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(54) **Method and apparatus for administration and control of train service.**

(57) Transmitter and receiver units (28, ..., 31, 32 ..., 35) each connected to corresponding one of a plurality of sections (37 ..., 42; 43 ..., 48) of an information transmission line (36), information transmission units (24, 25; 26, 27), control-processing unit (22; 23) and a single administration-processing unit (21) are arranged to form a hierarchy structure. The administration-processing unit (21) monitors the operation of the whole system and supplies to the control-processing units (22; 23) information relating to a train service schedule of a group of trains, a modified train service schedule to meet a change in demand, etc., and the control-processing units (22; 23) performs the traffic control of each train.

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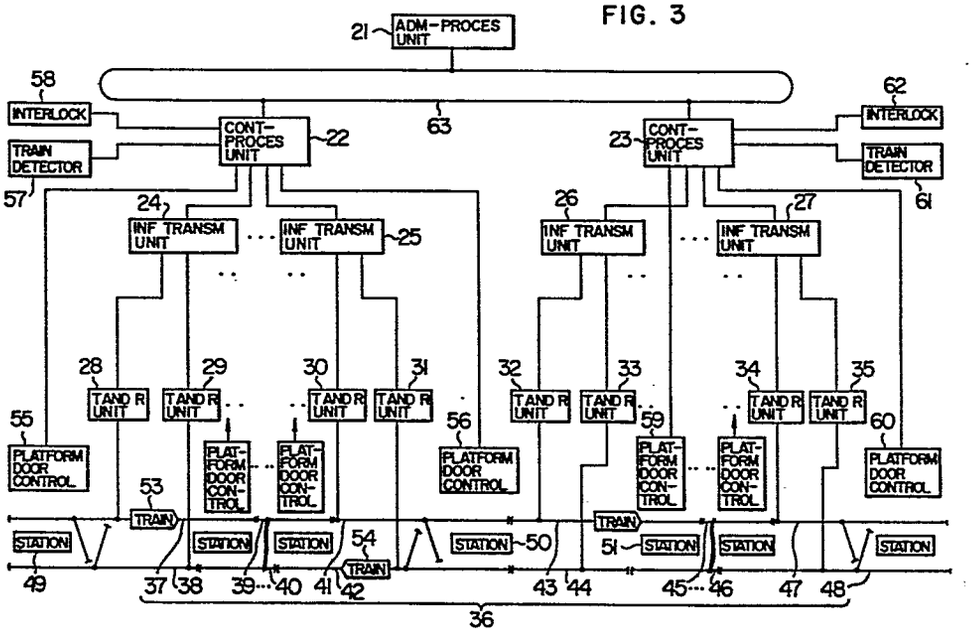
FIG. 3


21
ADM-PROCES UNIT
58
INTERLOCK
TRAIN DETECTOR
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CONT-PROCES UNIT
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CONT-PROCES UNIT
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METHOD AND APPARATUS FOR ADMINISTRATION AND CONTROL OF TRAIN SERVICE

This invention relates to a method and apparatus for administration and control of train service.

Prior art train service administration and control systems which can attain unmanned train operation are broadly classified into a so-called centralized control type and a so-called decentralized control type. The prior art system of the centralized control type is shown in FIG. 1. Referring to FIG. 1, an information transmission line 6 extending along the entire length of the track (not shown) laid for running of trains 7A to 7X (of which only two, 7A and 7X, are shown) is divided nto a plurality of sections 6A, 6B, 6C, 6D, ..., 6K, 6L, 6M and 6N (some of which are not shown). Transmitter and receiver units 5A, 5B, ..., 5M and 5N are respectively connected to the individual sections 6A, 6B, .., 6M and 6N of the information transmission line 6. (The transmitter and receiver units 5C to 5L corresponding to the sections 6C to 6L respectively are not shown to avoid confusion of illustration.) A single or a plurality of information transmission units 4 are connected to all of the transmitter and receiver units 5A, 5B, ..., 5M and 5N to transmit and receive information required for the control of the operation of the trains 7A to 7X existing within the extent of the sections 6A to 6N of the information transmission line 6. (In FIG. 1,

a single information transmission unit 4 is shown.) Connected to the information transmission unit 4 is a train service administration and control unit 1 to exchanging information with the information transmission unit 4. Connected to the train service administration and control unit 1 are platform door control units 10A to 10Z controlling opening and closure of doors disposed at the platform of stations 8A to 8Z. Connected also to the train service administration and control unit 1 are a train detection unit 11 and an interlocking operation unit 12. Both of the train service administration and control unit 1 and the information transmission unit 4 are collectively installed in a central control center. The train service administration and control unit 1 functions to prepare the train service schedule, administrate the group of the trains and control the operation of the individual trains.

According to such a train service administration and control system of the centralized control type, the structure of its control system can be simplified, and all of necessary information can be collected in the train service administration and control unit 1. Therefore, this sytem has such an advantage that the operators can acquire all the information of the whole system and can readily intervene or interrupt in the control as required. This sytem has such another advantage that the installation of the important parts of the system in the central control center facilitates maintenance of those

parts. However, the prior art system of the centralized control type has such a disadvantage that, in the event of occurrence of an accident, the load attributable to the accident is added to the normal load of the train service administration and control unit 1, and the response speed for processing is inevitably reduced due to the concentration of the loads to be processed. Further, the prior art system of the centralized control type has such another disadvantage that the expansion of the system to deal with an extension of the train track is difficult since the load to be processed by the unit 1 is generally proportional to the length of the track or the frequency of train service.

