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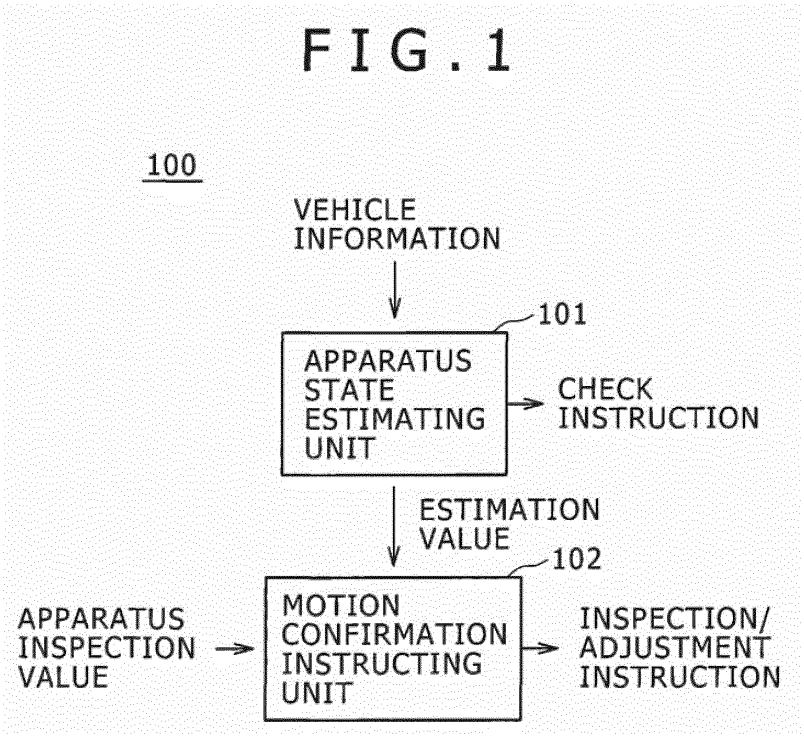
(54) Maintenance system for rolling stock

(57) A maintenance system for a rolling stock is provided in which the maintenance system substitutes for abnormality detection by a maintenance staff which has been hard in the checking work of the state reference maintenance, and the countermeasure support when abnormality has been found can be also executed by instructing the maintenance staff of countermeasure method when the abnormality has been detected.

The maintenance system for a rolling stock includes an apparatus state estimating unit (101) for estimating an estimation value of the state of a vehicular apparatus based on vehicle information collected from the rolling stock and displaying check instruction, and a motion confirmation instructing unit (102) for determining abnormality of the vehicular apparatus based on the estimation value an apparatus inspection value inputted by the maintenance staff and displaying inspection/adjustment instruction when abnormality has occurred.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a maintenance system for a rolling stock.

Background

[0002] In order to improve the maintenance efficiency of a rolling stock, introduction of state reference maintenance has progressed in which a vehicle state is estimated from vehicle information (sensor values, control command values) and maintenance is executed based on the estimated vehicle state.

[0003] For example, in Japanese Unexamined Patent Application Publication No. H9 (1997) -243518 (Patent Literature 1), a fatigue monitoring device of a vehicular axle has been disclosed which includes a filtering means for extracting data larger than the fatigue limit from the measurements of the stress of the axle of the vehicle during traveling by a sensor, a calculating means for inputting the extracted data for a predetermined period to accumulate and add the stress amplitude values extracted at respective inputs, a data base for storing the occurrence probability data of the fatigue damage generated in the case of past traveling relating to the axle of the same type and the occurrence probability data of the fatigue damage of the stress amplitude value cumulative value operated until the fatigue damage occurs, and an evaluating means for subtracting the cumulative value of the stress amplitude value calculated from the cumulative value of the amplitude values for giving the lower limit value of the occurrence probability of the fatigue damage impossible to be allowed on the occurrence probability data of the fatigue damage to evaluate the no fatigue allowance at the axle if the subtracted value is zero or a negative value (refer to the abstract).

[0004] Also, in Japanese Unexamined Patent Application Publication No. 2007-118887 (Patent Literature 2), a vehicle check support device has been disclosed which includes a check start instruction means for instructing the start of the predetermined check in a vehicle, a check content storage means for storing the check contents and the checking method for apparatuses or sensors and the like which are objects to be checked mounted on the vehicle, a checking method guide means for guiding the check contents and the checking method for the objects to be checked to a user based on the instruction and the stored content, a check result display means for displaying the results of the checks performed by the user, and a check result confirmation means for confirming the results of the checks by the user, in which, when the results of the checks are confirmed by the check result confirmation means, the checking method guide means guides the check contents and the checking method for a next object to be checked to the user (refer to the abstract).

Summary

[0005] However, when such the state reference maintenance as the Patent Literature 1 is introduced, the occasion for periodically checking the vehicle by a maintenance staff as done in the past is eliminated, and therefore such the possibility increases that the abnormality having been found by the maintenance staff in the periodical check in the past is overlooked.

[0006] Further, also in the case of executing the check according to the check instruction of the maintenance system and determining normality and abnormality as described in the Patent Literature2, the maintenance staff does not observe the status change of the apparatus as done in the conventional periodical check in the state reference maintenance, therefore it is hard for the maintenance staff to find a minute change of the vehicular apparatus and to determine abnormality or normality, and the abnormality is highly liable to be overlooked.

[0007] An object of the present invention is to provide a maintenance system for a rolling stock in which the maintenance system substitutes for abnormality detection by a maintenance staff which has been hard in the checking work of the state reference maintenance, and the countermeasure support when abnormality has been found can be executed by instructing the maintenance staff of the countermeasure method when the abnormality has been detected.

[0008] In order to address the present problems, according to the present invention, the maintenance system for a rolling stock includes

an apparatus state estimating means for estimating an estimation value of the state of a vehicular apparatus based on vehicle information collected from the rolling stock and displaying check instruction, and

a motion confirmation instructing means for determining abnormality of the vehicular apparatus based on the estimation value and an apparatus inspection value inputted by a maintenance staff and displaying inspection/adjustment instruction when abnormality has occurred.

[0009] According to the present invention, because the maintenance system substitutes for abnormality detection by the maintenance staff and observation of the state change of the apparatus by the maintenance staff is eliminated, the possibility that the maintenance staff overlooks the abnormality of the minute change of the vehicular apparatus reduces, and the countermeasure support when the abnormality has been found can also be executed. The problems, constitutions and effects other than those described will be clarified by the detailed description below.

Brief Description of the Drawings

[0010]

Fig. 1 is a block diagram showing the outline of the present invention.

Fig. 2 is a flow chart showing the outline of the present invention.
Fig. 3 is an example of the time chart of the apparatus state estimation value of the present invention.
Fig. 4 is a drawing explaining an application example of the present invention to a rolling stock.
Fig. 5 is an example of a screen for a maintenance staff of the first embodiment.
Fig. 6 is an example of the countermeasure flow chart of the first embodiment.
Fig. 7 is an example of a screen for a maintenance staff of the second embodiment.
Fig. 8 is an example of the countermeasure flow chart of the second embodiment.
Fig. 9 is another example of a screen for a maintenance staff of the second embodiment.
Fig. 10 is another example of the countermeasure flow chart of the second embodiment.
Fig. 11 is an example of a screen for a maintenance staff of the third embodiment.
Fig. 12 is an example of the countermeasure flow chart of the third embodiment.
Fig. 13 is an example of a screen for the maintenance staff of the fourth embodiment.
Fig. 14 is an example of the countermeasure flow chart of the fourth embodiment.
Fig. 15 is an example of a screen for a maintenance staff of the fifth embodiment.
Fig. 16 is an example of the countermeasure flow chart of the fifth embodiment.

Detailed Description

[0011] It is preferable that a maintenance system for a rolling stock of an embodiment of the present invention includes an apparatus state estimating unit for calculating an estimation value of a state of a plurality of vehicular apparatuses based on vehicle information received from an on-vehicle control device of the rolling stock collecting vehicle information that controls the plurality of vehicular apparatuses formed of on-vehicle apparatus or vehicle control apparatus mounted on a plurality of vehicles and displaying check instruction for the vehicular apparatus the estimation value of which has exceeded a predetermined threshold value, and a motion confirmation instructing unit for determining abnormality of the vehicular apparatus based on the estimation value and an apparatus inspection value inputted by a maintenance staff having inspected the vehicular apparatus, determining whether a comparison value of the estimation value and the apparatus inspection value is out of a predetermined range or not, and displaying inspection/adjustment instruction with reason that abnormality has occurred when the comparison value is out of the predetermined range.

[0012] Also, according to an embodiment of the present invention, it is preferable that the motion confirmation instructing unit displays the inspection/adjustment instruction when abnormality has occurred so that the apparatus inspection value comes closer to the estimation value.

[0013] It is preferable that a maintenance system for a rolling stock of an embodiment of the present invention includes an apparatus state estimating means for estimating a sand consumption amount from accumulation of sanding commands for a sanding device, and displaying check instruction for the sanding device when the estimation value has exceeded a predetermined value.

[0014] Also, it is preferable to include a motion confirmation instructing means for displaying inspection/adjustment instruction for the sanding device when a comparison value of an inspection value of an amount of sand replenished in checking the sand and an estimation value of a sand consumption amount estimated by the apparatus state estimating means exceeds a predetermined range.

[0015] It is preferable that a maintenance system for a rolling stock of an embodiment of the present invention includes an apparatus state estimating means for estimating a reserved water use amount from accumulation of toilet flushing commands and displaying check instruction for reserved water of the toilet when the estimation value exceeds a predetermined value.

[0016] Also, it is preferable to include a motion confirmation instructing means for displaying inspection/adjustment instruction for the toilet when a comparison value of an inspection value of a reserved water replenished amount in checking the reserved water and an estimation value of a reserved water use amount estimated by the apparatus state estimating means exceeds a predetermined range.

[0017] It is preferable that a maintenance system for a rolling stock of an embodiment of the present invention includes an apparatus state estimating means for estimating a sewage accumulated amount from accumulation of toilet flushing commands and displaying check instruction for sewage of the toilet when the estimation value exceeds a predetermined value.

[0018] Also, it is preferable to include a motion confirmation instructing means for displaying inspection/adjustment instruction for the toilet when a comparison value of an inspection value of a sewage extraction amount in sewage checking and an estimation value of a sewage accumulated amount estimated by the apparatus state estimating means exceeds a predetermined range.

[0019] It is preferable that a maintenance system for a rolling stock of an embodiment of the present invention includes an apparatus state estimating means for estimating a wear thickness of a brake pad from accumulation of brake control commands and displaying check instruction for the brake pad when the estimation value exceeds a predetermined value.

[0020] Also, it is preferable to include a motion confirmation instructing means for displaying inspection/adjustment instruction for the brake when a comparison value of an inspection value of the checking result of the brake pad wear thickness and the estimation value of the

brake pad wear thickness estimated by the apparatus state estimating means exceeds a predetermined range.

[0021] It is preferable that a maintenance system for a rolling stock of an embodiment of the present invention includes an apparatus state estimating means for estimating a wear amount of a third rail shoe based on accumulation of lowering control commands for the third rail shoe and displaying check instruction for a third rail when the estimation value exceeds a predetermined value.

[0022] Also, it is preferable to include a motion confirmation instructing means for displaying inspection/adjustment instruction for a third rail device when a comparison value of an inspection value of the checking result of the wear amount of the third rail and an estimation value of the third rail wear amount estimated by the apparatus state estimating means exceeds a predetermined range.

[0023] It is preferable that a maintenance system for a rolling stock of an embodiment of the present invention includes an apparatus state estimating means for estimating a wear amount of a pantograph based on accumulation of lifting control command time for the pantograph, and displaying check instruction for the pantograph when the estimation value exceeds a predetermined value.

[0024] Also, it is preferable to include a motion confirmation instructing means.for displaying inspection/adjustment instruction for a pantograph device when a comparison value of an inspection value of the checking result of the wear amount of the pantograph and an estimation value of the pantograph wear amount estimated by the apparatus state estimating means exceeds a predetermined range.

[0025] Below, the embodiments of the present invention will be described referring to the drawings.

[0026] Fig. 1 is a block diagram showing the outline of the present invention. An apparatus state estimating unit 101 of a maintenance system 100 for a rolling stock calculates an estimation value of an apparatus state (consumption amount/wear amount) that becomes an object based on vehicle information received from a vehicle. When the estimation value exceeds a predetermined value, an e-mail instructing the apparatus check is transmitted to a maintenance staff, or the check instruction is displayed on a screen so that the maintenance staff checks the object apparatus. Also, when the maintenance staff checks the object apparatus and inputs inspection values of the consumption amount and the wear amount of the object apparatus to the maintenance system, a motion confirmation instructing unit 102 compares the estimation value and the inspection value. When this comparison amount is larger than a predetermined range, it is determined that abnormality has occurred in the object apparatus, and inspection/adjustment instruction is displayed so that the inspection value comes closer to a predetermined value. That is, according to the present invention, by using the estimated information of the vehicular apparatus for not only displaying the check instruction but also for abnormality detection, detection of abnormality of the object apparatus which is liable to be overlooked by the maintenance staff by the state reference maintenance and the countermeasure (inspection/adjustment) can be achieved.

