A
160
21C
22B
22
22C
(22C1)
2
150
170
190
21
41
21B
44A1
22
22C(22C1)
22A
22B
47A1
34
3
21A
200
23D
140
23L
110

FIG. 20

FIG. 21(A)



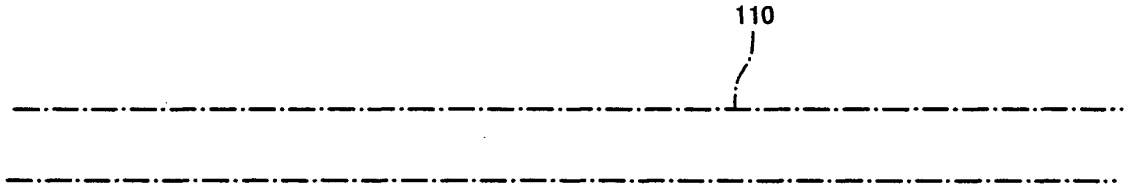
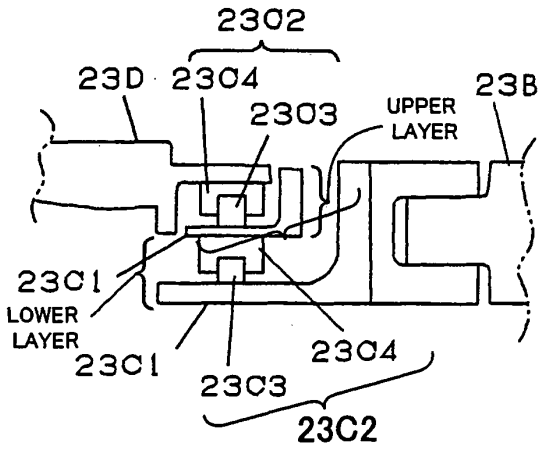


FIG. 21(B)



