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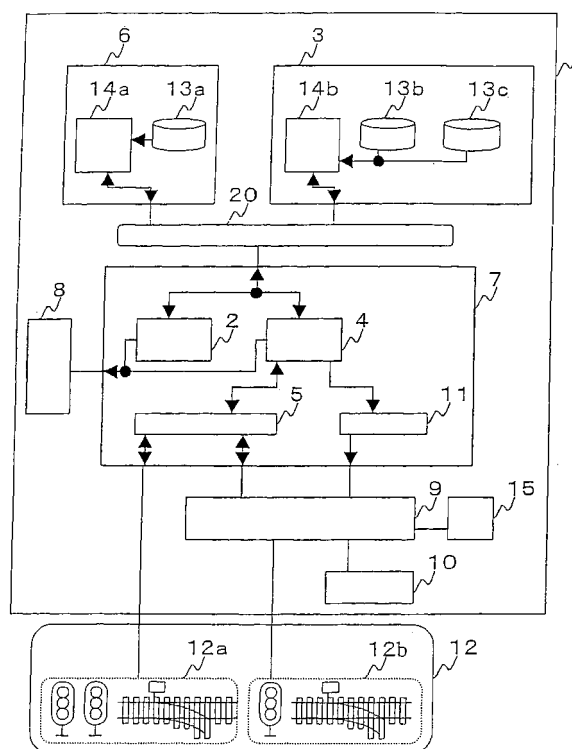
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(54) **Testing apparatus and testing method for an electronic interlocking system**

(57) A computerized interlocking system includes an interlocking logic section 6 that produces a control command to a field apparatus 12, a field control terminal 7 that produces a control output to the field apparatus 12, and simulator means 10 that simulates the function of the railway signaling field apparatus 12 during testing. The computerized interlocking system further includes a testing interlocking logic section 3 that is connected to the field control terminal 7 and has a follow mode in which the testing interlocking logic section performs control without inhibiting the operation of the interlocking logic section 6. The interlocking logic section 6 and the testing interlocking logic section 3 output a control command for the railway signaling field apparatus 12 to the field control terminal 7 along with output presence/absence information about the relevant control command. In the case where the interlocking logic section 6 outputs a control command, and the testing interlocking logic section 3 is in the follow mode or produces no output, the field control terminal 7 outputs the control command from the interlocking logic section 6 of the control commands for the field apparatus 12.

FIG.1



Description

BACKGROUND OF THE INVENTION

Field of the invention

[0001] The present invention relates to a computerized interlocking system for controlling a railway signal. In particular, it relates to a computerized interlocking system in the case where an existing field installation is modified or where the function of the computerized interlocking system is expanded, and a testing method therefor.

Description of the related art

[0002] In the following, a method of modifying the function of a conventional computerized interlocking system will be described. When installing a new computerized interlocking system or renewing all installations, it is common practice to install the new computerized interlocking system adjacent to the existing installations, connects the new computerized interlocking system to field simulator means to check the functionality of the system, and then, during a time period in which the existing installations are out of service, connects the new computerized interlocking system to the existing installations for testing.

[0003] Furthermore, when partially modifying the existing computerized interlocking system, adding a field installation or modifying an existing field installation, the computerized interlocking system is connected to the wiring of the modified installation, the test is performed, and then the original state is recovered during a time period in which the existing installation is out of service.

[0004] As a method of testing an existing installation in the field when the installation is in operation, the patent reference 1 discloses a method of performing a test by linking field simulator means to a new computerized interlocking system via simulator communication means in a field apparatus, for example.

[0005] Furthermore, as a method of disconnecting field simulator means and interconnecting a new interlocking logic section and a field apparatus when performing a test by connecting the new interlocking logic section to an existing installation, the patent reference 2 discloses a method of using an optical switch for switching between a new computerized interlocking apparatus and an existing computerized interlocking apparatus in the case where communication means is optical communication means.

[Patent Reference 1] Japanese Patent Laid-Open No. 2003-327122

[Patent Reference 2] Japanese Patent Laid-Open No. 2000-52989

[0006] In modification of a conventional computerized interlocking system, an updated system or a testing system cannot be connected to the communication line of

the existing computerized interlocking system to make them operate in parallel during operation of an existing installation. For example, the method of performing a test by linking field simulator means to a new computerized interlocking system via simulator communication means in a field apparatus has a problem that the test can be performed only in a limited time period in which the existing installation is out of service, such as in the nighttime.