The prior art train service administration and control system of the decentralized control type is shown in FIG. 2. In FIG. 2, the same reference numerals are used to designate the same or equivalent parts appearing in FIG. 1. In the system of the distributed control type , station control units 9A to 9Z are disposed for the individual stations 8A to 8Z respectively. All of these station control units 9A to 9Z are connected to the train service administration and control unit 1. Connected to the station control units 9A to 9Z are the platform door control units 10A to 10Z, interlocking operation units 12A to 12Z and station information transmission lines 13A to 13Z respectively. Information of a train or trains stopped at the station or stations and information of the individual stations are exchanged between the train

service administration and control unit 1 and the station control units 9A to 9Z. The train service administration and control 1 monitors generally the status of the individual trains 7A to 7X and applies to the station control units 9A to 9Z, the train control information for controlling the trains according to a predermined schedule of train service. The station control units 9A to 9Z control the operation of the trains 7A to 7X according to a predetermined sequence and timing. While the trains 7A to 7X are running, the train service administration and control unit 1 monitors the status of the trains on the basis of information applied through the information transmission unit 4 and transmits the control command through the information transmission unit 4.

The system of the decentralized control type has such an advantage that the load processed by the train service administration and control 1 can be distributed to improve the response speed for processing. However, due to the fact that the component units of the system are widely distributed, the maintenance of the distributed units is not easy, and the necessity for providing two systems of the train information transmission line 6 and station information transmission lines 13, leads to an increase in the cost. Further, when any one of the station control units 9A to 9Z is disabled, the function of the disabled one of the station control units 9A to 9Z cannot be substituted by the train service administration and control unit 1 disposed in the central control

center and since the trouble cannot be dealt with by intervention from the central control center, an operator must be dispatched to the associated stations 8A to 8Z for which the station control units 9A to 9Z are provided respectively. The prior art system of the distributed control type is therefore defective in that the unmanning of the stations cannot be realized in such an event.

With a view to solve the technical problems encountered by the prior art systems described above, it is a primary object of the present invention to provide a method and apparatus for administration and control of train service, which increases the response speed for processing, facilitates an expansion of the system to deal with an extension of the train track and yet permits easy maintenance of the system.

The present invention provides a method and apparatus for train service administration and control including means for exchanging information including status information indicative of the operating status of each of a plurality of trains running on the track and command information controlling the operation of the train, through an information transmission line divided into a plurality of sections of a predetermined length extending along the entire length of the track thereby controlling the train operation according to a train service schedule, the apparatus comprising a plurality of transmitter and receiver units connected individually to the sections of the information transmission line,

at least one information transmission unit installed in a central control center to be connected to at least one of the transmitter and receiver units, at least one control-processing unit installed in the central control center to be connected to the information transmission unit, and a single administration and control unit installed in the central control center to be connected to the control-processing unit, all of the units being disposed in a hierarchy in the above order, so that the distribution of processing functions to the administration-processing unit and control-processing unit can improve the response speed of these processing units.

The present invention differs from the prior art system of the centralized control type in that the train service administration-processing unit is divided into a single administration-processing unit and a plurality of control-processing units constituting a hierarchy structure, and the tasks of the processing for administration and the processing for control are respectively allocated to respective stages of the hierarchy thereby improving the response speed for processing. The present invention differs also from the prior art system of the distributed control type in that all of information are collected in a central control center for conveniences of the operators, and simplification of the structure of the system and improvement in the maintenance are further achieved.

Preferred embodiments of the present invention

will now be described in detail with reference to the drawings.

FIGs. 1 and 2 are block diagrams illustrating the prior art train service administration and control systems.

FIG. 3 is a block diagram of a preferred embodiment of the present invention.

FIG. 4 is a block diagram showing the detailed structure of the control-processing unit 22 shown in FIG. 3.

FIG. 5 is a block diagram of another preferred embodiment of the present invention.

Referring to FIG. 3 which is a block diagram of a preferred embodiment of the present invention, the train service administration and control system according to the present invention comprises an administration-processing unit 21, a plurality of or, for example, two control-processing units 22 and 23, a plurality of information transmission units 24, ..., 25 and 26, ..., 27 (some of which are not shown), and a plurality of transmitter and receiver units 28, 29, ..., 30, 31, 32, 33, ..., 34 and 35 (some of which are not shown). The administration-processing unit 21 and the control-processing units 22, 23; the control-processing units 22, 23 and the information transmission units 24 to 27; and the information transmission units 24 to 27 and the transmitter and receiver units 28 to 35 are disposed in a hierarchy as shown.

An information transmission line 36 extends along the entire length of the track laid for running of trains (of which only two, 53 and 54, are shown). This information transmission line 36 is divided into a plurality of sections 37, 38, 39, ..., 40, 41, 42, 43, 44, 45, ..., 46, 47 and 48 (some of which are not shown in FIG. 3). The sections 37 to 42 of the information transmission line 36 are those disposed along a section of track which was constructed in the first stage of the tranck construction work, while the sections 43 to 48 of the information transmission line 36 are those disposed along an extended track section which was constructed in the second stage of the track construction work carried out to extend the track. Stations 49, ..., 50 are those provided in the first stage of the track construction work, while stations 51, ..., 52 are those provided in the second stage of the track construction work. The transmitter and receiver units 28 to 35 are disposed in a relation individually corresponding to the sections 37 to 48 respectively of the information transmission line 36. (The transmitter and receiver units corresponding to the sections 39, ..., 40 and 45, ..., 46 of the information transmission line 36 are not shown.) These transmitter and receiver units 28 to 35 are installed in the individual stations nearest thereto or two or more of them are collectively installed in each of the key stations of a plurality of stations.

