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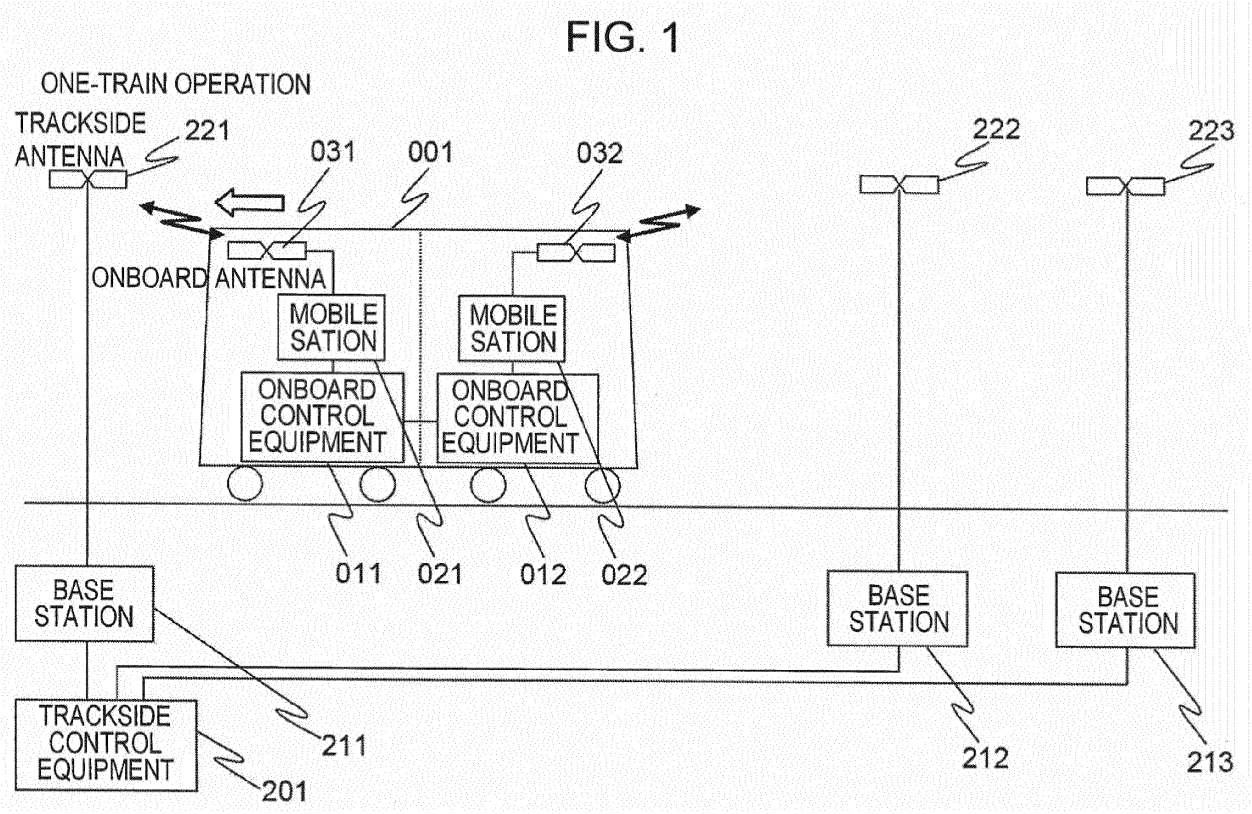
(54) Train control system

(57) Wireless communication is proveded between moving bodies in a signaling system of the moving body traveling on a predetermined track such as a railway. By providing communication between multiple onboard control equipments, one control equipment conducts wireless communication with a base station while the other conducts wireless communication with a further onbaord control equipment on another train to which the first train is coupled. Without installing a transmission cable between the coupled trains , the train control system is capable of reducing facility costs and improving of operability.

FIG. 1



EP 2 792 573 A2

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to wireless communication between moving bodies in a signaling system of the moving body traveling on a predetermined track such as a railway, a monorail or a new transportation system.

Description of the Related Art

[0002] Recently, in a moving block type signaling system using wireless communication in a railway and a monorail, a trackside wireless apparatus and an antenna are arranged along a track, an onboard antenna and an onboard wireless apparatus for conducting communication with the trackside wireless apparatus are arranged on a train, an onboard equipment transmits positional information of the own train via the wireless communication to a trackside equipment, the trackside equipment manages the position of each train on the basis of the received train positional information and transmits control data including limit of movement authority or speed information to each train via the wireless communication, and the onboard equipment executes speed control of the train on the basis of a speed limit profile.