[0007] Furthermore, the method of using an optical switch for switching between a new computerized interlocking apparatus and an existing computerized interlocking apparatus, which has been described above as a method of disconnecting field simulator means and interconnecting a new interlocking logic section and a field apparatus when performing a test by connecting the new interlocking logic section to an existing installation, requires a switch to be inserted to each cable or the connection of the cable to be changed for each test. In the case where a switch is inserted to each cable, there is a problem that wiring requires a high cost. On the other hand, in the case where the connection of the cable is changed for each test, the connection has to be changed from the simulator means to the field apparatus before test, and once the test is completed, the connection has to be changed again from the field apparatus to the simulator means. Thus, there is a problem that a cost for the changing occurs. In addition, the continuity has to be checked after the original connection is recovered, so that there is a problem that the test time is reduced accordingly.

SUMMARY OF THE INVENTION

[0008] An object of the present invention is to provide a computerized interlocking system that controls a railway signaling field apparatus, a computerized interlocking system that is suitable for simplifying addition to or modification of a railway signaling field apparatus, a testing apparatus therefor and a testing method therefor.

[0009] In order to achieve the object, according to the present invention, an interlocking logic section that produces a control command for a plurality of currently used railway signaling field apparatus, such as a railway switch, a signal and a contact output, a testing interlocking logic section for performing a test via an existing communication line in the railway signaling field apparatus, which is connected to and controlled by the interlocking logic apparatus via the communication line, when either or both of the interlocking logic section and the railway signaling field apparatus are modified, the railway signaling field apparatus to be modified or added, and simulator means are connected to each other. The interlocking logic section and the testing interlocking logic section produces, for each control command for the field apparatus, "output/not-output" information, which is a control command for the field apparatus, such as a switch command for the railway switch, and "used/not-used" infor-

mation for indicating the presence or absence of output of the control command for the field apparatus and transmits the control command and these pieces of information to the field control terminal. The field control terminal refers to "existing/testing" information that specifies which of the interlocking logic section and the testing interlocking logic section has produced the received control command, information indicating the presence or absence of output of the control command for the field apparatus, which is associated with each control command, and information indicating the presence or absence of output of the control command to the field apparatus, which is associated with each of the control commands, and controls the field apparatus and the simulator means.

[0010] For information for which the interlocking logic section designates "output" in the control commands, the "used/not-used" information from the interlocking logic section, which is a control command from the interlocking logic section, is adopted. This permits the interlocking logic section to perform control of the existing installation.

[0011] If the testing interlocking logic section designates "output" for information for which the interlocking logic section designates "not-output" in the control commands, the "used/not-used" information from the testing interlocking logic section, which is a control command from the testing interlocking logic section, is adopted. This permits the interlocking logic section and the testing interlocking logic section to operate in parallel without affecting the control by the interlocking logic section.

[0012] When the operation of the interlocking logic section is halted, if the testing interlocking logic section designates "output", the "used/not-used" information from the testing interlocking logic section, which is a control command from the testing interlocking logic section, is adopted. This permits the test using only the testing interlocking logic section to be performed without switching the wiring connection between the interlocking logic section and the testing interlocking logic section.

[0013] By using the system configuration according to the present invention, a testing interlocking logic section 3 can be always connected to an existing interlocking logic section 6 via a LAN 20, and the operation of the testing interlocking logic section 3 having a modified interlocking system mounted thereon can be checked even during operation of the interlocking logic section 6. Thus, when the connection between the testing interlocking logic section and the field apparatus is tested by halting the existing interlocking logic section, there is no need of changing the wiring connection, and a part of the test can be performed in the daytime. In addition, the time that would be conventionally required for wiring change or wiring checking after wiring change can be omitted, and the time and cost required for performing a test in a field apparatus room when updating the computerized interlocking system can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a drawing for illustrating a configuration of a computerized interlocking system according to an example.

[0015] FIG. 2 shows an exemplary relationship among operation modes of an interlocking logic section, a testing interlocking logic section and a field control terminal according to the example.

[0016] FIG. 3 shows an example of a telegram synthesizing procedure performed by the field control terminal according to the example.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] A best mode for carrying out the present invention will be described.

[0018] In the following, a computerized interlocking system, a testing apparatus and a testing method according to embodiments of the present invention will be described with reference to the drawings.

(Example)

[0019] An example of the present invention will be described. FIG. 1 shows a configuration of a computerized interlocking system according to an embodiment of the present invention during a switching test. An interlocking logic section 6 is connected to a field control terminal 7 via a LAN 20. A testing interlocking logic section 3 is also connected to the LAN 20. The interlocking logic section 6 and the testing interlocking logic section 3 produce a control command for controlling a field apparatus 12, such as a railway switch and a signal, and outputs the control command to the field control terminal 7 via the LAN 20.

[0020] The field apparatus 12 may be a field apparatus 12a that is directly controlled by the field control terminal 7 and a field apparatus 12b that is controlled via a switching device 9. The switching device 9 switches the destination of the control command between the field apparatus 12b and the simulator means 10.