[0027] Fig. 2 is a flow chart showing the outline of the present invention. In step S201, the estimation value of the vehicle information (for example accumulation of the control commands, the detail thereof will be described below in the examples) is calculated, and the consumption amount and the wear amount of the object vehicular apparatus are estimated. In step S202, whether the estimation value is larger than a predetermined value or not is determined. When the estimation value is not larger than the predetermined value, the process returns to step S201, and calculation of the estimation value is continued. When the estimation value is larger than the predetermined value in step S202, the process proceeds to step S203, and the check instruction of the object apparatus is displayed.

[0028] This check instruction display is executed until the maintenance staff inputs the apparatus inspection value in step S204. When the inspection value is inputted in step S204, whether the comparison value of the apparatus inspection value and the estimation value is out of the predetermined range or not is determined in step S205, and, when it is out of the predetermined range, the effect that abnormality has occurred in the apparatus is notified in step S206, and the instruction of disposal of the abnormality is displayed on the screen of the maintenance system. In step S207, by resetting the estimation value, the process returns to step S201, and calculation of the estimation value until the next inspection time is restarted. After the restart, the check instruction display of step S203 and the abnormality disposal procedure display of step S207 are repeated in a similar manner, and the process is carried on so that the estimation values comes closer to the inspection value.

[0029] Fig. 3 shows a time chart of the estimation value. When the estimation value exceeds a predetermined check reference value, the check instruction is issued. At the time of normality of Fig. 3-1, the estimation value is reset at a time point the inspection value is inputted.

[0030] Also, at the time of abnormality shown in Fig. 3-2, although the process is same until the check instruction is issued when the estimation value exceeds the check reference value, it is different that the estimation value is reset after the abnormality disposal instruction is displayed. The reason of doing so is for the purpose of displaying the abnormality disposal instruction based on the comparison value of the estimation value and the inspection value, and both of the inspection value and the estimation value are necessary for displaying the abnormality disposal instruction.

[0031] Fig. 4 is a drawing explaining an application example of the present invention to a rolling stock. In the rolling stock 400, a plurality of vehicles 401 are connect-

ed. Each vehicle 401 is provided with on-vehicle apparatuses 406 such as a sanding device 402, an on-vehicle toilet 403, a brake control unit 404, a pantograph 405 and the like or a vehicle control apparatus 407. The vehicular apparatuses formed of the on-vehicle apparatuses 406 or the vehicle control apparatus 407 are connected to each other by an on-vehicle network 411, and each vehicular apparatus is controlled by a control signal from an on-vehicle control device 410.

[0032] The on-vehicle control device 410 collects vehicle information including control signals for respective vehicular apparatuses or motion signals for respective vehicular apparatuses via the on-vehicle network 411, and transmits them to a ground control device 420 for the rolling stock by an on-vehicle antenna 412 for example. The vehicle information transmitted from the on-vehicle antenna 412 of the on-vehicle control device 410 is received by a ground antenna 421 of the ground control device 420, and is stored in a storage unit 423 via a transmission/reception unit 422.

[0033] The storage unit 423 is provided with functions of the apparatus state estimating unit 101 of the maintenance system 100 for a rolling stock and the motion confirmation instructing unit 102, executes processing according to a procedure shown in Fig. 2, displays required check instruction of an apparatus on a display terminal 425, and displays required inspection/adjustment instruction for the apparatus responding input of the apparatus inspection value by a maintenance staff by control of a CPU 424.

First Embodiment

[0034] The first embodiment of the present invention will be described using Fig. 5 and Fig. 6. The present example shows a case of applying the present invention to the state reference maintenance of a sanding device for a rolling stock.

[0035] Fig. 5 is an example of a screen produced to a maintenance staff when the present invention is applied. Fig. 5-1 is an example of the check instruction screen displayed when the consumption amount of the injected sand is estimated from accumulation of the sanding control command value in the flow chart described in Fig. 2 and the estimation value exceeds the check reference value in the time chart shown in Fig. 3.

[0036] The maintenance staff confirms a method for replenishing sand for the sanding device by selecting a button at the left bottom of the present screen, and proceeds to an inspection value input screen shown in Fig. 5-2 by selecting an inspection value input button after completion of the replenishing work. In the inspection value input screen, the amount of the sand replenished by the maintenance staff is inputted as an inspection value.

[0037] Here, in the maintenance system, the inspection value inputted by the maintenance staff and the estimation value estimated by accumulation of the sanding injection command value are compared to each other, and abnormality of the sanding device is determined. Fig. 5-3 shows a case the comparison value of the estimation value and the inspection value is out of a predetermined range, and, when an inspection procedure button at the left bottom is selected, the inspection procedure is displayed according to a flow chart described below.

[0038] Fig. 6 shows an example of the flow chart when the sanding device is determined to be abnormal. In step S601, whether the code of the difference of the inspection value and the estimation value (comparison value) is positive or not is determined. The process proceeds to step S602 when the code is positive, and the process proceeds to step S605 when the code is not positive. The fact that the comparison value is positive here means that the consumption amount of the sand is more than that of the time of normality, and, in step S602, in order to investigate the cause of it, the instruction of checking abnormality such as a hole, crack and the like in a tank for storing the sand is displayed first.

[0039] Next, whether the tank is abnormal or not is inputted to the system in step S603. When abnormality of the tank is inputted to the maintenance system, the process further proceeds to step S604, a tank repair procedure is displayed, and the abnormality disposal finishes. Next, step S605 shows a case abnormality is not found in the tank. Here, a method for checking whether the sand injection amount of the sanding device is more or less compared to a stipulated value based on the comparison value is displayed.

[0040] When abnormality of injection is inputted to the maintenance system in step S606, the process proceeds to step S607, and a means for adjusting the injection amount to the stipulated value is displayed. When abnormality is not detected even in step S606, abnormality of an inspection apparatus or a mistake in inputting the inspection value is doubted, and therefore a procedure for confirming them is displayed in step S608.

[0041] In the present invention, notification is given by e-mail or on the screen to replenish the sand when the remaining amount of the sand of the sanding device is estimated from accumulation of the sand injection command value and the estimation value of the sand consumption amount becomes larger than a predetermined value (for example 80% of the total tank volume). Also, by inputting the sand replenishing amount replenished then to the maintenance system as the inspection value, abnormality of the sanding device is automatically detected by the maintenance system. In addition, by displaying' the inspection procedure depending on the comparison value of the estimation value and the inspection value, the maintenance work can be executed efficiently even when the maintenance staff is not accustomed to the maintenance work of the sanding device.

Second Embodiment

[0042] The second embodiment of the present inven-

tion will be described using Fig. 7 to Fig. 10. The present example shows a case of applying the present invention to the state reference maintenance of a toilet for a rolling stock.

[0043] Fig. 7 is an example of a screen produced to the maintenance staff when the present invention is applied. Fig. 8-1 is an example of the check instruction screen displayed when the consumption amount of the water utilized is estimated from accumulation of the flushing control command value in the flow chart of Fig. 2 and the estimation value exceeds the check reference value in the time chart shown in Fig. 3. The maintenance staff confirms a method for replenishing the water for the flush toilet by pressing a button at the left bottom of the present screen, and proceeds to an inspection value input screen shown in Fig. 7-2 by pressing an inspection value input button after completion of the replenishing work.

[0044] In the inspection value input screen, the amount of the water replenished by the maintenance staff is inputted as an inspection value. Here, in the maintenance system, the inspection value inputted by the maintenance staff and the estimation value estimated from accumulation of the flushing control command value are compared to each other, and abnormality of the flush toilet is determined. Fig. 7-3 shows a case the comparison value of the estimation value and the inspection value is out of a predetermined range, and, when an inspection procedure button at the left bottom is pressed, the inspection procedure is displayed according to a flow chart described below.

[0045] Fig. 8 shows an example of the flow chart when the flush toilet is determined to be abnormal. In step S801, whether the code of the difference of the inspection value and the estimation value (comparison value) is positive or not is determined. The process proceeds to step S802 when the code is positive, and the process proceeds to step S805 when the code is not positive. The effect that the comparison value is positive here means that the consumption amount of the water is more than that of the time of normality, and, in step S802, in order to investigate the cause of it, the instruction of checking abnormality such as a hole, crack and the like in a tank for storing the water is displayed first.

[0046] Next, when abnormality of the tank is inputted to the maintenance system in step S803, the process proceeds to step S804, a tank repair procedure is displayed, and the abnormality disposal finishes. Next, step S805 shows a case abnormality is not found in the tank. Here, a method for checking whether the flushing amount per one time is more or less compared to a stipulated value based on the comparison value is displayed.

[0047] In step S806, when abnormality of the flushing amount is found, abnormality of flushing is inputted to the maintenance system, and a means for adjusting the flushing amount to the stipulated value is displayed is step S807. When abnormality is not detected even in step S806, abnormality of an inspection apparatus or a mistake in inputting the inspection value is doubted, and therefore a procedure for confirming them is displayed in step S808.

[0048] In the present invention, the check instruction is issued to replenish the water when the remaining amount of the water of the flush toilet is estimated from accumulation of the flushing command value and the estimation value of the water consumption amount becomes larger than a predetermined value (for example 80% of the total tank volume). In addition, by inputting the water replenishing amount replenished then to the system as an inspection value, abnormality of the flush toilet is automatically detected by the system, and, by displaying the inspection procedure depending on the comparison value of the estimation value and the inspection value, the maintenance work can be executed efficiently even when the maintenance staff is not accustomed to the maintenance work of the flush toilet.

[0049] Fig. 9 is another example of a screen produced to the maintenance staff when the present invention is applied. Fig. 9-1 is an example of a warning screen displayed when the consumption amount of the water utilized is estimated from accumulation of the flushing command value in the flow chart of Fig. 2 and the estimation value exceeds the check reference value in the time chart of Fig. 3. The maintenance staff confirms a method for extracting the sewage of the flush toilet by pressing a button at the left bottom of the present screen, and proceeds to an inspection value input screen shown in Fig. 9-2 by selecting an inspection value input button after completion of the extracting work.

[0050] In the inspection value input screen, the maintenance staff inputs the amount of the extracted water as an inspection value. Here, in the maintenance system, the inspection value inputted by the maintenance staff and the estimation value estimated from accumulation of the flushing command value are compared to each other, and abnormality of the flush toilet is determined. Fig. 9-3 shows a case the comparison value of the estimation value and the inspection value is out of a predetermined range, and, when an inspection procedure button at the left bottom is pressed, the inspection procedure is displayed according to a flow chart described below.

[0051] Fig. 10 shows another example of the flow chart when the flush toilet is determined to be abnormal. In step S1001, whether the code of the difference of the inspection value and the estimation value (comparison value) is positive or not is determined. The process proceeds to step S1002 when the code is positive, and the process proceeds to step S1005 when the code is not positive. The effect that the comparison value is positive here means that the accumulated amount of the sewage is more than that of the time of normality, and, in step S1002, in order to investigate the cause of it, the instruction of checking abnormality such as a hole, crack and the like in a tank for storing the sewage is displayed.

[0052] Next, when abnormality of the tank is inputted to the maintenance system in step S1003, the process proceeds to step S1004, a tank repair procedure is dis-

played, and the abnormality disposal finishes. Step S1005 shows a case abnormality is not found in the tank, and, here, a method for checking whether the flushing amount per one time is more or less compared to a stipulated value is displayed.

[0053] When abnormality of the flushing amount is found, abnormality of flushing is inputted to the maintenance system in step 51006, and an adjustment procedure for adjusting the flushing amount to a stipulated value is displayed in step S1007. When abnormality is not detected even in step S1006, abnormality of an inspection apparatus or a mistake in inputting the inspection value is doubted, and therefore a procedure for confirming them is displayed in step S1008.

[0054] In the present invention, the check instruction is issued to extract the sewage when the sewage amount of the flush toilet is estimated from accumulation of the flushing command value and the estimation value of the sewage amount becomes larger than a predetermined value (for example 80% of the total tank volume), the sewage amount extracted then is inputted to the system as an inspection value, thereby abnormality of the flush toilet is automatically detected by the system, and, by displaying the inspection procedure depending on the comparison value of the estimation value and the inspection value, the maintenance work can be executed efficiently even when the maintenance staff is not accustomed to the maintenance work of the flush toilet.

Third Embodiment

[0055] The third embodiment of the present invention will be described using Fig. 11 and Fig. 12. The present example shows a case of applying the present invention to the state reference maintenance of a brake for a rolling stock.

[0056] Fig. 11 is an example of a screen produced to the maintenance staff when the present invention is applied. Fig. 11-1 is a check instruction screen displayed when the brake wear amount is estimated from accumulation of the brake control command value in the flow chart described in Fig. 2 and the estimation value exceeds the check reference value in the time chart of Fig. 3.

[0057] The maintenance staff confirms a method for replacing a brake pad by pressing a button at the left bottom of the present screen, and proceeds to an inspection value input screen shown in Fig. 11-2 by selecting an inspection value input button after completion of the replacement work. In the inspection value input screen, the wear amount of the brake pad replaced by the maintenance staff is inputted as an inspection value. In the maintenance system, the inspection value inputted by the maintenance staff and the estimation value estimated from accumulation of the brake command value are compared to each other, and abnormality of the brake is determined.

