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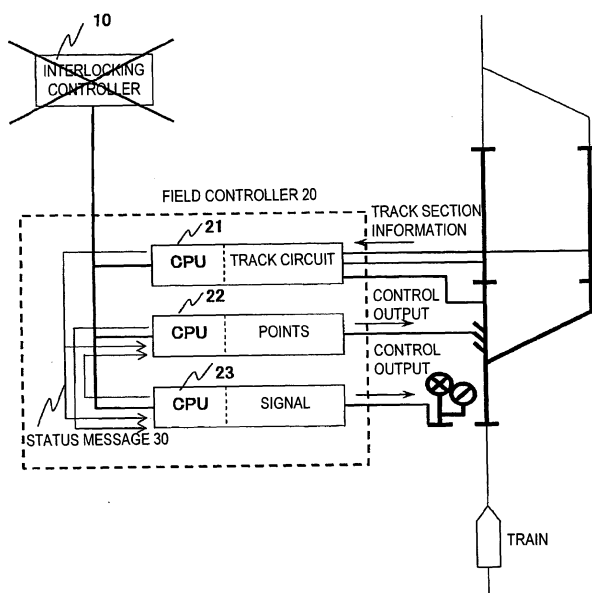
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(54) **Signalling system**

(57) Wayside equipment cannot acquire control information when an interlocking controller is terminated. Therefore, signals inside the premises show stop indications, and operations of trains stop. Field controllers of a signalling system realizes route control, the field controllers having a transmission path for transmitting and receiving state information between the field controllers constituting a route, having wayside equipment control logic for realizing the route control of a train based on the received state information, having first wayside equip-

ment control logic used when communication from the interlocking controller to the field controllers continues, having second wayside equipment control logic for continuing the route control when the communication from the interlocking controller to the field controllers is interrupted, and switching the control logic from the first wayside equipment control logic to the second wayside equipment control logic to continue the route control if the interrupt of communication with the interlocking controller is detected.

FIG. 1



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a signalling system for railway, and particularly, to a signalling system configured to connect an interlocking device for railway and a wayside signalling device through a network.

Description of the Related Art

[0002] In order to reduce a large number of power cables installed for each control output from a station apparatus room, in which an interlocking controller exists, to wayside equipment, such as a track circuit, a signal, and points, in an electronic interlocking device, field controllers including arithmetic processing units are connected to the wayside equipment to progress communication networking of connection between the interlocking controller and the field controllers. In Japanese Patent No. 2705818 (Patent Document 1), wiring is reduced by networking. There is also an example as in Japanese Patent Laid-Open Publication No. 2007-91178 (Patent Document 2) for autonomous distributed control of the wayside equipment to improve the operating rate of the interlocking device.

SUMMARY OF THE INVENTION

[0003] Although the distributed control of the wayside equipment is proposed, the distributed control is difficult due to problems caused by difficulty in maintaining communication lines and complexity of autonomous distributed control logic. Therefore, an interlocking device is still mainly used, in which an interlocking controller centrally processes state information from the wayside equipment. Although the communications between the interlocking controller and the field controllers are networked, a format, in which the interlocking controller processes the route control at the center, is mainly used.

[0004] In the central processing-type interlocking device, even if there are field controllers including arithmetic processing units that control the wayside equipment, the field controllers only execute a process of interpreting a control message transmitted through the network to perform control output, and the interlocking controller executes all central processing of determining the occupation of track section of a track circuit, instructing switching of points, changing a signal indication, and the like.

[0005] Therefore, the field controllers cannot receive the control message if the interlocking controller stops, and correct control output becomes unclear. As a result, all signals inside the premises show stop indications for safety control, and the operations of the trains stop. Much time is required to restore the normal schedule due to the time before recovery and the disordered schedule

after the recovery, and the stop of the train operations is an incident that the railway company wants to avoid. Therefore, it is desirable not to completely stop the operations of the trains even if the interlocking controller at the center stops.

[0006] An object of the present invention is to provide a signalling system that realizes operations in a degenerate mode for continuing route control only by field controllers, even if communication from an interlocking controller to the field controllers is interrupted.

[0007] A signalling system of the present invention realizes route control by field controllers, the field controllers having a transmission path for transmitting and receiving state information between the field controllers constituting a route, having wayside equipment control logic for realizing the route control of a train based on the received state information, having first wayside equipment control logic used when communication from an interlocking controller to the field controllers continues, having second wayside equipment control logic for continuing the route control when the communication from the interlocking controller to the field controllers is interrupted, and switching the control logic from the first wayside equipment control logic to the second wayside equipment control logic to continue the route control if the interrupt of communication with the interlocking controller is detected.

[0008] According to the present invention, a signalling system that realizes operations in a degenerate mode for continuing route control only by field controllers is realized even if communication from an interlocking controller to the field controllers is interrupted after termination of the interlocking controller. Therefore, the operation stop time and the schedule recovery time can be reduced, and the operating rate of the signalling system can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a diagram showing a configuration of a first embodiment of a signalling system according to the present invention;

FIG. 2 is a diagram showing a configuration during normal operation of a network-type electronic interlocking device;

FIG. 3 is a diagram showing a block configuration of logic in a field controller according to the present invention;

FIGS. 4A and 4B are diagrams showing interlocking tables of the first embodiment of the signalling system according to the present invention;

FIG. 5 is a diagram showing a flow chart of a switch process from a normal control mode to a degenerate mode of a track circuit controller of the first embodiment according to the present invention;

FIG. 6 is a diagram showing a flow chart of a switch

process from the normal control mode to the degenerate mode of a point controller of the first embodiment according to the present invention;
 FIG. 7 is a diagram showing a flow chart of a switch process from the normal control mode to the degenerate mode of a signal controller of the first embodiment according to the present invention;
 FIG. 8 is a diagram showing a flow chart of a switch process from the degenerate mode to the normal control mode of the track circuit controller of the first embodiment according to the present invention;
 FIG. 9 is a diagram showing a flow chart of a switch process from the degenerate mode to the normal control mode of the point controller of the first embodiment according to the present invention;
 FIG. 10 is a diagram showing a flow chart of a switch process from the degenerate mode to the normal control mode of the signal controller of the first embodiment according to the present invention;
 FIGS. 11A to 11C are diagrams showing block configurations of logic in the field controllers according to a second embodiment of the present invention;
 FIGS. 12A to 12C are diagrams showing block configurations of logic in the field controllers according to a third embodiment of the present invention;
 FIG. 13 is a diagram showing a block configuration of logic in the field controllers of points according to a fourth embodiment of the present invention;
 FIG. 14 is a diagram showing a flow chart of an operation of the degenerate mode of the point controller of the fourth embodiment according to the present invention;
 FIG. 15 is a diagram showing a configuration of a fifth embodiment of the signalling system according to the present invention;
 FIG. 16 is a diagram showing a configuration during normal operation of the interlocking controller of the fifth embodiment of the signalling system according to the present invention;
 FIGS. 17A and 17B are diagrams showing block configurations of logic in the field controllers according to the fifth embodiment of the present invention;
 FIG. 18 is a diagram showing routing data of the fifth embodiment of the present invention;
 FIG. 19 is a diagram showing a flow chart of an operation of the degenerate mode of the point controller of the fifth embodiment according to the present invention;
 FIG. 20 is a diagram showing a flow chart of an operation of the degenerate mode of the signal controller of the fifth embodiment according to the present invention; and
 FIGS. 21A and 21B are diagrams showing block configurations of logic in the field controllers according to a seventh embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Embodiments of a signalling system that realizes operations in a degenerate mode for continuing route control only by field controllers even if communication from an interlocking controller to the field controllers is interrupted after termination of the interlocking controller will be described using the drawings.

[First Embodiment]

[0011] FIG. 1 is a diagram showing a configuration of the signalling system according to a first embodiment of the present invention and shows a state in which the interlocking controller is terminated. FIG. 2 shows a state in which the interlocking controller operates normally in the signalling system of FIG. 1.

[0012] The interlocking controller and each field controller including an arithmetic processing unit are connected through a network. The field controllers are also connected to each other through the network. The interconnected field controllers at least include field controllers that constitute a route.

[0013] In an interlocking device connected through the network, an interlocking controller 10 calculates control output of the next control period based on a status message 30 (such as track section information from a track circuit, a switching direction of points, and an indication of a signal) transmitted by field controllers 21 to 23 to the interlocking controller 10 and transmits a control message 40 to the field controllers 21 to 23.

[0014] The field controllers 21 to 23 decipher the control message 40 and output instructed control output. The field controllers 21 to 23 then set the output result as the status message 30 again and transmit the status message 30 to the interlocking controller 10. The field controllers 21 to 23 are installed in a station apparatus room in some cases and installed approximate to wayside equipment in other cases.

[0015] The operation described above is carried out as a normal control mode in the embodiments of the present invention if the interlocking controller 10 operates normally. If the interlocking controller 10 is terminated, the termination is detected. A degenerate mode is set, and only the field controllers realize simple route control without the interlocking controller.

[0016] FIG. 3 is a diagram showing a logic block structure in the field controller 20. An arithmetic processing unit (CPU) includes: an interlocking controller termination determination unit and logic switching unit 20a that receives a control message from the interlocking controller to determine the termination of the interlocking controller to switch wayside equipment control logic; wayside equipment control logic of normal control mode 20b; and wayside equipment control logic of degenerate mode 20c.

[0017] A control input/output unit 20d carries out input

of track section information of the track circuit and control output to points and a signal through the interlocking controller termination determination unit and logic switching unit 20a. The interlocking controller termination determination unit and logic switching unit 20a determines with which of the wayside equipment control logic of normal control mode 20b and the wayside equipment control logic of degenerate mode 20c the controllers will be operated. The interlocking controller termination determination unit and logic switching unit 20a switches the control logic.

[0018] The control input/output unit 20d includes a circuit constituted by a relay, a switch, and a sensor. The arithmetic processing unit (CPU) activates the relay and the switch to control the wayside equipment and imports the status of the relay and the switch by a sensor to recognize the status of the wayside equipment.

[0019] Operations of the field controllers 21 to 23 of the present invention in the degenerate mode will be described in FIG. 1. When the degenerate mode is set, the field controller transmits the status message 30 of the field controller to related field controllers.

[0020] In the case of the field controller of track circuit 21, the status message 30 is transmitted to the field controller of points 22 and the field controller of signal 23.

[0021] In the case of the field controller of points 22, the status message 30 is transmitted to the field controller of signal 23. In the case of the field controller of signal 23, the status message 30 is transmitted to the field controller of points 22.

[0022] The field controllers control the control output in accordance with preset wayside equipment control logic based on the status message 30 received by the wayside equipment control logic of degenerate mode.

[0023] FIGS. 4A and 4B are diagrams showing interlocking tables as an example of the control logic. The interlocking controller 10 holds the interlocking table in the control logic of normal control mode, and the operations of the wayside equipment are controlled in accordance with the interlocking table based on information from the wayside equipment.

[0024] On the other hand, the field controllers hold a necessary interlocking table in the control logic of degenerate mode, and the field controllers control the operations of the wayside equipment based on information of the wayside equipment from other field controllers.

[0025] If a station has a railway track shaped as shown in FIG. 4A, track circuits 2T and 3AT need to be unoccupied, and a point 2 needs to be locked at a normal position to output an advance indication to the signal of a route 1RA. Furthermore, track section information of a track circuit 1T needs to be acquired for approach locking.

[0026] Therefore, the signal of the route 1RA acquires status information of track circuits 1T, 2T, and 3AT and status information of the point 2 to control the signal indication.

[0027] FIGS. 5 to 7 are diagrams showing switching conditions of the field controllers of track circuit, points,

and signal to the degenerate mode and operations after the transition to the degenerate mode. The mode transitions of the field controllers will be described in FIGS. 5 to 7.

[0028] FIG. 5 is a diagram showing a switching condition to the degenerate mode of the field controller of track circuit 21. The field controller of track circuit 21 in the normal control mode (101) transmits track circuit information to the interlocking controller 10 (102). If the communication with the interlocking controller is interrupted (103, Yes), it triggers mode switching to the degenerate mode (104), and the track circuit information is transmitted to related wayside equipment (points and signal, 105).

[0029] The transmission of the track circuit information to the related wayside equipment may be unicast transmission for one-to-one transmission to the wayside equipment, multicast transmission for transmission to all wayside equipment within a transmission target group, or broadcast transmission for transmission to all devices connected to the network. If the communication with the interlocking controller is not interrupted (103, No), the normal control mode continues (101).

[0030] FIG. 6 is a diagram showing a switching condition to the degenerate mode of the field controller of points 22. The field controller of points 22 in the normal control mode (201) transmits point state information to the interlocking controller (202). If communication with the interlocking controller is interrupted (203, Yes), it triggers the points to be locked (204).

[0031] After the points are locked, if the track circuit information is received from the field controller of track circuit 21 (205, Yes), the mode moves to the degenerate mode (206). After the transition to the degenerate mode, the point state information is transmitted to the related signal (207). In the degenerate mode, the points are controlled in accordance with a locking condition of the interlocking table (208). If the communication with the interlocking controller is not interrupted (203, No) or if the track circuit information is not received (205, No), the normal control mode continues (201).

[0032] FIG. 7 is a diagram showing a switching condition to the degenerate mode of the field controller of signal 23. The field controller of signal 23 in the normal control mode (301) transmits signal state information to the controller (302).

[0033] If the communication with the interlocking controller is interrupted (303, Yes), it triggers the signal to be temporarily changed to a stop indication (304). After the output of the stop indication, if the track circuit information is received from the field controller of track circuit 21 (305, Yes), the mode moves to the degenerate mode (306).

[0034] After the transition to the degenerate mode, the signal state information is transmitted to the related points (307). In the degenerate mode, the signal indication is controlled in accordance with a signal control condition of the interlocking table (308). If the communication

with the interlocking controller is not interrupted (303, No) or if the track circuit information is not received (305, No), the normal control mode continues (301).

[0035] FIGS. 8 to 10 are diagrams showing conditions for returning from the degenerate mode to the normal control mode of the field controllers of track circuit, points, and signal and operations after the transition to the normal control mode. The mode transitions of the field controllers will be described in FIGS. 8 to 10.

[0036] FIG. 8 is a diagram showing a condition for returning from the degenerate mode to the normal control mode of the field controller of track circuit 21. In the degenerate mode (111), the track circuit information is transmitted to related equipment (112). After the communication with the interlocking controller is restored (113, Yes), if the normal control mode restoration is received from the related signal (114, Yes), the normal control mode is restored (115), and the transmission of the track circuit information to the related wayside equipment is terminated (116). If the communication with the interlocking controller is not restored (113, No) or if the communication control mode restoration is not received from the related signal (114, No), the degenerate mode continues (111).

[0037] FIG. 9 is a diagram showing a condition for returning from the degenerate mode to the normal control mode of the field controller of points 22. In the degenerate mode (211), the point state information is transmitted to the related signal (212). After the restoration of the communication with the interlocking controller (213, Yes), if the normal control mode restoration is received from the related signal (214, Yes), the normal control mode is restored (215), and the transmission of the point state information to the related signal is terminated (216). An instruction of the interlocking controller is then followed (217). If the communication with the interlocking controller is not restored (213, No) or if the communication control mode restoration is not received from the related signal (214, No), the degenerate mode continues (211).

[0038] FIG. 10 is a diagram showing a condition for returning from the degenerate mode to the normal control mode of the field controller of signal 23. In the degenerate mode (311), the signal indication is controlled in accordance with the signal control condition of the interlocking table (312), and the signal state information is transmitted to the related points (313). After the communication with the interlocking controller is restored (314, Yes), if the instruction of the interlocking controller is below the signal indication (315, Yes), the normal control mode is restored (316), the related wayside equipment is notified of the restoration of the normal control mode (317), and the transmission of the signal state information to the related points is terminated (318).