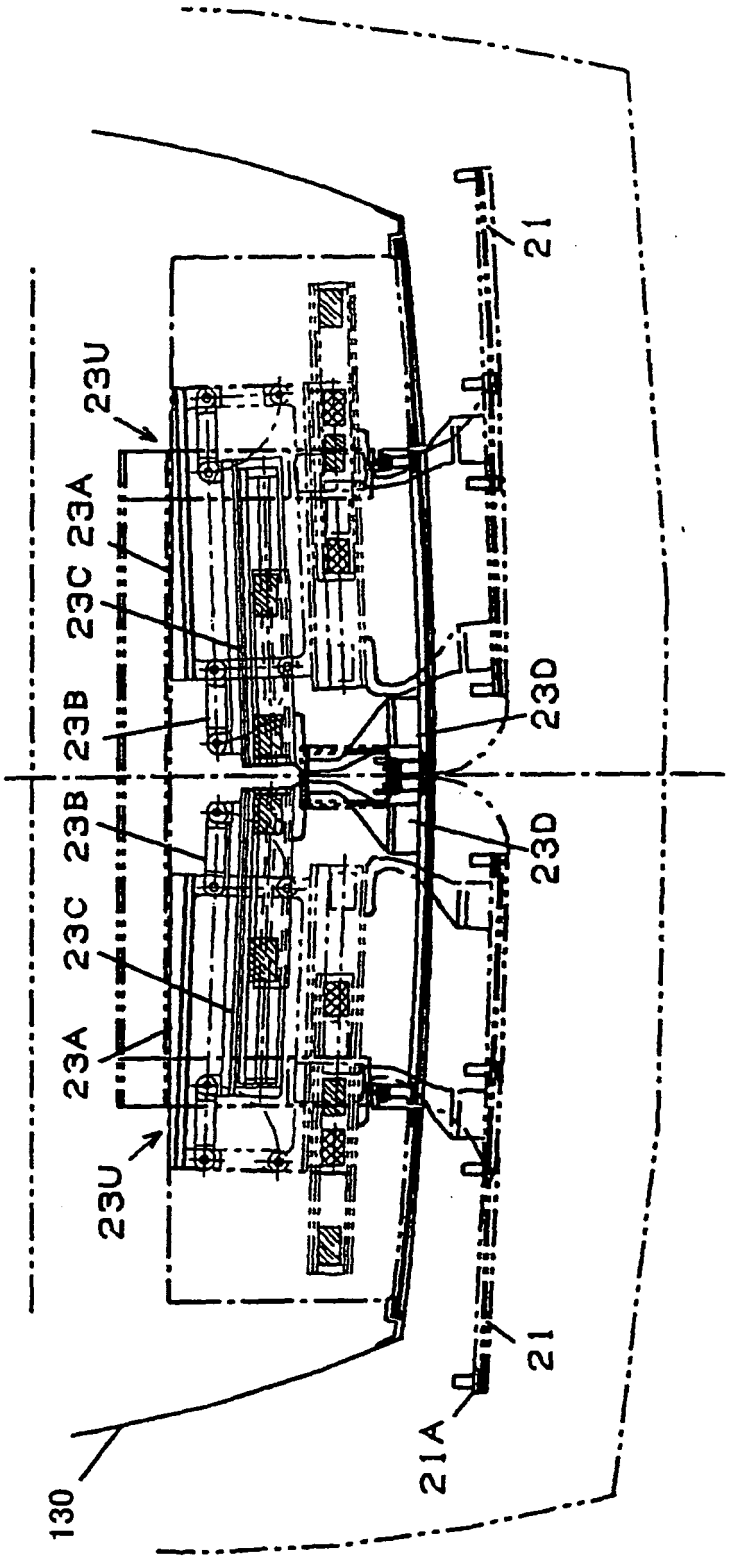


FIG. 22

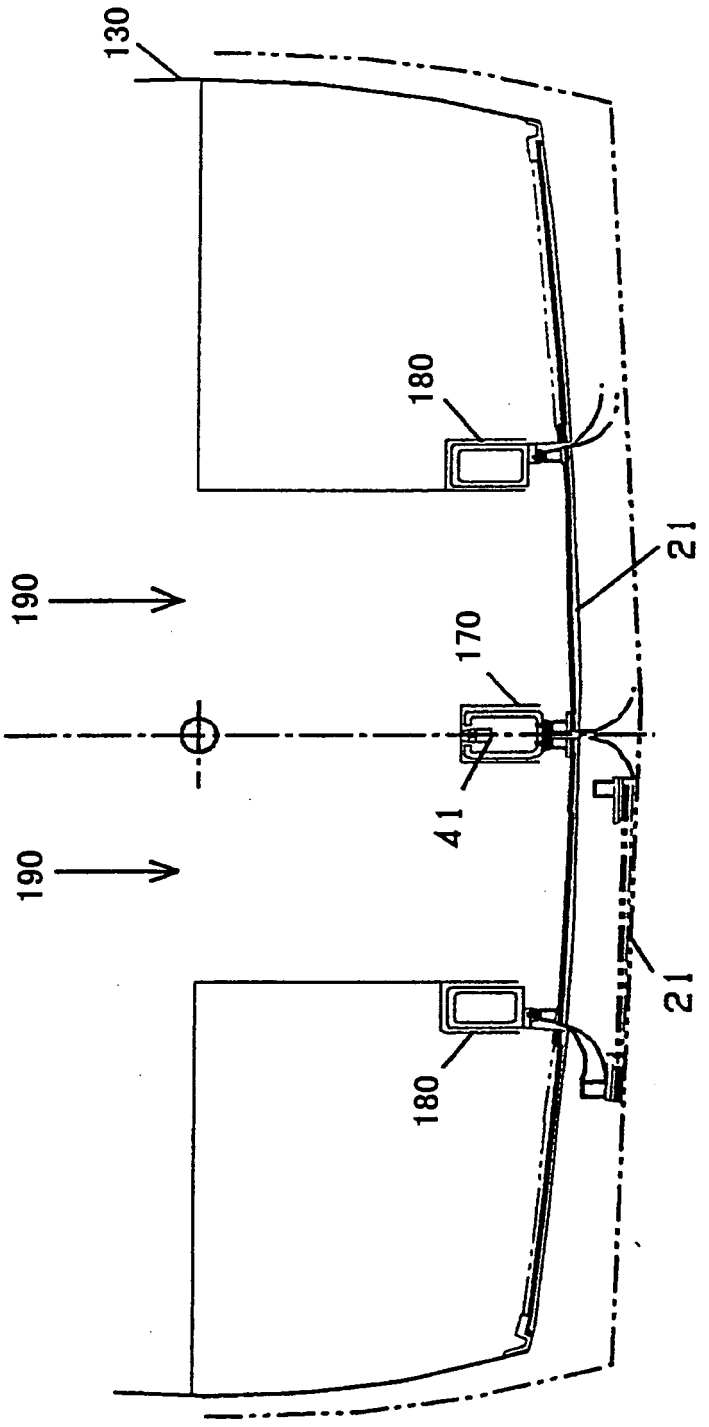


FIG. 23

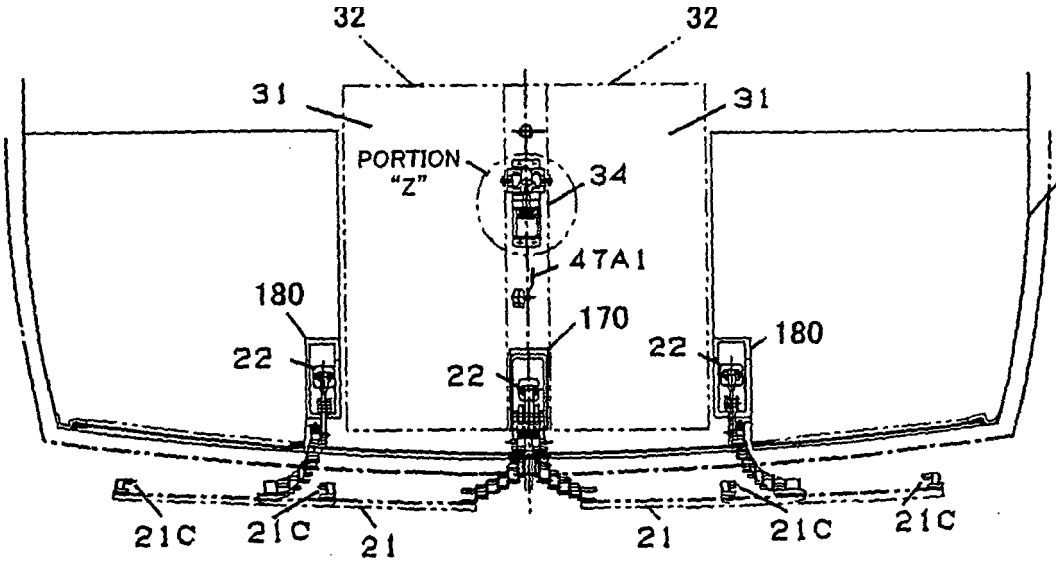
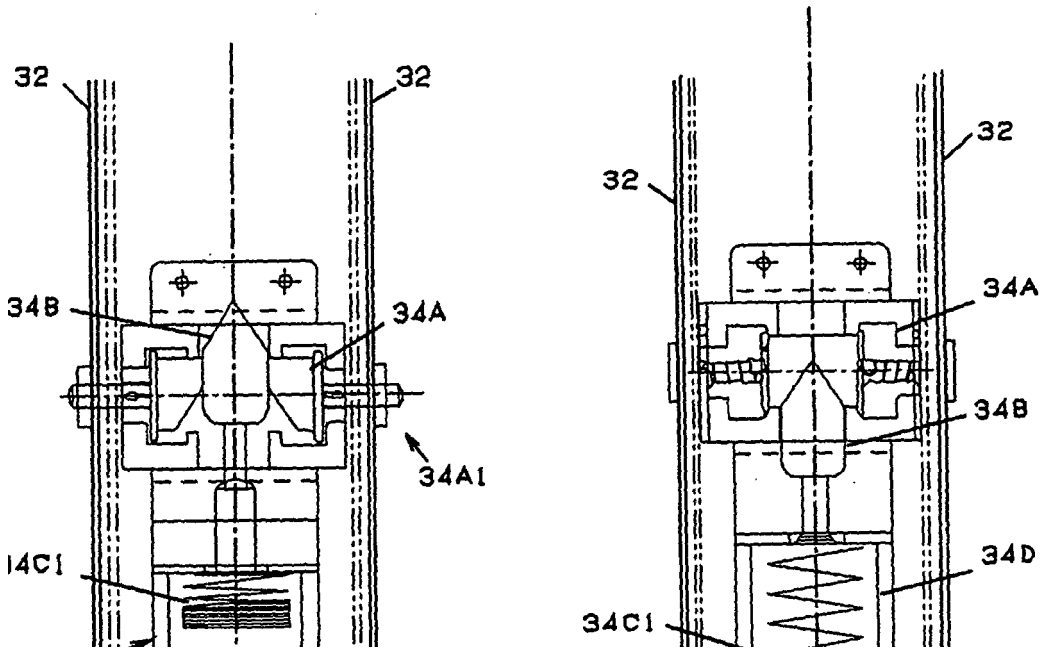

32
32
31
31
PORTION
"Z"
34
47A1
180
170
180
22
22
22
21C
21C
21
21
21C
21C

FIG. 24(A)