[0058] Fig. 11-3 shows a case the comparison value of the estimation value and the inspection value is out of a predetermined range, and, when an inspection procedure button at the left bottom is pressed, the inspection procedure is displayed according to a flow chart described below. Also, in Fig. 11-2, the remaining thickness may be inputted instead of the wear amount of the brake pad, and the wear amount may be calculated from the thickness when the brake pad is new and the inputted remaining thickness on the maintenance system.

[0059] Fig. 12 shows an example of the flow chart when the brake is determined to be abnormal. In step S1201, whether the code of the difference of the inspection value and the estimation value (comparison value) is negative or not is determined. The process proceeds to step S1202 when the code is negative, and the process proceeds to step S1105 when the code is not negative. The effect that the comparison value is negative here means that the wear amount of the brake is less than that at the time of normality, and, in step S1202, in order to investigate the cause of it, the instruction of checking whether the brake stroke is abnormal or not (whether the stroke is short or not) is displayed.

[0060] Next, whether the brake stroke is abnormal or not is inputted to the system is step S1203. When abnormality of the stroke is inputted, a procedure for adjusting the brake stroke is displayed in step S1204, and the abnormality disposal finishes. Next, step S1205 shows a case abnormality is not found in the brake stroke. Here, a method for checking whether the brake pressure is more or less compared to a stipulated value based on the code of the comparison value is displayed. More specifically, the pressure is excessively high when the comparison value is positive, the pressure is excessively low when the comparison value is negative, and the means for inspecting and adjusting them is displayed.

[0061] In step S1206, when abnormality of the brake pressure is inputted to the maintenance system, a means for adjusting the brake pressure to a stipulated value is displayed in step S1207. When abnormality is not detected even in step S1206, abnormality of an inspection apparatus or a mistake in inputting the inspection value is doubted, and therefore a procedure for confirming them is displayed in step S1208.

[0062] In the present invention, the check instruction is issued to replace the brake pad when the wear amount of the brake pad is estimated from accumulation of the brake command value and the estimation value of the brake use amount becomes larger than a predetermined value. Also, by inputting the wear amount of the brake pad replaced then to the system as an inspection value, abnormality of the brake is automatically detected by the system, and, by displaying the inspection procedure depending on the comparison value of the estimation value and the inspection value, the maintenance work can be executed efficiently even when the maintenance staff is not accustomed to the maintenance of the brake.

Fourth Embodiment

[0063] The fourth embodiment of the present invention will be described using Fig. 13 and Fig. 14. The present example shows a case of applying the present invention to the state reference maintenance of a brake for a rolling stock.

[0064] Fig. 13 is an example of a screen produced to the maintenance staff when the present invention is applied. Fig. 13-1 is a check instruction screen displayed when the third rail wear amount is estimated from accumulation of the third rail shoe control command value in the flow chart described in Fig. 2 and the estimation value exceeds the check reference value in the time chart shown in Fig. 3.

[0065] The maintenance staff confirms a method for replacing a third rail shoe by pressing a button at the left bottom of the present screen, and proceeds to an inspection value input screen shown in Fig. 13-2 by pressing an inspection value input button after completion of the replacement work. In the inspection value input screen, the wear amount of the third rail shoe replaced by the maintenance staff is inputted as an inspection value.

[0066] In the maintenance system, the inspection value inputted by the maintenance staff and the estimation value estimated from accumulation of the third rail shoe control command value are compared to each other, and abnormality of the third rail is determined. Fig. 13-3 shows a case the comparison value of the estimation value and the inspection value is out of a predetermined range, and, when an inspection procedure button at the left bottom is pressed, the inspection procedure is displayed according to a flow chart described below.

[0067] Fig. 14 shows an example of a flow chart when the third rail.is determined to be abnormal. In step S1401, whether the code of the difference of the inspection value and the estimation value (comparison value) is negative or not is determined. The process proceeds to step S1305 when the code is negative, and the process proceeds to step S1402 when the code is not negative. The effect that the comparison value is negative here means that the wear amount of the third rail is less than that at the time of normality, and, in step S1402, in order to investigate the cause of it, the instruction of checking whether the stroke of the third rail control is abnormal or not (whether the stroke is short or not) is displayed.

[0068] When abnormality of the stroke of the third rail control is inputted to the maintenance system is step S1403, a procedure for adjusting the third rail stroke is displayed in step S1404, and the abnormality disposal finishes.. Step S1405 shows a case abnormality is not found in the stroke of the third rail control. Here, a method for checking whether the third rail pressure is more or less compared to a stipulated value based on the code of the comparison value is displayed.

[0069] More specifically, the pressure is excessively high when the comparison value is positive, the pressure is excessively low when the comparison value is negative, and the means for inspecting and adjusting them is displayed. When abnormality of the third rail pressure has been found in step S1406, if the abnormality of the third rail pressure is inputted to the maintenance system, a means for adjusting the third rail pressure to a stipulated value is displayed in step S1407. When abnormality is not detected even in step S1306, abnormality of an inspection apparatus or a mistake in inputting the inspection value is doubted, and therefore a procedure for confirming them is displayed in step S1408.

[0070] In the present invention, the check instruction is issued to replace the third rail shoe when the wear amount of the third rail shoe is estimated from accumulation of the third rail control command value and the estimation value of the third rail shoe wear amount becomes larger than a predetermined value. In addition, by inputting the wear amount of the third rail shoe replaced then to the system as an inspection value, abnormality of the third rail is automatically detected by the system, and, by displaying the inspection procedure depending on the comparison value of the estimation value and the inspection value, the maintenance work can be executed efficiently even when the maintenance staff is not accustomed to the maintenance of the third rail.

Fifth Embodiment

[0071] The fifth embodiment of the present invention will be described using Fig. 15 and Fig. 16. The present example shows a case of applying the present invention to the state reference maintenance of a pantograph for a rolling stock.

[0072] Fig. 15 is an example of a screen produced to the maintenance staff when the present invention is applied. Fig. 15-1 is a warning screen displayed when the pantograph shoe wear amount is estimated from accumulation of the pantograph control command value in the flow chart described in Fig. 2 and the estimation value exceeds the alarm reference value in the time chart of Fig. 3.

[0073] The maintenance staff confirms a method for replacing a pantograph shoe by pressing a button at the left bottom of the present screen, and proceeds to an inspection value input screen shown in Fig. 15-2 by selecting an inspection value input button after completion of the replacement work. In the inspection value input screen, the wear amount of the pantograph shoe replaced by the maintenance staff is inputted as an inspection value.

[0074] In the maintenance system, the inspection value inputted by the maintenance staff and the estimation value estimated from accumulation of the pantograph command value are compared to each other, and abnormality of the pantograph is determined. Fig. 15-3 shows a case the comparison value of the estimation value and the inspection value is out of a predetermined range, and, when an inspection procedure button at the left bottom is pressed, the inspection procedure is dis-

played according to a flow chart described below.

[0075] Fig. 16 shows an example of a flow chart when the pantograph is determined to be abnormal. In step S1601, whether the code of the difference of the inspection value and the estimation value (comparison value) is negative or not is determined. The process proceeds to step S1605 when the code is negative, and the process proceeds to step S1602 when the code is not negative. The effect that the comparison value is negative here means that the wear amount of the pantograph is less than that at the time of normality, and, in step S1602, in order to investigate the cause of it, the instruction of checking whether the pantograph stroke is abnormal or not (whether the stroke is short or not) is displayed.

[0076] Next, when abnormality of the pantograph stroke is inputted is step S1603, a procedure for adjusting the pantograph stroke is displayed in step S1604, and the abnormality disposal finishes. Next, step S1605 shows a case abnormality is not found in the pantograph stroke. Here, a method for checking whether the pressing pressure for the pantograph is more or less compared to a stipulated value based on the code of the comparison value is displayed.

[0077] More specifically, the pressure is excessively high when the comparison value is positive, the pressure is excessively low when the comparison value is negative, and the means for inspecting and adjusting them is displayed. In step S1606, when the effect that the pantograph pressure is abnormal is inputted to the maintenance system, a means for adjusting the pressing pressure of the pantograph to a stipulated value is displayed in step S1607. When abnormality is not detected even in step S1606, abnormality of an inspection apparatus or a mistake in inputting the inspection value is doubted, and therefore a procedure for confirming them is displayed in step S1608.

[0078] In the present invention, the check instruction is issued to replace the pantograph shoe when the wear amount of the pantograph shoe is estimated from accumulation of the pantograph control command value and the estimation value of the pantograph shoe wear amount becomes larger than a predetermined value. In addition, by inputting the wear amount of the pantograph shoe replaced then to the system as an inspection value, abnormality of the pantograph is automatically detected by the maintenance system, and, by displaying the inspection procedure depending on the comparison value of the estimation value and the inspection value, the maintenance work can be executed efficiently even when the maintenance staff is not accustomed to the maintenance of the pantograph.

[0079] Also, the present invention is not limited to the examples described above, and various alterations are included therein. For example, the examples described above were described in detail in order to describe the present invention so as to be understood easily, and the present invention is not necessarily limited to those including all of the constitutions described.

[0080] Further, it is possible to replace a part of a constitution of a certain example with a constitution of another example, and it is also possible to add a constitution of another example to a constitution of a certain example. Furthermore, with respect to a part of a constitution of each example, it is possible to add and replace other constitutions.

[0081] Also, respective constitutions, functions, processing units, processing procedures and the like described above may be achieved by hardware by designing and the like of a part or all of them with an integrated circuit for example. Further, respective constitutions, functions and the like described above may be achieved by software by that a processor interprets and executes programs that achieve respective functions. Information such as a program, table, file and the like achieving respective functions can be placed in a storage device or a storage medium.

[0082] Further, with respect to the control line and the information line, those considered to be necessary for explanation have been shown, and all of the control lines and the information lines included in products have not necessarily been shown. In fact, it is generally considered that almost all constitutions are connected to each other.

Claims

1. A maintenance system for a rolling stock, comprising:

   an apparatus state estimating unit for calculating an estimation value of a state of a vehicular apparatus based on vehicle information collected from the rolling stock, and displaying check instruction; and

   a motion confirmation instructing unit for determining abnormality of the vehicular apparatus based on the estimation value and an apparatus inspection value inputted by a maintenance staff, and displaying inspection/adjustment instruction when abnormality has occurred.

2. The maintenance system for a rolling stock according to claim 1, wherein

   the apparatus state estimating unit calculates an estimation value of a state of the plurality of the vehicular apparatuses based on the vehicle information received from an on-vehicle control device of a rolling stock collecting the vehicle information that controls the plurality of vehicular apparatuses mounted on the plurality of the rolling stock, and displays check instruction for the vehicular apparatus the estimation value of which has exceeded a predetermined threshold value; and

   the motion confirmation instructing unit determines whether a comparison value of the estimation value and an apparatus inspection value inputted by a

maintenance staff having inspected the vehicular apparatus is out of a predetermined range or not, and displays inspection/adjustment instruction when the comparison value is out of the predetermined range.

3. The maintenance system for a rolling stock according to claim 1 or claim 2, wherein
the motion confirmation instructing unit displays the inspection/adjustment instruction when abnormality has occurred so that the apparatus inspection value comes closer to the estimation value.

4. The maintenance system for a rolling stock according to claim 1 or claim 2 further comprising:

an apparatus state estimating means for estimating a sand consumption amount from accumulation of sanding commands for a sanding device, and displaying check instruction for the sanding device when the estimation value has exceeded a predetermined value.

5. The maintenance system for a rolling stock according to claim 4 further comprising:

a motion confirmation instructing means for displaying inspection/adjustment instruction for the sanding device when a comparison value of an inspection value of an amount of sand replenished in checking the sand and an estimation value of a sand consumption amount estimated by the apparatus state estimating means exceeds a predetermined range.

6. The maintenance system for a rolling stock according to claim 1 or claim 2 further comprising:

an apparatus state estimating means for estimating a reserved water use amount from accumulation of toilet flushing commands, and displaying check instruction for reserved water of a toilet when the estimation value exceeds a predetermined value.

7. The maintenance system for a rolling stock according to claim 6 further comprising:

a motion confirmation instructing means for displaying inspection/adjustment instruction for the toilet when a comparison value of an inspection value of a reserved water replenished amount in checking the reserved water and an estimation value of a reserved water use amount estimated by the apparatus state estimating means exceeds a predetermined range.

8. The maintenance system for a rolling stock according to claim 1 or claim 2 further comprising:

an apparatus state estimating means for estimating a sewage accumulated amount from accumulation of toilet flushing commands and displaying check instruction for sewage of the toilet when the estimation value exceeds a predetermined value.

9. The maintenance system for a rolling stock according to claim 8 further comprising:

a motion confirmation instructing means for displaying inspection/adjustment instruction for the toilet when a comparison value of an inspection value of a sewage extraction amount in sewage checking and an estimation value of a sewage accumulated amount estimated by the apparatus state estimating means exceeds a predetermined range.

10. The maintenance system for a rolling stock according to claim 1 or claim 2 further comprising:

an apparatus state estimating means for estimating a wear thickness of a brake pad from accumulation of brake control commands, and displaying check instruction for the brake pad when the estimation value exceeds a predetermined value.