[0039] After that, an instruction of the interlocking controller is followed (319). If the communication with the interlocking controller is not restored (314, No) or if the instruction of the interlocking controller is above the signal indication (315, No), the degenerate mode continues

(311).

[Second Embodiment]

[0040] FIGS. 11A to 11C are diagrams showing block configurations of logic in the field controllers according to a second embodiment of the present invention. In the field controller of track circuit 21 of the first embodiment, the normal control mode control logic 21b may be designed to transmit the track circuit information not only to the interlocking controller 10, but also to the related field controllers 22 and 23, and the receiving field controllers may discard the track circuit information in modes other than the degenerate mode. As a result, the degenerate mode does not have to be set in the field controller of track circuit 21, and the logic can be simplified.

[0041] The field controller of points 22 in the first embodiment may be configured to be locked in a state at the time of detection of the communication interrupt if the communication with the controller is interrupted, and the lock may be continued until the communication with the controller is restored.

[0042] As a result, the points cannot be switched while the interlocking controller is stopped. However, since the points are not in operation, the degenerate mode does not have to be set in the field controller of points 22, and the logic can be simplified only by the normal control mode control logic 22b.

[0043] At this point, the point state information may be transmitted to the signal related to the interlocking controller along with the deletion of the degenerate mode, and the point state information may be discarded in the field controller of signal 23 in modes other than the degenerate mode. As a result, the field controller of signal 23 can obtain the point state information in the degenerate mode.

[0044] The track circuit information from the field controller of track circuit 21 is discarded. This can prevent the track circuit information from the field controller of track circuit 21 from affecting the normal control mode.

[0045] In the field controller of signal 23, a status message discard circuit 23f discards status messages (track circuit information and point state information) transmitted from the field controllers of track circuit and points 21 and 22 in the normal control mode. This can prevent the status messages of the field controllers of track circuit and points 21 and 22 in the second embodiment from affecting the normal control mode.

[Third Embodiment]

[0046] FIGS. 12A to 12C are diagrams showing block configurations of logic in the field controllers according to a third embodiment of the present invention. In the field controller of points 22 of the second embodiment, only the point lock and the approach locking may be made effective by control logic of point lock and approach locking 22b', regardless of the mode.

[0047] The point lock based on the track circuit information from the field controller of track circuit 21 in the control mode makes the response faster than the reception of a point locking instruction from the interlocking controller. The logic of approach locking is activated when the signal indication is changed.

[0048] Since the field controller of signal 23 does not transmit the signal state information in the normal control mode, the field controller of points 22 does not receive the change in the signal indication during normal control. The interlocking controller has the logic of approach locking during normal operation and transmits the control message to the points, and the field controller of points 22 just performs the control output in accordance with the control message. Therefore, the control is not affected in the normal control mode of the field controller of points 22.

[Fourth Embodiment]

[0049] FIG. 13 is a diagram showing a block configuration of logic in the field controller of points 22 according to a fourth embodiment. Station passing route configuration logic 22g is added to wayside equipment control logic during degenerate mode 22c. In the fourth embodiment, the field controller of track circuit 21 may be any of the field controllers of track circuit 21 in the first to third embodiments. The field controller of signal 23 may also be any of the field controllers of signal 23 in the first to third embodiments.

[0050] FIG. 14 is a diagram showing an operation of the field controller of points 22 in the degenerate mode according to the fourth embodiment. In the degenerate mode, the point state information is first acquired (401), and whether the direction of the points is a set station passing route direction is checked (402). If the point direction is not the station passing direction (402, No), whether the points are locked is checked (403). If the points are not locked (403, No), the points are switched to the station passing route direction (404), and the points are controlled in accordance with the locking condition of the interlocking table based on the state information of other wayside equipment control devices (405). If the point direction is the station passing direction (402, Yes) or if the points are locked (403, Yes), the points are not switched to the station passing direction, and the points are controlled in accordance with the locking condition of the interlocking table (405). After the control of the points, the point state is transmitted to the related signal. The process returns to the point state information acquisition (401), and the same process continues.

[0051] As a result, the station passing route can be constituted regardless of the point switching direction during the degenerate mode transition, and the trains passing through the station can be operated.

[Fifth Embodiment]

[0052] FIG. 15 is a diagram showing a configuration of the signalling system according to a fifth embodiment of the present invention and shows a state in which the interlocking controller is terminated. FIG. 16 shows a state in which the interlocking controller operates normally in the signalling system of FIG. 15.

[0053] In the fifth embodiment, routing data 50 for several hours is transmitted to the field controllers of points and signal 22 and 23 if the interlocking controller 10 operates normally. If the interlocking controller 10 is terminated, the field controllers 22 and 23 detect the termination, and simple route control is realized only by the field controllers, without the interlocking controller in the degenerate mode.

[0054] FIGS. 17A and 17B are diagrams showing logic block structures in the field controllers of points and signal 22 and 23 according to the fifth embodiment. In the fifth embodiment, the field controller of track circuit 21 may be any of the field controllers of track circuit 21 in the first to third embodiments.

[0055] The logic block structure of the field controller of points 22 of FIG. 17A will be described. The arithmetic processing unit (CPU) includes: an interlocking controller termination determination unit and logic switching unit 22a that receives the control message 40 from the interlocking controller 10 to determine the termination of the interlocking controller 10 to switch the wayside equipment control logic; the wayside equipment control logic of normal control mode 22b; and wayside equipment control logic of degenerate mode 22c' including train passing detection logic 22j. The arithmetic processing unit (CPU) also includes a routing data receiver 22h that receives the routing data 50 from the interlocking controller 10 and a routing data storage 22i that stores the routing data 50. The routing data 50 stored in the routing data storage 22i is used by the wayside equipment control logic of degenerate mode 22c' including the train passing detection logic 22j.

[0056] The same applies to the field controller of signal 23 of FIG. 17B.

[0057] FIG. 18 shows an example of the routing data 50 received and stored by the field controllers of points and signal 22 and 23. Routes corresponding to the order of passing trains are described. The data may include only the routes in one line as long as the order can be determined.

[0058] FIGS. 19 and 20 are diagrams showing how the control logics of generate mode 22c' and 23c' of the field controllers of points and signal 22 and 23 use the routing data 50 to execute a switching process and a signal indicating process. The contents of the processes will be described with reference to FIGS. 19 and 20.

[0059] FIG. 19 is a diagram showing the switching process using the routing data 50 of the field controller of points 22. The routing data 50 is first acquired in the degenerate mode control logic 22c' (501). The next route

direction is checked in the acquired routing data 50 (502). After the check of the next route direction, the point direction is checked (503), and whether the point direction and the next route direction match is determined (504).

[0060] If the point direction and the next route direction do not match (No), whether the points are locked is determined (505). If the points are locked (Yes), the determination (505) is repeated until the lock is released. If the lock of the points is released (No), the points are switched to the next route direction (506). After the switch, whether the train has passed is determined based on the train passing detection logic 22j (507).

[0061] If the point direction and the next route direction match in the determination (504, Yes), the switching process is not carried out (skip 505 and 506), and whether the train has passed is determined (507).

[0062] If the train has not passed (No), the determination (507) is repeated until the train passes. If the train has passed (Yes), the information of the current route is discarded, and the information of the next route is selected (508). After the selection of the next routing data, the next route direction is checked again (502), and the same process continues.

[0063] FIG. 20 is a diagram showing the indication process using the routing data 50 of the field controller of signal 23. The routing data 50 is first acquired in the degenerate mode control logic 23c' (601). The next route direction is checked in the acquired routing data 50 (602). After the check of the next route direction, whether the track section is clear is determined from the status information of the related wayside equipment (603).

[0064] If the track section is not clear (No), the stop indication is displayed (604), and the determination (603) is repeated until the track section is clear. If the track section is clear (Yes), the advance indication is displayed (605), and whether the train has passed is determined based on train passing detection logic 23j (606). If the train has not passed (No), the determination (606) is repeated until the train passes. If the train has passed (Yes), the information of the current route is discarded, and the information of the next route is selected (607). After the selection of the next routing data, the next route direction is checked again (602), and the same process continues.

[0065] As a result, operations of a normal schedule can be continued for several hours even if the interlocking controller is stopped. The routing data of one day may be stored, instead of the routing data for several hours. In this case, the operations of the normal schedule can be carried out only by the wayside equipment control device. If the schedule is disordered, operations can be carried out based on a new schedule by receiving new routing data from the interlocking controller or by directly receiving routing data from the operation management device through wired transmission or wireless transmission.

[Sixth Embodiment]

[0066] Instead of storing the routing data 50 in both the field controllers of points and signal 22 and 23, the routing data 50 may be stored only in the field controller of points 22, and the train passing detection logic 22j may be used to determine the passage of the train to change the route. In this case, the field controller of track circuit 21 may be any of the field controllers of track circuit 21 in the first to third embodiments. The field controller of signal 23 may also be any of the field controllers of signal 23 in the first to third embodiments.

[0067] As a result, the routing data receiver 23h, the routing data storage 23i, and the train passing detection logic 23j in the degenerate mode control logic may not be included in the field controller of signal 23, and the configuration and logic of the field controller of signal 23 can be simplified. Storing the routing data only in the points can prevent a situation in which the signal continues to show the stop indication when the routing data stored in the field controllers of points and signal are different and the constituted routes do not match.

[Seventh Embodiment]

[0068] FIGS. 21A and 21B are diagrams showing block configurations of logic in the field controllers according to a seventh embodiment of the present invention. Switch instruction logic 23k is additionally included in the degenerate mode control logic 23c' of the field controller of signal 23, and a control message 41 as a switch instruction can be outputted to the field controller of points 22 in the degenerate mode. The routing data receiver 22h, the routing data storage 22i, and the train passing detection logic 22j are deleted in the field controller of points 22, and degenerate mode control logic 22c" is switched by the control message 41 from the field controller of signal 23. In the seventh embodiment, the field controller of track circuit 21 may be any of the field controllers of track circuit 21 in the first to third embodiments.

[0069] This can prevent a situation, in which the points are incompatibly switched and the route cannot be constituted, even in a route where a plurality of points interlock.

Claims

1. A signalling system **characterized by** comprising:

one or more wayside equipments including a track circuit, points, and a signal;
field controllers that are arranged in association with the wayside equipments and that control the wayside equipments;
an interlocking controller that controls the field controllers based on state information from the wayside equipments; and

- a network that connects the interlocking controller and the field controllers, wherein control information is transmitted from the interlocking controller to the field controllers through the network, state information is transmitted from the field controllers to the interlocking controller, and route control of a train is performed by field controllers, the field controllers comprising: a transmission path and a function for transmitting and receiving the state information between the field controllers that constitute a route; and wayside equipment control logic for receiving the state information necessary for the route control from the field controllers and for maintaining the route control of the train based on the state information if the information from the interlocking controller cannot be received.
2. The signalling system according to claim 1, **characterized by** comprising field controllers, the field controllers comprising:
- first wayside equipment control logic used when the interlocking controller is in operation and second wayside equipment control logic for maintaining the route control when the interlocking controller according to claim 1 is terminated; a function for detecting a fact that the information from the interlocking controller cannot be received; and a function for switching the wayside equipment control logic from the first wayside equipment control logic to the second wayside equipment control logic if the fact that the information from the interlocking controller cannot be received is detected.
3. The signalling system according to claim 2, **characterized in that** the field controllers detects the fact that the information from the interlocking controller cannot be received when communication from the interlocking controller is interrupted.
4. The signalling system according to claim 3, **characterized in that** in the case of the field controllers of the points and the signal, a condition for switching the wayside equipment control logic is a reception of the state information from the field controller of the track circuit.
5. The signalling system according to claim 1, **characterized in that** the field controller of the track circuit transmits the state information to the interlocking controller and the field controllers constituting the route,
- the field controller of the points has control logic of point lock and approach locking and transmits the state information to the interlocking controller and the field controllers constituting the route, and the field controller of the signal has the first wayside equipment control logic and the second wayside equipment control logic, has a function for detecting the termination of the interlocking controller based on the communication interrupt, has a function for switching the route control logic from the first wayside equipment control logic to the second wayside equipment control logic if the termination of the interlocking controller is detected, and transmits the state information to the interlocking controller and the field controllers constituting the route.
6. The signalling system according to claim 2, **characterized in that** the field controller of the points constitutes a route enabling to pass through a station based on the second wayside equipment control logic.
7. The signalling system according to any of claims 1 to 4, **characterized in that** the field controllers have a function for receiving and storing routing data from the interlocking controller, have a function for detecting passage of a train if the information from the interlocking controller cannot be received, and control the points or the signal in accordance with the passage of the train based on the routing data.
8. The signalling system according to claim 7, **characterized in that** the field controller of the signal has logic for creating a switch instruction to the points in the second wayside equipment control logic and has a function for transmitting the switch instruction to the field controller of the points, and the field controller of the points controls the points in accordance with the switch instruction transmitted by the field controller of the signal in the second wayside equipment control logic for maintaining the route control during the termination of the interlocking controller.