32
32
34B
34A
34A1
14C1
32
32
34A
34B
34D
34C1

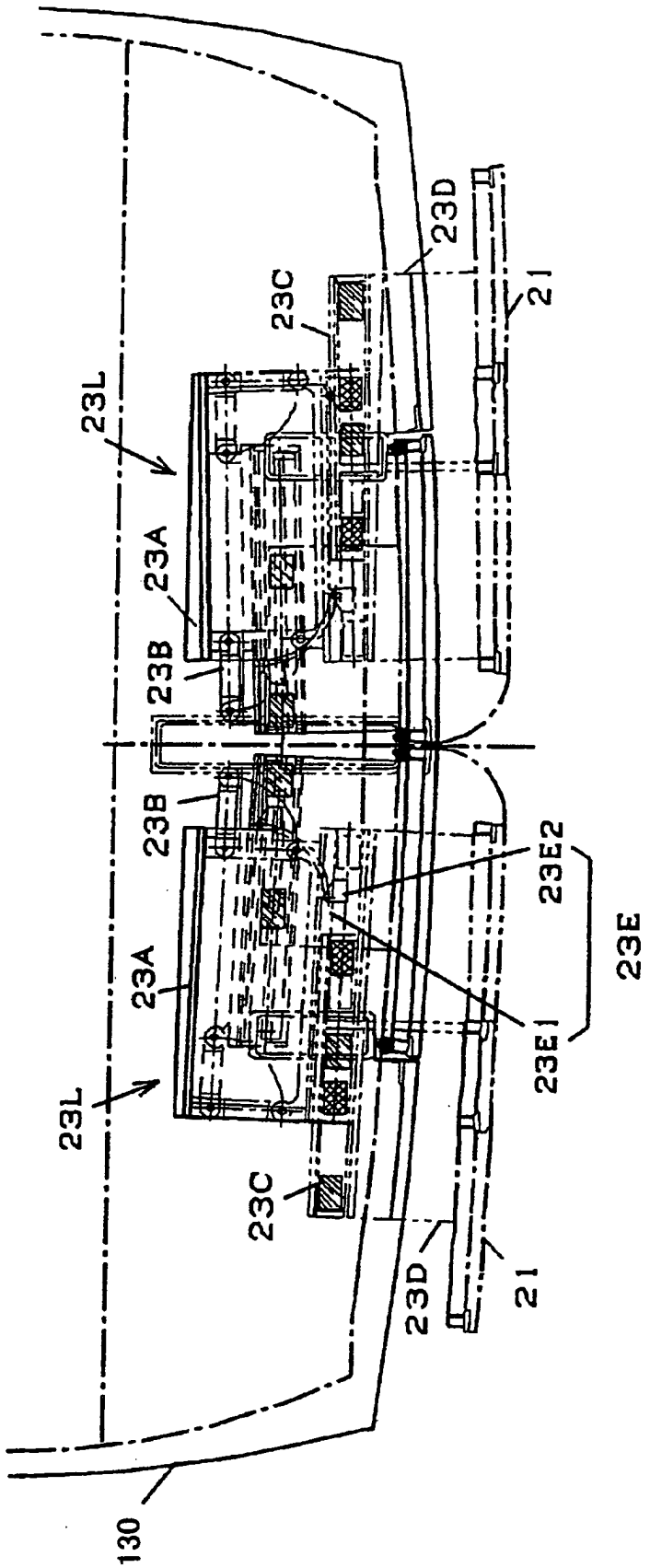


FIG. 25

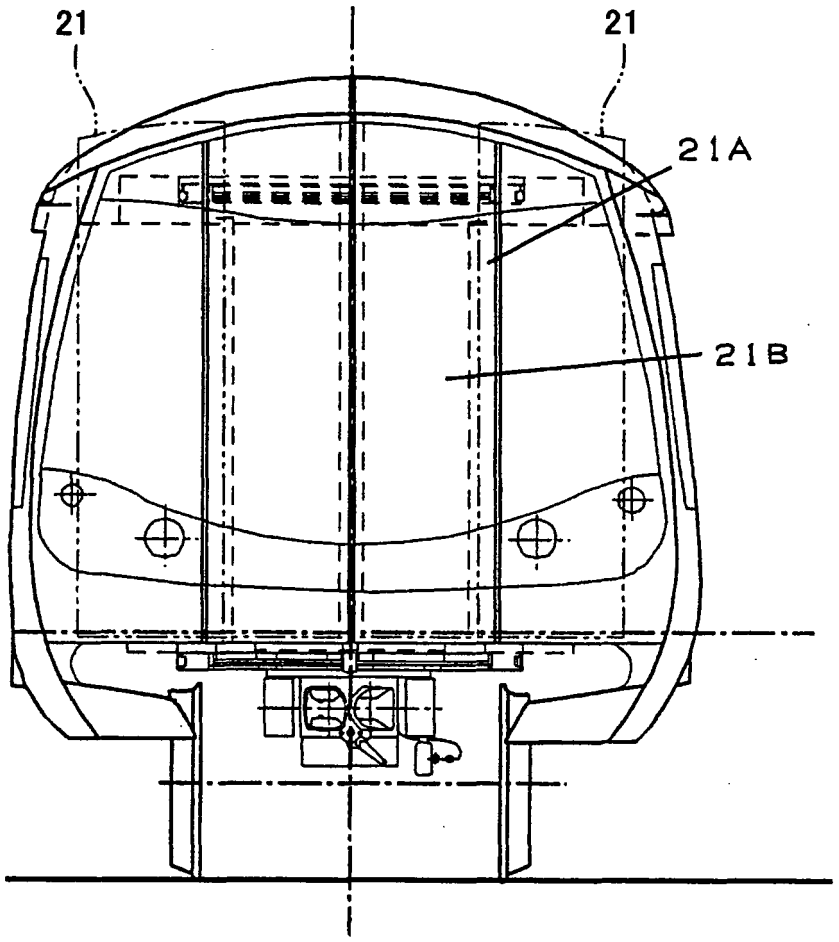


FIG. 26

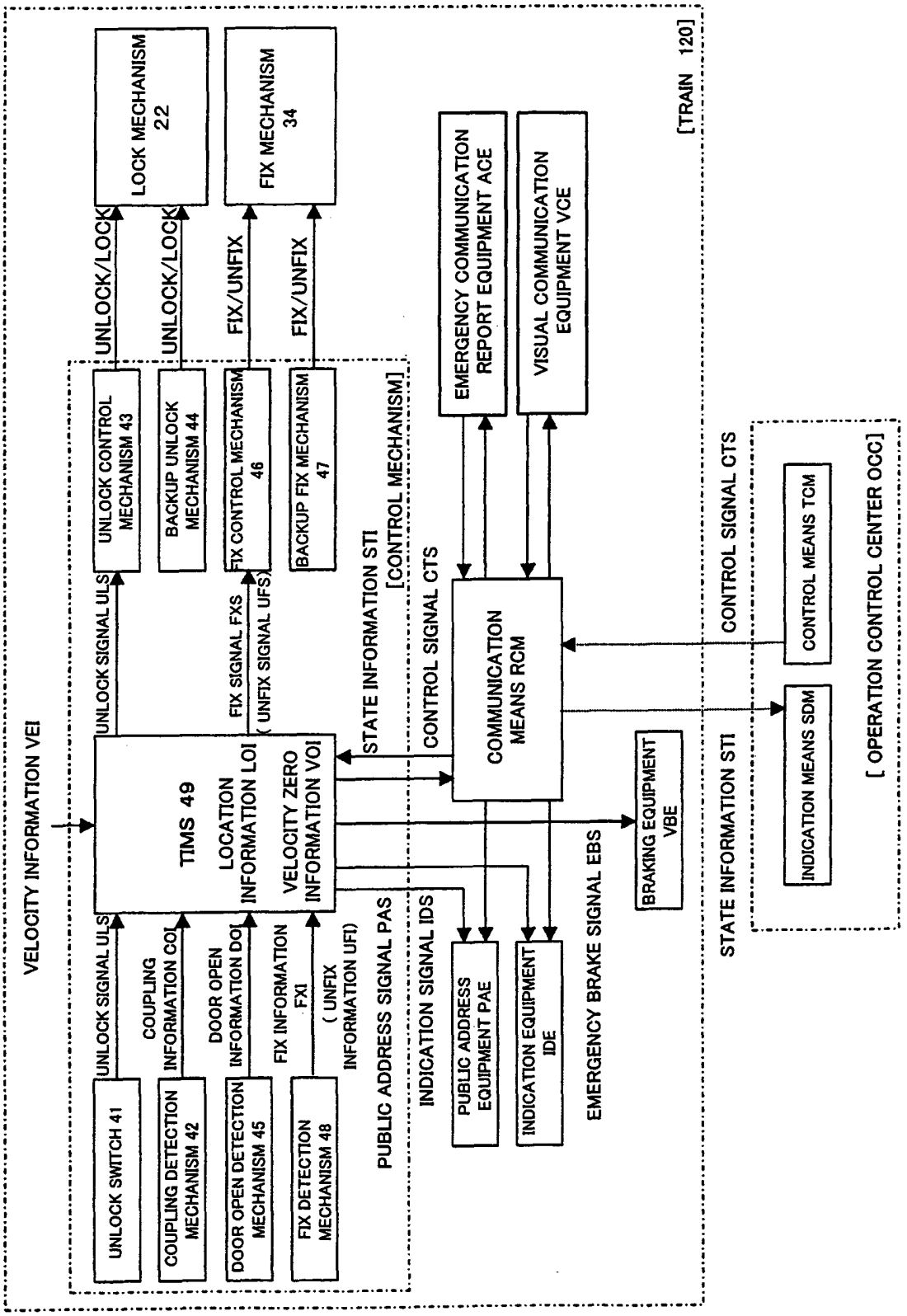

[TRAIN 120]
VELOCITY INFORMATION VEI
UNLOCK SWITCH 41
COUPLING DETECTION MECHANISM 42
DOOR OPEN DETECTION MECHANISM 45
FIX DETECTION MECHANISM 48
UNLOCK SIGNAL ULS
COUPLING INFORMATION COI
DOOR OPEN INFORMATION DOI
FIX INFORMATION FXI
(UNFIX INFORMATION UFI)
TIMS 49
LOCATION INFORMATION LOI
VELOCITY ZERO INFORMATION VOI
UNLOCK CONTROL MECHANISM 43
BACKUP UNLOCK MECHANISM 44
FIX CONTROL MECHANISM 46
BACKUP FIX MECHANISM 47
LOCK MECHANISM 22
FIX MECHANISM 34
UNLOCK/LOCK
UNLOCK/LOCK
FIX/UNFIX
FIX/UNFIX
UNLOCK SIGNAL ULS
FIX SIGNAL FXS
(UNFIX SIGNAL UFS)
[CONTROL MECHANISM]
STATE INFORMATION STI
CONTROL SIGNAL CTS
PUBLIC ADDRESS SIGNAL PAS
INDICATION SIGNAL IDS
EMERGENCY BRAKE SIGNAL EBS
COMMUNICATION MEANS RCM
EMERGENCY COMMUNICATION REPORT EQUIPMENT ACE
VISUAL COMMUNICATION EQUIPMENT VCE
PUBLIC ADDRESS EQUIPMENT PAE
INDICATION EQUIPMENT IDE
BRAKING EQUIPMENT VBE
CONTROL SIGNAL CTS
STATE INFORMATION STI
CONTROL MEANS TCM
INDICATION MEANS SDM
[OPERATION CONTROL CENTER OCC]