11. The maintenance system for a rolling stock according to claim 10 further comprising:

a motion confirmation instructing means for displaying inspection/adjustment instruction for a brake when a comparison value of an inspection value of the checking result of the brake pad wear thickness and an estimation value of the brake pad wear thickness estimated by the apparatus state estimating means exceeds a predetermined range.

12. The maintenance system for a rolling stock according to claim 1 or claim 2 further comprising:

an apparatus state estimating means for estimating a wear amount of a third rail shoe based on accumulation of lowering control commands for the third rail shoe, and displaying check instruction for a third rail when the estimation value exceeds a predetermined value.

13. The maintenance system for a rolling stock according to claim 12 further comprising:

a motion confirmation instructing means for displaying inspection/adjustment instruction for a third rail device when a comparison value of an inspection value of the checking result of the

wear amount of the third rail and an estimation value of the third rail wear amount estimated by the apparatus state estimating means exceeds a predetermined range.

14. The maintenance system for a rolling stock according to claim 1 or claim 2 further comprising:

an apparatus state estimating means for estimating a wear amount of a pantograph based on accumulation of lifting command time for the pantograph, and displaying check instruction for the pantograph when the estimation value exceeds a predetermined value.

15. The maintenance system for a rolling stock according to claim 14 further comprising:

a motion confirmation instructing means for displaying inspection/adjustment instruction for a pantograph device when a comparison value of an inspection value of the checking result of the wear amount of the pantograph and an estimation value of the pantograph wear amount estimated by the apparatus state estimating means exceeds a predetermined range.

FIG. 1

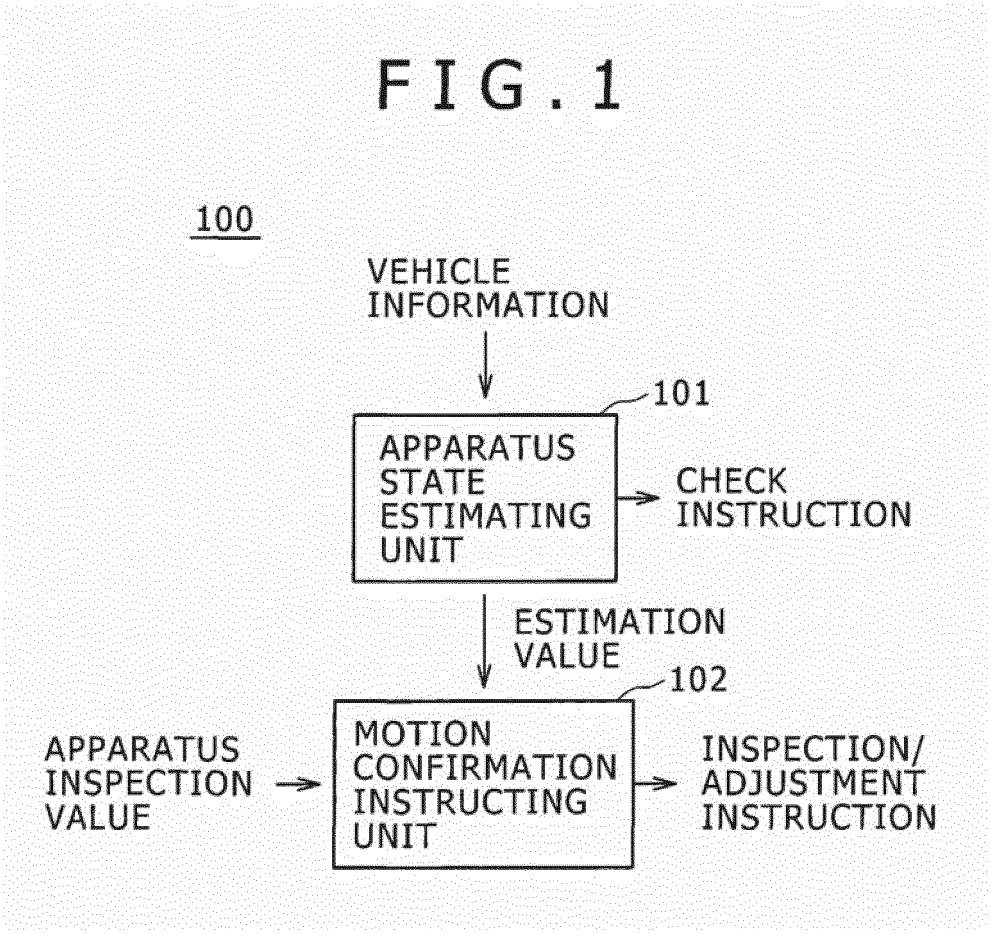

100
VEHICLE INFORMATION
101
APPARATUS STATE ESTIMATING UNIT
CHECK INSTRUCTION
ESTIMATION VALUE
102
APPARATUS INSPECTION VALUE
MOTION CONFIRMATION INSTRUCTING UNIT
INSPECTION/ ADJUSTMENT INSTRUCTION

FIG. 2

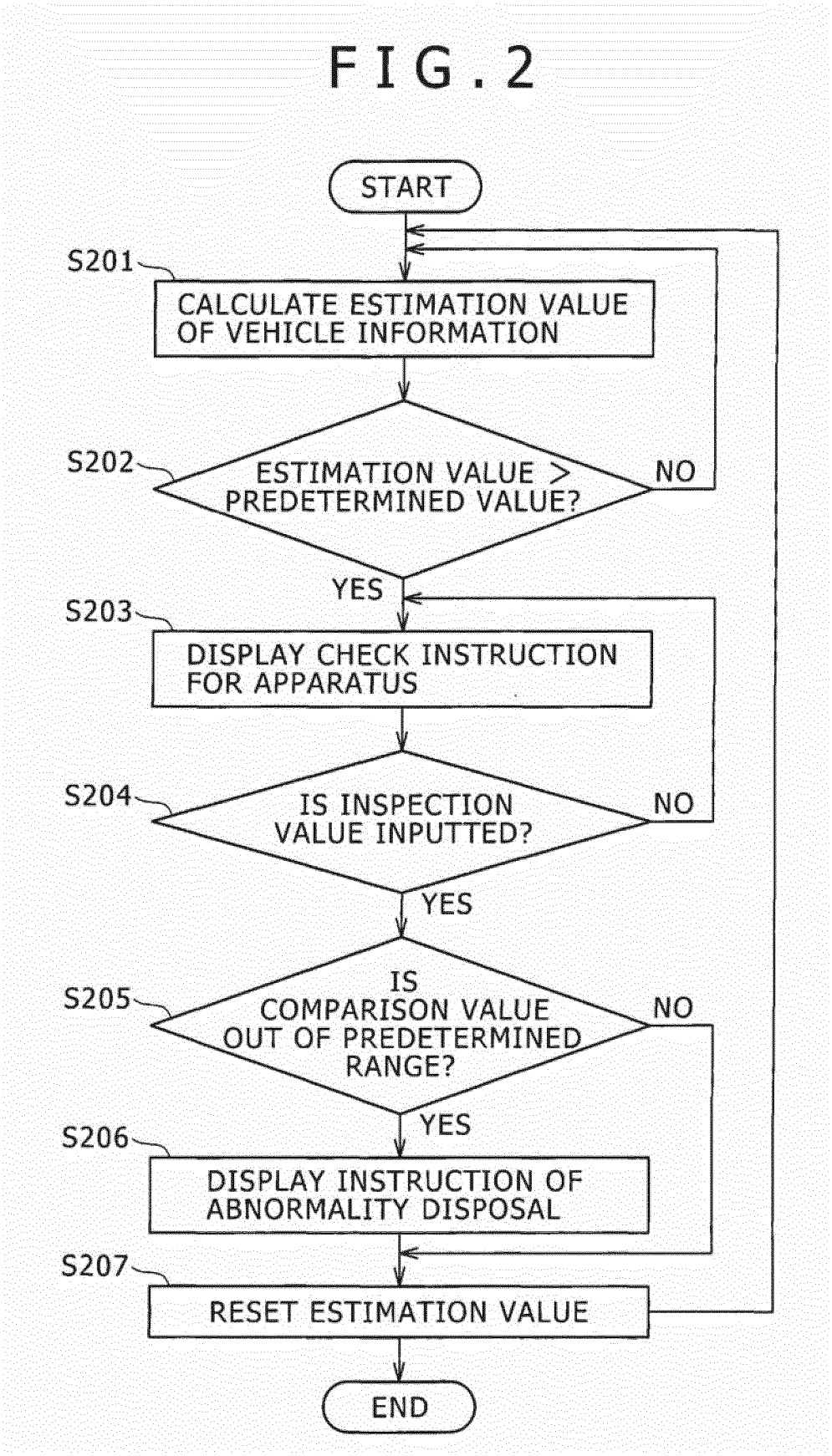

START
S201
CALCULATE ESTIMATION VALUE OF VEHICLE INFORMATION
S202
ESTIMATION VALUE > PREDETERMINED VALUE?
NO
YES
S203
DISPLAY CHECK INSTRUCTION FOR APPARATUS
S204
IS INSPECTION VALUE INPUTTED?
NO
YES
S205
IS COMPARISON VALUE OUT OF PREDETERMINED RANGE?
NO
YES
S206
DISPLAY INSTRUCTION OF ABNORMALITY DISPOSAL
S207
RESET ESTIMATION VALUE
END