FIG. 1

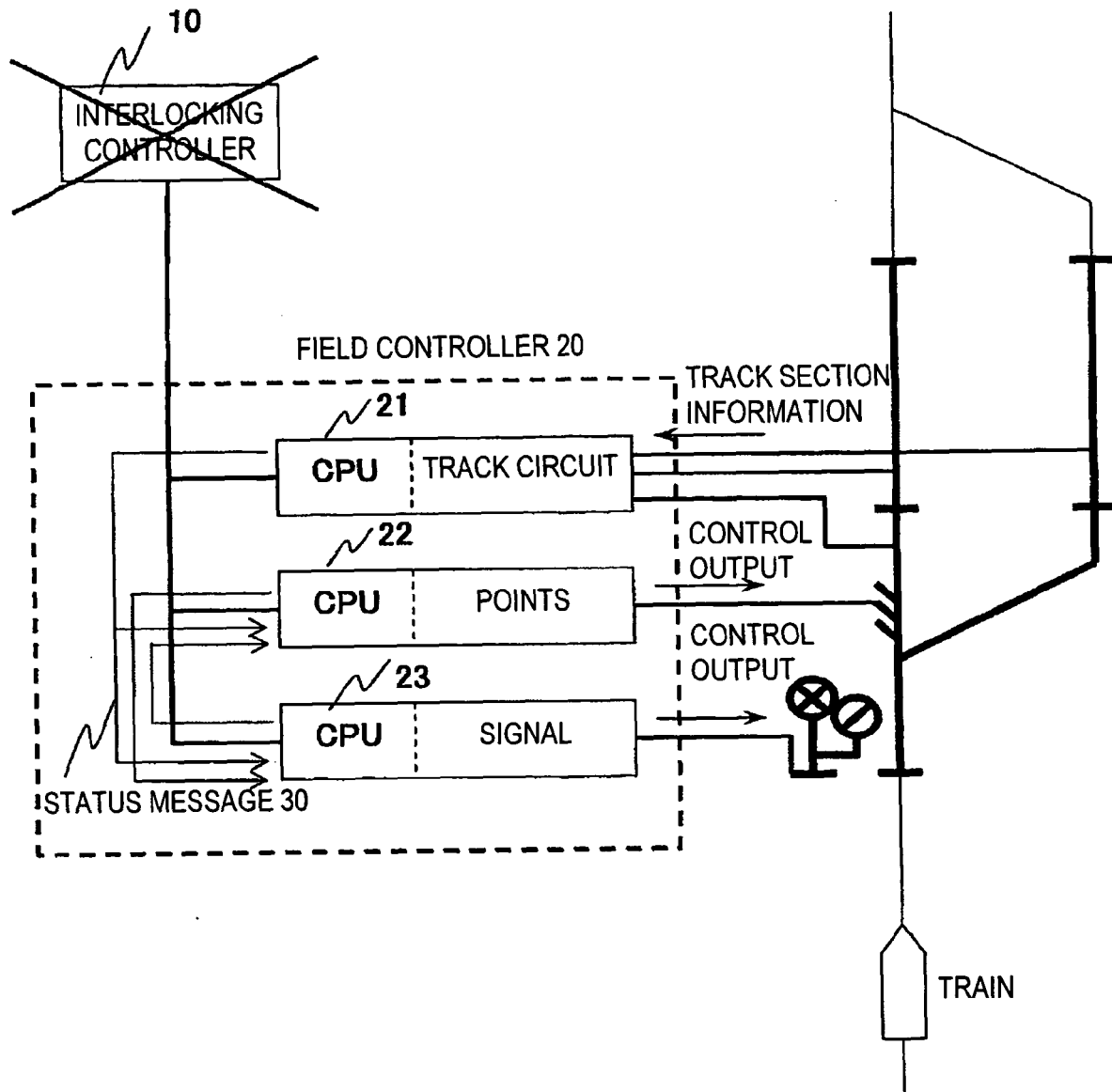


FIG. 2

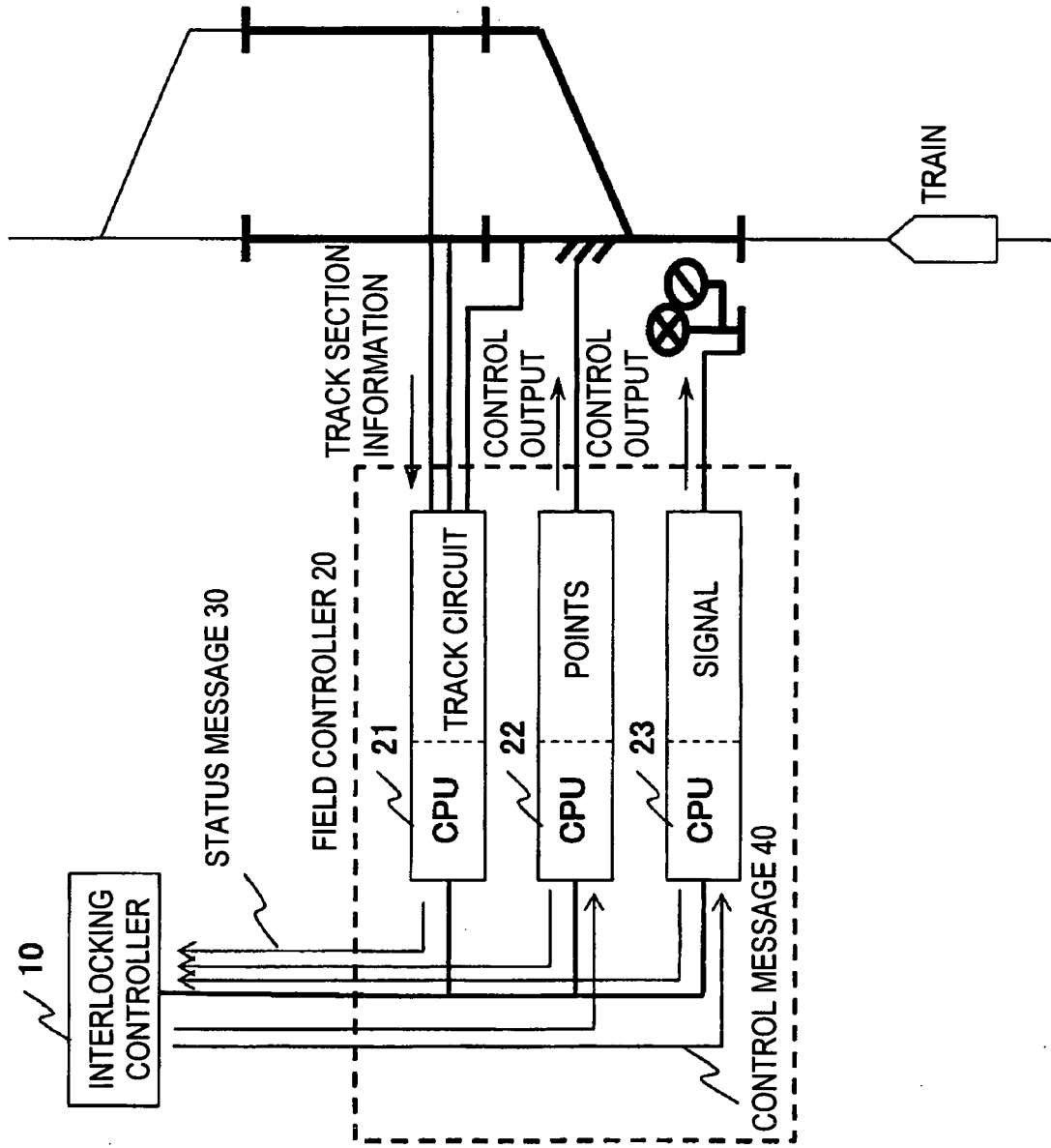


FIG. 3

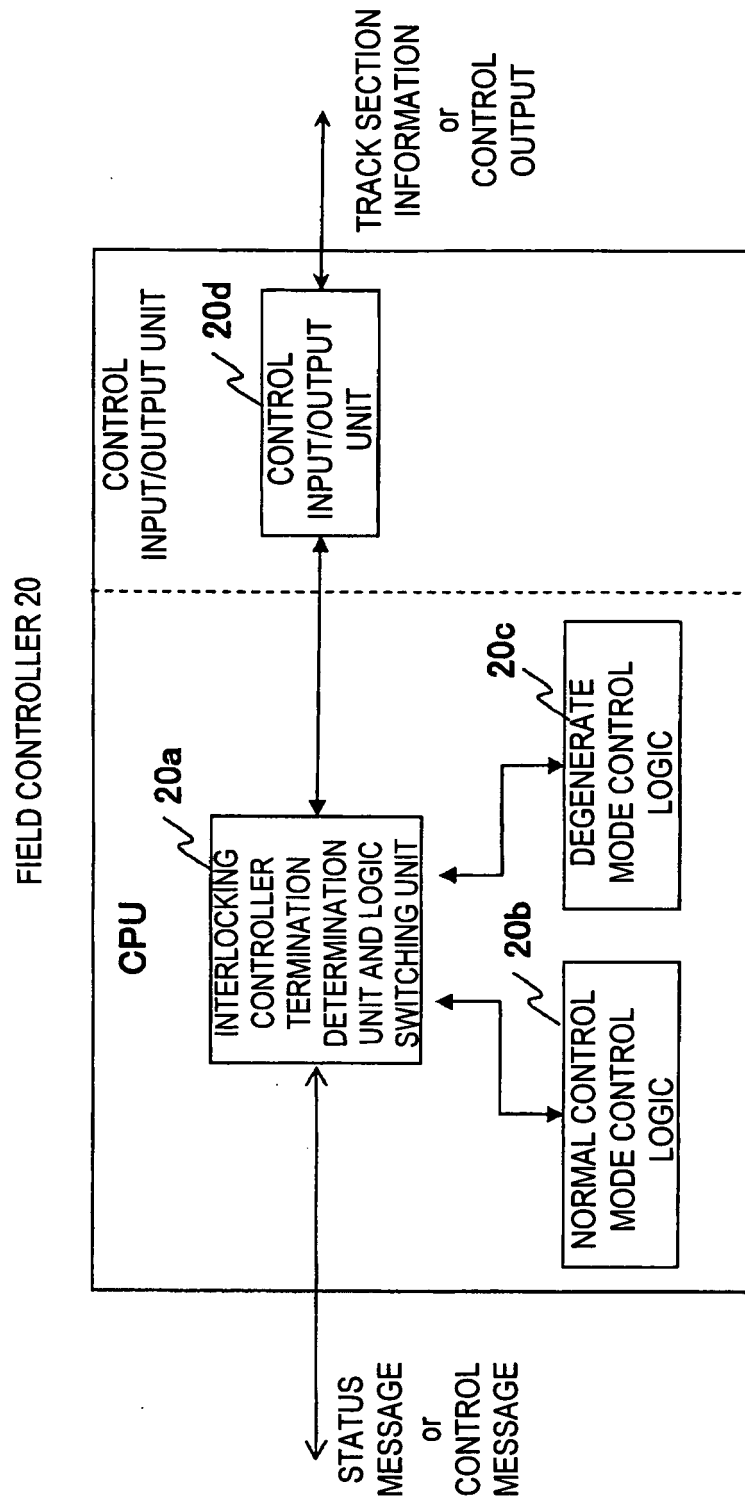
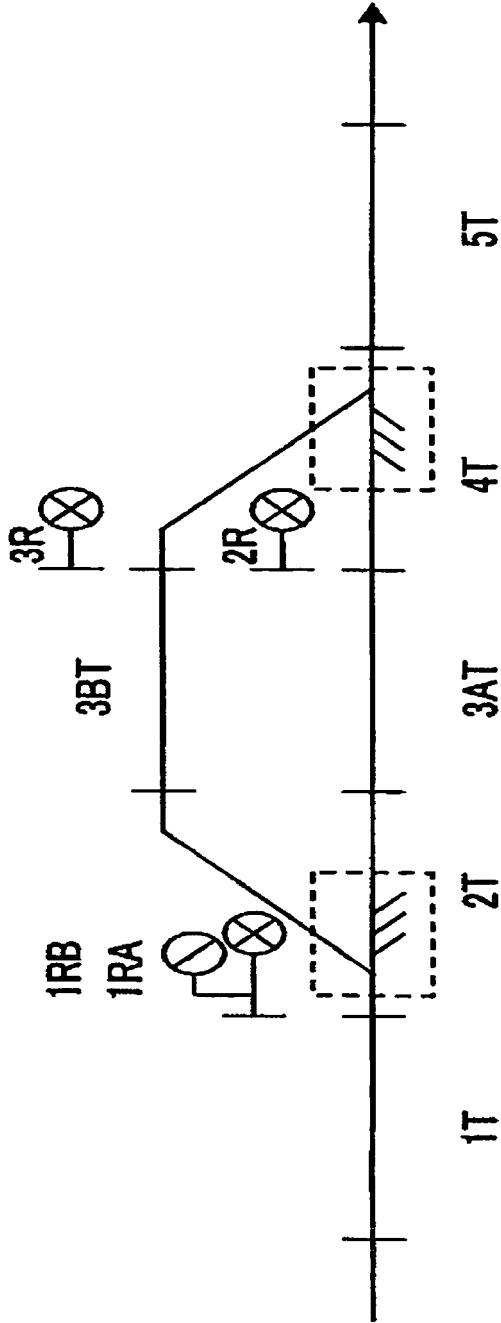


FIG. 4A



	NUMBER	LOCK	SIGNAL CONTROL OR POINT LOCK	ROUTE LOCK	APPROACH LOCKING OR STICK LOCKING
ROUTE	1RA	2	2T 3AT	2T	1T<<n SEC>>
	1RB	②	2T 3BT	2T	1T<<n SEC>>
	2R	4	4T 5T	4T	3AT<<m SEC>>
	3R	④	4T 5T	4T	3BT<<m SEC>>
POINTS	2		2T		
	4		4T		

<INTERLOCKING TABLE>

NORMAL CONTROL
MODE
(INTERLOCKING
CONTROLLER 10)

FIG. 4B

<INTERLOCKING TABLE>

DEGENERATE MODE
(FIELD CONTROLLER
OF SIGNAL 23)

	NUMBER	LOCK	SIGNAL CONTROL OR POINT LOCK	ROUTE LOCK	APPROACH LOCKING OR STICK LOCKING
ROUTE	1RA	2	2T 3AT	2T	1T<<n SEC>>

DEGENERATE MODE
(FIELD CONTROLLER
OF SIGNAL 23)

	NUMBER	LOCK	SIGNAL CONTROL OR POINT LOCK	ROUTE LOCK	APPROACH LOCKING OR STICK LOCKING
ROUTE	1RB	②	2T 3BT	2T	1T<<n SEC>>

DEGENERATE MODE
(FIELD CONTROLLER
OF SIGNAL 23)

	NUMBER	LOCK	SIGNAL CONTROL OR POINT LOCK	ROUTE LOCK	APPROACH LOCKING OR STICK LOCKING
ROUTE	2R	4	4T 5T	4T	3AT<<m SEC>>

DEGENERATE MODE
(FIELD CONTROLLER
OF SIGNAL 23)

	NUMBER	LOCK	SIGNAL CONTROL OR POINT LOCK	ROUTE LOCK	APPROACH LOCKING OR STICK LOCKING
ROUTE	3R	④	4T 5T	4T	3BT<<m SEC>>

DEGENERATE MODE
(FIELD CONTROLLER
OF POINTS 22)

	NUMBER	LOCK	SIGNAL CONTROL OR POINT LOCK	ROUTE LOCK	APPROACH LOCKING OR STICK LOCKING
POINTS	2		2T		

DEGENERATE MODE
(FIELD CONTROLLER
OF POINTS 22)