[0003] Usually, the onboard wireless apparatus and the antenna are arranged on a head and a tail of a train in order to realize redundancy so that communication is conducted by the other if one of the wireless apparatuses cannot conduct communication due to a failure or an influence of disturbance.

[0004] On the other hand, if two trains are coupled, for the onboard antennas of the both located at a coupled portion between a coupled train and a de-coupled train, a car body of the train located on the front of each becomes an obstacle and interferes with wireless communication with the trackside equipment, and thus, the wireless antenna may in some cases be installed in a form of protruding on an upper part of the train so that the train on the front does not cause interference.

[0005] Regarding train control at coupling, Japanese Patent Laid-Open Publication No. 2006-240490, for example, proposes a method of stopping communication with the coupled train and of communicating only with the de-coupled train. However, in such method, the trackside equipment needs to delete a train ID of the coupled train, to restore the train ID of the coupled train after split of the coupled trains, and/or to modify a series of train operation management. Moreover, communication only with the de-coupled train does not ensure redundancy, and an onboard control equipment, a mobile station, and the onboard antenna of the de-coupled train cannot continue train control if wireless communication is disabled due to a failure of the device or disturbance.

[0006] In the case of train control at coupling, when speed control is to be executed by the onboard control equipment on each of the coupled train and the de-coupled train, an error in position detection of each train or a difference in speed limit profile involved in a difference in braking performances causes a problem of a shift in brake timing or the like.

[0007] Thus, communication such as transmission/reception of control data should be conducted between the onboard control equipments of the coupled train and the de-coupled train so as to execute common control, but at that time, it is necessary to conduct transmission/reception of the control data between the onboard control equipments. In transmission/reception of the control data, it is a common practice to provide a transmission cable in a coupler portion of the train for connection between the coupled train and the de-coupled train.

[0008] However, in connection using the transmission cable, the transmission cable needs to be installed in the coupler portion, which makes a mechanism complicated. Moreover, manual connection and checking of the cable is required at train coupling, which results in a problem of time required for train coupling and the like.

[0009] An object of the present invention is to provide a train control system which can reduce facility costs and improve operability by omitting or reducing time required for a work of connecting the transmission cable between the coupled train and the de-coupled train at coupling.

SUMMARY OF THE INVENTION

[0010] In order to solve the above described problems, a train control system according to the present invention is configured such that one of train antennas and onboard wireless apparatuses on a head and a tail of a train used for communication with a trackside equipment during normal traveling of a single train is used for communication between the onboard control equipments of a coupled train and a de-coupled train when two trains are coupled.

[0011] According to the train control system according to the present invention, a train control system which can reduce facility costs by realizing data communication between the onboard control equipments of the coupled train and the de-coupled train at coupling without increasing facilities such as a transmission cable at a coupler portion and is excellent in operability by reducing time required for manual connection and checking works of the cable can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a configuration diagram of a train control system;

FIG. 2 is a diagram illustrating a communication state when trains are coupled;

FIG. 3 is an example of an operation mode of an

onboard control equipment;

FIG. 4 is a diagram illustrating a communication sequence between a base station and a mobile station; and

FIG. 5 is a diagram illustrating a communication sequence between the mobile stations at coupling.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] An embodiment of a train control system according to the present invention will be described below by referring to the attached drawings.

[Embodiment 1]

[0014] FIG. 1 is a configuration diagram of the train control system which is the present invention.

[0015] A trackside control equipment 201 is a device which manages positional information received via trackside antennas 221 to 223 and base stations 211 to 213 from a plurality of trains within a control range including a train 001 and edits control data to each train on the basis of the positional information and states of a signal, a switch and the like. The trackside control equipment 201 transmits the edited control data to the base stations 211 to 213 arranged along the track, and the base stations 211 to 213 transmit the control data to each train 001 via the trackside antennas 221 to 223. The control data is transmitted to the onboard control equipments 011 and 012 via onboard antennas 031 and 032 and mobile stations 021 and 022 arranged onboard.

[0016] On the other hand, the onboard control equipments 011 and 012 are devices for calculating a traveling position of their own train and executing speed/stop control of the train on the basis of the traveling position and control data received from the trackside control equipment 201. The onboard control equipments 011 and 012 edit the traveling position of their own train 001 as positional information and transmit the edited positional information to the mobile stations 021 and 022. The mobile stations 021 and 022 transmit the positional information to the trackside equipment via the onboard antennas 031 and 032. The positional information is transmitted to the trackside control equipment 201 via the trackside antennas 221 to 223 and base stations 211 to 213 arranged along the track.