FIG.3-1

IN NORMALITY

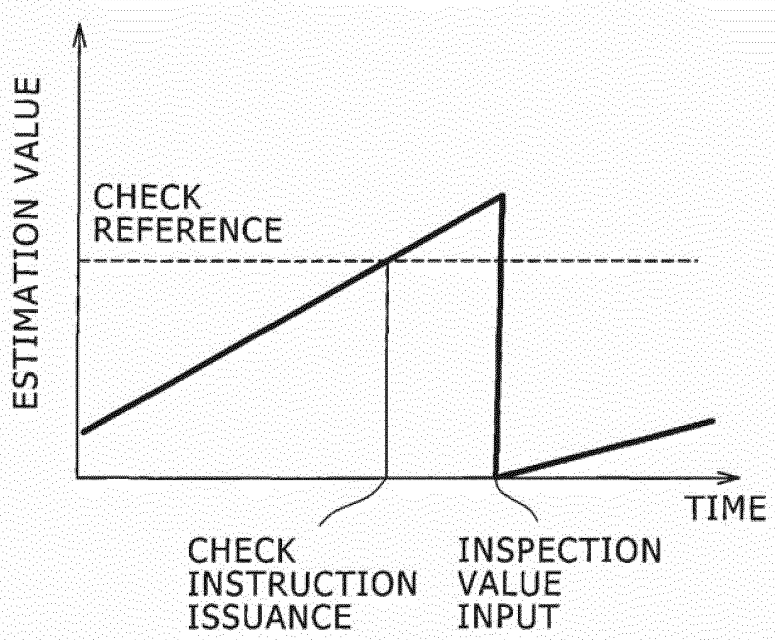


FIG.3-2

IN ABNORMALITY

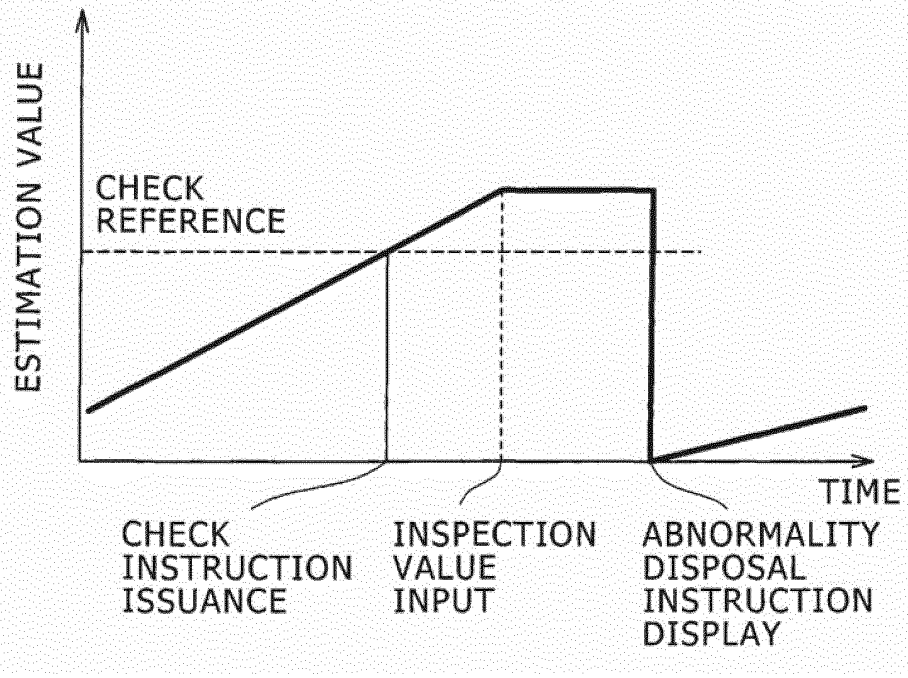


FIG. 4

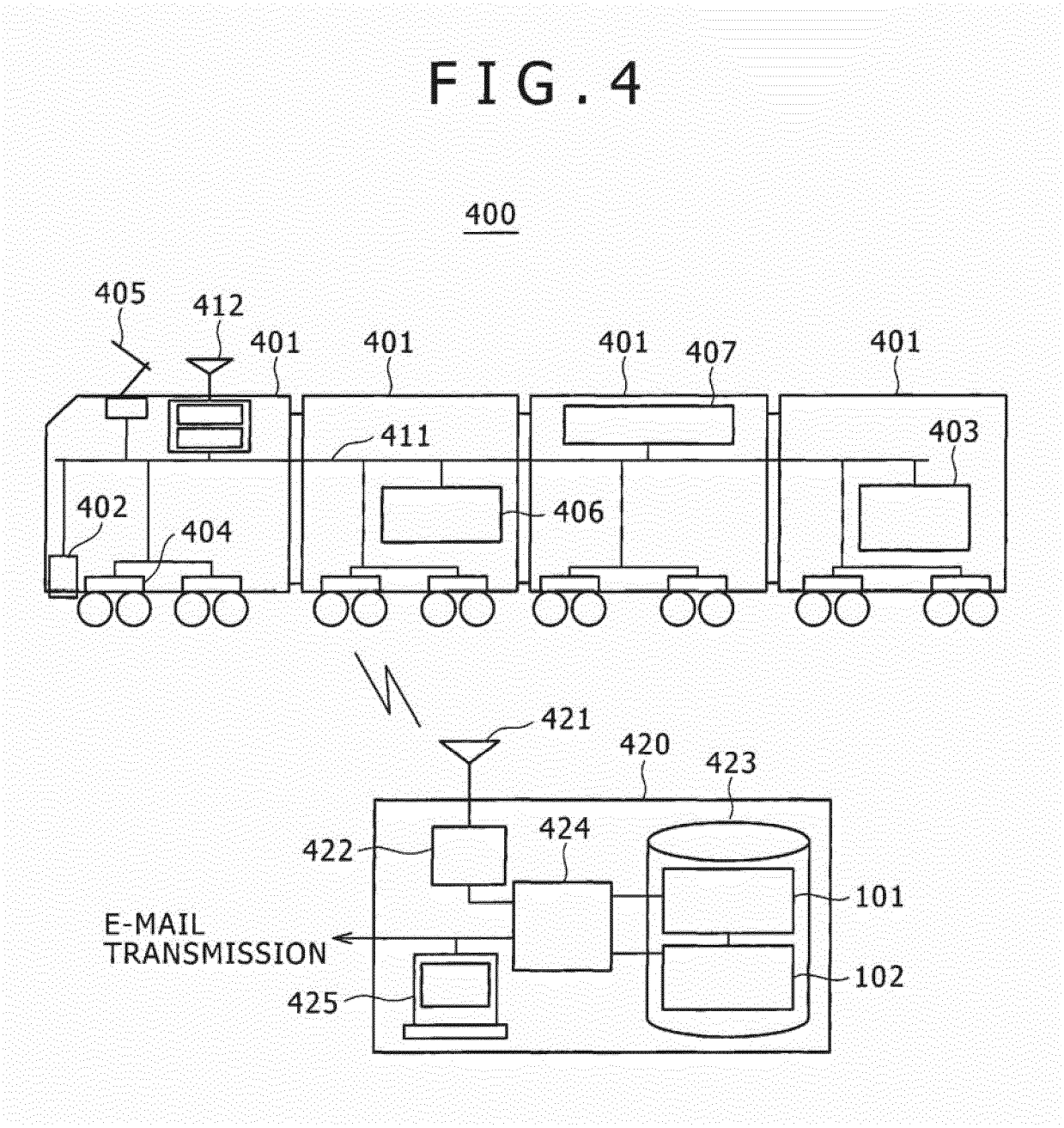

400
405
412
401
401
401
407
401
411
403
402
404
406
421
420
423
424
422
101
E-MAIL
TRANSMISSION
102
425

FIG.5-1

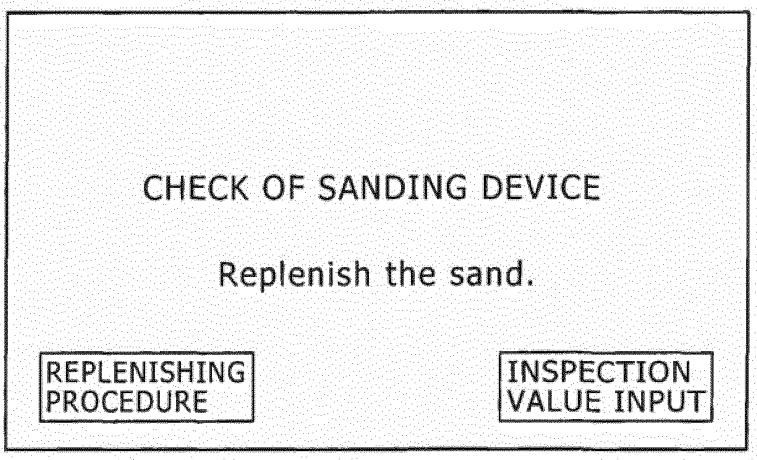


FIG.5-2

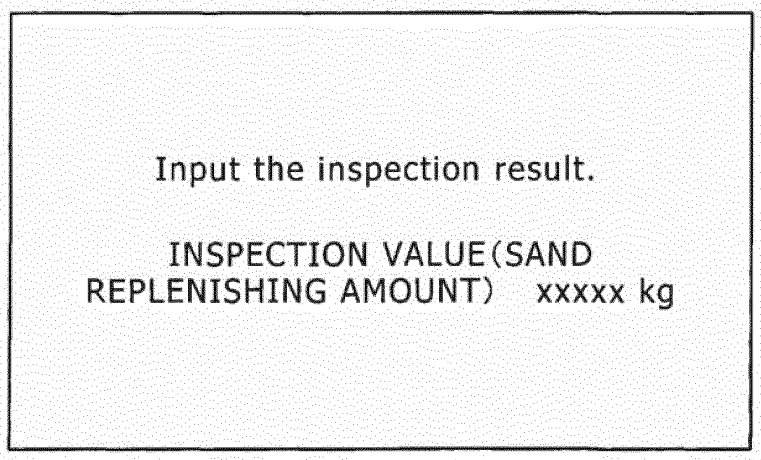


FIG.5-3

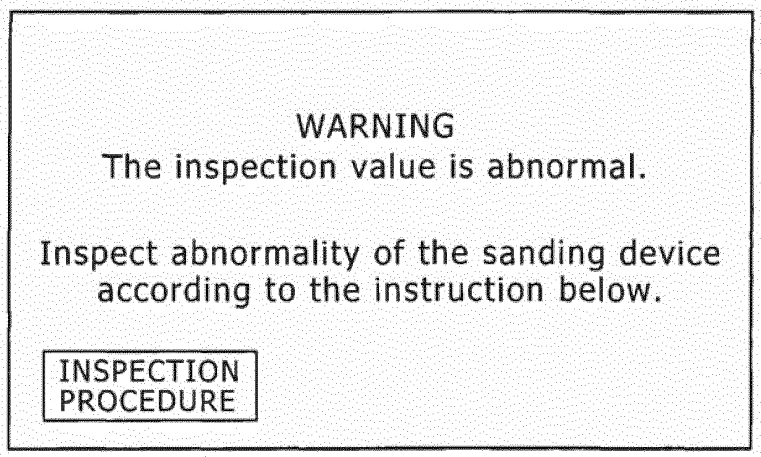


FIG. 6

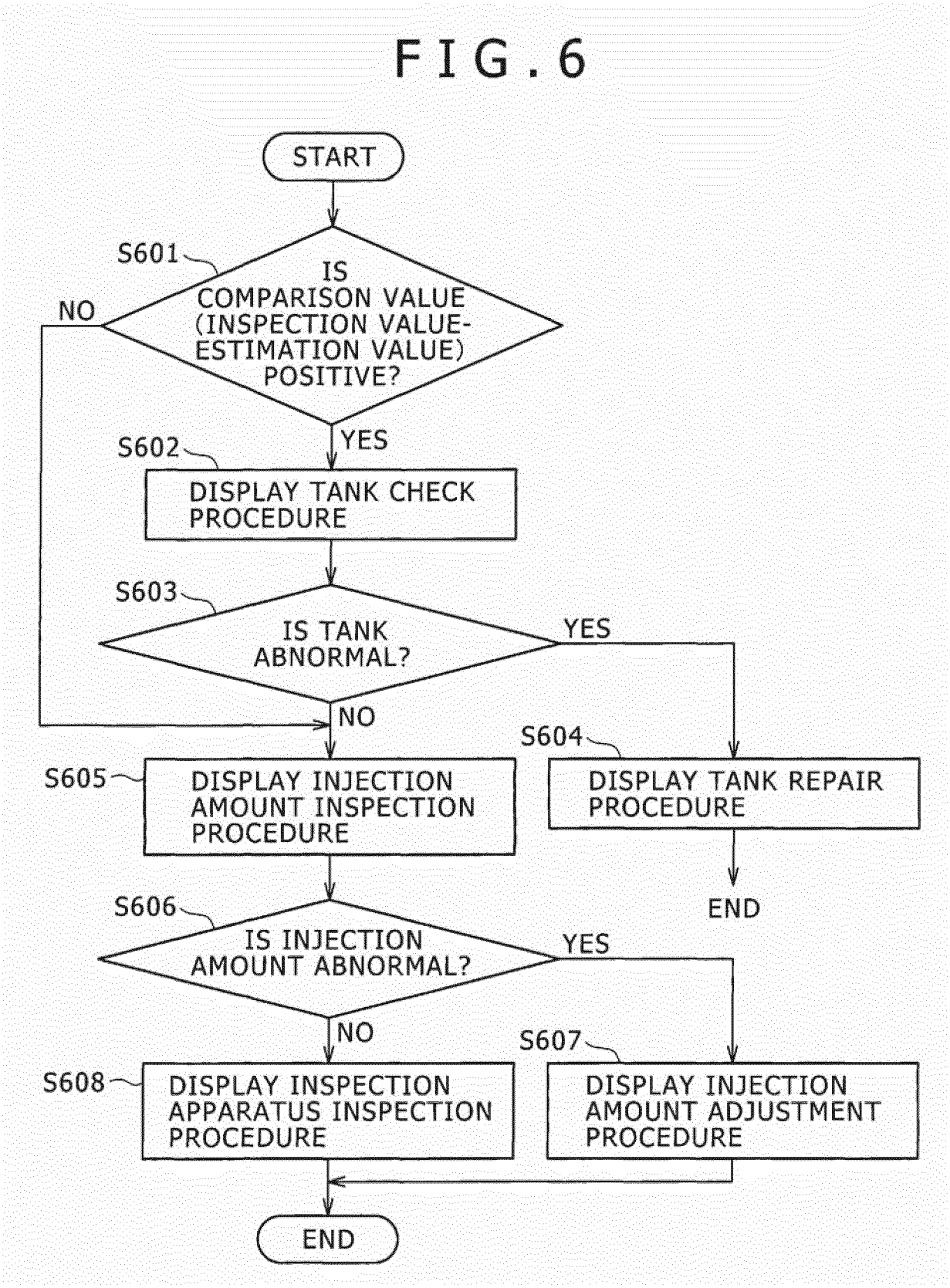

START
S601
IS COMPARISON VALUE (INSPECTION VALUE-ESTIMATION VALUE) POSITIVE?
NO
YES
S602
DISPLAY TANK CHECK PROCEDURE
S603
IS TANK ABNORMAL?
YES
NO
S604
DISPLAY TANK REPAIR PROCEDURE
END
S605
DISPLAY INJECTION AMOUNT INSPECTION PROCEDURE
S606
IS INJECTION AMOUNT ABNORMAL?
YES
NO
S607
DISPLAY INJECTION AMOUNT ADJUSTMENT PROCEDURE
S608
DISPLAY INSPECTION APPARATUS INSPECTION PROCEDURE
END