FIG. 27

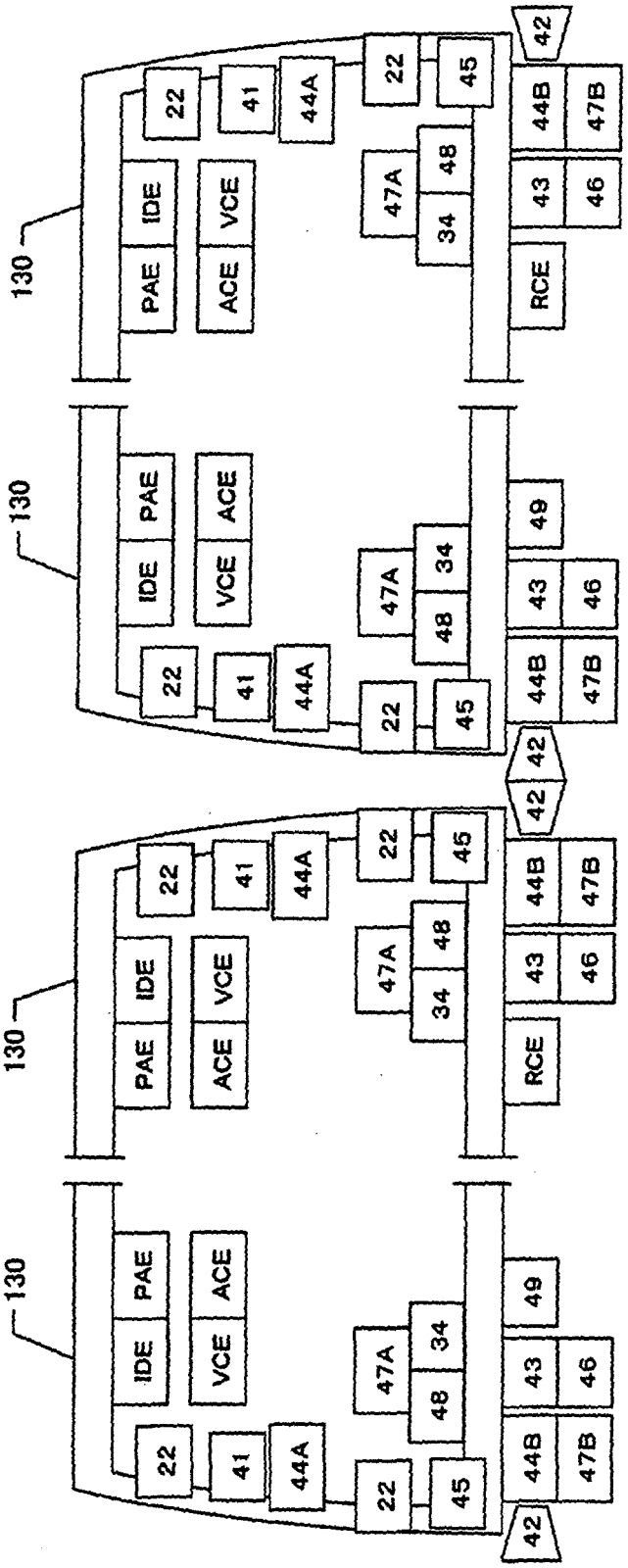

130
130
130
130
PAE
IDE
ACE
VCE
22
41
44A
45
47A
48
34
49
43
46
44B
47B
42
RCE

FIG. 28

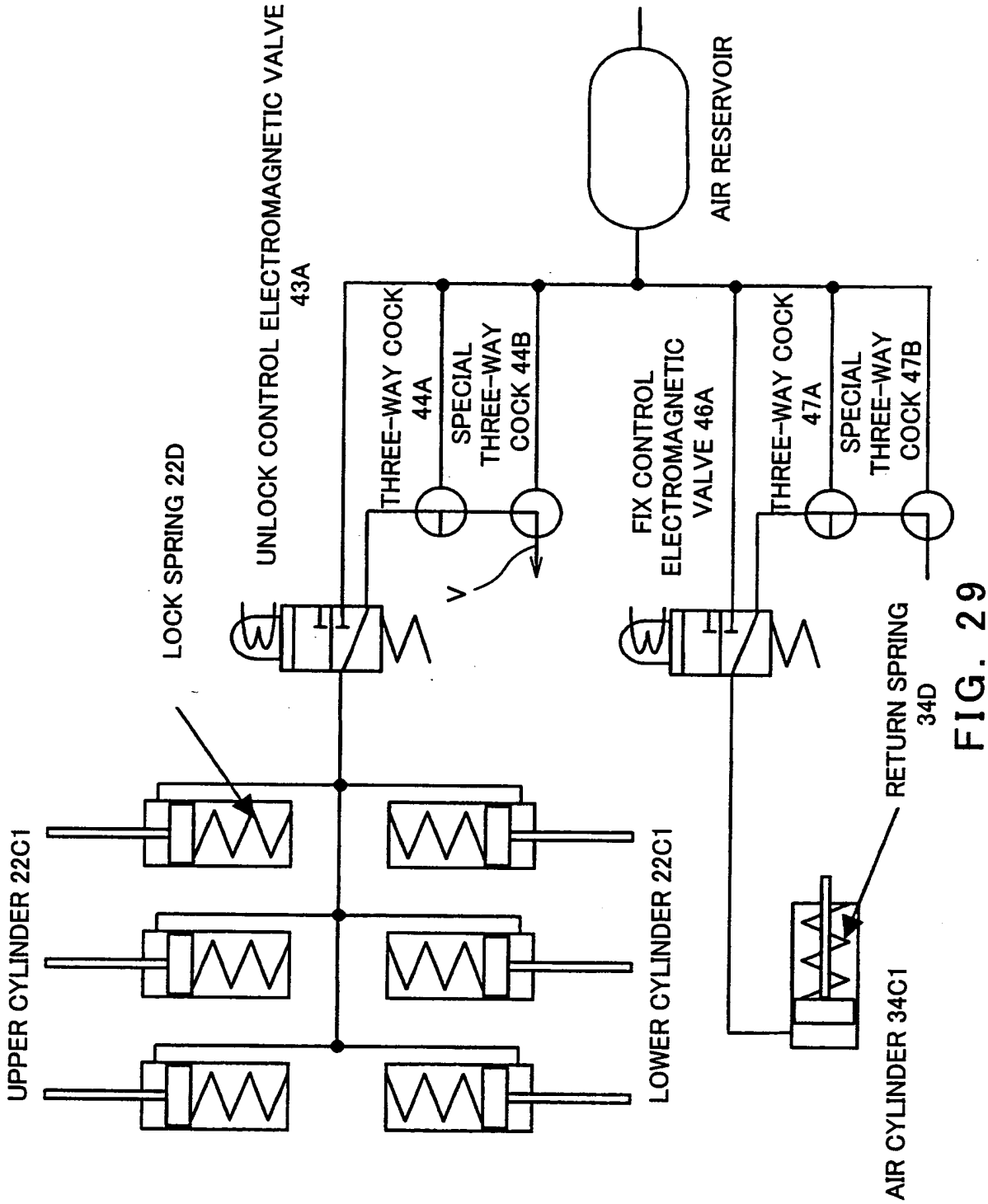

AIR RESERVOIR
UNLOCK CONTROL ELECTROMAGNETIC VALVE 43A
THREE-WAY COCK 44A
SPECIAL THREE-WAY COCK 44B
FIX CONTROL ELECTROMAGNETIC VALVE 46A
THREE-WAY COCK 47A
SPECIAL THREE-WAY COCK 47B
LOCK SPRING 22D
V
RETURN SPRING 34D
UPPER CYLINDER 22C1
LOWER CYLINDER 22C1
AIR CYLINDER 34C1