[0017] The onboard control equipments 011 and 012, the mobile stations 021 and 022, and the onboard antennas 031 and 032 employ dual system redundant configuration in order to continue control even if wireless communication is disabled due to a failure of the device or disturbance. The onboard antennas 031 and 032 and the mobile stations 021 and 022 are arranged at a head and a tail of the train, and during a single-train operation, the onboard antenna 031 and the mobile station 021 at the head and the onboard antenna 032 and the mobile station 022 at the tail conduct wireless communication with the trackside equipment.

[0018] FIG. 2 is a diagram illustrating a communication state when two trains are coupled. When two trains 001 and 101 are coupled, the onboard control equipments 111 and 012 detect coupling between the tail side of the train 001 and the head side of the train 101 by obtaining mode information. The head mobile station 121 of the coupled train 101 and the tail mobile station 022 of the de-coupled train 001 switch a wireless communication channel (frequency) to a wireless communication channel (frequency) for inter-train communication which is a value different from that of the wireless communication channel for communication with the trackside equipment upon receipt of the mode information indicating coupling from the onboard control equipments 111 and 012. As a result, wireless communication between the onboard control equipment 111 of the coupled train 101 and the onboard control equipment 012 of the de-coupled train 001 is enabled.

[0019] Moreover, the tail mobile station 122 of the coupled train 101 and the head mobile station 021 of the de-coupled train 001 continue wireless communication with the trackside equipment.

[0020] The mode information is assumed to be generated when it is included in the control data from the trackside equipment, when it is provided by a switch operation on a motorman's platform or when a coupled state is automatically detected by the onboard control equipment.

[0021] The onboard control equipments 111, 112, 011, and 012 of the coupled train 101 and the de-coupled train 001 execute driving control such as braking, acceleration and the like as the coupled train 101 and the de-coupled train 001 as a single train by exchanging train identification information (train length, train ID, brake characteristics and the like) required for train control via wireless communication between the onboard control equipments 111 and 012 via the head mobile station 121 of the coupled train 101 and the tail mobile station 022 of the de-coupled train. Moreover, each of the onboard control equipments 111, 112, 011, and 012 of the coupled train 101 and the de-coupled train 001 exchange control data received by the tail mobile station 122 of the coupled train 101 and the head mobile station 021 of the de-coupled train 001 from the trackside control equipment via wired communication between each onboard control equipment in the trains and further exchange the information via the wireless communication between the onboard control equipment 111 of the coupled train 101 and the onboard control equipment 012 of the de-coupled train 001 so that each of the onboard control equipments 111, 112, 011, and 012 can execute train control on the basis of common control data.

[0022] In the case of coupling as described above, the wireless communication by the head mobile station 021 of the de-coupled train 001 and the tail mobile station 122 of the coupled train 101 with the trackside equipment does not impair redundancy of the wireless communica-

tion. Moreover, since the head mobile station 121 of the coupled train 101 and the tail mobile station 022 of the de-coupled train 001 faced with a coupled portion between the coupled train 101 and the de-coupled train 001 do not conduct wireless communication with the trackside equipment, even if a train is present on the front of the onboard antennas 131 and 032, wireless communication is not interfered, and it is not necessary to arrange the onboard antennas 131 and 032 on upper parts of the trains.

[0023] FIG. 3 illustrates an example of an operation mode of each of onboard equipments when this train control system is applied.

[0024] If two trains are coupled, the head onboard control equipment 111 of the coupled train 101 and the tail onboard control equipment 012 of the de-coupled train 001 transit to a coupling mode and control wireless communication between the onboard control equipments 111 and 012. Moreover, it is assumed that the head onboard control equipment 011 of the de-coupled train 001 on the front in a traveling direction is an active controller, and the tail onboard control equipment 112 of the coupled train 101 is a standby controller.

[0025] Car identification information held by the head onboard control equipment 011 of the de-coupled train 001 and control equipment management information including control modes (active controller mode, standby controller mode or coupling mode) held by the tail onboard control equipment 112 of the coupled train 101 and failure information are exchanged via communication between each of the onboard control equipments 011 and 012 in a car of the de-coupled train 001, communication between each of the onboard control equipments 111 and 112 in a car of the coupled train 101, and wireless communication between the onboard control equipment 111 of the coupled train 101 and the onboard control equipment 012 of the de-coupled train 001 so as to ensure redundant configuration of the onboard control equipment. Usually, train control is executed by the head onboard control equipment 011 of the de-coupled train 001 which is an active controller, and if failure information indicating occurrence of a failure in the head onboard control equipment 011 of the de-coupled train 001 is received by the tail onboard control equipment 112, the tail onboard control equipment 112 of the coupled train 101 is switched to the active controller, and train control is continued.

[0026] FIG. 4 illustrates an example of a wireless communication sequence between the base station and the mobile station. Moreover, FIG. 5 illustrates an example of the wireless communication sequence between the mobile stations. In the wireless communication sequence between the base station and the mobile station illustrated in FIG. 4, the mobile station returns an answer to periodical polling from the base station.