[0021] The interlocking logic section 6 produces, in control information producing section 14a, control information for controlling the field apparatus 12 in safety, which concerns the current field apparatus 12, and performs a normal control, such as revenue train operation during the daytime. The testing interlocking logic section 3 produces, in testing control information producing section 14b, control information for controlling the modified field apparatus 12 in safety and performs a control for a test concerning the modification.

[0022] Combinations of operation modes of the interlocking logic section 6, the testing interlocking logic section 3 and the field control terminal 7 in this example are shown in FIG. 2. The interlocking logic section 6 has two operation modes: a "control mode" in which the interlock-

ing logic section 6 performs the normal control; and a "halt mode" in which the interlocking logic section 6 is in a halt condition.

[0023] The testing interlocking logic section 3 has three operation modes: a "follow mode" in which the testing interlocking logic section 3 performs a control by following the operation of the interlocking logic section 6 to avoid interfering with the operation of the interlocking logic section 6 when the interlocking logic section 6 is in operation; an "independent mode" in which the testing interlocking section 3 operates according to a schedule of its own based on post-modification interlocking information when the interlocking logic section 6 is in a halt condition; and a "halt mode" in which the testing interlocking logic section 3 is in a halt condition.

[0024] The field control terminal 7 has modes that are determined by combinations of the operation modes of the interlocking logic section 6 and the testing interlocking logic section 3. Since the interlocking logic section 6 has two operation modes, and the testing interlocking logic section 3 has three operation modes, the field control terminal 7 has six operation modes depending on how those operation modes are combined to each other. The six operation modes are sorted into five operation modes: a following test mode; a normal mode; an independent test mode; an error mode; and a halt mode. The five operation modes will be described in succession in the following.

[0025] With reference to FIG. 1, an exemplary configuration of and exemplary outputs from a computerized interlocking system 1 in the case where the interlocking logic section 6 operates in the control mode and the testing interlocking logic section 3 operates in the follow mode will be described. In this case, the field control terminal 7 operates in the following test mode, as can be seen from FIG. 2.

[0026] The interlocking logic section 6 produces a telegram 30 as a control command destined for the field apparatus 12 and transmits the control command to the field control terminal 7 via the LAN 20. Similarly, the testing interlocking logic section 3 produces a telegram 32 as a control command destined for the field apparatus 12 and transmits the control command to the field control terminal 7 via the LAN 20. At the same time, the interlocking logic section 6 and the testing interlocking logic section 3 inform the field control terminal 7 via the LAN 20 that the interlocking logic section 6 and the testing interlocking logic section 3 operate in the control mode and in the follow mode, respectively.

[0027] The telegrams 30 and 32 contain "output/not-output" information that specifies the presence (1, H or On) or absence (0, L or Off) of control of each field apparatus 12, for example, information about a railway switch that specifies whether the railway switch is turned to a straight track or to a branch track.

[0028] In addition to the "output/not-output" information concerning the presence or absence of control of the field apparatus 12, the telegrams 30 and 32 contain

"used/not-used" information that specifies whether the "output/not-output" information is output or not for the field apparatus 12, which is associated with each piece of "output/not-output" information.

[0029] The "used/not-used" information is retained by the interlocking logic section 6 or the testing interlocking logic section 3 and specifies the presence or absence of control output to the field apparatus 12 for each of the operation modes. Since the interlocking logic section 6 has only the control mode as the active operation mode, the interlocking logic section 6 retains only control-mode output specifying information 13a as the "used/not-used" information. On the other hand, since the testing interlocking logic section 3 has the follow mode and the independent operation mode as the active operation mode, the testing interlocking logic section 3 retains follow-mode output specifying information 13b and independent-operation-mode output specifying information 13c as the "used/not-used" information.

[0030] Information indicating that the interlocking logic section 6 and the testing interlocking logic section 3 operate in the control mode and in the follow mode, respectively, is retained in an operation mode management section 2 in the field control terminal 7. From the information indicating that the interlocking logic section 6 and the testing interlocking logic section 3 operate in the control mode and in the follow mode, respectively, the operation mode management section 2 determines that the field apparatus terminal operates in the following test mode according to the mode/state definition shown in FIG. 2.

[0031] Using the telegrams 30 and 32 and the operation mode information about the interlocking logic section 6 and the testing interlocking logic section 3 retained in the operation mode management section 2, the field control terminal 7 synthesizes control information for each field apparatus 12 in a telegram synthesizing/dividing section 4, determines the information for controlling the field apparatus 12 and issues a command to the field apparatus 12 via a control information interface section 5 or to the field apparatus 12 or the simulator means 10 further via the switching device 9.

[0032] The telegram synthesizing/dividing section 4 manages the "used/not-used" information, the "output/not-output" information and "controller" information for each field apparatus 12.