	NUMBER	LOCK	SIGNAL CONTROL OR POINT LOCK	ROUTE LOCK	APPROACH LOCKING OR STICK LOCKING
POINTS	4		4T		

FIG. 5

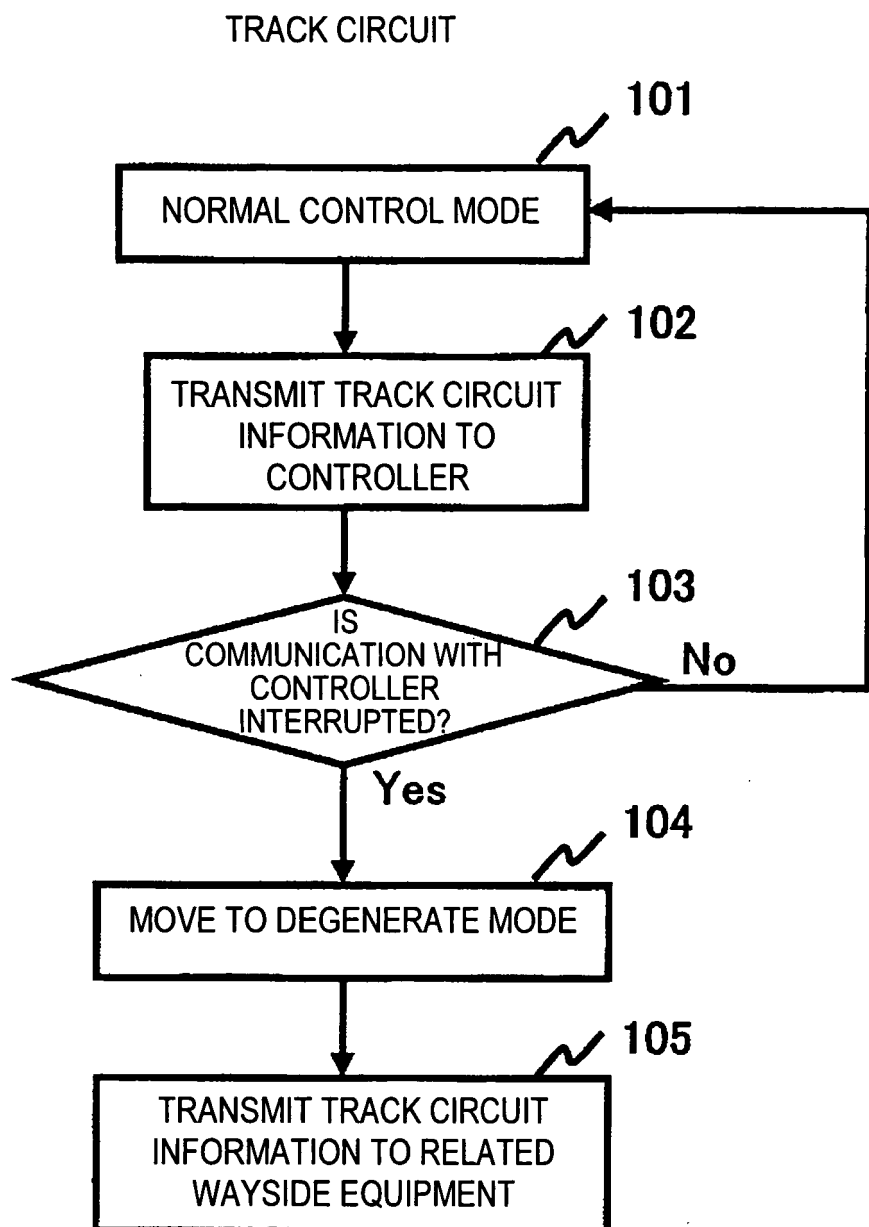


FIG. 6

POINTS

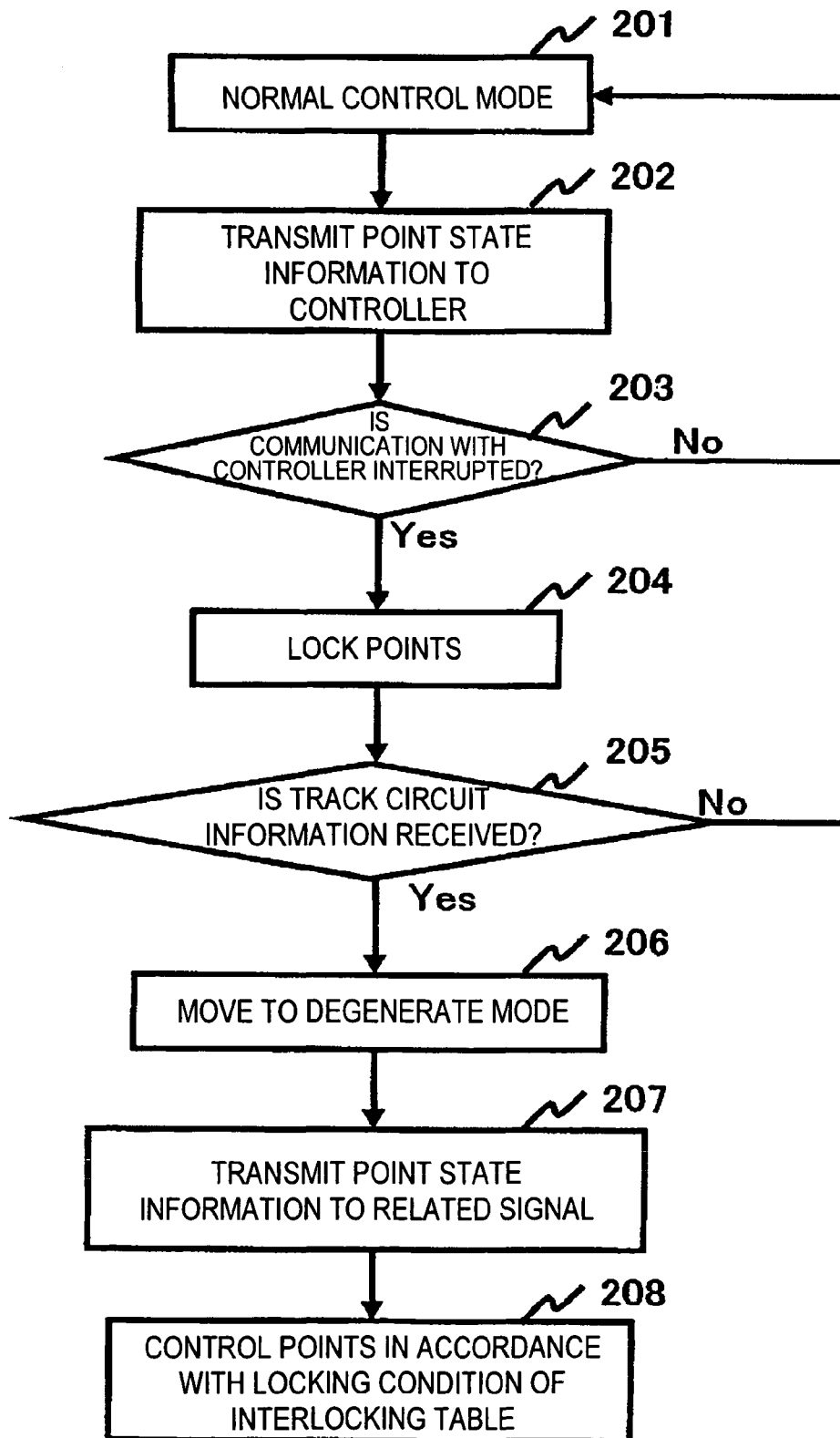


FIG. 7

SIGNAL

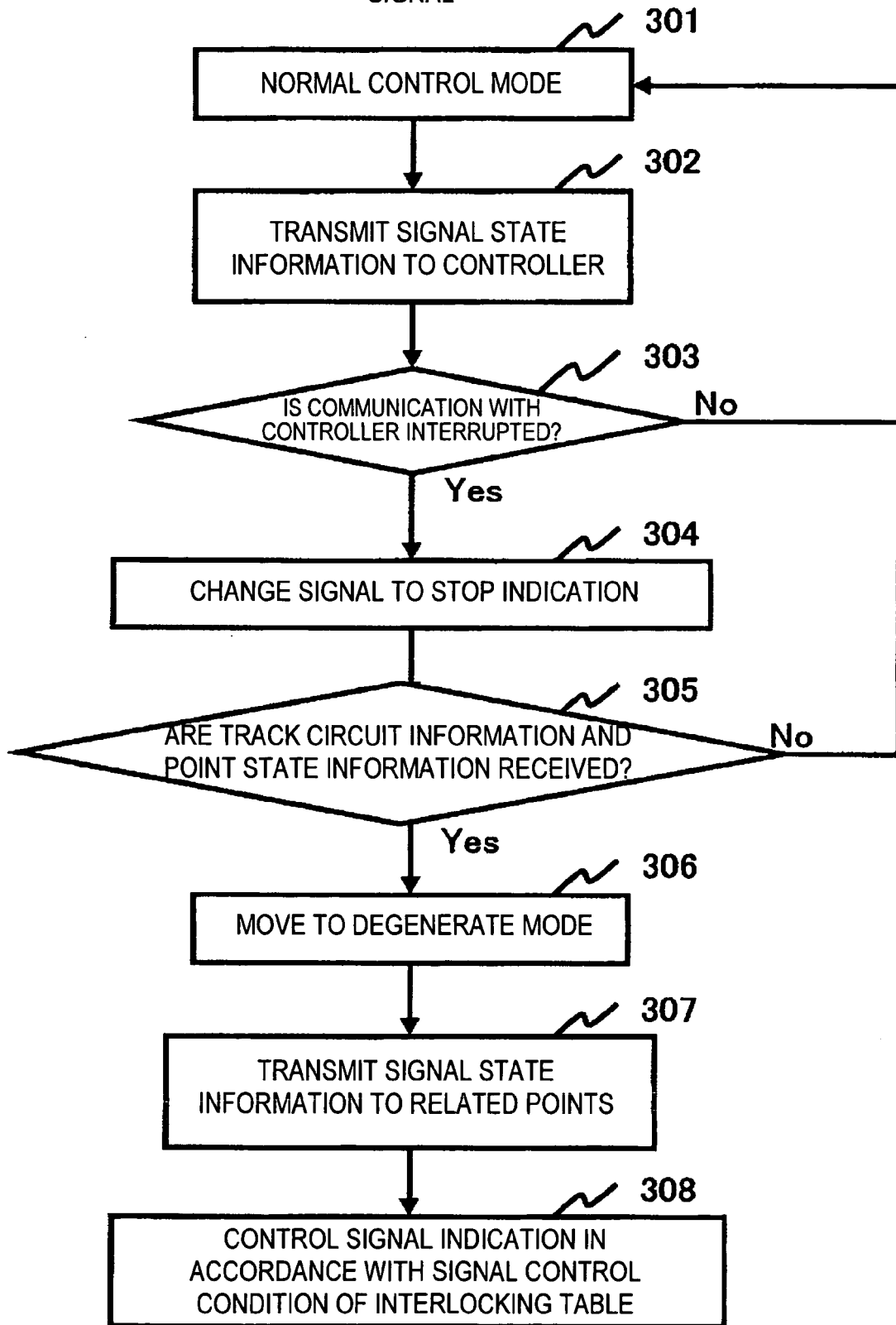


FIG. 8