FIG. 29

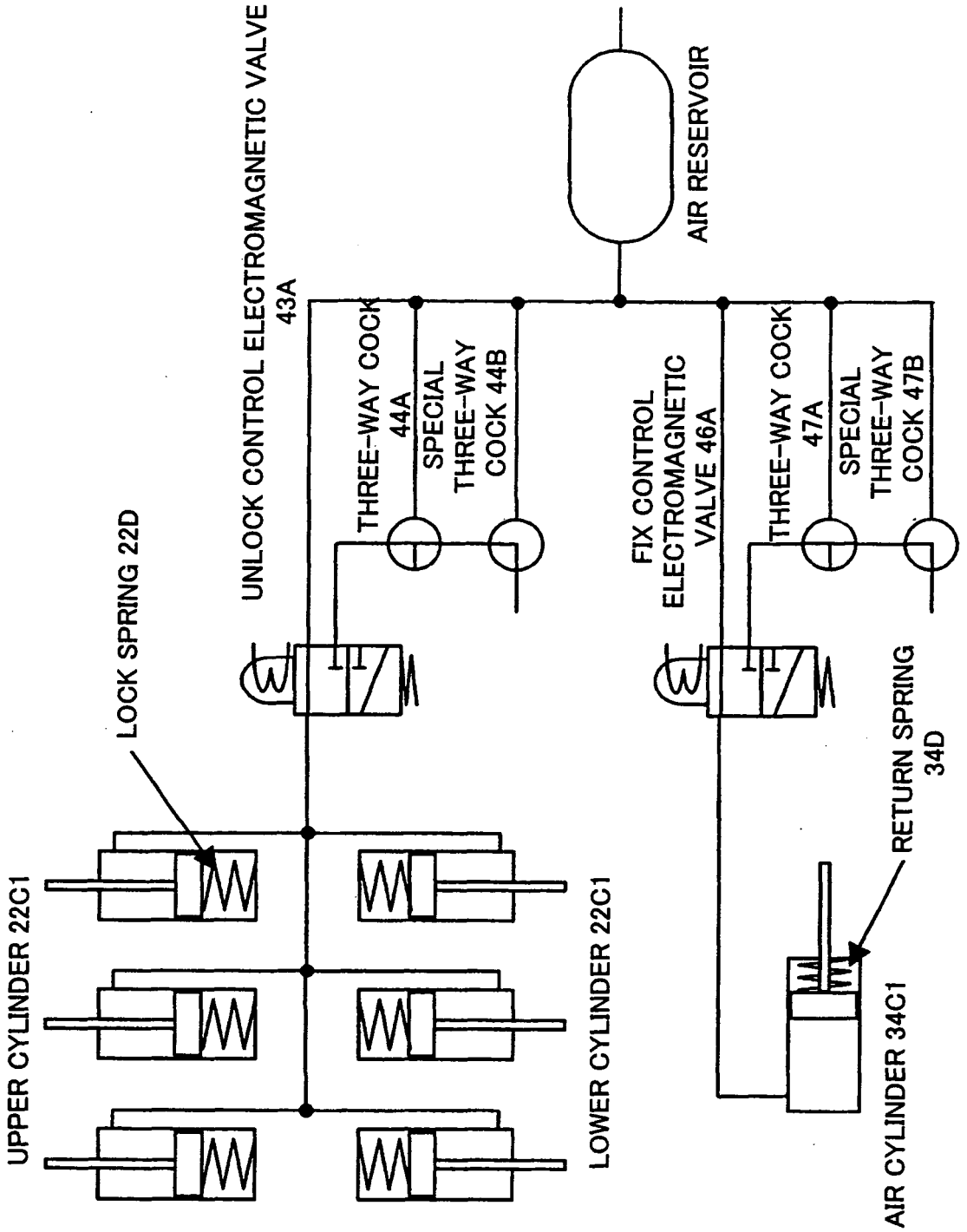

AIR RESERVOIR
UNLOCK CONTROL ELECTROMAGNETIC VALVE 43A
THREE-WAY COCK 44A
SPECIAL THREE-WAY COCK 44B
FIX CONTROL ELECTROMAGNETIC VALVE 46A
THREE-WAY COCK 47A
SPECIAL THREE-WAY COCK 47B
LOCK SPRING 22D
RETURN SPRING 34D
UPPER CYLINDER 22C1
LOWER CYLINDER 22C1
AIR CYLINDER 34C1

FIG. 30

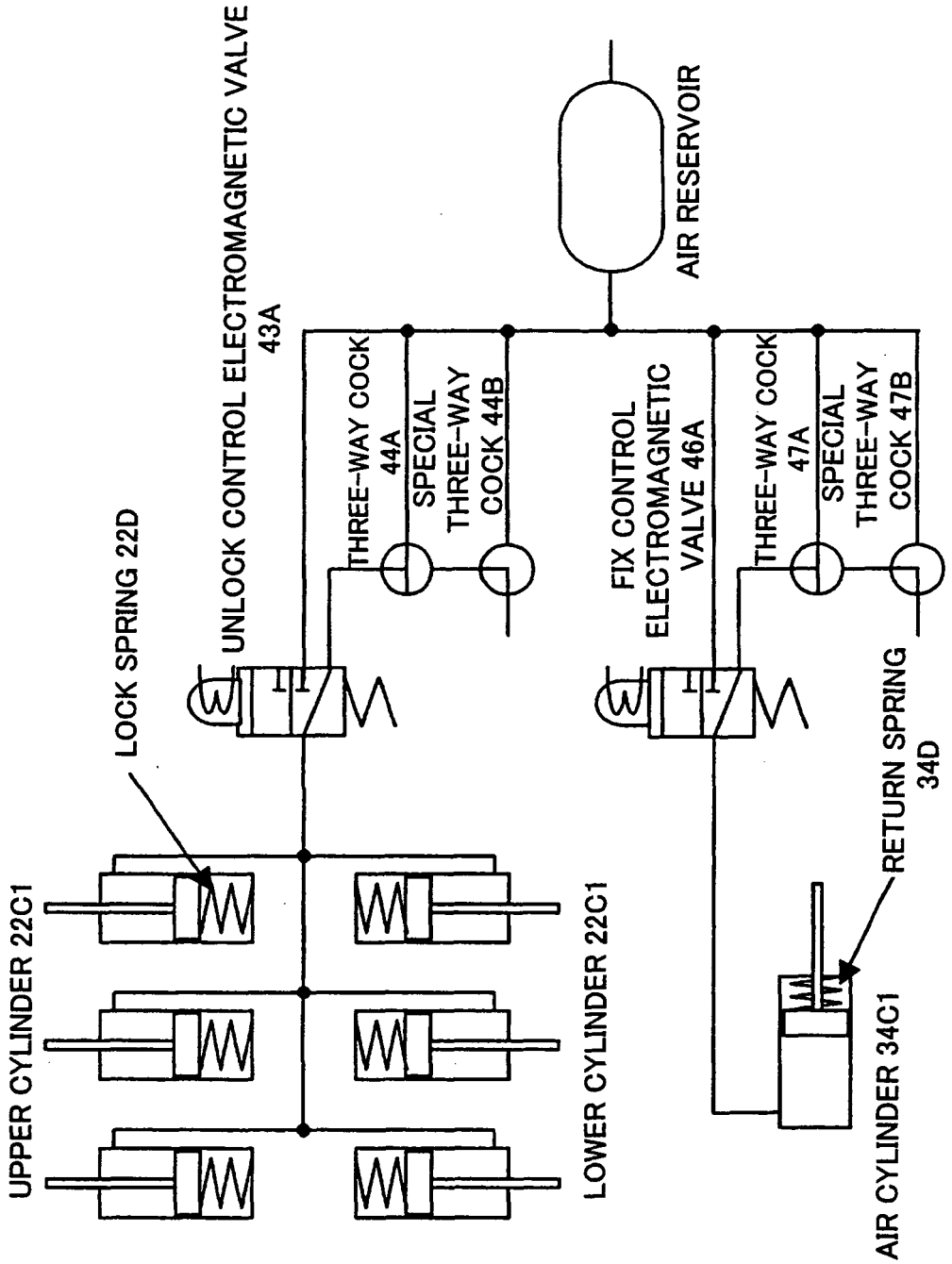

UNLOCK CONTROL ELECTROMAGNETIC VALVE 43A
AIR RESERVOIR
THREE-WAY COCK 44A
SPECIAL THREE-WAY COCK 44B
FIX CONTROL ELECTROMAGNETIC VALVE 46A
THREE-WAY COCK 47A
SPECIAL THREE-WAY COCK 47B
LOCK SPRING 22D
RETURN SPRING 34D
UPPER CYLINDER 22C1
LOWER CYLINDER 22C1
AIR CYLINDER 34C1