[0033] The "controller" information indicates which of the telegram 30, which is the control command produced by the interlocking logic section 6, and the telegram 32, which is the control command produced by the testing interlocking logic section 3, is used. For example, in the case where the telegram 30 produced by the interlocking logic section 6 is used, the "controller" information indicates "existing", and in the case where the telegram 32 produced by the testing interlocking logic section 3 is used, the "controller" information indicates "simulation". The "used/not-used" information and the "output/not-output" information correspond to "used/not-used" and "output/not-output" of the interlocking logic section 6 or the

testing interlocking logic section 3, respectively, and are determined by the "used/not-used" and "output/not-output" information of the interlocking logic section 6 or the testing interlocking logic section 3 that are retained as the "controller" information.

[0034] A procedure of determining the "controller" information is shown in FIG. 3. First, an initialization step 102 of setting all the values at "not-used" or "not-output" is performed, and then, a step 103 of receiving the telegram 30 produced by the interlocking logic section 6 and the telegram 32 produced by the testing interlocking logic section 3 is performed. Then, of all the outputs, first, the "used/not-used" information and the "output/not-output" information contained in the telegram 30, which is a control command from the interlocking logic section 6, are checked in step 106. If the telegram 30 indicates "output", since the relevant output is controlled by the interlocking logic section 6, the "controller" information is set at "existing", and a step 108 of outputting the "used/not-used" information and the "output/not-output" information contained in the telegram 30 is performed. Then, a determination step 104 and the following steps are repeated for the next output yet to be processed.

[0035] If the telegram 30 indicates "not-output" in the information checking step 106, then the "used/not-used" information and the "output/not-output" information contained in the telegram 32, which is a control command from the testing interlocking logic section 3, are checked in step 107. If the telegram 32 indicates "output", since the relevant output is not controlled by the interlocking logic section 6 but controlled by the testing interlocking logic section 3, the "controller" information is set at "simulation", and a step 109 of outputting the "used/not-used" information and the "output/not-output" information contained in the telegram 32 is performed. Then, the procedure returns to the determination step 104.

[0036] If the telegram 32 indicates "not-output" in the information checking step 107, the relevant output is not from the interlocking logic section 6 and the testing interlocking logic section 3. Thus, the values "not-used" and "not-output" set in the initialization step 102 are kept unchanged, and the procedure returns to the determination step 104.

[0037] For example, in the case where the information from the interlocking logic section 6 indicates "used" and "output", and the information from the testing interlocking logic section 3 indicates "not-used" and "not-output", the information of the field control terminal 7 indicates "existing", "used" and "output". Similarly, in the case where the information from the interlocking logic section 6 indicates "not-used" and "not-output", and the information from the testing interlocking logic section 3 indicates "used" and "output", the information of the field control terminal 7 indicates "simulation", "used" and "output".

[0038] The field control terminal 7 outputs a synthesis telegram 31, which comprises the "used/not-used" information, the "output/not-output" information and the "controller" information determined by the procedure de-

scribed above, to the field apparatus 12a via the control information interface section 5 or to the field apparatus 12b or the simulator means 10 via the switching device 9.

[0039] When the testing interlocking logic section 3 is operating in the follow mode, the control-mode output specifying information 13a and the follow-mode output specifying information 13b is determined in such a manner that both the commands from the interlocking logic section 6 and the testing interlocking logic section 3 to the same field apparatus 12 are not "output", in order to prevent the information from inhibiting the operation of the interlocking logic section 6 and thereby affecting the field apparatus 12 in operation.

[0040] In the procedure shown in FIG. 3, it is checked whether both the telegram 30 produced by the interlocking logic section 6 and the telegram 32 produced by the testing interlocking logic section 3 indicate "output" or not in a step 105. If both the telegram indicate "output", it indicates an error that, during operation of the interlocking logic section 6 in which the testing interlocking logic section 3 should be in the follow mode, the testing interlocking logic section 3 does not perform control following the operation of the interlocking logic section 6 not to inhibit the operation of the interlocking logic section 6.

Thus, an error processing step 110 is performed to inform an error management section 8 of the error. The error management section 8 halts the testing interlocking logic section 3, performs a processing using only the telegram 30 from the interlocking logic section 6 by ignoring the telegram 32 from the testing interlocking logic section 3 or halts the output of the field control terminal 7.

[0041] In addition, since the telegram synthesizing/dividing section 4 retains information that indicates that the interlocking logic section 6 operates in the control mode, and the testing interlocking logic section 3 operates in the follow mode, the telegram synthesizing/dividing section 4 transmits, to an switching information interface 11, an output for switching an output specified as "simulation" in the telegram 31 from the field apparatus 12b to the simulator means 10. The switching information interface 11 produces an output that instructs the switching device 9 to switch the output from the control information interface 5 from the field apparatus 12b to the simulator means 10, and the switching device 9 controls the connection target according to the output.