The transmitter and receiver units 28 to 35

are divided into a plurality of groups (some of which are not shown), and the information transmission units 24 to 27 are disposed in a relation corresponding individually to the groups of the transmitter and receiver units 28 to 35. In FIG. 3, the transmitter and receiver units 28 and 29 are connected to the information transmission unit 24, and the transmitter and receiver units 30 and 31 are connected to the information transmission unit 25. The transmitter and receiver units 32 and 33 are connected to the information transmission unit 26, and the transmitter and receiver units 34 and 35 are connected to the information transmission unit 27.

The information transmission units 24 to 27 are divided into a plurality of groups, for example, two groups as shown, and the control-processing units 22 and 23, which may be composed of computers, are disposed in a relation individually corresponding to the groups of the information transmission units 24 to 27. The information transmission units 24 to 25 are connected to the control-processing unit 22, and the information transmission units 26 to 27 are connected to the control-processing unit 23.

Connected also to the control-processing unit 22 are platform door control units 55 to 56 controlling the opening and closure of doors disposed at the platform of the stations in relation to the opening and closure of the doors of the trains 53 to 54 running along the corresponding sections of the track, a train detection

unit 57 detecting the position of the trains 53 to 54, and an interlocking operation unit 58 controlling the route of advancing movement of the trains 53 to 54 and indicating the advancing route status. Connected also to the control-processing unit 23 are platform door control units 59 to 60 similar to the platform door control units 55 to 56, a train detection unit 61 similar to the train detection unit 57, and an interlocking operation unit 62 similar to interlocking operation unit 58.

The control-processing units 22 and 23 are connected to each other and to an administration-processing unit 21, which may be also composed of a computer, through an exclusive circuit 63 which is in the form of , for example, an optical fiber cable or a coaxial cable. The administration-processing unit 21, control-processing unit 22 and information transmission units 24 to 25 are collectively installed in a central control center. The control-processing unit 23 and information transmission units 26 to 27 are collectively installed in a sub-control center. The central control center and sub-control center may be located in the same place or separate places.

The administration-processing unit 21, which is of the high echelon in the hierarchy arrangement, exchanges information with the control-processing units 22 and 23 of the lower echelon through the exclusive circuit 63, to carry out processing for the purpose of administration. The administration-processing unit 21

supplied to the control-processing units 22 and 23 the information including the train service schedule prepared for the group of the trains 53 to 54, modified schedule required to deal with, for example, a change of the transportation demand and occurrence of an accident, and intervening or interrupt information for inhibiting departure of or emergency stopping of a train or trains. The administration-processing unit 21 functions also to monitor the status of the train service administration and control system.

The control-processing unit 22 receives train status information from the sections 37 to 42 of the information transmission line 36 through the transmitter and receiver units 28 to 31 and information transmission units 24 to 25. The control-processing unit 22 receives also platform door status information from the platform door control units 55 to 56, trains position information from the train detection unit 57 and train advancing route status information from the interlocking operation unit 58. In response to the train service schedule information and interrupt information supplied from the administration-processing unit 21, the control-processing unit 22 generates train control command information, platform door control command information and route setting command information with appropriate timing on the basis of the train status information, platform door status information, train position information and train advancing route status information applied thereto.

FIG. 4 is a block diagram showing the detailed structure of the control-processing unit 22 shown in FIG. 3. Referring to FIG. 4, the control-processing unit 22 includes a timer 70, a plurality of memory parts 71, 72, 73, 74, 75 and 76, a plurality of selector parts 77, 78 and 79, a plurality of output parts 80, 81 and 82, and a plurality of checking parts 83, 84 and 85.

The timer 70 performs time keeping operation. The first memory part 71 stores the train operation schedule information supplied from the administration-processing unit 21. The second memory part 72 stores the interrupt information supplied from the administration-processing unit 21. The third memory part 73 stores the train position information supplied from the train detection unit 57. The fourth memory part 74 stores the train status information supplied from the information transmission units 24 to 25. The fifth memory part 75 stores the platform door status information supplied from the platform door control units 55 to 56. The sixth memory part 76 stores the train advancing route status information supplied from the interlocking operation unit 58.

The selector 77, 78 and 79 are actuated in response to the application of the train position information together with the time information and select a train control command, a platform door control command and a route setting command respectively depending on the train service schedule. The first output part 80 supplies the selected train control command information to the

information transmission units 24 to 25. The second output part 81 supplies the selected platform door control command information to the platform door control units 55 to 56. The third output part 82 supplies the selected route setting command information to the interlocking operation unit 58.

The first checking part 83 compares the train control command information supplied from the first output part 80 to the information transmission units 24 to 25, with the train status information supplied to the first memory part 74 from the information transmission units 24 to 25, and if there is a non-coincidence therebetween, informs the administration-processing unit 21 of the presence of non-coincidence or trouble. The second checking part 84 compares the platform door control command information supplied from the second output part 81 to the platform door control units 55 to 56, with the platform door status information supplied to the fifth memory part 75 from the platform door control units 55 to 56, and, if there is a non-coincidence therebetween, informs the administration-processing unit 21 of the presence of non-coincidence or trouble. The third checking part 85 compares the route setting command information supplied from the third output part 82 to the interlocking operation unit 58, with the train advancing route status information supplied to the sixth memory part 76 from the interlocking operation unit 58, and, if there is a non-coincidence therebetween, informs the administration-processing unit 21 of the presence of non-coincidence

or trouble.