FIG. 31

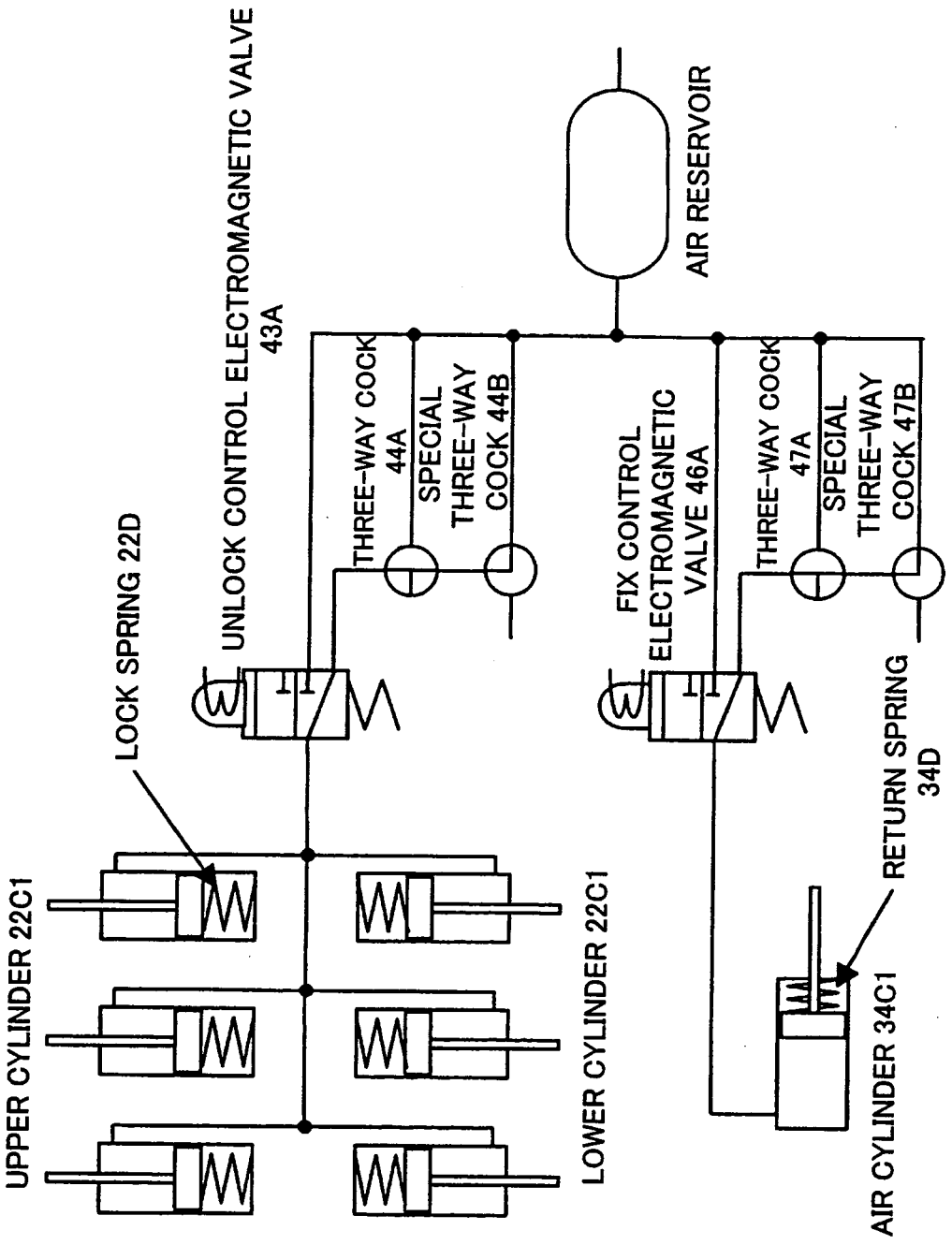

AIR RESERVOIR
UNLOCK CONTROL ELECTROMAGNETIC VALVE 43A
THREE-WAY COCK 44A
SPECIAL THREE-WAY COCK 44B
FIX CONTROL ELECTROMAGNETIC VALVE 46A
THREE-WAY COCK 47A
SPECIAL THREE-WAY COCK 47B
LOCK SPRING 22D
RETURN SPRING 34D
UPPER CYLINDER 22C1
LOWER CYLINDER 22C1
AIR CYLINDER 34C1