FIG.7-1

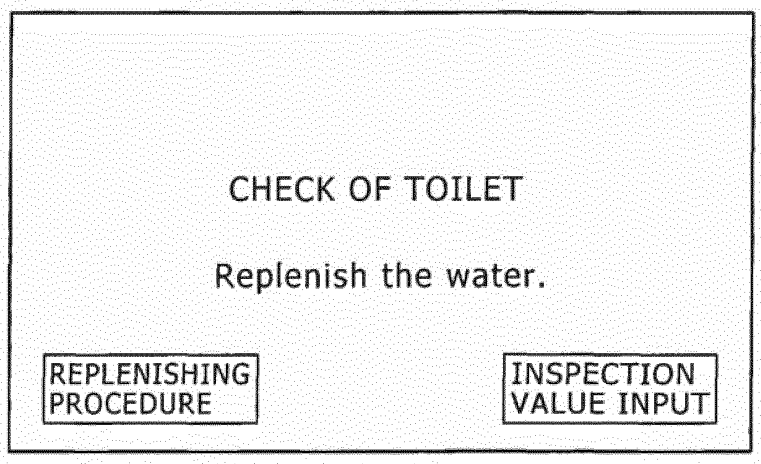


FIG.7-2

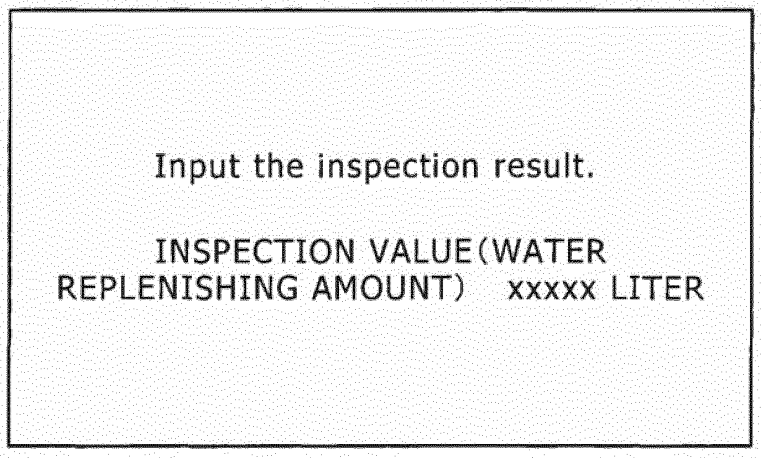


FIG.7-3

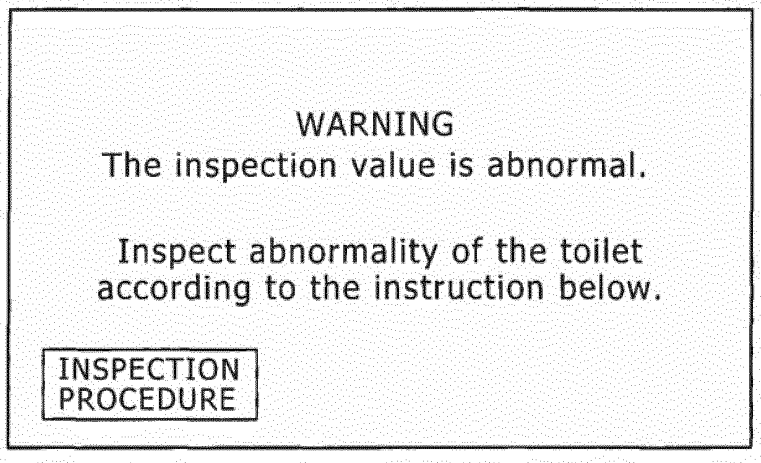


FIG. 8

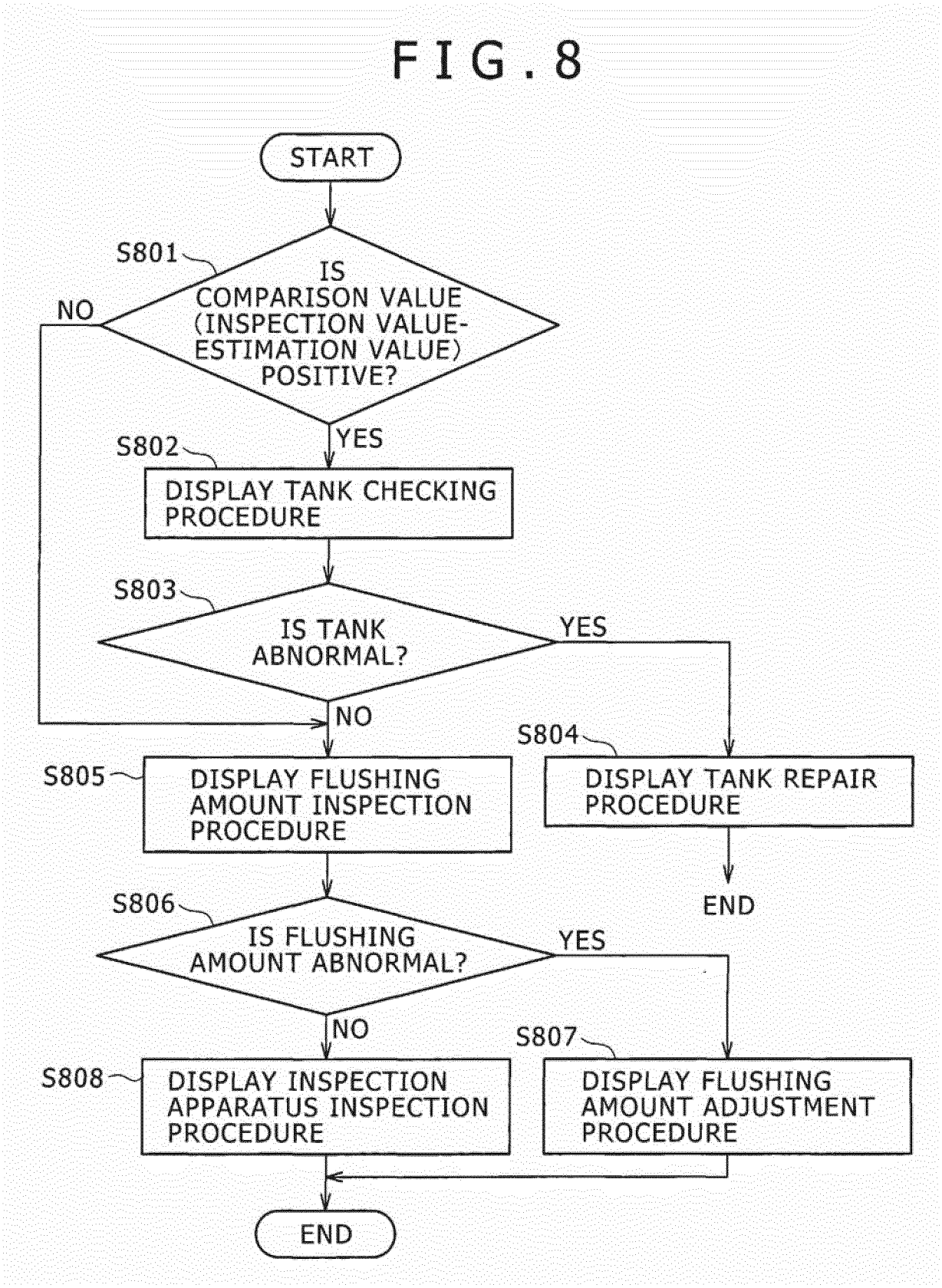

START
S801
IS COMPARISON VALUE (INSPECTION VALUE-ESTIMATION VALUE) POSITIVE?
NO
YES
S802
DISPLAY TANK CHECKING PROCEDURE
S803
IS TANK ABNORMAL?
YES
NO
S804
DISPLAY TANK REPAIR PROCEDURE
END
S805
DISPLAY FLUSHING AMOUNT INSPECTION PROCEDURE
S806
IS FLUSHING AMOUNT ABNORMAL?
YES
NO
S807
DISPLAY FLUSHING AMOUNT ADJUSTMENT PROCEDURE
S808
DISPLAY INSPECTION APPARATUS INSPECTION PROCEDURE
END

FIG.9-1

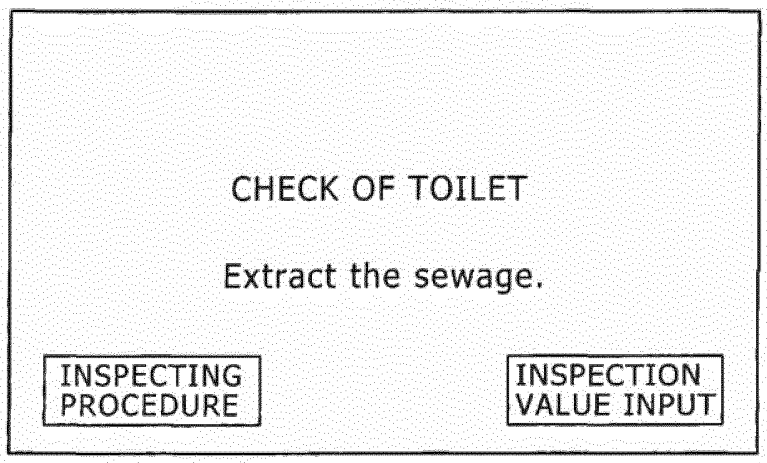


FIG.9-2

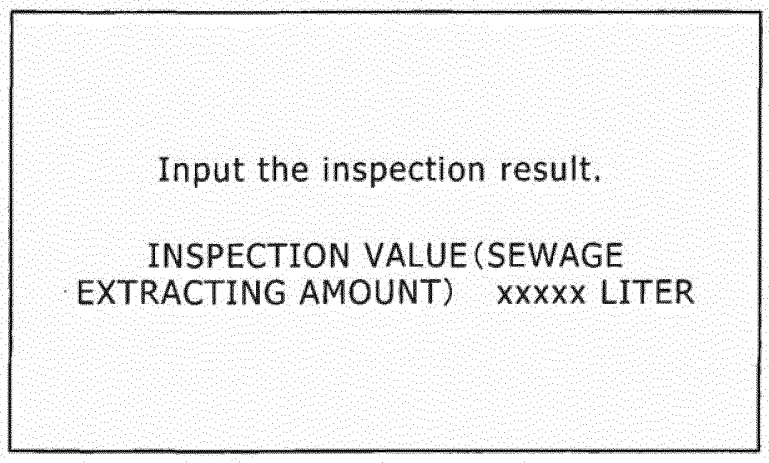


FIG.9-3

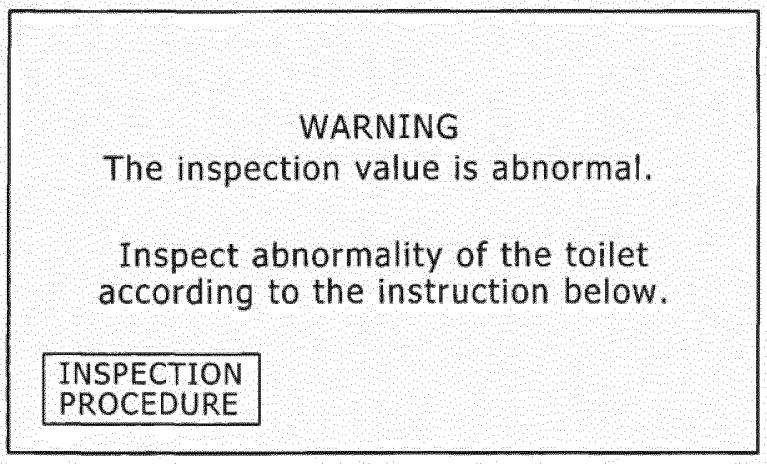


FIG.10

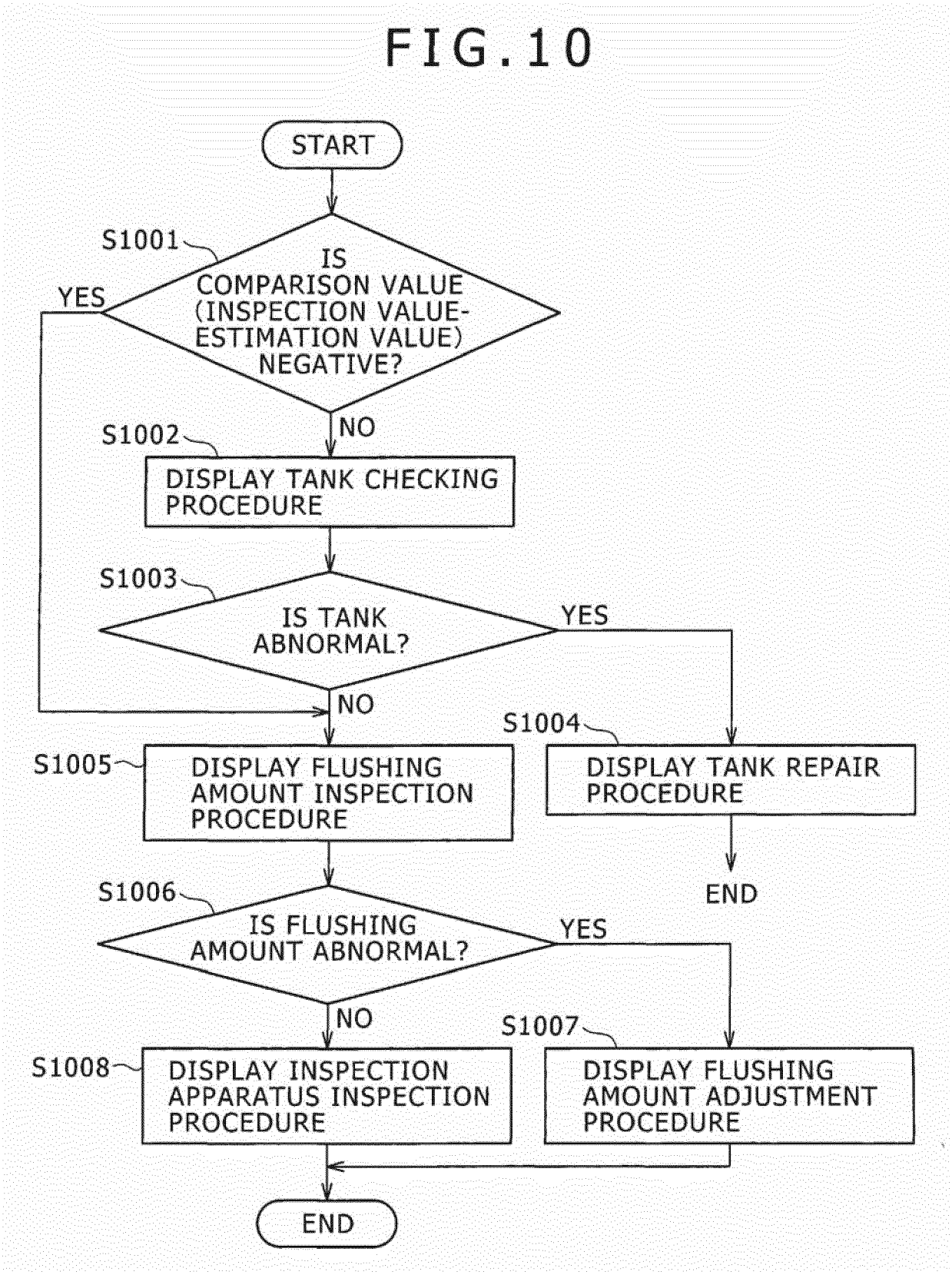

START
S1001
IS COMPARISON VALUE (INSPECTION VALUE-ESTIMATION VALUE) NEGATIVE?
YES
NO
S1002
DISPLAY TANK CHECKING PROCEDURE
S1003
IS TANK ABNORMAL?
YES
NO
S1004
DISPLAY TANK REPAIR PROCEDURE
END
S1005
DISPLAY FLUSHING AMOUNT INSPECTION PROCEDURE
S1006
IS FLUSHING AMOUNT ABNORMAL?
YES
NO
S1007
DISPLAY FLUSHING AMOUNT ADJUSTMENT PROCEDURE
S1008
DISPLAY INSPECTION APPARATUS INSPECTION PROCEDURE
END