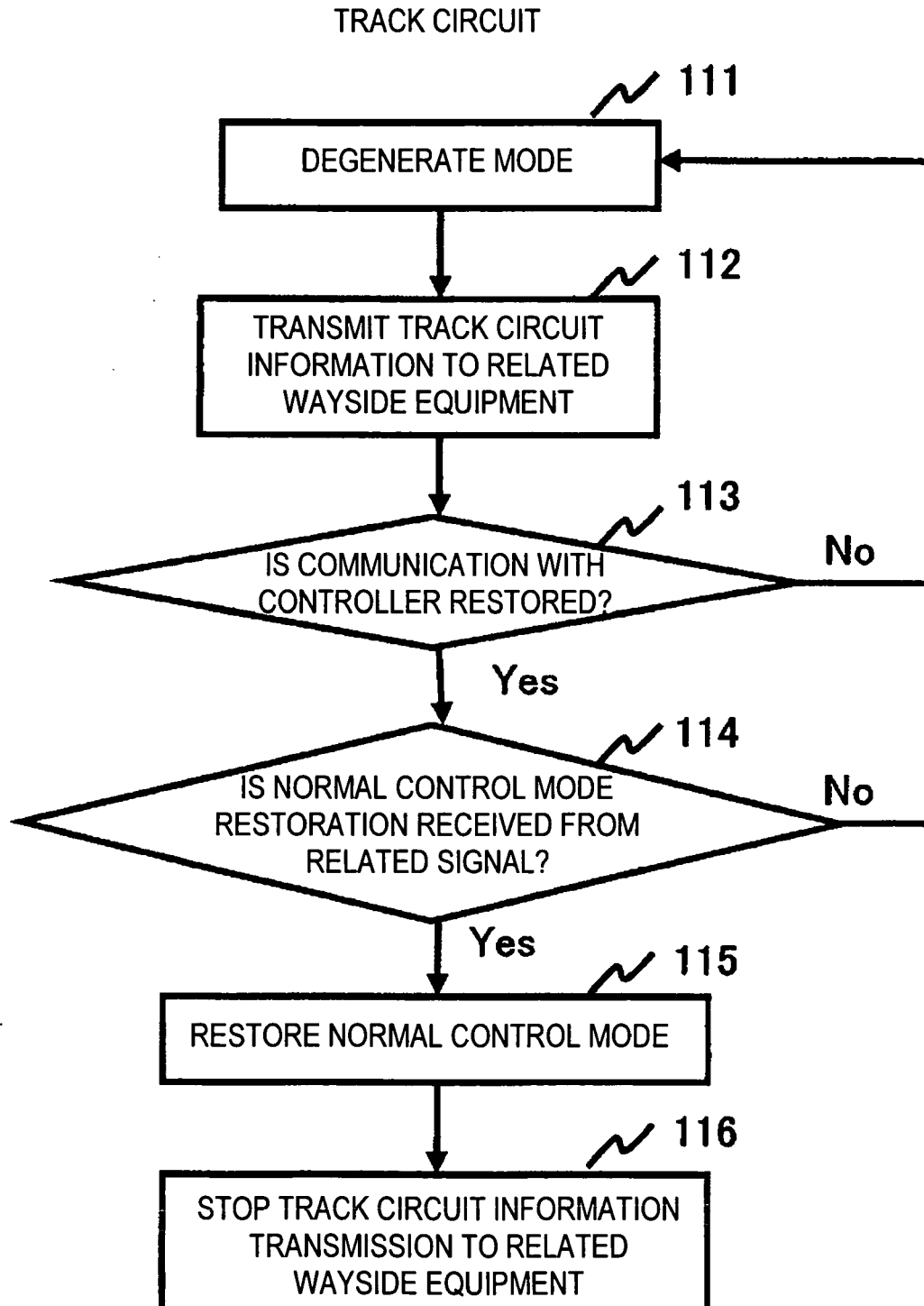


FIG. 9

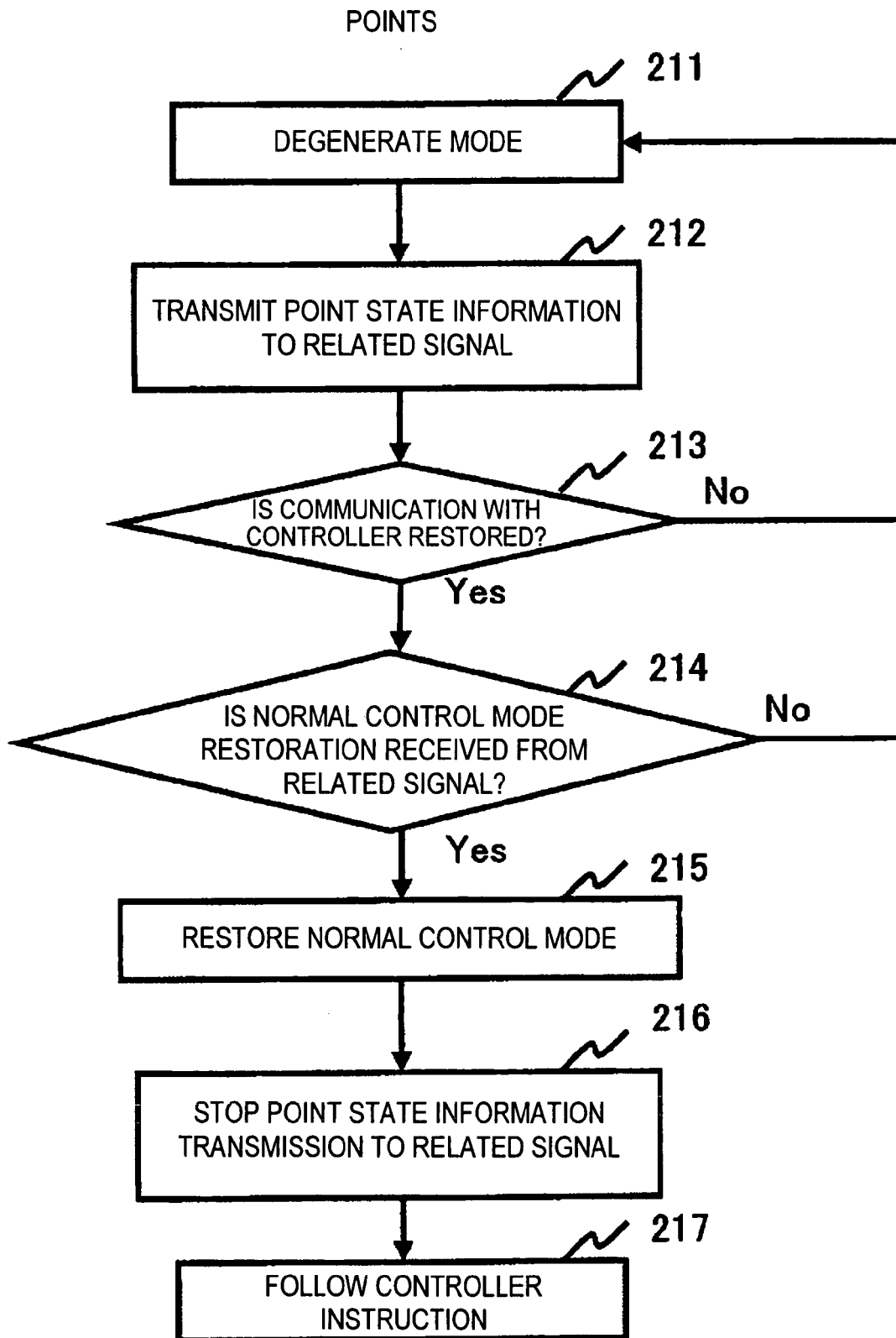


FIG. 10

SIGNAL

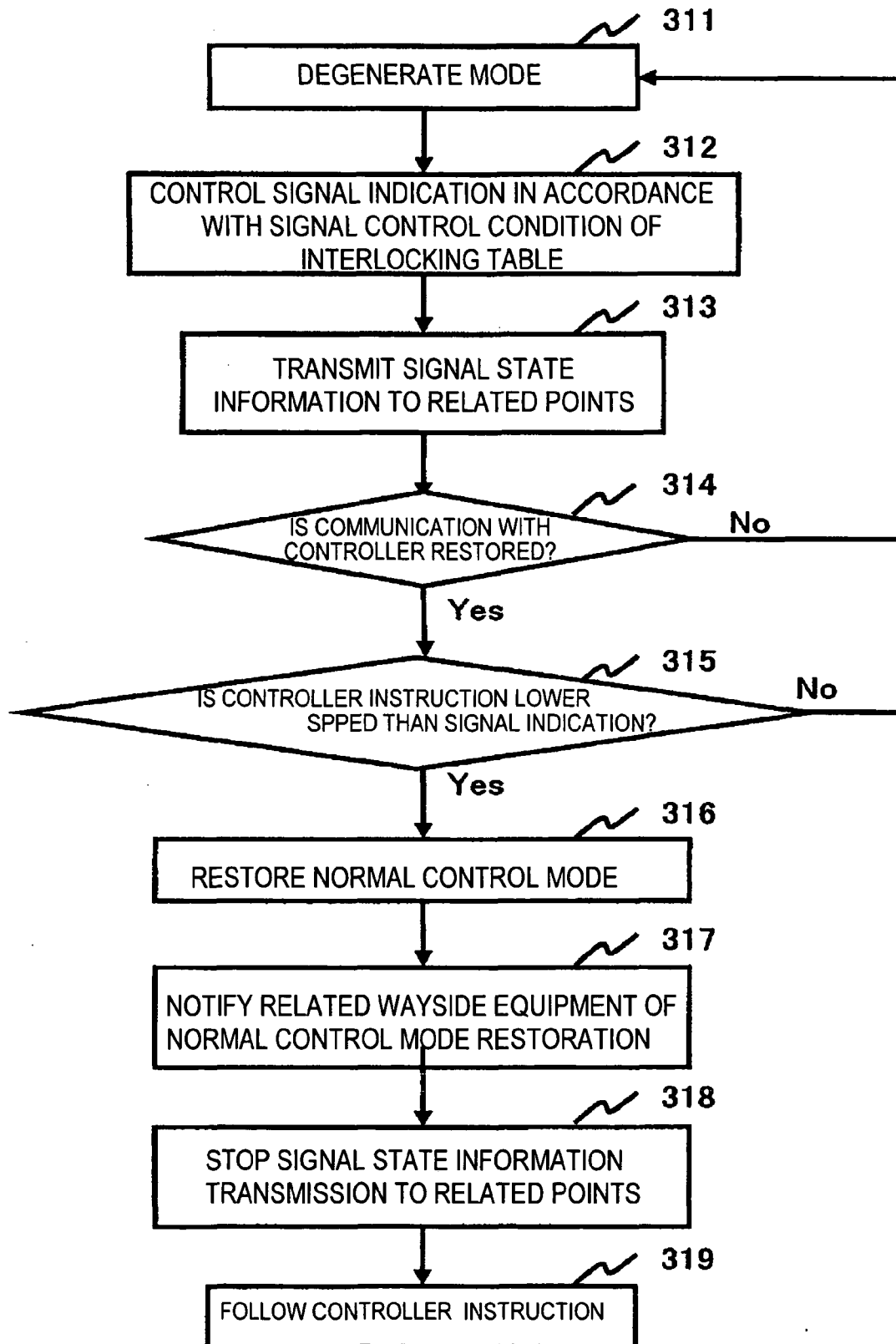


FIG. 11A

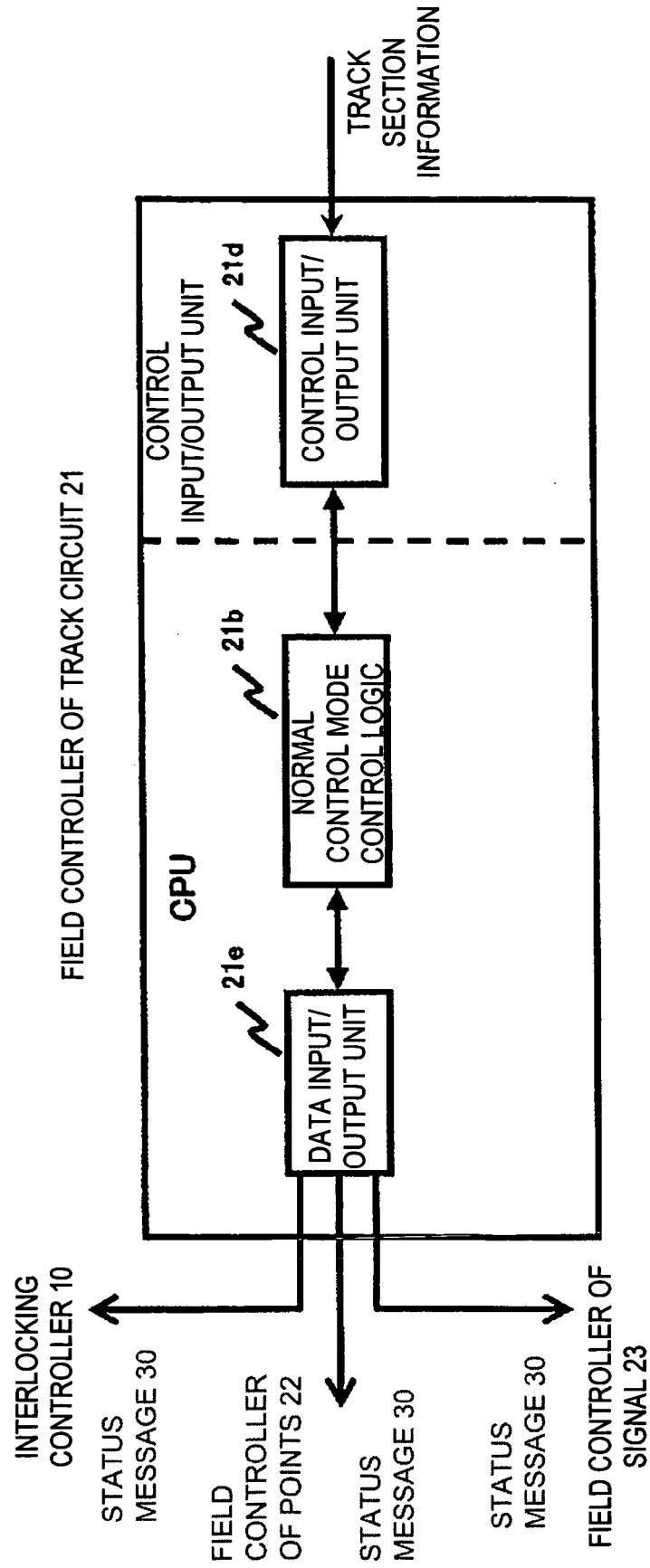


FIG. 11B

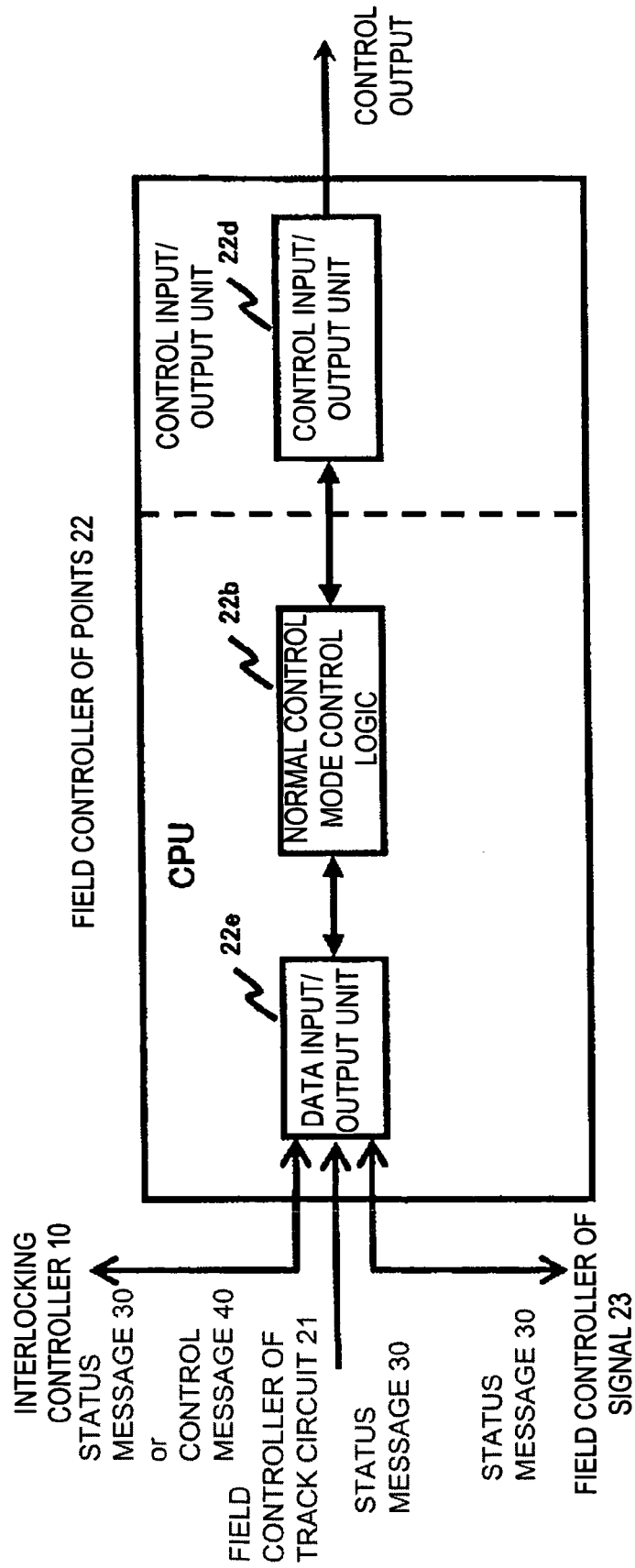


FIG. 11C

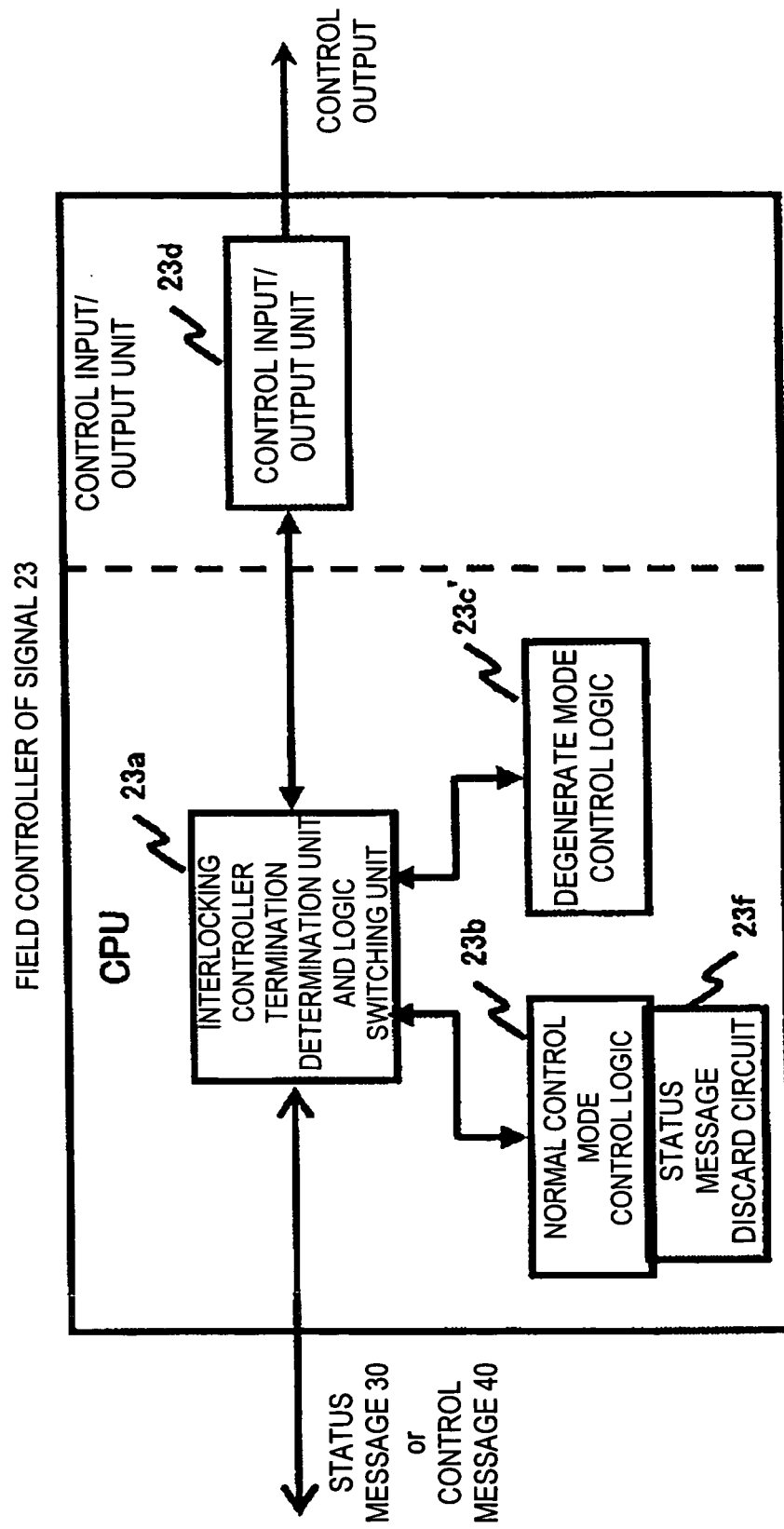