When such a non-coincidence is found as a result of the check for comparison between the train status information and the train control command information, between the platform door status information and the platform door control command information and/or between the train advancing route status information and the route setting command information, the control-processing unit 22 supplies a non-coincidence information output indicative of the presence of the non-coincidence or trouble to the administration-processing unit 21. Also the control-processing unit 22 supplies the train status information, platform door status information and train advancing route status information to the administration-processing unit 21.

The administration-processing unit 21 supplies the train service schedule information to the control-processing unit 22 and, when so required, supplies also manual interrupt information by the operator for train departure inhibition, emergency train stopping, door opening-closure, etc. with appropriate timing. On the basis of the train service schedule information and interrupt information and in response to the train position information applied together with the time information as trigger the control-processing unit 22 selects and stores the required train control command information, platform door control information and route setting command information in the respective selectors, and send these command information at appropriate timing. When a

predetermined period of time has elapsed or when any one of the statuses changes after sending of the command information from the control-processing unit 22, the specific status information and command information are checked to be compared with each other. When the result of the comparison check proves that there is a non-coincidence therebetween, the administration-processing unit 21 at the highest echelen is informed of the presence of non-coincidence or trouble.

The other control-processing unit 23 has a structure similar to that of the control-processing unit 22 and executes functions similar to those of the control-processing unit 22. Further, the second stage of the track construction work can be started at any desired time after the first stage of the track construction work was completed, and it can be made while the trains are running on the first stage track, and the second control-processing unit 23 can be very easily connected to the administration-processing unit 21 by connecting the exclusive circuit 63.

The information transmission units 24 to 27 transmit the command information to the trains 53 to 54 through the transmitter and receiver units 28 to 35 and the sections 37 to 48 of the information transmisstion line 36 according to a predetermined information transmission sequence. Further, the information transmission units 24 to 27 scan the status information of each of the trains 53 to 54 at intervals of a

predetermined period of time for detecting any change in the status of each train. When the result of scanning proves that a change has occurred in the status of any one of the trains, the corresponding one of the information transmission units 24 to 27 trainsmits the status information of the specific train to the associated one of the control-processing units 22 and 23 at the higher echelon.

The administration-processing unit 21 monitors the status of the train service administration and control system on the basis of the train status information, platform door status information and trouble information supplied from the control-processing units 22 and 23 and sends out interrupt information to the control-processing units 22 and 23. More precisely, the administration-processing unit 21 supplies to the control-processing units 22 and 23 the information including the train service schedule prepared for the train group, modified train service schedule required to deal with, for example, a change of the transportation demand and occurrence of an accident, and interrupt information for inhibiting departure of or emergency stopping of the train or trains, open-close control of the platform door or doors, etc. The administration-processing unit 21 functions also to offer various information indicative of the status of the system to the operators in the central control center, so that the operators monitoring the status of the system on the

control panel can operate the control console as required to supply to the control-processing units 22 and 23 the interrupt information for inhibiting departure or emergency stopping of a train or trains, open-close control of the platform door or doors, etc.

FIG. 5 is a block diagram of another preferred embodiment of the present invention. In FIG. 5, the scan reference numerals are used to designate the same or equivalent parts appearing in FIG. 3. It is to be noted that, in order to provide redundancy, the administration-processing unit 21, control-processing units 22 and 23, information transmission units 24 to 27, and transmitter and receiver units 28 to 35 shown in FIG. 3 are replaced by a dual or duplex configuration of administration-processing units 21a and 21b, control processing units 22a, 22b and 23a, 23b, information transmission units 24a, 24b, ..., 25a, 25b and 26a, 26b, ..., 27a, 27b, and transmitter and receiver units 28a, 28b, 29a, 29b, ..., 30a, 30b, 31a, 31b and 32a, 32b, 33a, 33b, ..., 34a, 34b, 35a, 35b. It will be seen that the administration-processing units 21a and 21b; control-processing units 22a, 22b and 23a, 23b; information transmission units 24a, 24b, ..., 25a, 25b and 26a, 26b, ..., 27a, 27b; and transmitter and receiver units 28a, 28b, 29a, 29b, ..., 30a, 30b, 31a, 31b and 32a, 32b, 33a, 33b, ..., 34a, 34b, 35a, 35b are provided in dual or duplex to operate as a dual system or duplex system. Therefore, the system constructed in this way can

operate with higher reliability. Although this redundant arrangement is applied to each of the administration-processing unit 21, control-processing units 22 and 23, information transmission units 24 to 27 and transmitter and receiver units 28 to 35 in FIG. 5, it may be applied to at least one of them.

It will be understood from the foregoing detailed description of the present invention that the distribution of processing functions to the processing units arranged in a hierarchy can increase the response speed for processing. Further, because of the arrangement in which the administration-processing unit, control-processing unit and information transmission units are collectively installed in the central control center to collect all of the information in the central control center, the operators in the central control center can readily intervene in the processing by the administration-processing unit or control-processing unit in the event of an emergency so that unmanning of the trains and stations can be achieved. Further, the system according to the present invention requires only a single information requires only a single information transmission line compared with the prior art system of the distributed control type. Therefore, the number of required units can be decreased and the system construction can be simplified, thereby to make easy the maintenance. Furthermore, because of the fact that the processing functions are so distributed that the

administration-processing unit participates in the processing for preparation of the train service schedule and the control-processing unit participates in the processing for train service control, an expansion of the sytem to deal with an extension of the track can be easily done compared with that in the prior art system of the centralized control type.