FIG.11-1

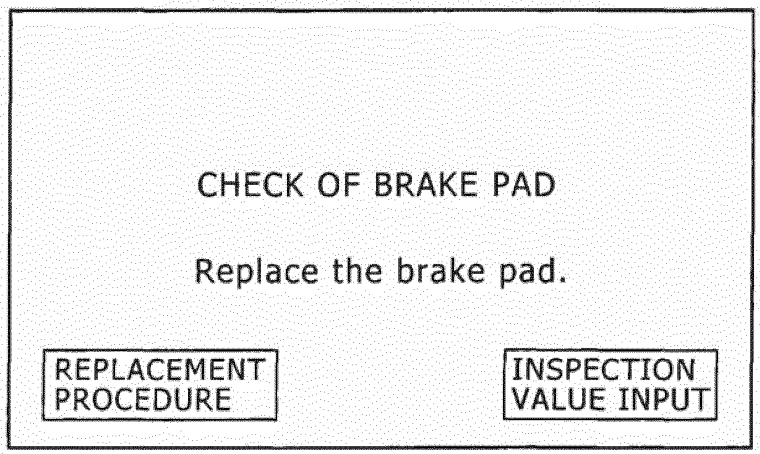


FIG.11-2

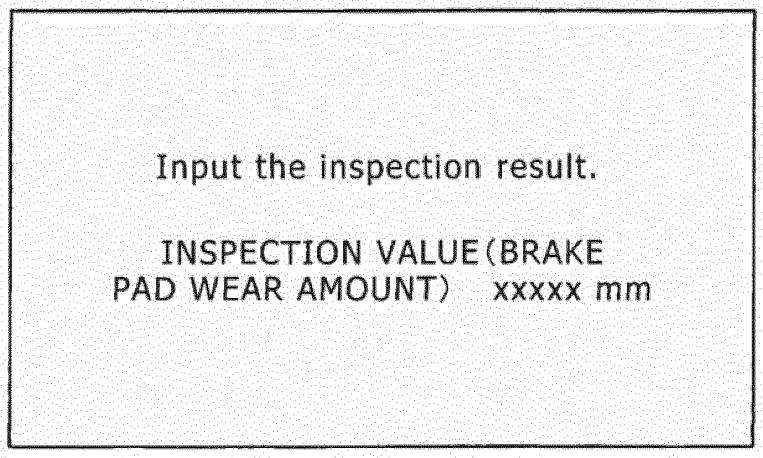


FIG.11-3

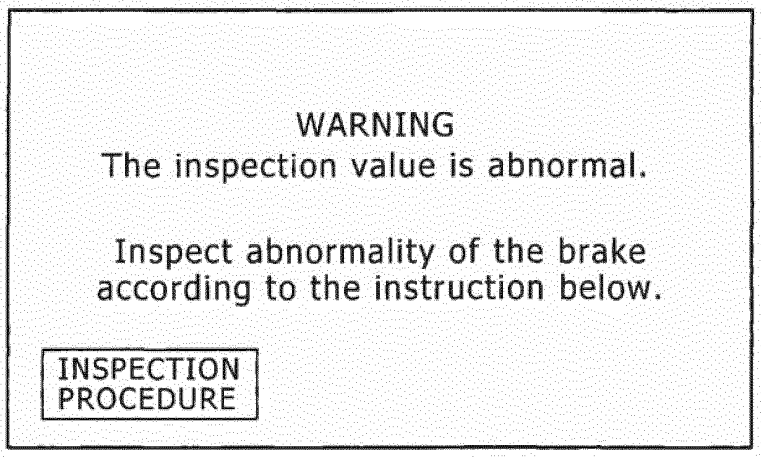


FIG. 12

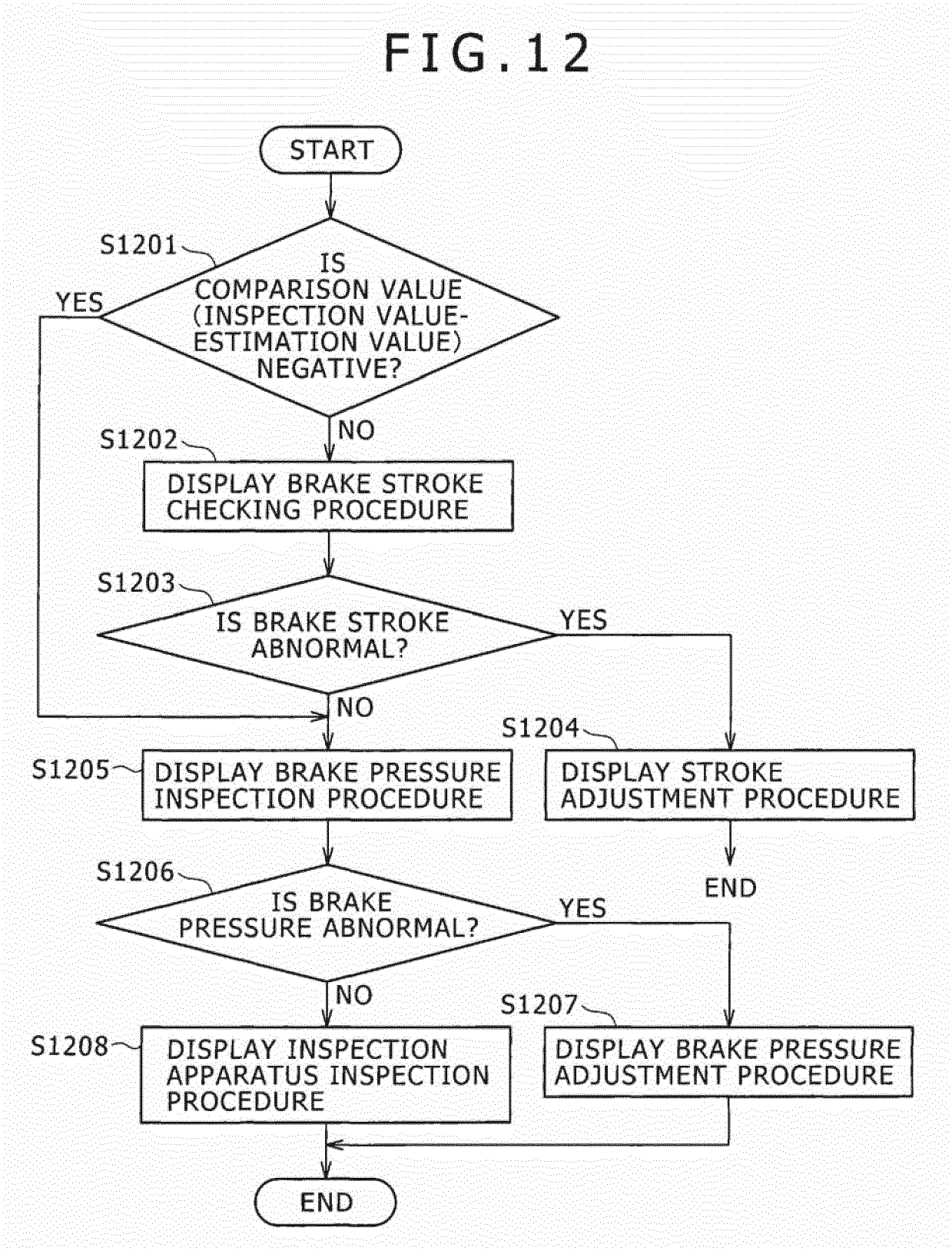

START
S1201
IS COMPARISON VALUE (INSPECTION VALUE-ESTIMATION VALUE) NEGATIVE?
YES
NO
S1202
DISPLAY BRAKE STROKE CHECKING PROCEDURE
S1203
IS BRAKE STROKE ABNORMAL?
YES
NO
S1204
DISPLAY STROKE ADJUSTMENT PROCEDURE
S1205
DISPLAY BRAKE PRESSURE INSPECTION PROCEDURE
END
S1206
IS BRAKE PRESSURE ABNORMAL?
YES
NO
S1207
DISPLAY BRAKE PRESSURE ADJUSTMENT PROCEDURE
S1208
DISPLAY INSPECTION APPARATUS INSPECTION PROCEDURE
END