FIG. 32

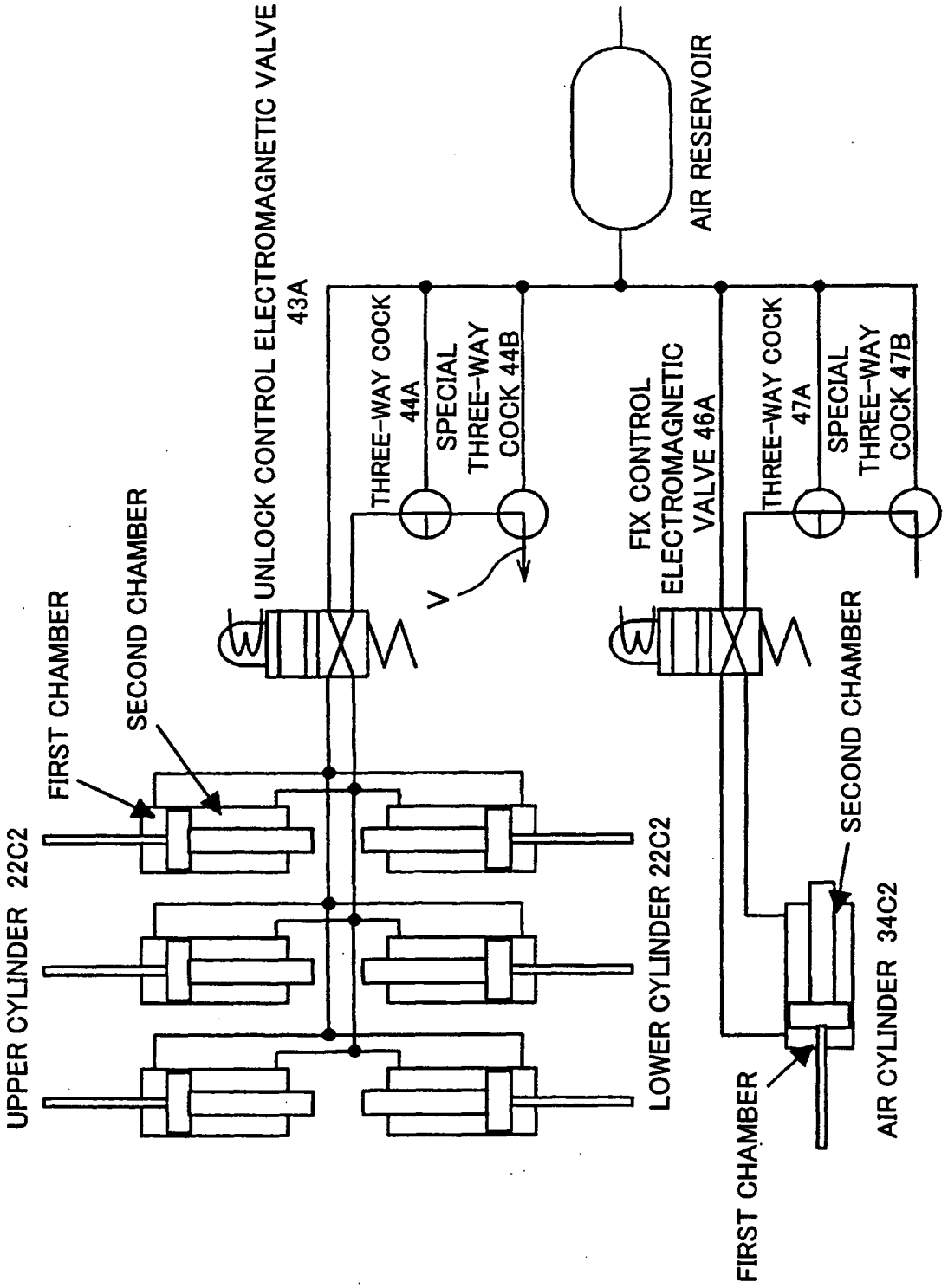

AIR RESERVOIR
UNLOCK CONTROL ELECTROMAGNETIC VALVE 43A
THREE-WAY COCK 44A
SPECIAL THREE-WAY COCK 44B
V
FIX CONTROL ELECTROMAGNETIC VALVE 46A
THREE-WAY COCK 47A
SPECIAL THREE-WAY COCK 47B
FIRST CHAMBER
SECOND CHAMBER
UPPER CYLINDER 22C2
LOWER CYLINDER 22C2
SECOND CHAMBER
FIRST CHAMBER
AIR CYLINDER 34C2

FIG. 33

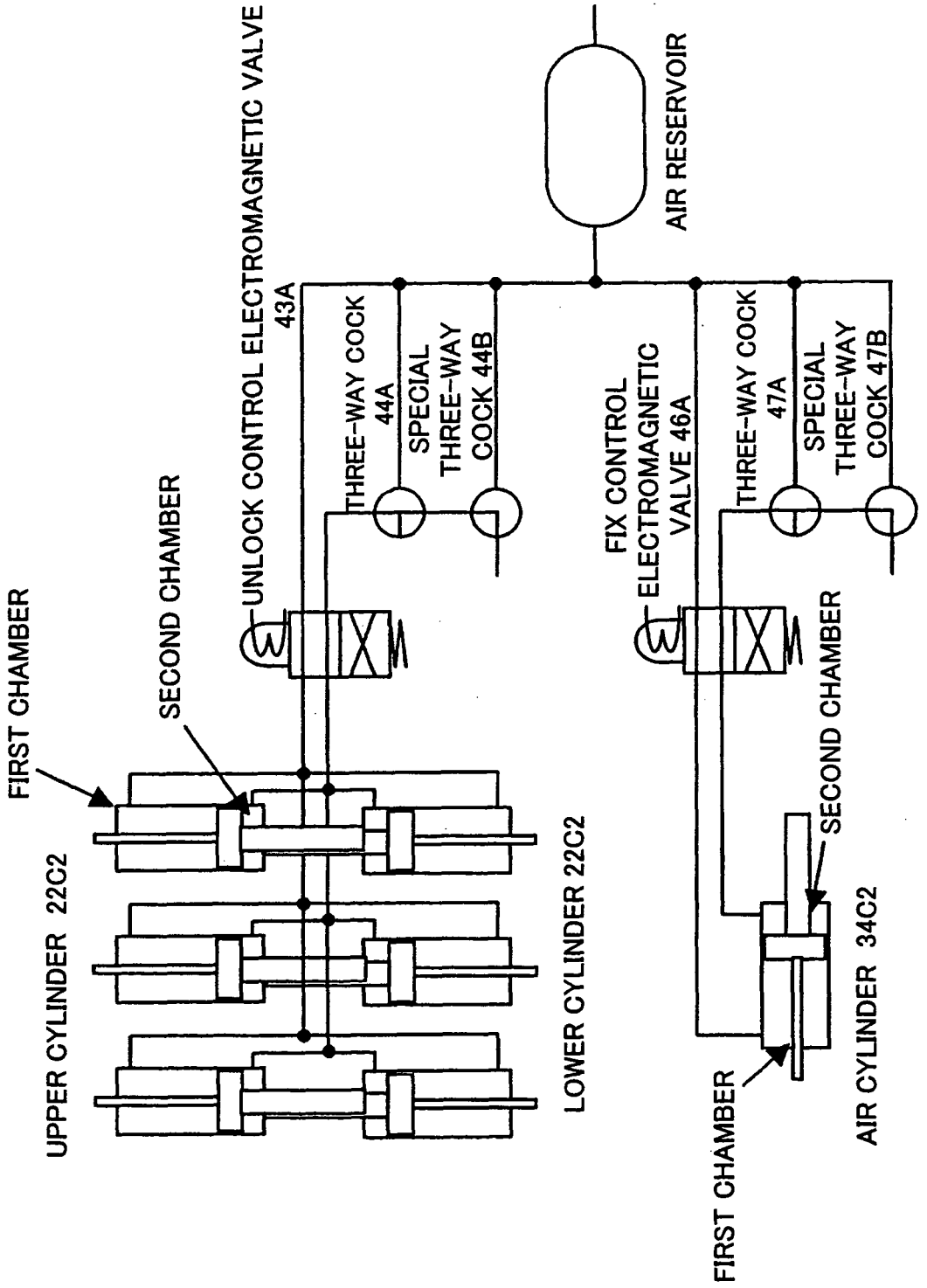

AIR RESERVOIR
UNLOCK CONTROL ELECTROMAGNETIC VALVE 43A
THREE-WAY COCK 44A
SPECIAL THREE-WAY COCK 44B
FIX CONTROL ELECTROMAGNETIC VALVE 46A
THREE-WAY COCK 47A
SPECIAL THREE-WAY COCK 47B
FIRST CHAMBER
SECOND CHAMBER
UPPER CYLINDER 22C2
LOWER CYLINDER 22C2
SECOND CHAMBER
FIRST CHAMBER
AIR CYLINDER 34C2