CLAIMS

1. A train service administration and control system including means for exchanging information including status information indicative of the operating status of a plurality of trains (53, ..., 54) running on the track, and command information controlling the operation of the train through an information transmission line (36) divided into a plurality of sections (37, 38, ..., 41, 42) of a predetermined length extending along the entire length of the track thereby controlling the train operation according to a train service schedule, characterized in that

a plurality of transmitter and receiver units (28, 29, ..., 30, 31) connected individually to said sections of said information transmission line, at least one information transmission unit (24, ..., 25) to be connected to at least one of said transmitter and receiver units, at least one control-processing unit (22) to be connected to said information transmission unit, and a single administration-processing unit (21) to be connected to said at least one control-processing unit, are connected to form a hierachy structure in this order with said administration-processing unit at the top echelon.

2. A train service administration and control systm as claimed in claim 1, characterized in that said administration-processing unit (21) and said control-processing unit (22) are connected to each other by an exclusive circuit (63).

3. A train service administration and control

system as claimed in claim 1 or 2, characterized in that at least one of said administration-processing unit (21), said control-processing unit (22), said information transmission unit (24, ..., 25) and the group of said plural transmitter and receive units (28, 29, ..., 30, 31) is further redundantly added to provide a multiplex system.

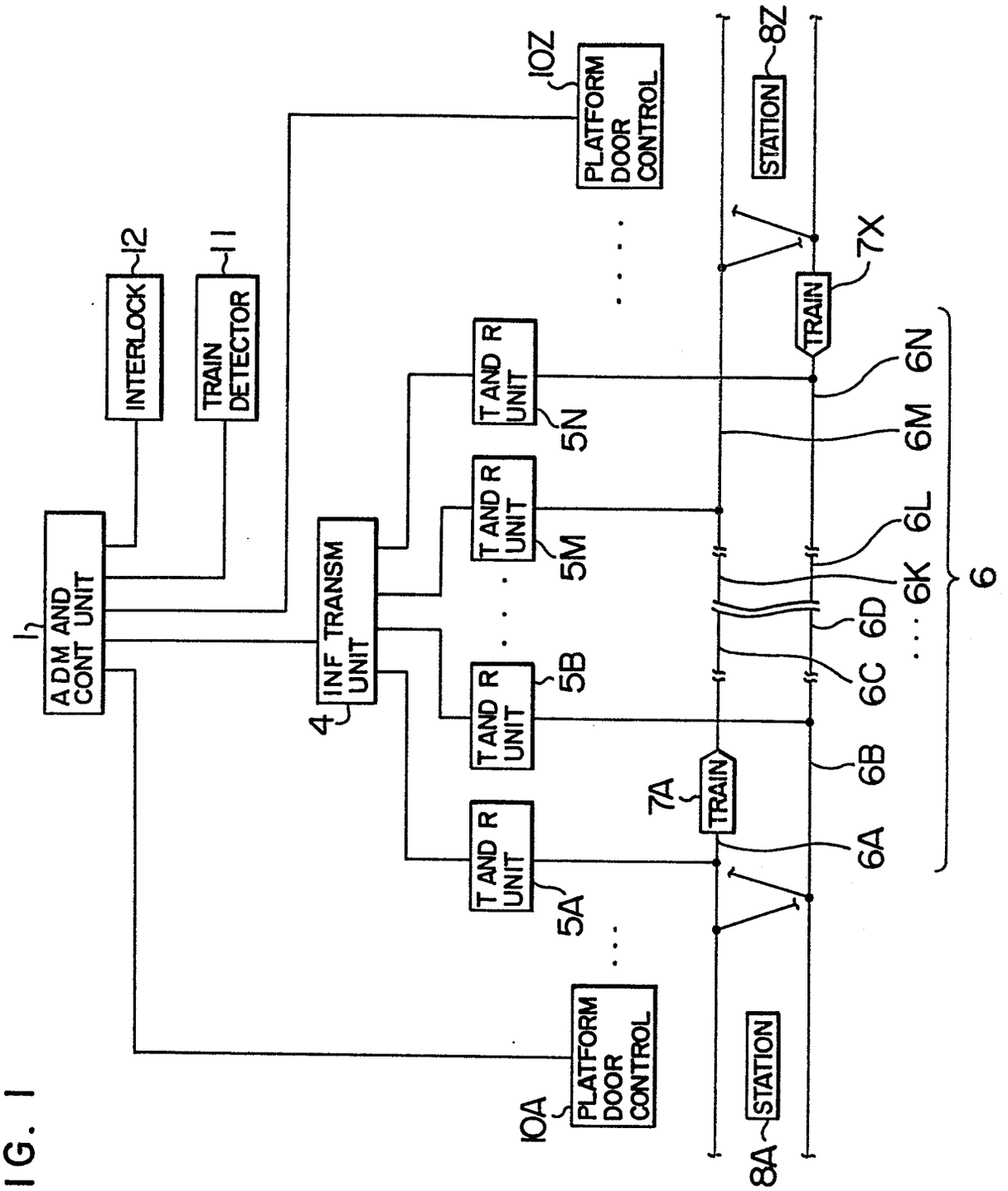
4. A train service administration and control systm, as claimed in claim 1, 2 or 3, characterized in that,

there are further provided a plurality of information transmission line sections (43, 44, ..., 47, 48) of a predetermined length extending along an extension of said track, a plurality of transmitter and receiver units (32, 33, ..., 34, 35) connected individually to said information transmission line sections, at least one information transmission unit (26, ..., 27) to be connected to at least one of said transmitter and receiver units, and at least one control-processing unit (23) to said information transmission unit, all of said units being disposed in a hierarchy in the above order, with said control-processing unit (23) being connected to said administration-processing unit (21) of the highest order in the hierarchy arrangement.