FIG.13-1

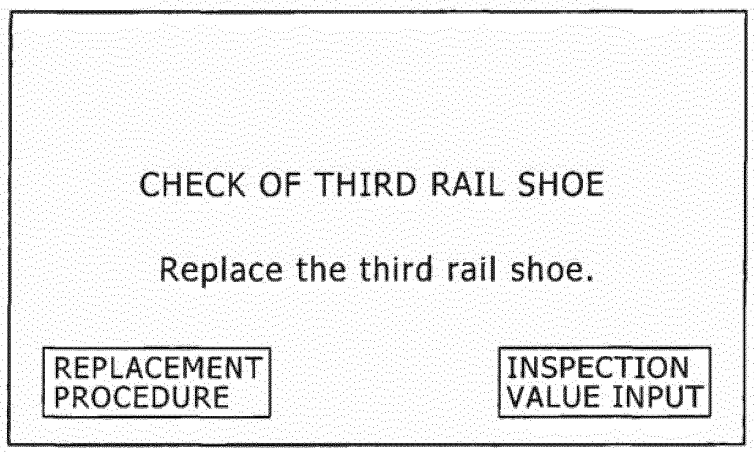


FIG.13-2

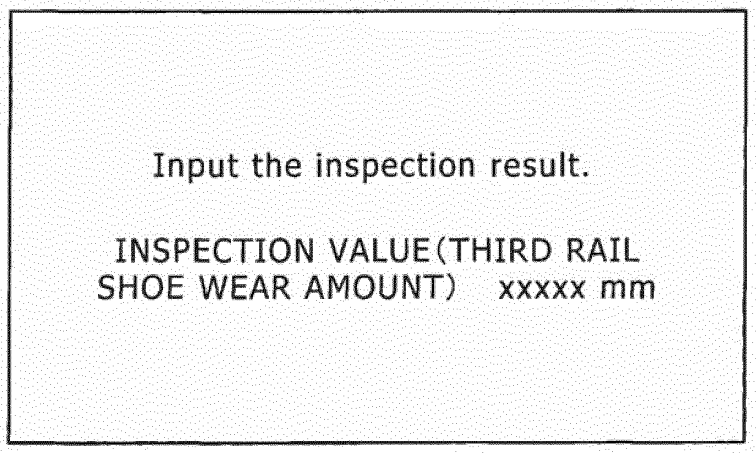


FIG.13-3

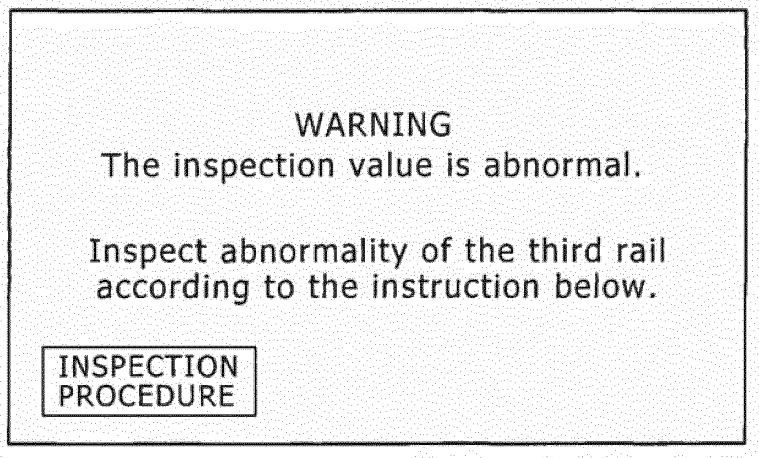


FIG.14

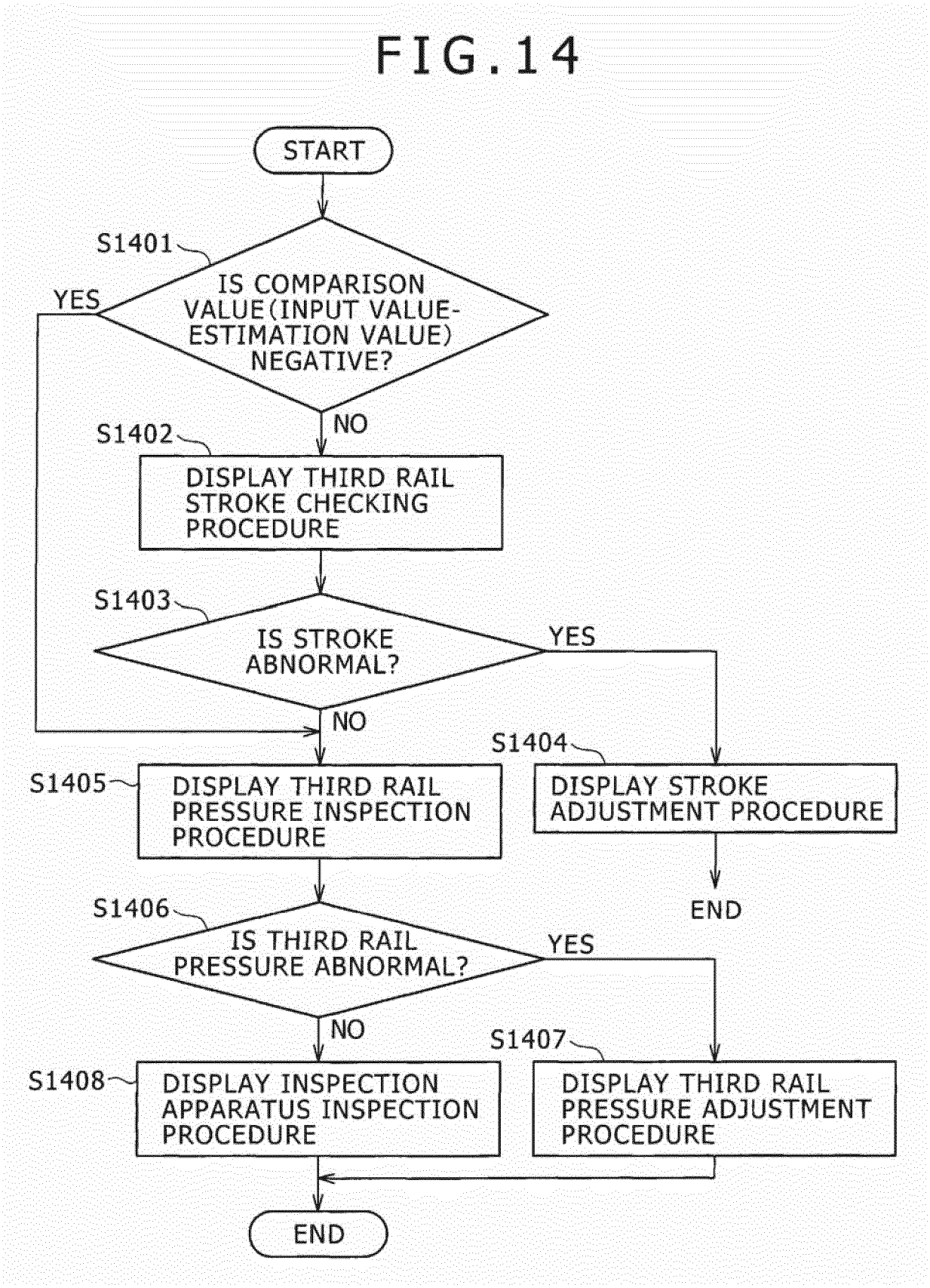

START
S1401
IS COMPARISON VALUE(INPUT VALUE-ESTIMATION VALUE) NEGATIVE?
YES
NO
S1402
DISPLAY THIRD RAIL STROKE CHECKING PROCEDURE
S1403
IS STROKE ABNORMAL?
YES
NO
S1404
DISPLAY STROKE ADJUSTMENT PROCEDURE
END
S1405
DISPLAY THIRD RAIL PRESSURE INSPECTION PROCEDURE
S1406
IS THIRD RAIL PRESSURE ABNORMAL?
YES
NO
S1407
DISPLAY THIRD RAIL PRESSURE ADJUSTMENT PROCEDURE
S1408
DISPLAY INSPECTION APPARATUS INSPECTION PROCEDURE
END

FIG.15-1

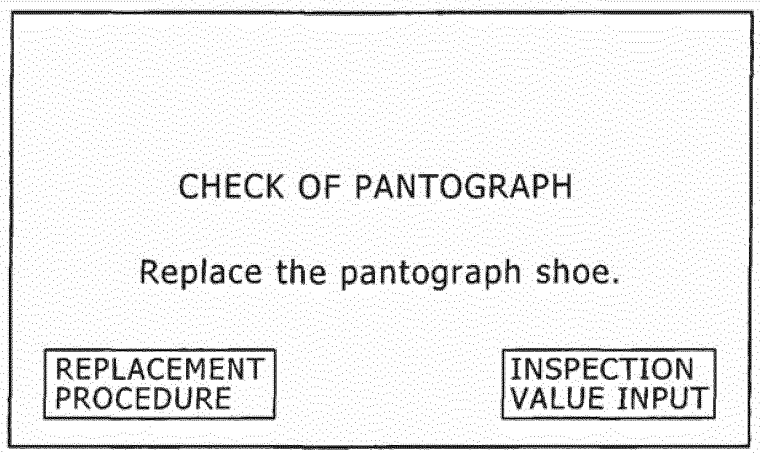


FIG.15-2

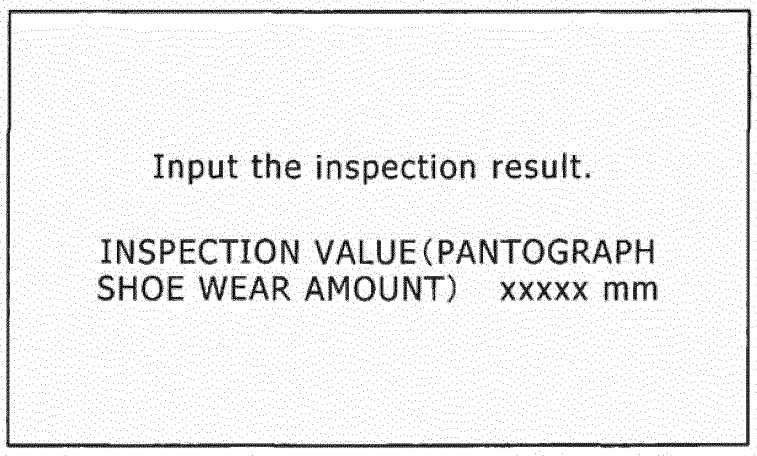


FIG.15-3

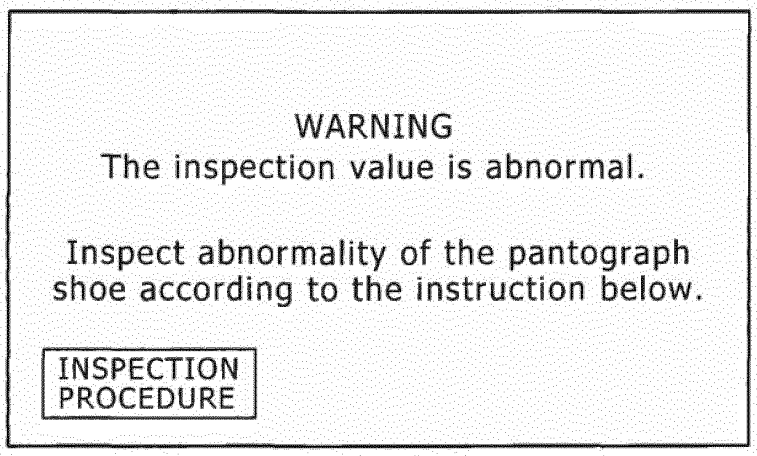
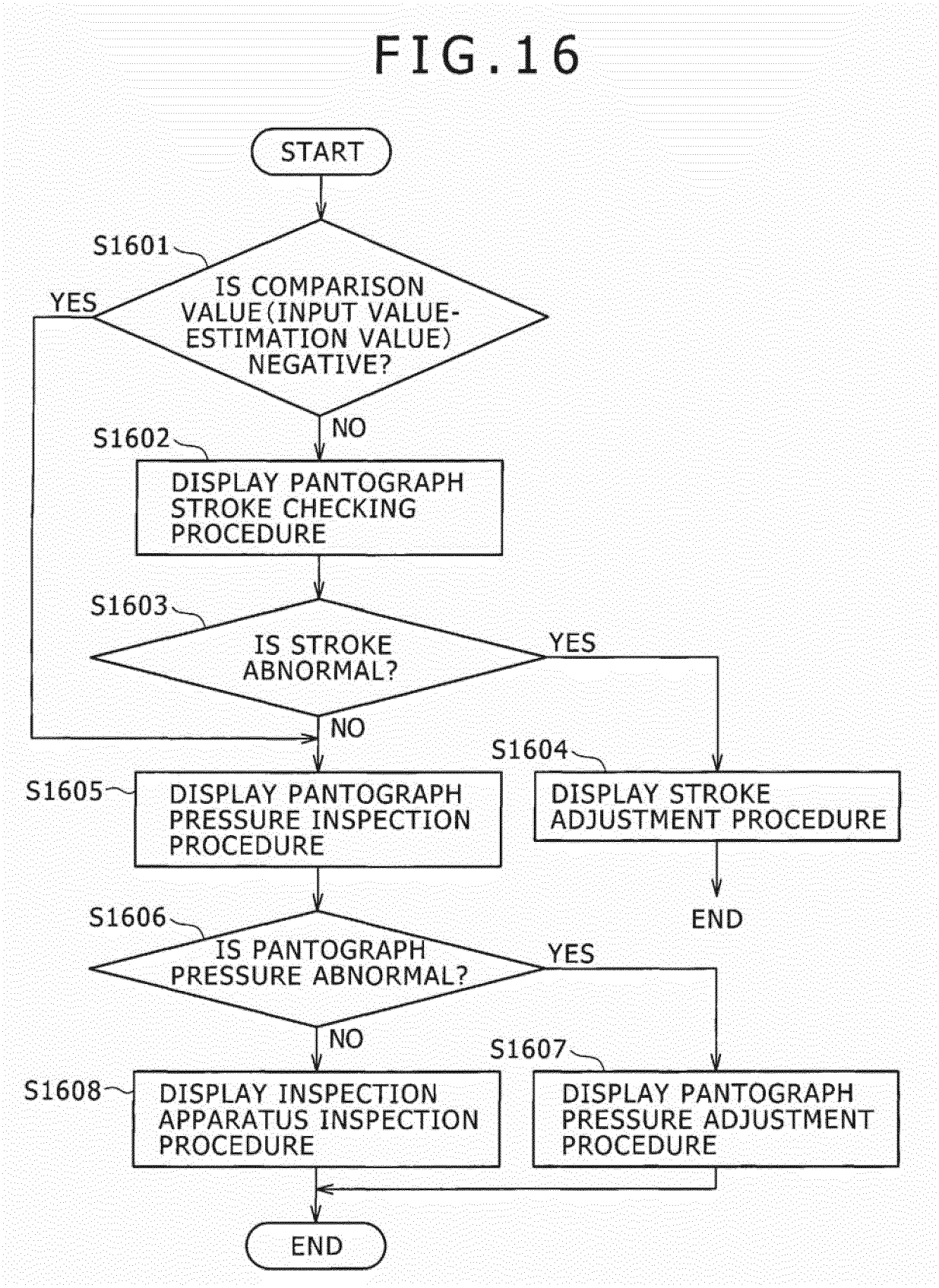


FIG.16


START
S1601
IS COMPARISON VALUE(INPUT VALUE-ESTIMATION VALUE) NEGATIVE?
YES
NO
S1602
DISPLAY PANTOGRAPH STROKE CHECKING PROCEDURE
S1603
IS STROKE ABNORMAL?
YES
NO
S1604
DISPLAY STROKE ADJUSTMENT PROCEDURE
END
S1605
DISPLAY PANTOGRAPH PRESSURE INSPECTION PROCEDURE
S1606
IS PANTOGRAPH PRESSURE ABNORMAL?
YES
NO
S1607
DISPLAY PANTOGRAPH PRESSURE ADJUSTMENT PROCEDURE
S1608
DISPLAY INSPECTION APPARATUS INSPECTION PROCEDURE
END

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H91997243518 B **[0003]**
- JP 2007118887 A **[0004]**