FIG. 12A

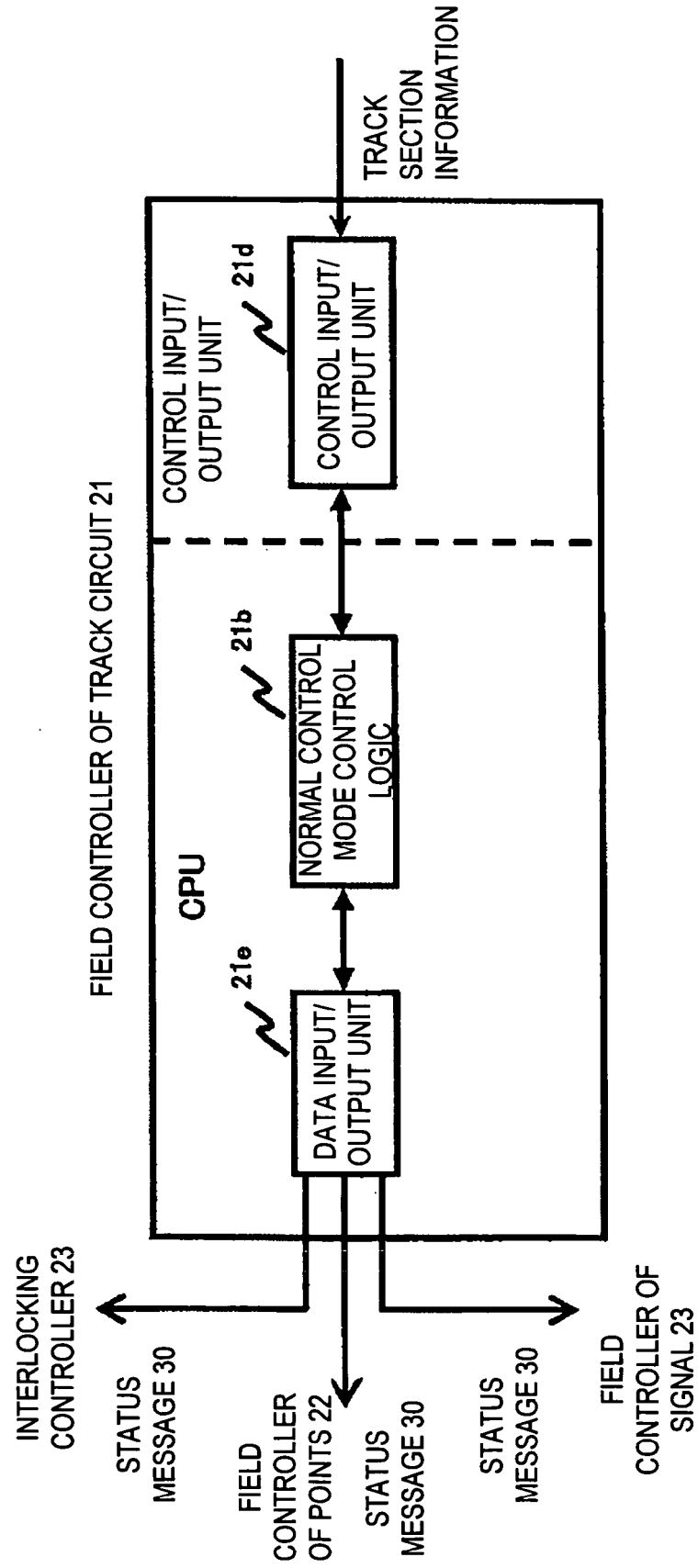


FIG. 12B

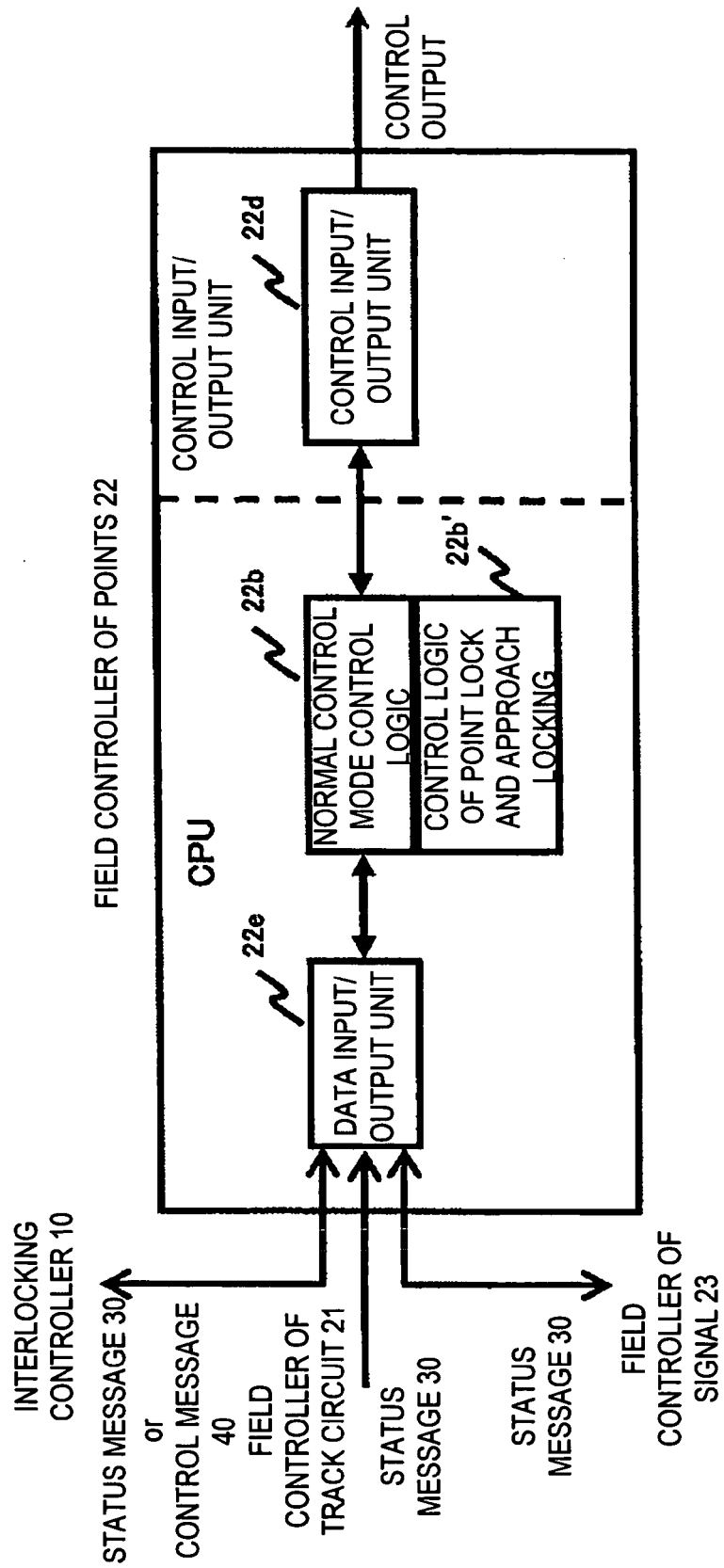


FIG. 12C

FIELD CONTROLLER OF SIGNAL 23

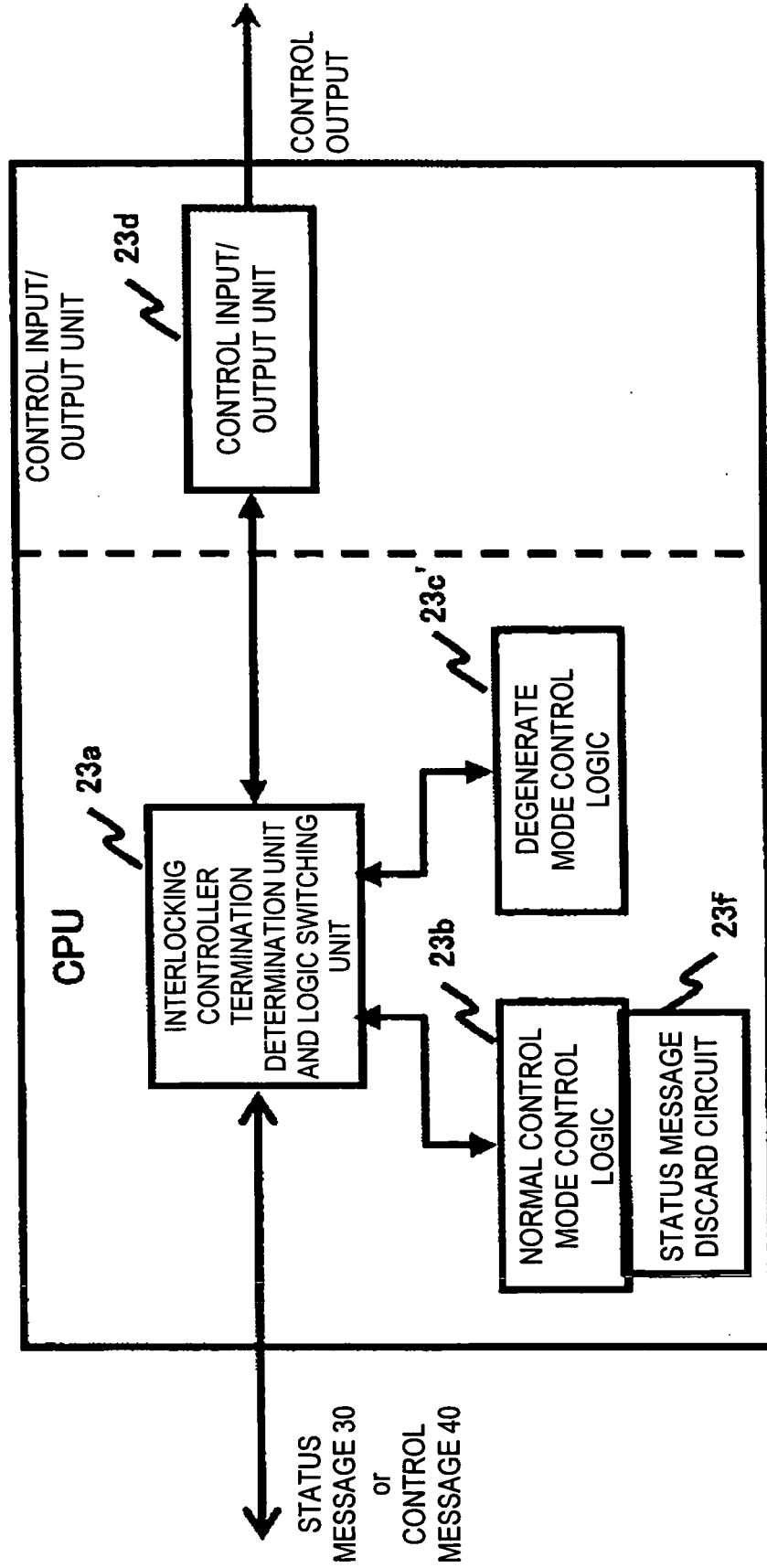


FIG. 13

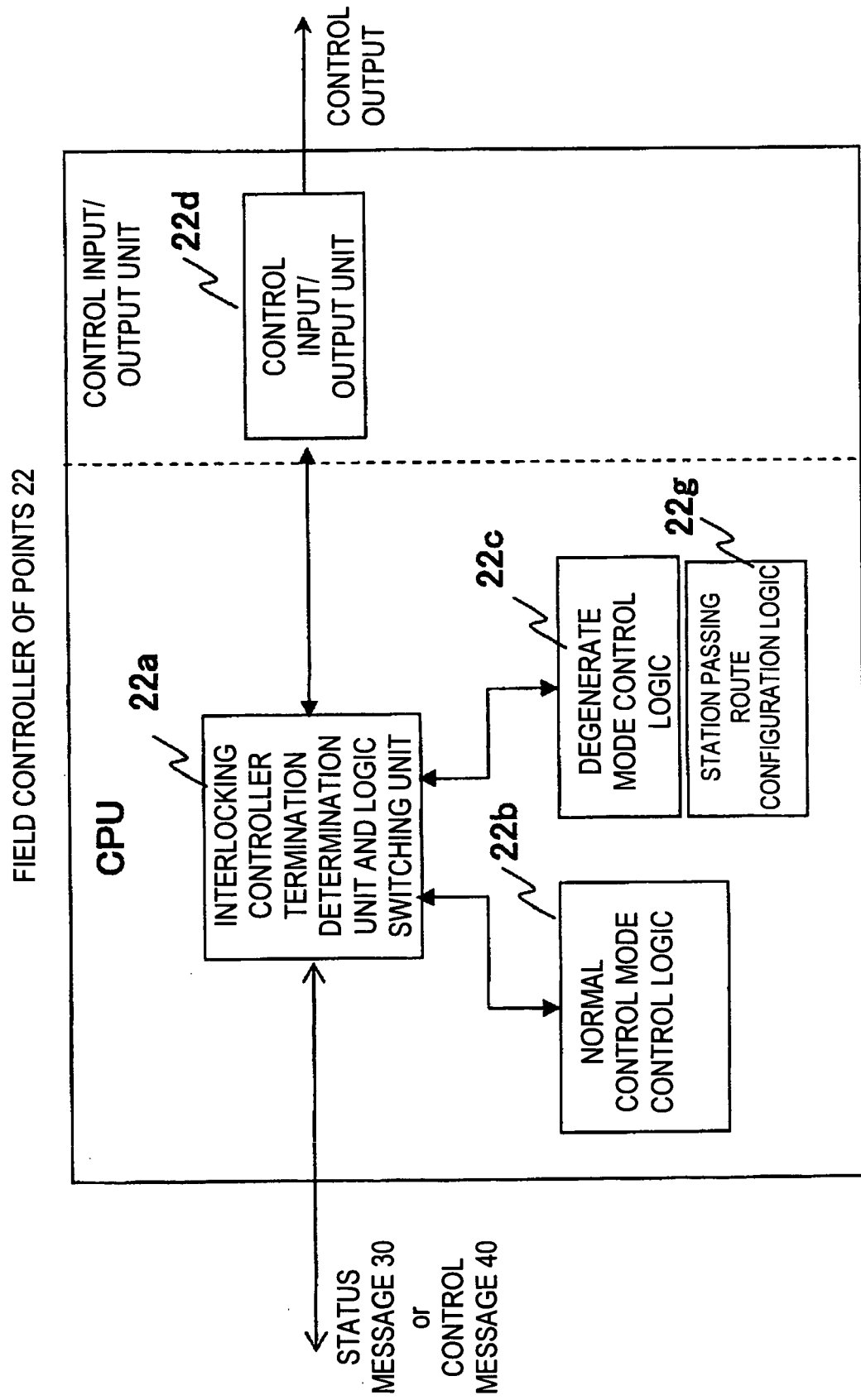


FIG. 14

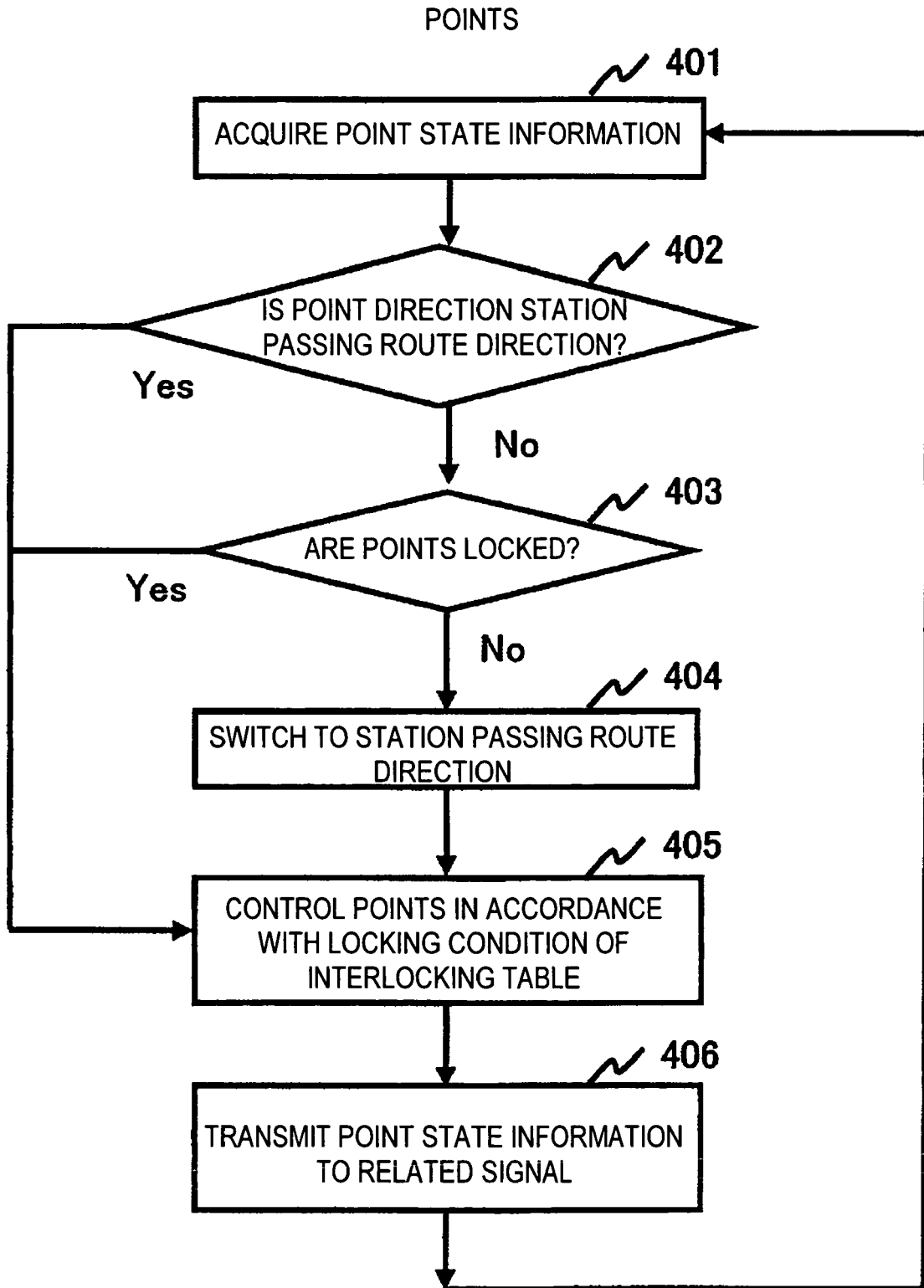


FIG. 15