5. A method for train service administration and control by a train service administration and control system as claimed in claim 1, 2, 3 or 4, characterized in that at least one control-processing unit (22) is connected to a single administration-processing unit

(21), train service schedule information from said administration-processing unit is supplied to said control-processing unit, and the service of trains (53, ..., 54) existing within the governing range of said control-processing unit is controlled by the function of said control-processing unit.

FIG. 1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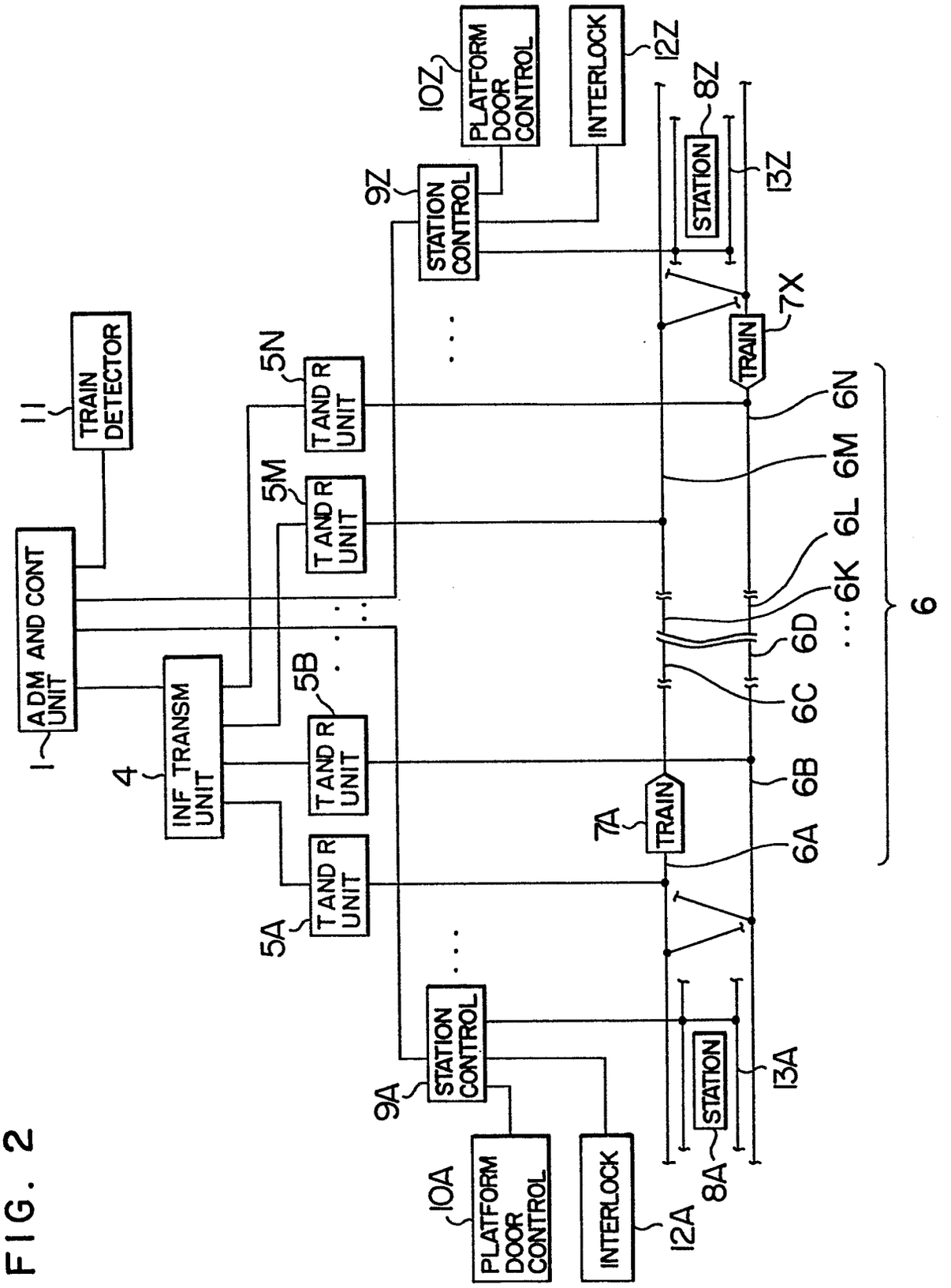
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FIG. 2