[0042] Alternatively, the switching device 9 may control the connection target without using the operation-mode information about the interlocking logic section 6 and the testing interlocking logic section 3 from the telegram synthesizing/dividing section 4. In this case, the switching device 9 is directly informed of the connection target via a connection-target specifying interface 15, and thus, the switching information interface 11 is not necessary.

[0043] The result of the output to the field apparatus 12 or the simulator means 10 is introduced into the field control terminal 7 via the control information interface section 5. The result is divided based on the "controller"

information contained in the telegram 31 and transmitted individually to the interlocking logic section 6 or the testing interlocking logic section 3. For example, if the "controller" information contained in the telegram 31 indicates "control", the result is transmitted to the interlocking logic section 6 via the LAN 20, and if the "controller" information indicates "simulation", the result is transmitted to the testing interlocking logic section 3 via the LAN 20.

[0044] Furthermore, alternatively, the result may be transmitted to each of the interlocking logic section 6 and the testing interlocking logic section 3 via the LAN 20 without being divided.

[0045] Thus, when performing a connection test of the testing interlocking logic section 3 and the field apparatus 12, the apparatus according to the present invention can check the operation of the testing interlocking logic section 3 without halting the interlocking logic section 6 or changing any wiring connection even when the interlocking logic section 6 is in operation, such as during the daytime, and the process time and cost of the test carried out in the field apparatus room can be reduced.

[0046] Now, with reference to FIG. 2, a case where the interlocking logic section 6 operates in the control mode, and the testing interlocking logic section 3 is halted will be described with regard to the difference from the case where the field apparatus terminal 7 operates in the following test mode described above. In this case, the field control terminal 7 operates in the normal mode, as can be seen from FIG. 2.

[0047] In this case, since the testing interlocking logic section 3 does not operate, the telegram 32 is not produced. In addition, since the operation mode management section 2 does not receive the operation mode information from the testing interlocking logic section 3 via the LAN 20, the operation mode management section 2 determines that the testing interlocking logic section 3 is halted, and that the field apparatus terminal 7 operates in the normal mode according to the mode/state definition shown in FIG. 2.

[0048] Since the telegram 32 is not produced, the telegram synthesizing/dividing section 4 performs a processing using only the telegram 30, that is, the information from the interlocking logic section 6. Because of the absence of the telegram 32, the determination step 105 relating to the information of the telegram 32 does not determine that both the telegram 30 and the telegram 32 indicate "output". In addition, the result of the determination step 107 is not "output", and there is no possibility that the information from the telegram 32 is output in the step 109. Thus, the field apparatus terminal 7 outputs only the information from the telegram 30 as the telegram 31. At the same time, the telegram 31 does not contain any piece of information that designates the "connection target" as "simulation".

[0049] Furthermore, in the case where the result of the output is divided and the divisional results are transmitted to the interlocking logic section 6 or the testing interlocking logic section 3, all the results are transmitted to the

interlocking logic section 6, since the telegram 31 does not contain any piece of information that designates "simulation".

[0050] Thus, in the case where the testing interlocking logic section 3 is halted, the computerized interlocking system 1 can operate by allowing only the interlocking logic section 6 to operate under the control mode. Thus, when the test is completed, the computerized interlocking system 1 can shift to the control by only the interlocking logic section 6 without the need of changing any wiring connection, and the process time and cost of the test carried out in the field apparatus room can be reduced.

[0051] Now, with reference to FIG. 2, a case where the interlocking logic section 6 is halted, and the testing interlocking logic section 3 operates in the independent mode will be described with regard to the difference from the case where the field apparatus terminal 7 operates in the following test mode described above. In this case, the field control terminal 7 operates in the independent test mode, as can be seen from FIG. 2.

[0052] The testing interlocking logic section 3 determines the "output/not-output" information contained in the telegram 32 based on the independent-mode output specifying information 13c. The independent-mode output specifying information 13c is information that defines an output that allows the testing interlocking logic section 3 to operate independently.

[0053] In this case, since the interlocking logic section 6 does not operate, the telegram 30 is not produced. In addition, since the operation mode management section 2 does not receive the operation mode information from the interlocking logic section 6 via the LAN 20, the operation mode management section 2 determines that the interlocking logic section 6 is halted, and that the field apparatus terminal 7 operates in the independent test mode according to the mode/state definition shown in FIG. 2.

[0054] Since the telegram 30 is not produced, the telegram synthesizing/dividing section 4 performs a processing using only the telegram 32, that is, the information from the testing interlocking logic section 3. Because of the absence of the telegram 30, the determination step 105 relating to the information of the telegram 30 does not determine that both the telegram 30 and the telegram 32 indicate "output". In addition, the result of the determination step 107 is not "output", and there is no possibility that the information from the telegram 30 is output in the step 109. Thus, the field apparatus terminal 7 outputs only the information from the telegram 32 as the telegram 31. At the same time, the telegram 31 does not contain any piece of information that designates the "connection target" as "control".