FIG. 34

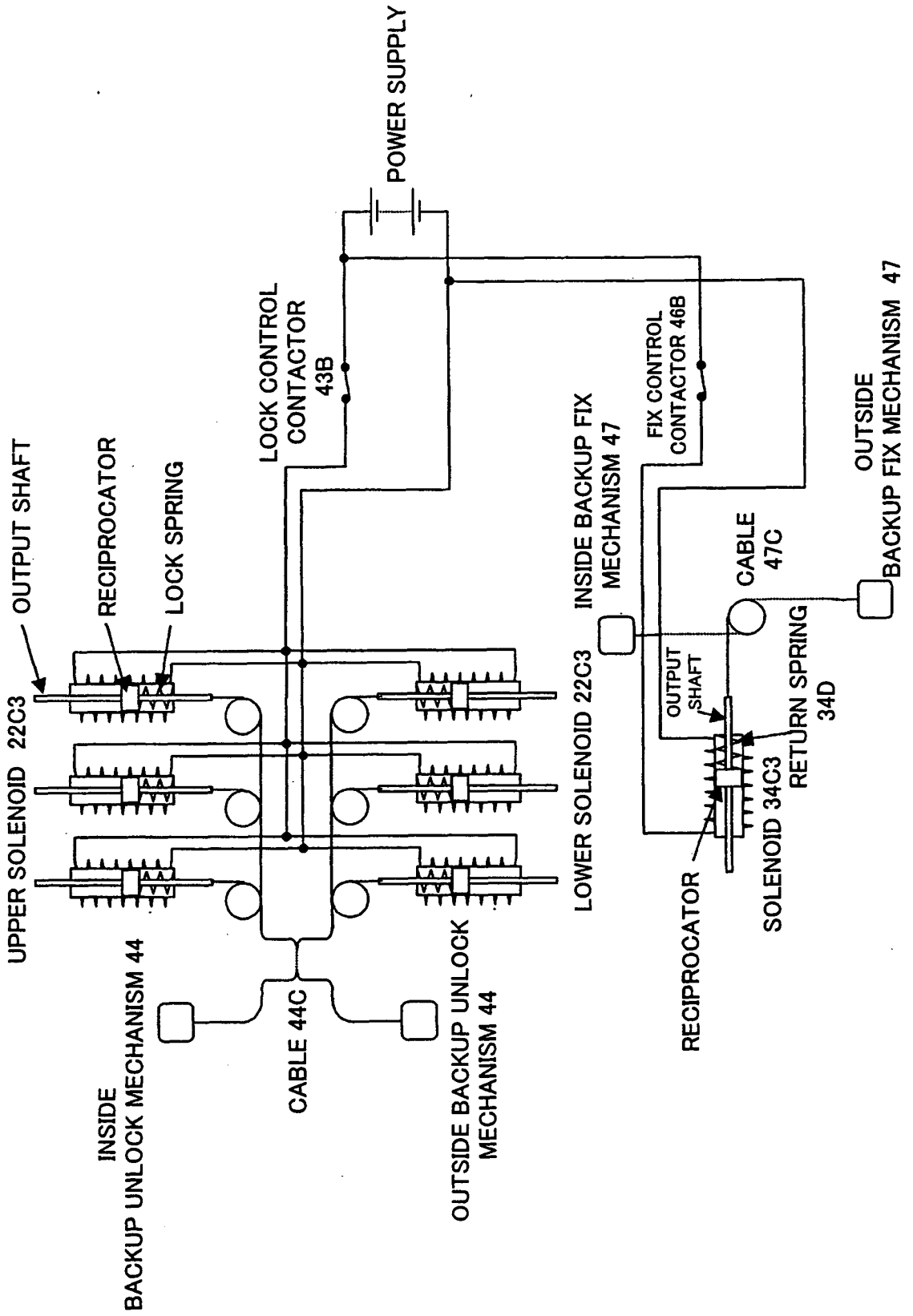

POWER SUPPLY
LOCK CONTROL CONTACTOR 43B
FIX CONTROL CONTACTOR 46B
OUTPUT SHAFT
RECIPROCATOR
LOCK SPRING
INSIDE BACKUP FIX MECHANISM 47
OUTSIDE BACKUP FIX MECHANISM 47
CABLE 47C
UPPER SOLENOID 22C3
LOWER SOLENOID 22C3
OUTPUT SHAFT
RETURN SPRING 34D
SOLENOID 34C3
RECIPROCATOR
INSIDE BACKUP UNLOCK MECHANISM 44
CABLE 44C
OUTSIDE BACKUP UNLOCK MECHANISM 44

FIG. 35

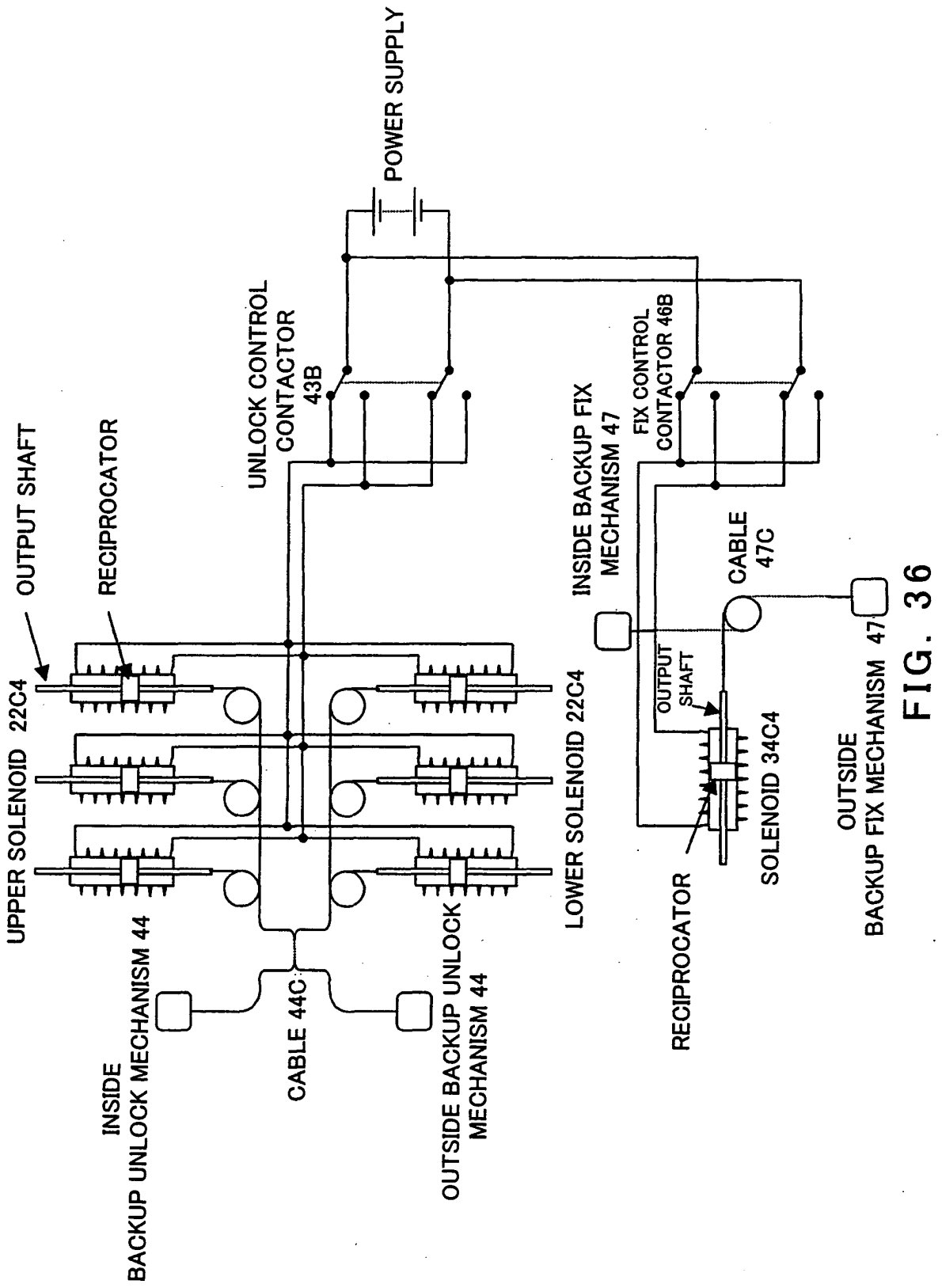

POWER SUPPLY
UNLOCK CONTROL CONTACTOR 43B
FIX CONTROL CONTACTOR 46B
INSIDE BACKUP FIX MECHANISM 47
OUTPUT SHAFT
RECIPROCATOR
UPPER SOLENOID 22C4
LOWER SOLENOID 22C4
CABLE 47C
SOLENOID 34C4
OUTSIDE BACKUP FIX MECHANISM 47
INSIDE BACKUP UNLOCK MECHANISM 44
CABLE 44C
OUTSIDE BACKUP UNLOCK MECHANISM 44

FIG. 36

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/006187

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B61D19/00, B61D17/20, B61D23/02

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[7] B61D19/00, B61D17/20, B61D23/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2004
Kokai Jitsuyo Shinan Koho 1971-2004 Jitsuyo Shinan Toroku Koho 1996-2004

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.
A	JP 7-25304 B2 (Kawasaki Heavy Industries, Ltd.), 22 March, 1995 (22.03.95), (Family: none)	1-5
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 39862/1991(Laid-open No. 132839/1992) (Kawaju Tetsudo Sharyo Engineering Kabushiki Kaisha), 09 December, 1992 (09.12.92), (Family: none)	1-5

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

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"A" document defining the general state of the art which is not considered to be of particular relevance
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"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
30 June, 2004 (30.06.04)	20 July, 2004 (20.07.04)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/006187

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 2002-339639 A (Mitsubishi Heavy Industries, Ltd.), 27 November, 2002 (27.11.02), (Family: none)	1-5
A	JP 59-209955 A (Hitachi, Ltd.), 28 November, 1984 (28.11.84), (Family: none)	1-5

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