FIG. 3

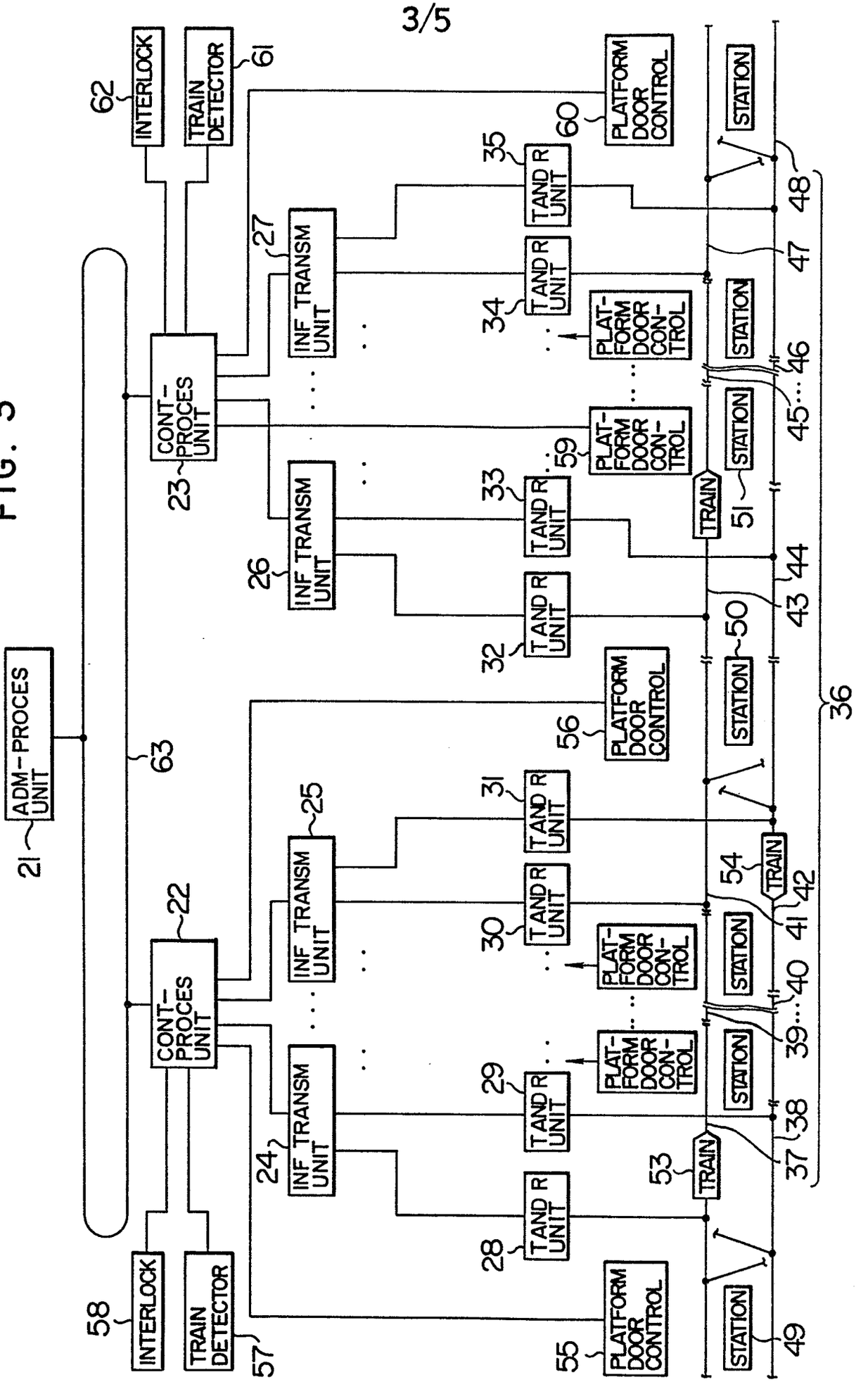
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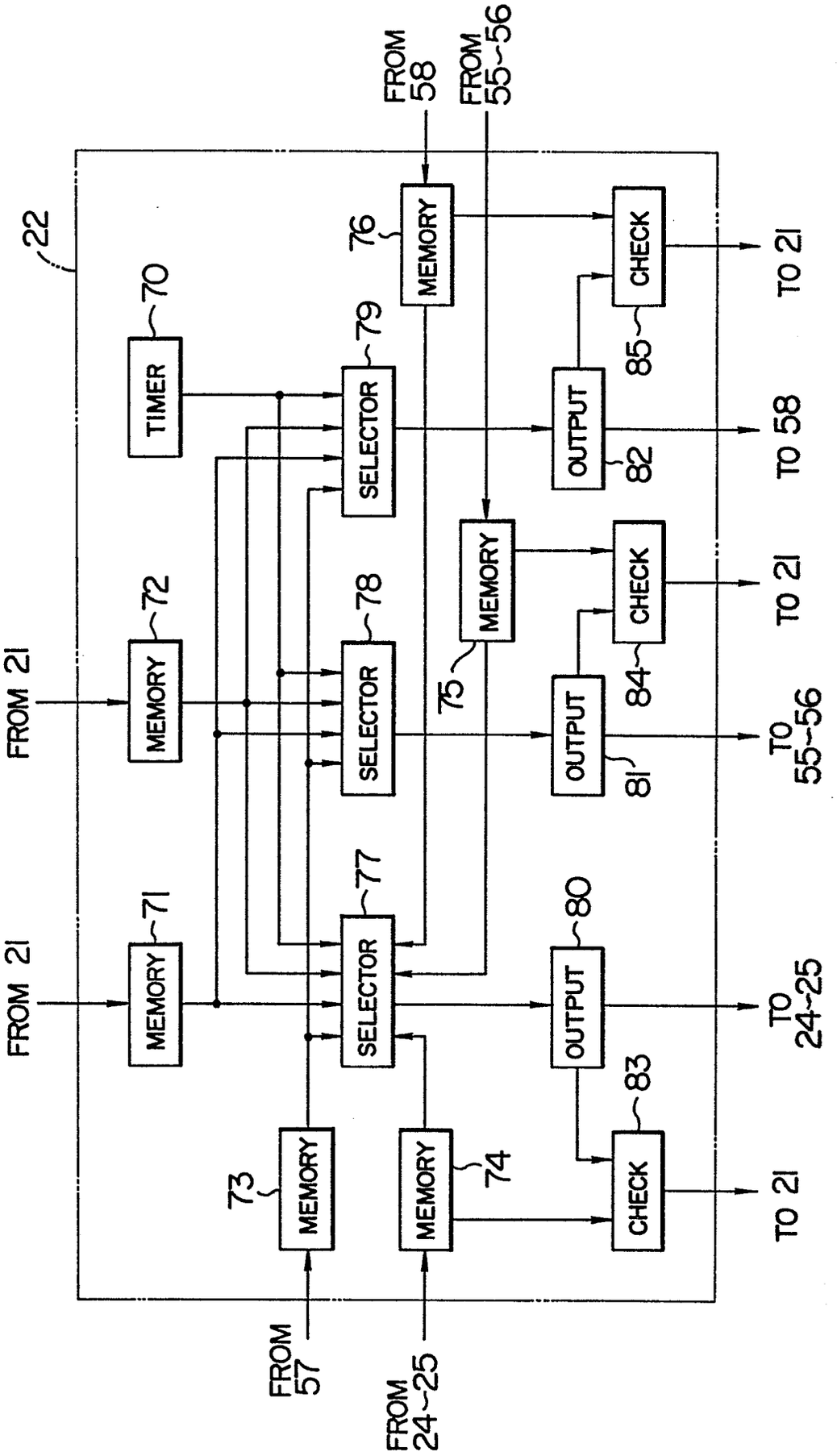
FIG. 4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TIMER
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SELECTOR
OUTPUT
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TO 58
MEMORY
CHECK