[0027] In exemplification of this wireless communication sequence, in the mobile station in each of the trains conducting wireless communication between the onboard control equipments at coupling illustrated in FIG. 5, one of the mobile stations enters a base station mode and periodically polls the other mobile station, which returns an answer.

[0028] As a result, only by switching a wireless communication channel (frequency) from a communication channel for communication with the base station to that for communication between the mobile stations, the one mobile station performs processing in a communication sequence similar to that of the base station, and the other mobile station does not change the communication sequence, whereby wireless communication processing can be made common.

[0029] In this embodiment, the example in which two trains each provided with the onboard antennas at the head and the tail are coupled to each other is illustrated, but the present invention is not limited to the train on which the onboard antennas are arranged at the head and the tail of the train but can be applied to any train on which two or more onboard antennas and mobile stations are mounted. That is, when two trains are coupled, one of the two or more onboard antennas in the train conducts communication with the base station, the other conducts communication with the mobile station on another coupled train so that the effect of the present invention that it is no longer necessary to perform a work of connecting the cars with a wired transmission cable at coupling of cars can be achieved.

[0030] Moreover, the object of the present invention is not necessarily complete elimination of the cable connecting work at coupling but includes reduction of the cable connecting work at coupling by wirelessly communicating at least a part of information between the cars if a plurality of cables need to be connected between the trains or the like.

Claims

1. A train control system comprising:

a plurality of mobile stations mounted on a train and capable of communication with a base station; and

a plurality of onboard control equipments receiving control data from the base station via the mobile stations and controlling traveling of the train, wherein

when a train is not coupled, the plurality of mobile stations conduct communication with the base station;

when two trains are coupled, one of the plurality of mobile stations is switched to conduct wireless communication with one of the plurality of mobile stations mounted on the other coupled train; and

the other of the plurality of mobile stations conducts communication with the base station.

2. The train control system according to claim 1, wherein
when two trains are coupled, communication of train identification information including at least any one of a train ID, a train length, and brake characteristics is conducted between the onboard control equipments of each of coupled trains via wireless communication between the mobile stations.

3. The train control system according to claim 1 or 2, wherein
when two trains are coupled, the onboard control equipment mounted on one of the trains and conducting communication with the base station operates as an active controller, while the onboard control equipment mounted on the other train and conducting communication with the base station operates as a standby controller;
communication of control equipment management information including failure information of the onboard control equipments is conducted via wireless communication between the mobile stations; and
when the onboard control equipment which is a standby controller receives failure information of the onboard control equipment which is an active controller via wireless communication between the mobile stations, the onboard control equipment which is a standby controller is switched to an active controller.