[0055] Furthermore, in the case where the result of the output is divided and the divisional results are transmitted to the interlocking logic section 6 or the testing interlocking logic section 3, all the results are transmitted to the testing interlocking logic section 3, since the telegram 31 does not contain any piece of information that designates

"control".

[0056] Thus, in the case where the interlocking logic section 6 is halted, the computerized interlocking system 1 can operate by allowing only the testing interlocking logic section 3 to operate under the independent mode. Thus, when starting the test, the computerized interlocking system 1 can shift to the control by only the testing interlocking logic section 3 without the need of changing any wiring connection, and the process time and cost of the test carried out in the field apparatus room can be reduced.

[0057] Now, a case where the interlocking logic section 6 operates in the control mode, and the testing interlocking logic section 3 operates in the independent mode will be described. In this case, the field control terminal 7 is considered to be in an error state according to the definition shown in FIG. 2.

[0058] In this case, the interlocking logic section 6 informs the field control terminal 7, via the LAN 20, of the fact that the operation mode thereof is the control mode. Similarly, the testing interlocking logic section 3 informs the field control terminal 7, via the LAN 20, of the fact that the operation mode thereof is the independent mode.

[0059] Since the testing interlocking logic section 3 operates in the independent mode, not in the follow mode in which the testing interlocking logic section 3 performs control following the operation of the interlocking logic section 6 not to inhibit the operation of the interlocking logic section 6 in the control mode, the operation of the testing interlocking logic section 3 may inhibit the operation of the interlocking logic section 6.

[0060] Thus, the operation mode management section 2 receives the operation mode information from the interlocking logic section 6 and the testing interlocking logic section 3 via the LAN 20. Then, if the interlocking logic section 6 operates in the control mode, and the testing interlocking logic section 3 operates in the independent mode, the operation mode management section 2 determines that the field control terminal 7 is in the error state according to the mode/state definition shown in FIG. 2.

[0061] In the case where the field control terminal 7 is in the error state, the operation mode management section 2 transmits the operation mode information from the interlocking logic section 6 and the testing interlocking logic section 3, which is considered erroneous, to the error management section 8, and the error management section 8 stores the information transmitted thereto. In addition, the operation mode management section 2 instructs the telegram synthesizing/dividing section 4 to discard the telegrams 30 and 32. In this way, the telegram synthesizing/dividing section 4 does not accept the telegrams 30 and 32, and thus, does not produce any output to the field apparatus 12 or the switching device 9 shown in the procedure of FIG. 3.

[0062] Thus, it is possible to avoid a situation in which the interlocking logic section operates in the control mode, and at the same time, the testing interlocking logic section 3 operates in the independent test mode, thereby

preventing any operation that can compromise the safety of the field apparatus 12.

[0063] Now, a case where the interlocking logic section 6 is halted, and the testing interlocking logic section 3 operates in the follow mode will be described. In this case, the field control terminal 7 is considered to be in an error state according to the mode/state definition shown in FIG. 2.

[0064] In this case, the interlocking logic section 6 cannot transmit the operation mode information to the field control terminal 7 via the LAN 20. On the other hand, the testing interlocking logic section 3 informs, via the LAN 20, the field control terminal 7 of the fact that the operation mode thereof is the independent mode.

[0065] Since the testing interlocking logic section 3 operates in the test mode, not in the independent mode in which the testing interlocking logic section 3 operates independently, the testing interlocking logic section 3 may be unable to safely control the field apparatus 12 by itself.

[0066] Thus, the operation mode management section 2 receives the operation mode information from the interlocking logic section 6 and the testing interlocking logic section 3 via the LAN 20. Then, if the interlocking logic section 6 is halted, and the testing interlocking logic section 3 operates in the follow mode, the operation mode management section 2 determines that the field control terminal 7 is in the error state according to the mode/state definition shown in FIG. 2. The following process is the same as in the case of the error state described above.

[0067] In the case where both the interlocking logic section 6 and the testing interlocking logic section 3 are halted, the field control terminal 7 does not receive the operation mode information of the interlocking logic section 6 and the testing interlocking logic section 3 via the LAN 20, and therefore, is considered to be in the error state according to the condition of combination of operation modes shown in FIG. 2. In this case, the field control terminal 7 receives neither the telegram 30 nor the telegram 32, and thus, does not transmit any output to the field apparatus 12.

[0068] Thus, in the case where the interlocking logic section 6 and the testing interlocking logic section 3 are halted, it is possible to prevent any operation that can compromise the safety of the field apparatus 12 by preventing any output from being transmitted to the field apparatus 12.