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FROM 21
MEMORY
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SELECTOR
OUTPUT
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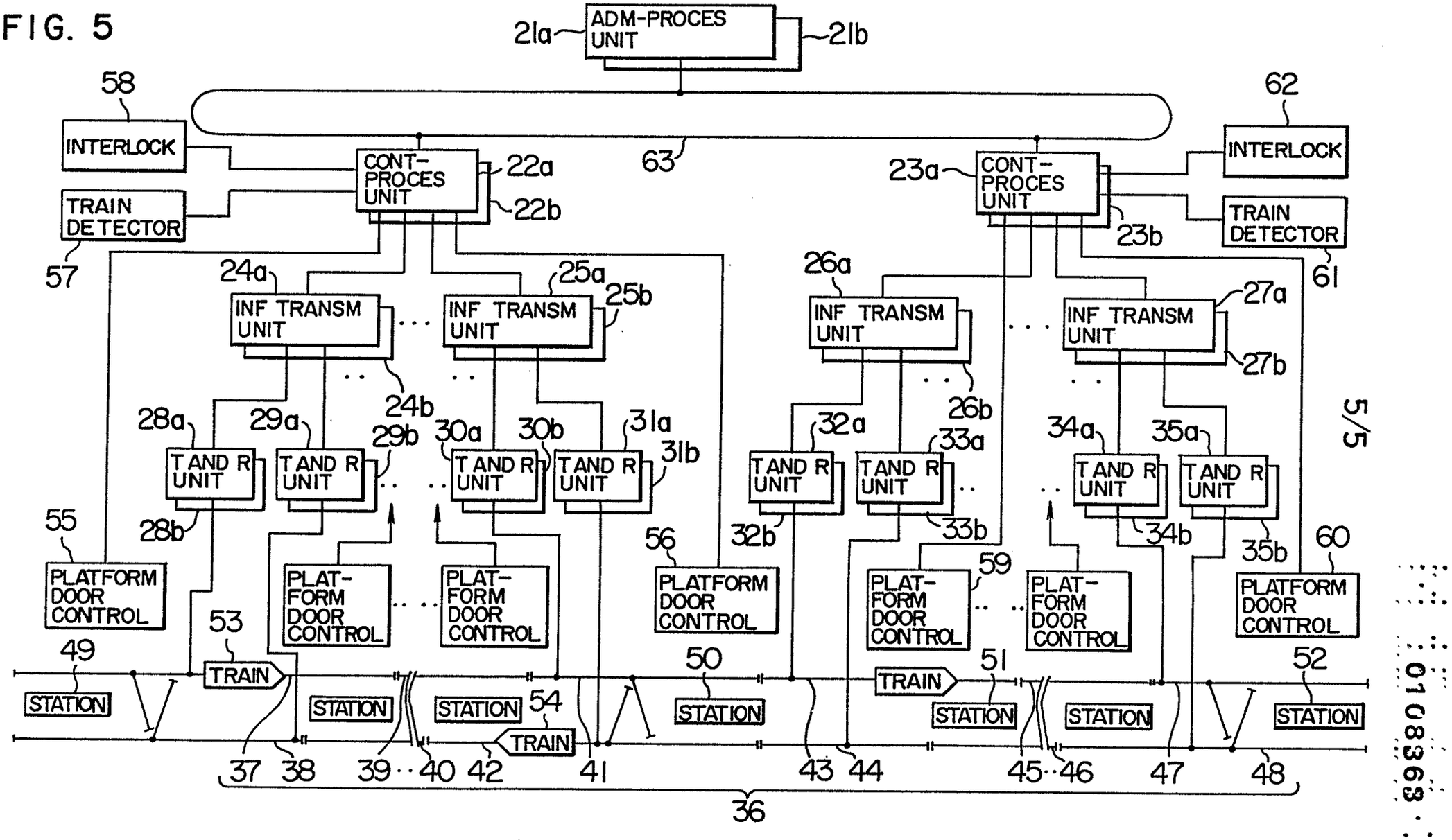
TO 55~56
FROM 21
MEMORY
71
77
SELECTOR
80
OUTPUT
TO 24~25
83
73
MEMORY
MEMORY
74
CHECK
TO 21
FROM 57
FROM 24~25

FIG. 5



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