FIG. 1

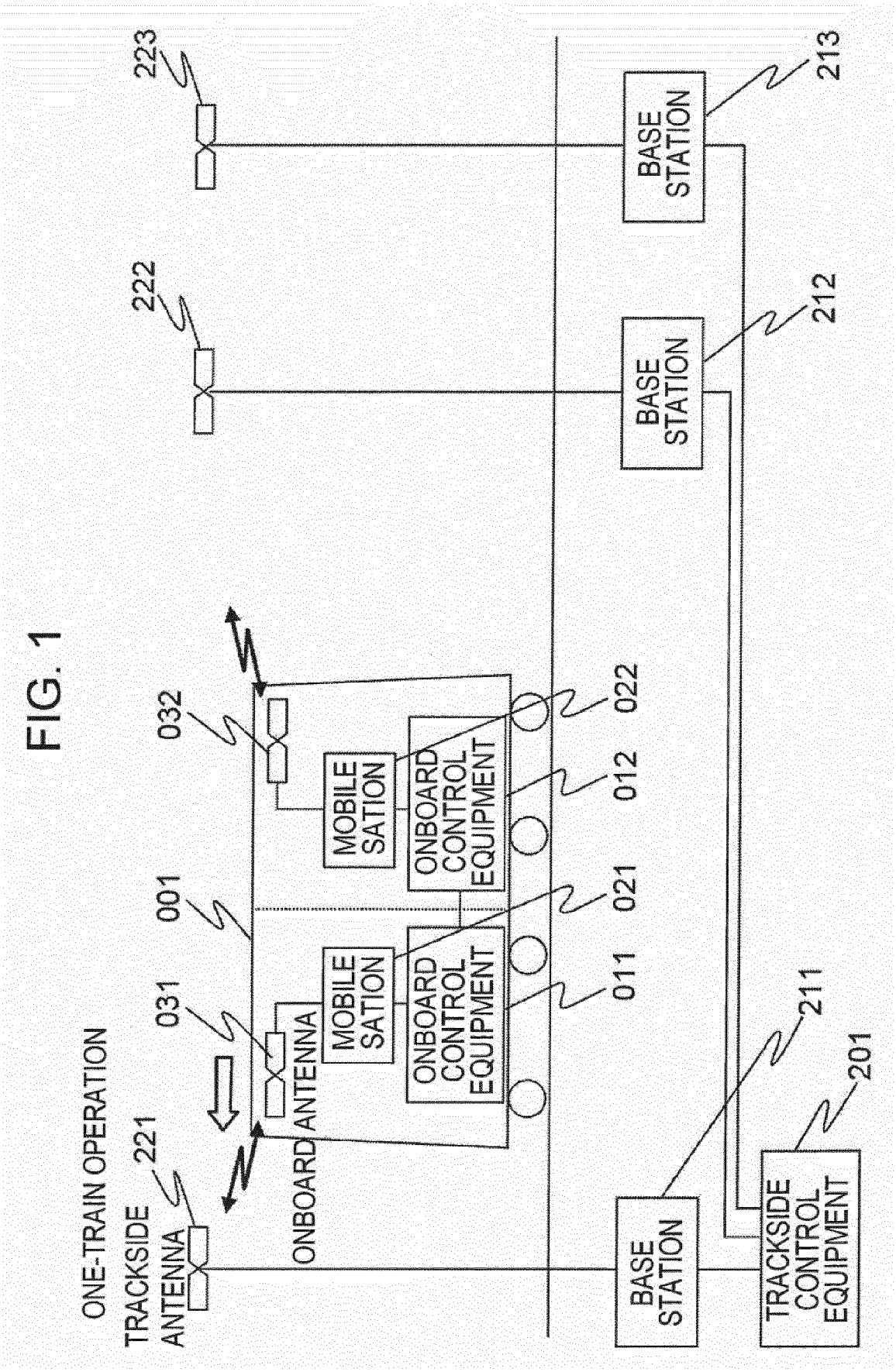

ONE-TRAIN OPERATION
TRACKSIDE ANTENNA
221
ONBOARD ANTENNA
031
001
032
MOBILE SATION
ONBOARD CONTROL EQUIPMENT
011
021
012
022
223
222
BASE STATION
213
212
211
201
TRACKSIDE CONTROL EQUIPMENT