[0069] As described above, the field control terminal 7 can safely control the field apparatus 12 for all the combinations of operation modes of the interlocking logic section 6 and the testing interlocking logic section 3.

[0070] As described above with reference to examples, the present invention provides a computerized interlocking system, comprising: an interlocking logic section that produces a control command to a plurality of railway signaling field apparatus, including a railway switch, a signal and a contact output; a field control ter-

minimal connected to the interlocking logic section via a communication line in which a control calculation section that produces a control output to the plurality of railway signaling field apparatus is implemented; and simulator means capable of simulating the functions of the railway signaling field apparatus during testing, characterized in that the computerized interlocking system further comprises a testing interlocking logic section that is connected to the plurality of field control terminals via the communication line and has, as an operation mode, a follow mode in which the testing interlocking logic section performs control following the operation of the interlocking logic section not to inhibit the operation of the interlocking logic section, either or both of the interlocking logic section and the testing interlocking logic section outputs a control command for one or more of the plurality of railway signaling field apparatus to the field control terminal along with output presence/absence information about the control command, and in the case where the interlocking logic section outputs a control command, and the testing interlocking logic section is in the follow mode or produces no output, the field control terminal outputs the control command from the interlocking logic section of control commands for the one or more field apparatus.

[0071] In addition, in the computerized interlocking system according to the present invention, the field control terminal outputs no control command to the one or more field apparatus or suppresses any output in the case where the interlocking logic section produces no output, and the testing interlocking logic section operates in the follow mode.

[0072] In addition, in the computerized interlocking system according to the present invention, the testing interlocking logic section has, as an operation mode, an independent mode in which the testing interlocking logic section performs control independently, either or both of the interlocking logic section and the testing interlocking logic section outputs a control command for the one or more field apparatus to the field control terminal along with output presence/absence information about the control command, and in the case where the interlocking logic section produces no output, and the testing interlocking logic section produces a control command in the independent mode, the field control terminal operates in an independent test mode and outputs the control command from the testing interlocking logic section of control commands for the one or more field apparatus.

[0073] In addition, in the computerized interlocking system according to the present invention, the field control terminal outputs no control command to the one or more field apparatus or suppresses any output in the case where the interlocking logic section produces an output or is in operation, and the testing interlocking logic section operates in the independent mode.

[0074] In addition, in the computerized interlocking system according to the present invention, the field control terminal is connected, via switching means, to the plurality of railway signaling field apparatus and the sim-

ulator means capable of simulating the operations of the plurality of railway signaling field apparatus, the field control terminal transmits operation mode information about the testing interlocking logic section to the switching means, and the switching means is connected to the simulator means in the case where the operation mode information about the testing interlocking logic section indicates that the operation mode of the testing interlocking logic section is the follow mode, and to the plurality of railway signaling field apparatus in the case where the operation mode information indicates that the operation mode of the testing interlocking logic section is the independent mode.

[0075] In addition, in the computerized interlocking system according to the present invention, the field control terminal is connected to the plurality of railway signaling field apparatus and the simulator means that simulates the operations of the plurality of railway signaling field apparatus via the switching means, and the switching means has an interface for specifying whether the switching means is connected to the simulator means or the railway signaling field apparatus.

[0076] In addition, in the computerized interlocking system according to the present invention, the field control terminal outputs no control command to the plurality of railway signaling field apparatus or suppresses any output in the case where both the interlocking logic section and the testing interlocking logic section designate an output.

[0077] Furthermore, the present invention provides a testing apparatus, comprising: a field control terminal in which an interlocking logic section that produces a control command to a plurality of railway signaling field apparatus, including a railway switch, a signal and a contact output, and a control calculation section that is connected to the interlocking logic section via a communication line and produces a control output to the plurality of railway signaling field apparatus are implemented, characterized in that the computerized interlocking system further comprises a testing interlocking logic section that is connected to the plurality of field control terminals via the communication line and has, as an operation mode, a follow-mode in which the testing interlocking logic section performs control following the operation of the interlocking logic section not to inhibit the operation of the interlocking logic section, either or both of the interlocking logic section and the testing interlocking logic section outputs a control command for one or more of the plurality of railway signaling field apparatus to the field control terminal along with output presence/absence information about the control command, and in the case where the interlocking logic section produces an output or is in operation, and the testing interlocking logic section operates in an independent mode in which the testing interlocking logic section performs control independently, the field control terminal outputs none of control commands for the one or more field apparatus.

[0078] Furthermore, the present invention provides a

testing method that produces a control output to a plurality of railway signaling field apparatus, including a railway switch, a signal and a contact output, via a communication line and simulates the functions of the railway signaling field apparatus during testing, characterized in that when either or both of a control command and a testing control command for one or more of the plurality of railway signaling field apparatus are transmitted for controlling and for performing a test, the testing control command is a follow-mode test command that does not inhibit the control command or an independent-mode test command for performing an independent test when there is no control command .