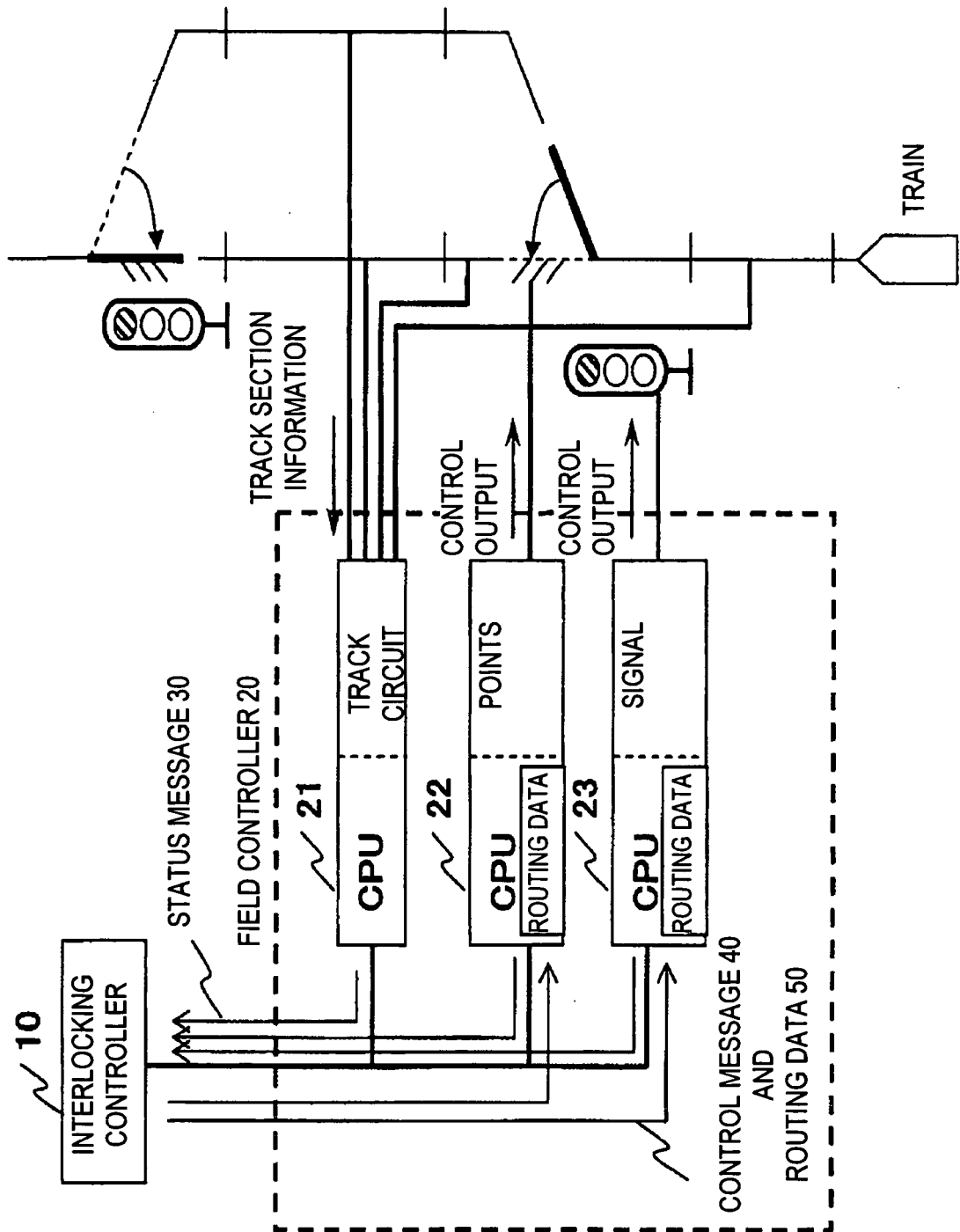


FIG. 16

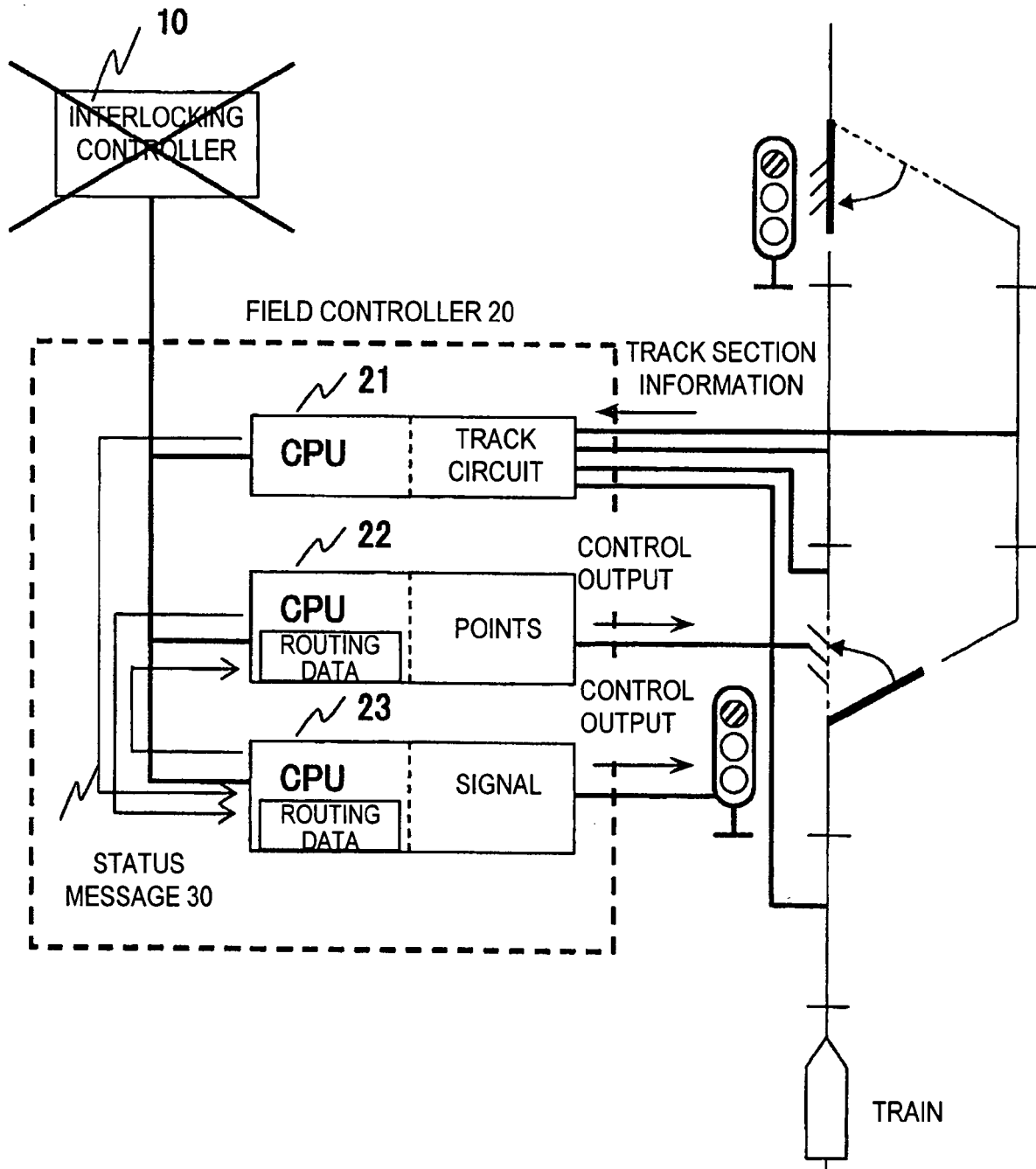


FIG. 17A

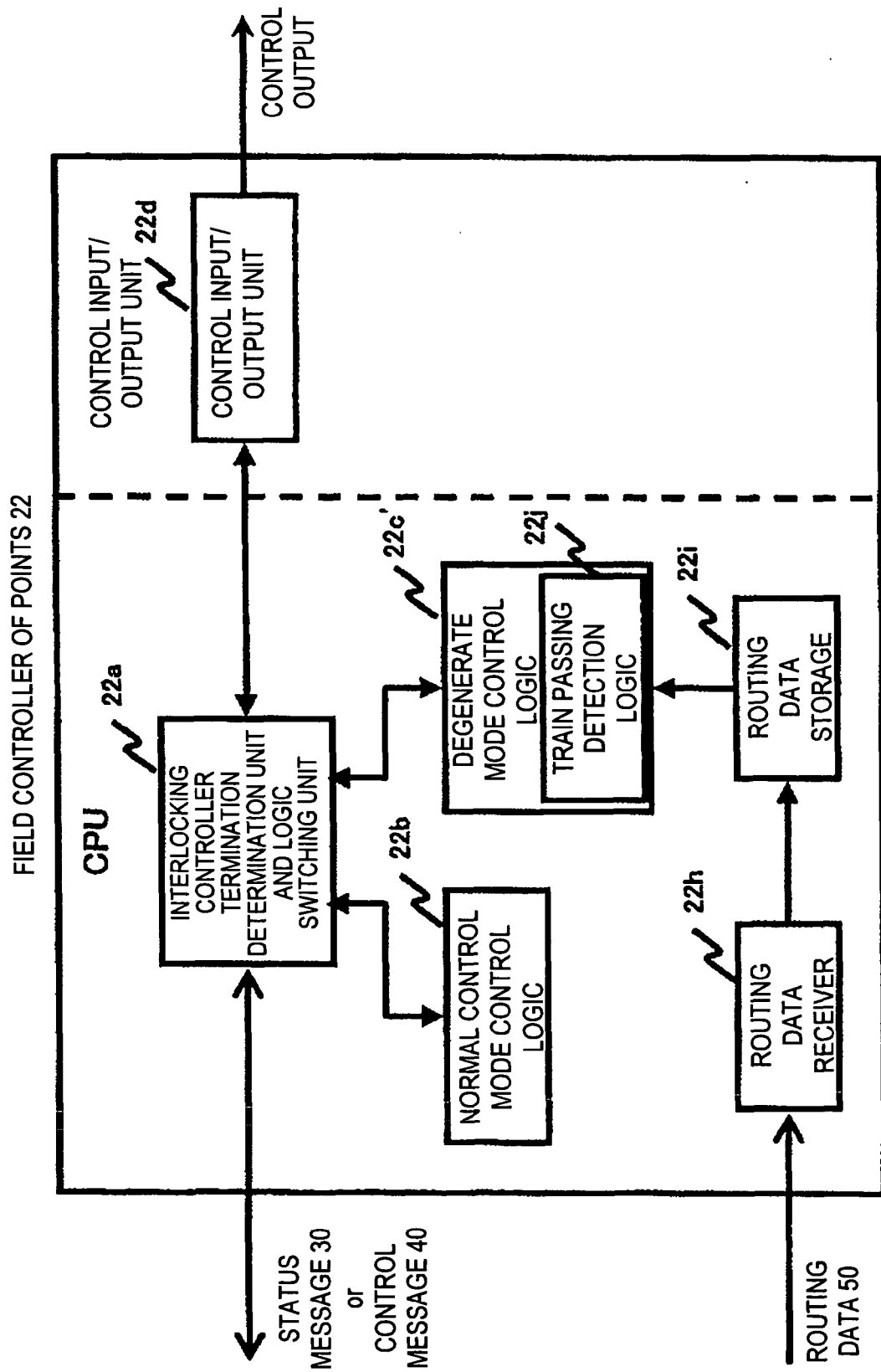


FIG. 17B

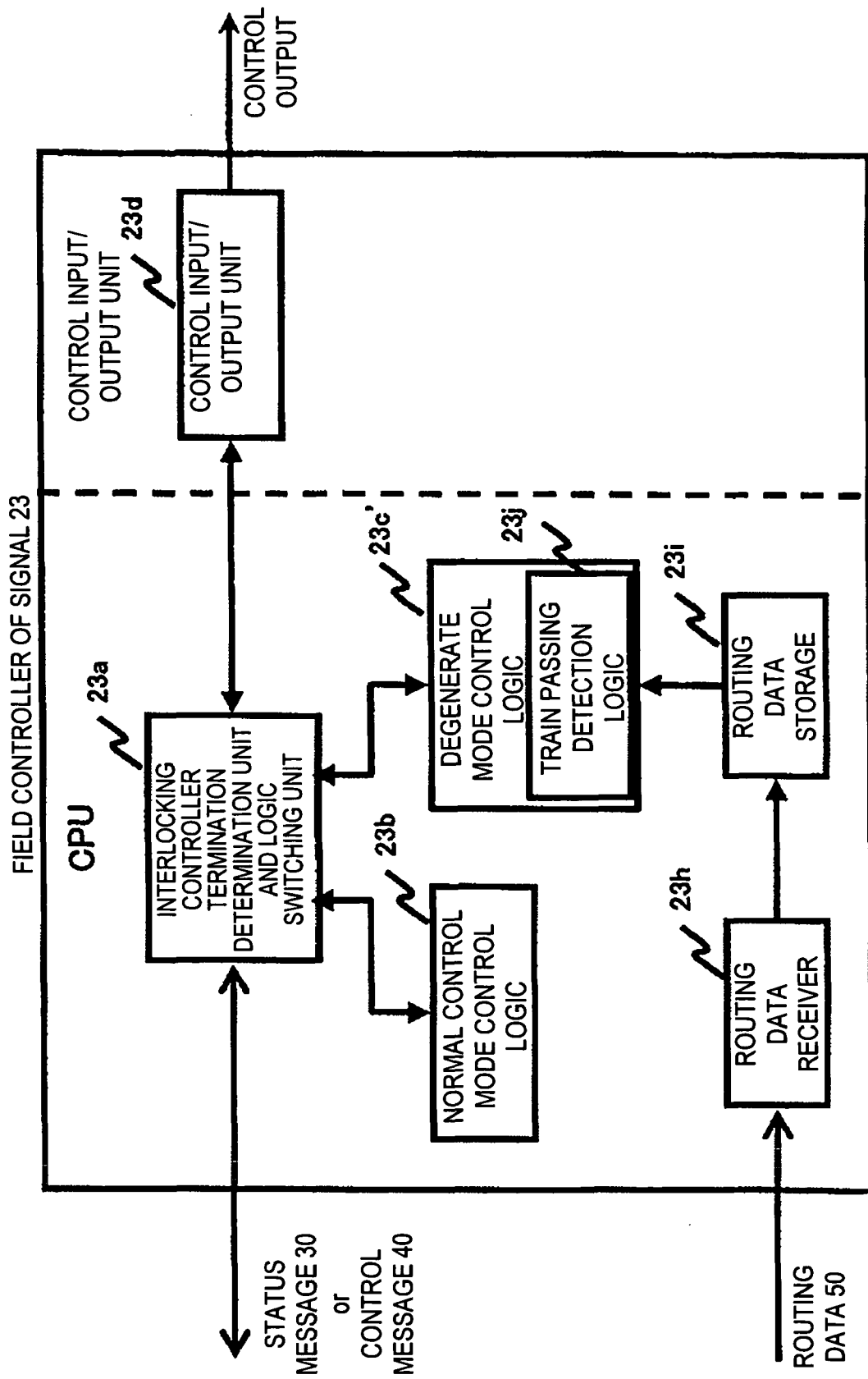


FIG. 18

ROUTING DATA

TRAIN	ROUTE
1	1RA
2	1RA
3	1RB
4	1RA
⋮	⋮

FIG. 19

POINTS