FIG. 2

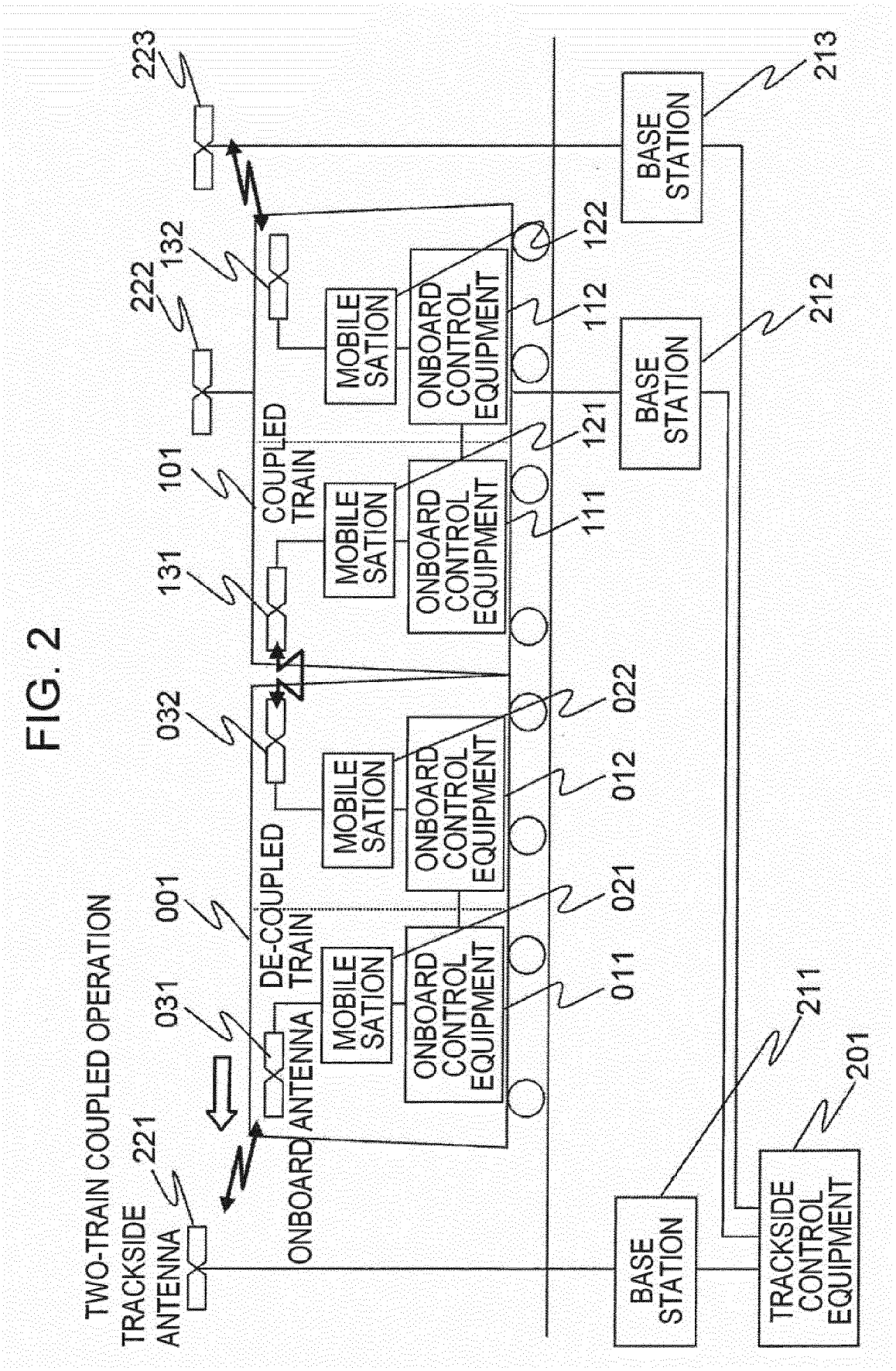

TWO-TRAIN COUPLED OPERATION
TRACKSIDE ANTENNA
221
ONBOARD ANTENNA
031
001
DE-COUPLED TRAIN
032
131
101
COUPLED TRAIN
222
132
223
MOBILE SATION
ONBOARD CONTROL EQUIPMENT
011
021
012
022
111
121
112
122
BASE STATION
211
201
TRACKSIDE CONTROL EQUIPMENT
212
213