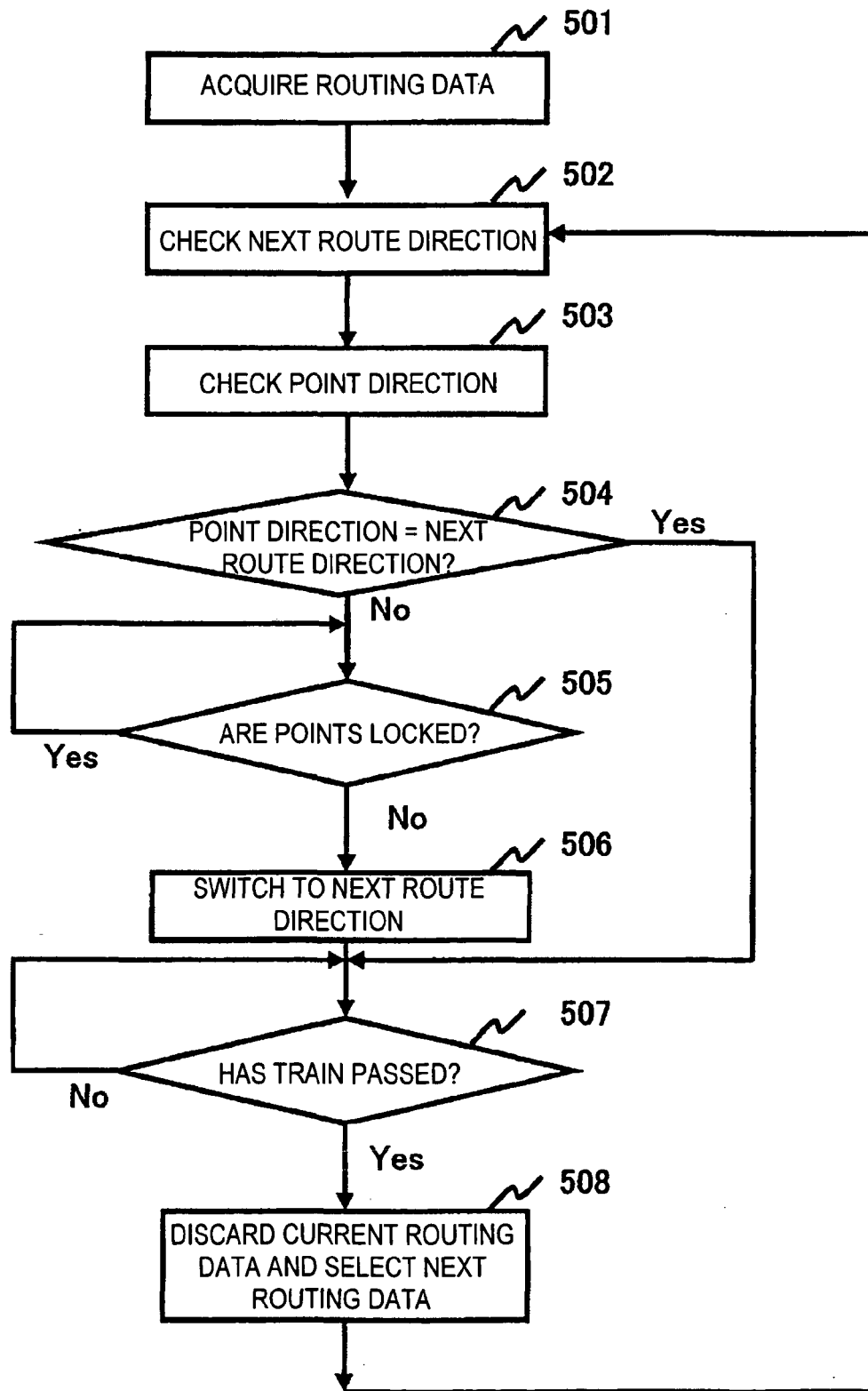


FIG. 20

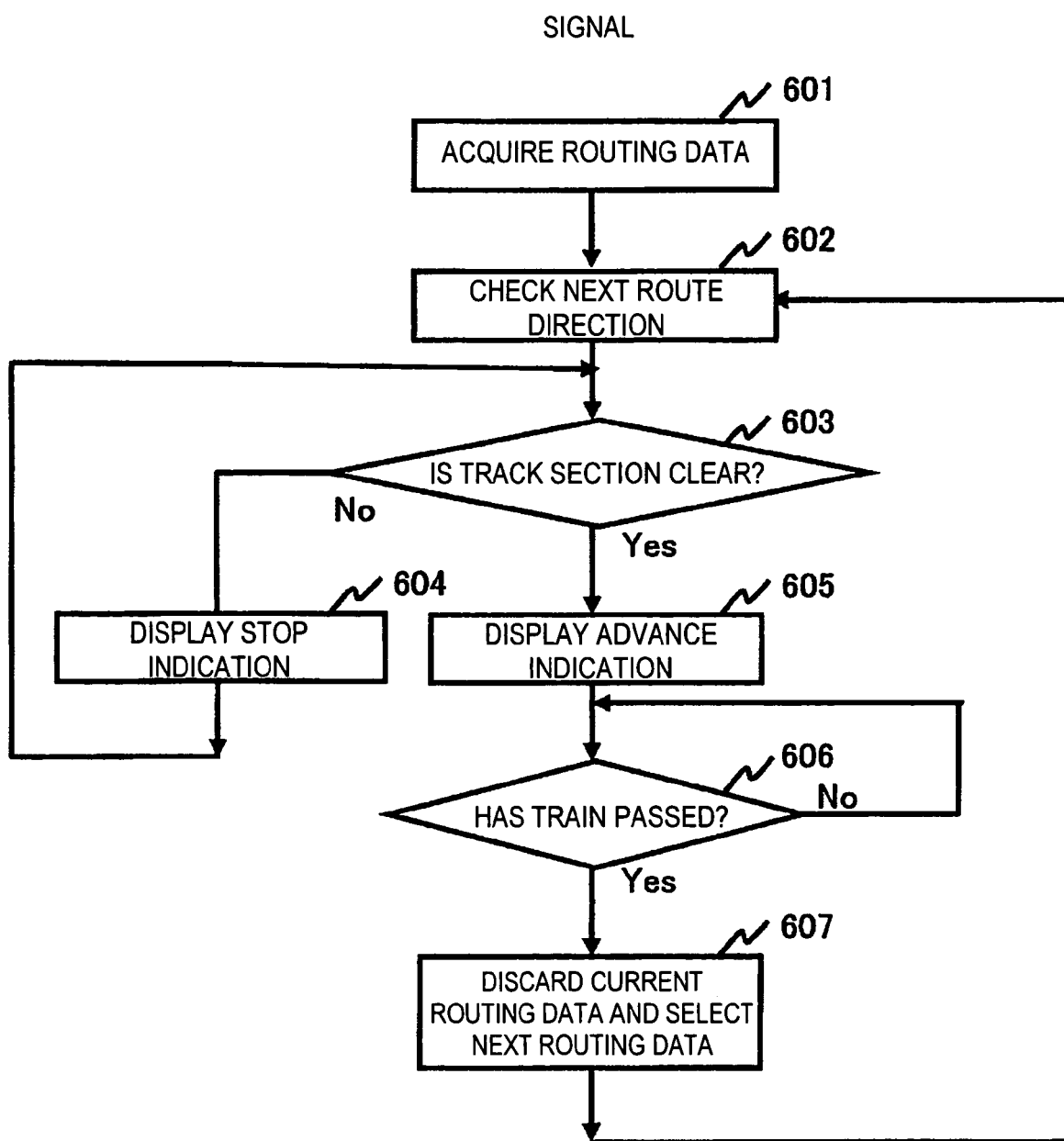


FIG. 21A

FIELD CONTROLLER OF POINTS 22

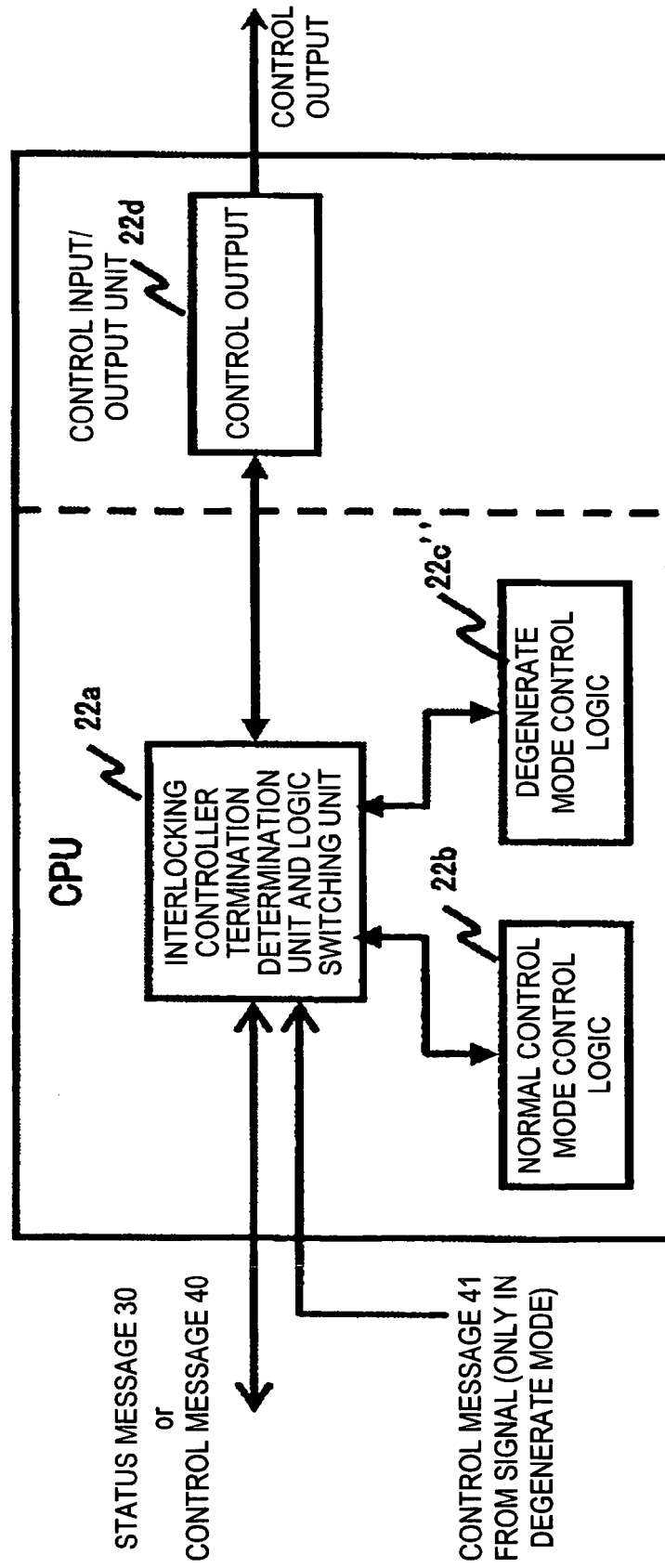
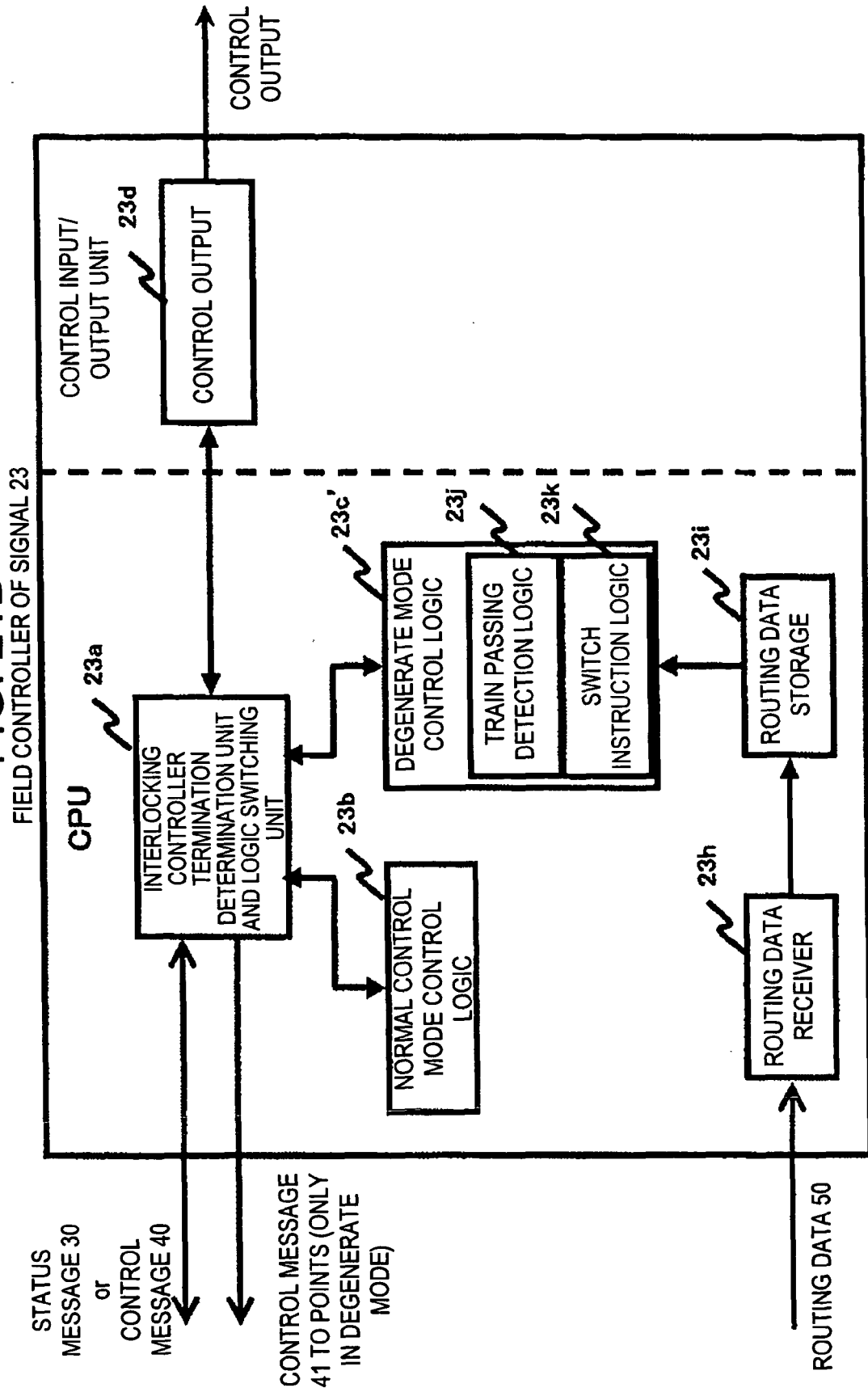


FIG. 21B



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- JP 2007091178 A [0002]