FIG. 3

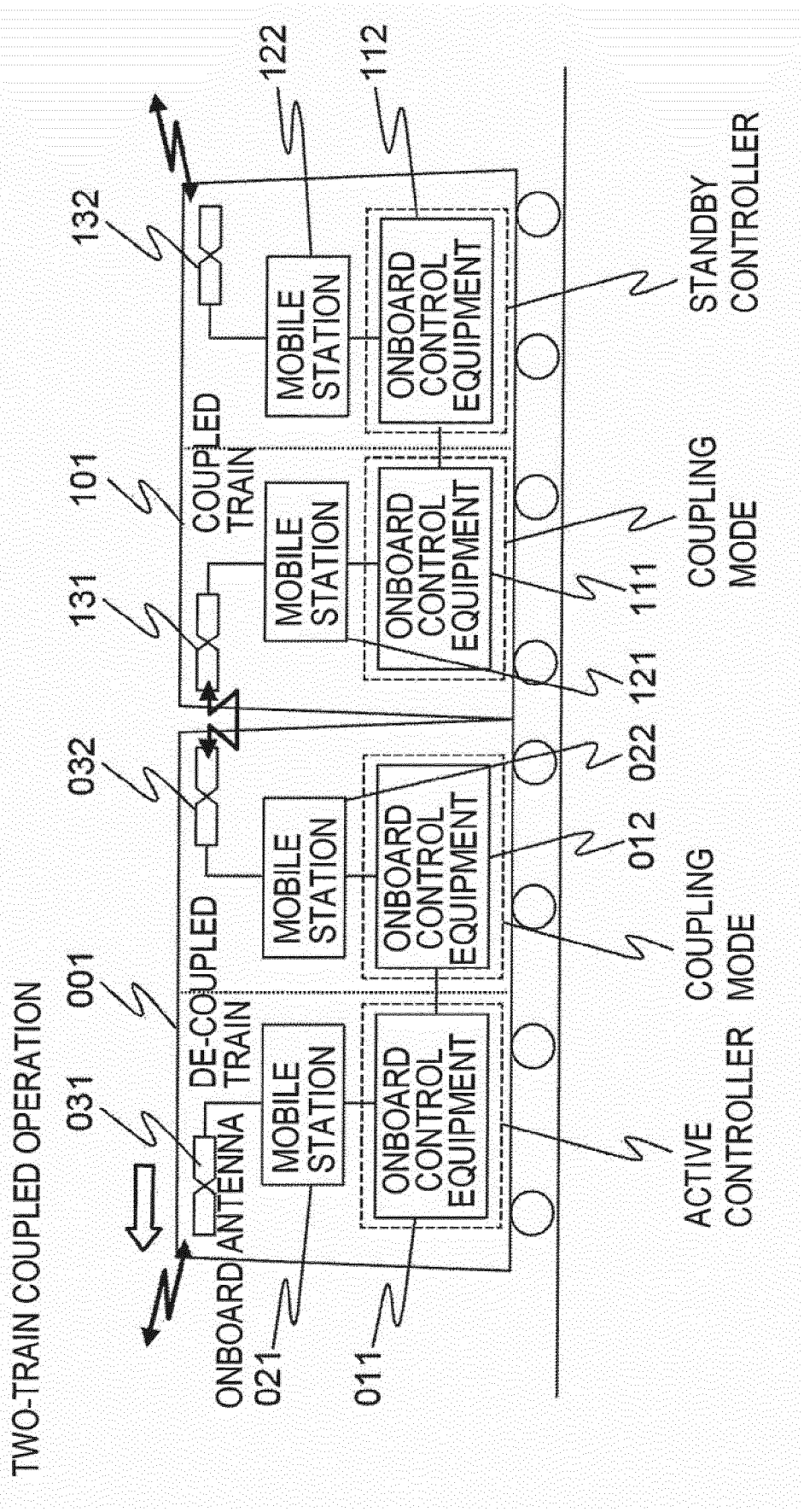

TWO-TRAIN COUPLED OPERATION
001
DE-COUPLED TRAIN
COUPLED TRAIN
101
ONBOARD ANTENNA
031
032
131
132
MOBILE STATION
ONBOARD CONTROL EQUIPMENT
021
011
012
022
111
121
112
122
ACTIVE CONTROLLER
COUPLING MODE
STANDBY CONTROLLER
COUPLING MODE

FIG. 4

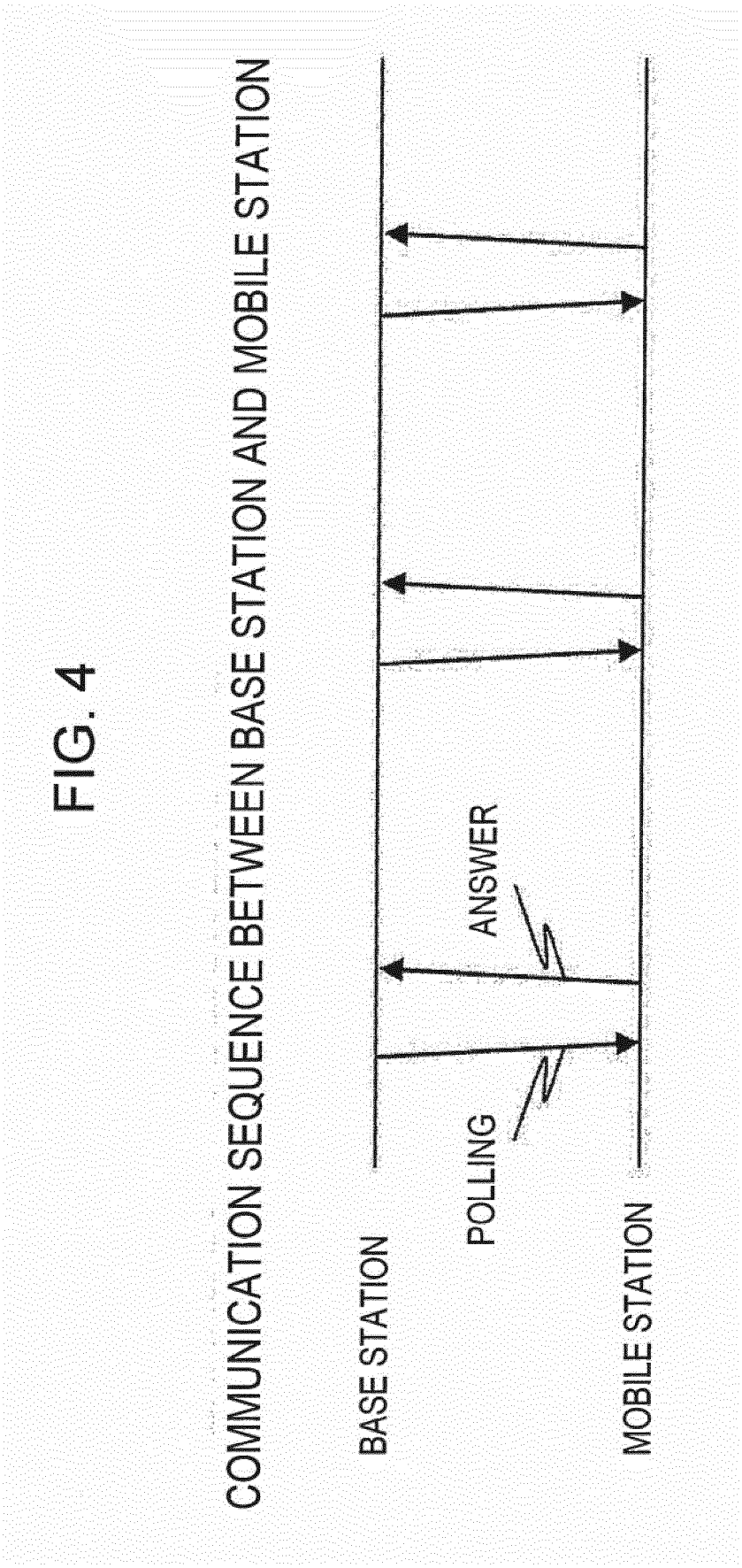
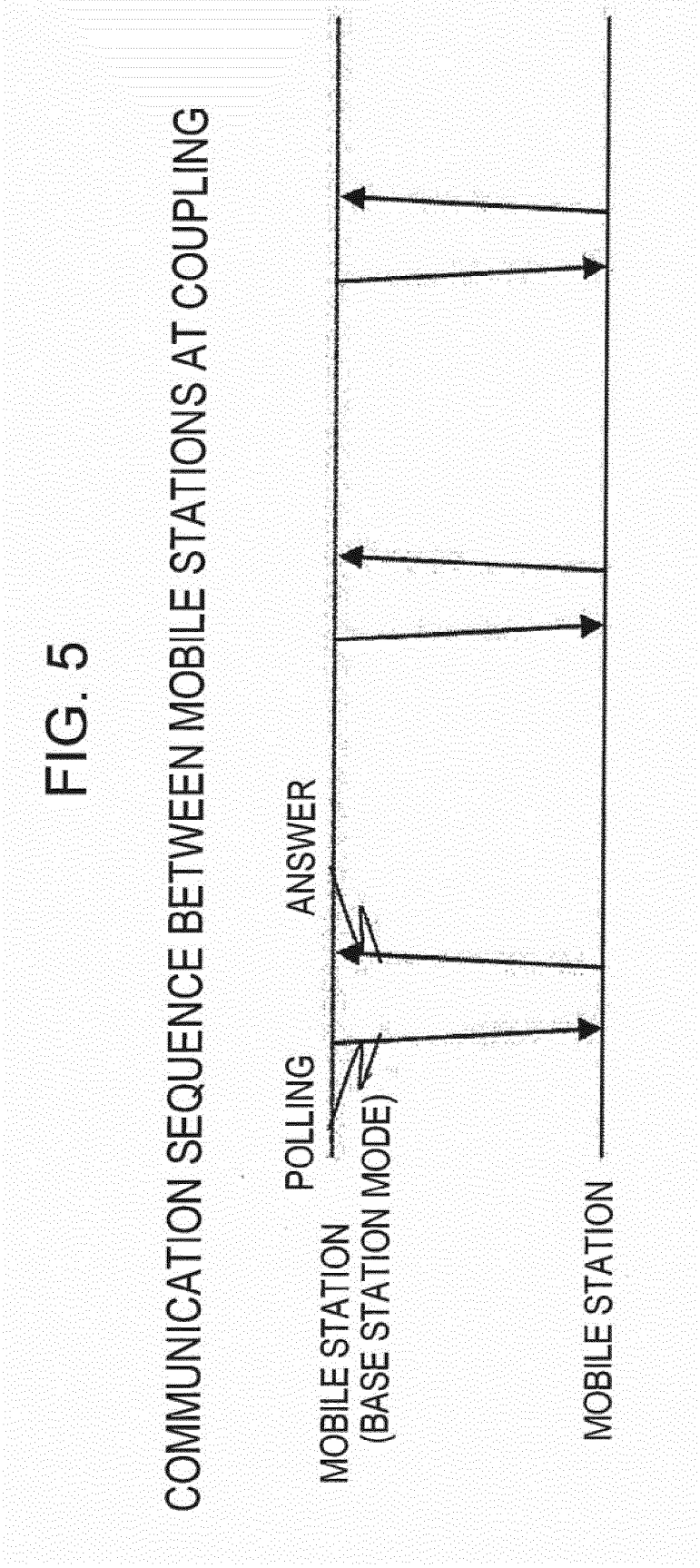

COMMUNICATION SEQUENCE BETWEEN BASE STATION AND MOBILE STATION
BASE STATION
POLLING
ANSWER
MOBILE STATION

FIG. 5

COMMUNICATION SEQUENCE BETWEEN MOBILE STATIONS AT COUPLING



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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