Claims

1. A computerized interlocking system, comprising:

an interlocking logic section that produces a control command to a plurality of railway signaling field apparatus, including a railway switch, a signal and a contact output;
a field control terminal connected to said interlocking logic section via a communication line in which a control calculation section that produces a control output to said plurality of railway signaling field apparatus is implemented; and
simulator means capable of simulating the functions of said railway signaling field apparatus during testing,

characterized in that the computerized interlocking system further comprises a testing interlocking logic section that is connected to said plurality of field control terminals via said communication line and has, as an operation mode, a follow mode in which the testing interlocking logic section performs control following the operation of said interlocking logic section not to inhibit the operation of the interlocking logic section,
either or both of said interlocking logic section and said testing interlocking logic section outputs a control command for one or more of said plurality of railway signaling field apparatus to said field control terminal along with output presence/absence information about the control command, and
in the case where said interlocking logic section outputs a control command, and said testing interlocking logic section is in the follow mode or produces no output, the field control terminal outputs the control command from said interlocking logic section of control commands for said one or more field apparatus.

2. The computerized interlocking system according to Claim 1, **characterized in that** said field control terminal outputs no control command to said one or

more field apparatus in the case where said interlocking logic section produces no output, and said testing interlocking logic section operates in the follow mode.

3. The computerized interlocking system according to Claim 1, **characterized in that** said testing interlocking logic section has, as an operation mode, an independent mode in which the testing interlocking logic section performs control independently, either or both of said interlocking logic section and said testing interlocking logic section outputs a control command for said one or more field apparatus to said field control terminal along with output presence/absence information about the control command, and in the case where said interlocking logic section produces no output, and said testing interlocking logic section produces a control command in the independent mode, the field control terminal operates in an independent test mode and outputs the control command from said testing interlocking logic section of control commands for said one or more field apparatus.

4. The computerized interlocking system according to Claim 3, **characterized in that** said field control terminal outputs no control command to said one or more field apparatus in the case where said interlocking logic section produces an output or is in operation, and said testing interlocking logic section operates in the independent mode.

5. The computerized interlocking system according to Claim 1 or 3, **characterized in that** said field control terminal is connected, via switching means, to said plurality of railway signaling field apparatus and the simulator means capable of simulating the operations of the plurality of railway signaling field apparatus, said field control terminal transmits operation mode information about said testing interlocking logic section to said switching means, and said switching means is connected to said simulator means in the case where the operation mode information about said testing interlocking logic section indicates that the operation mode of said testing interlocking logic section is the follow mode, and to said plurality of railway signaling field apparatus in the case where the operation mode information indicates that the operation mode of said testing interlocking logic section is the independent mode.

6. The computerized interlocking system according to Claim 1, **characterized in that** said field control terminal is connected to said plurality of railway signaling field apparatus and the simulator means that simulates the operations of the plurality of railway

signaling field apparatus via said switching means, and said switching means has an interface for specifying whether said switching means is connected to said simulator means or said railway signaling field apparatus .

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7. The computerized interlocking system according to Claim 1, **characterized in that** said field control terminal outputs no control command to said plurality of railway signaling field apparatus in the case where both said interlocking logic section and said testing interlocking logic section designate an output.

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8. A testing apparatus, comprising:

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a field control terminal in which an interlocking logic section that produces a control command to a plurality of railway signaling field apparatus, including a railway switch, a signal and a contact output, and a control calculation section that is connected to said interlocking logic section via a communication line and produces a control output to said plurality of railway signaling field apparatus are implemented,

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characterized in that the computerized interlocking system further comprises a testing interlocking logic section that is connected to said plurality of field control terminals via said communication line and has, as an operation mode, a follow mode in which the testing interlocking logic section performs control following the operation of said interlocking logic section not to inhibit the operation of the interlocking logic section,

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either or both of said interlocking logic section and said testing interlocking logic section outputs a control command for one or more of said plurality of railway signaling field apparatus to said field control terminal along with output presence/absence information about the control command, and

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in the case where said interlocking logic section produces an output or is in operation, and said testing interlocking logic section operates in an independent mode in which said testing interlocking logic section performs control independently, said field control terminal outputs none of control commands for said one or more field apparatus.

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9. A testing method that produces a control output to a plurality of railway signaling field apparatus, including a railway switch, a signal and a contact output, via a communication line and simulates the functions of said railway signaling field apparatus during testing,

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characterized in that when either or both of a control command and a testing control command for one or more of said plurality of railway signaling field apparatus are transmitted for controlling and for per-

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forming a test, said testing control command is a follow-mode test command that does not inhibit said control command or an independent-mode test command for performing an independent test when there is no control command .

FIG.1

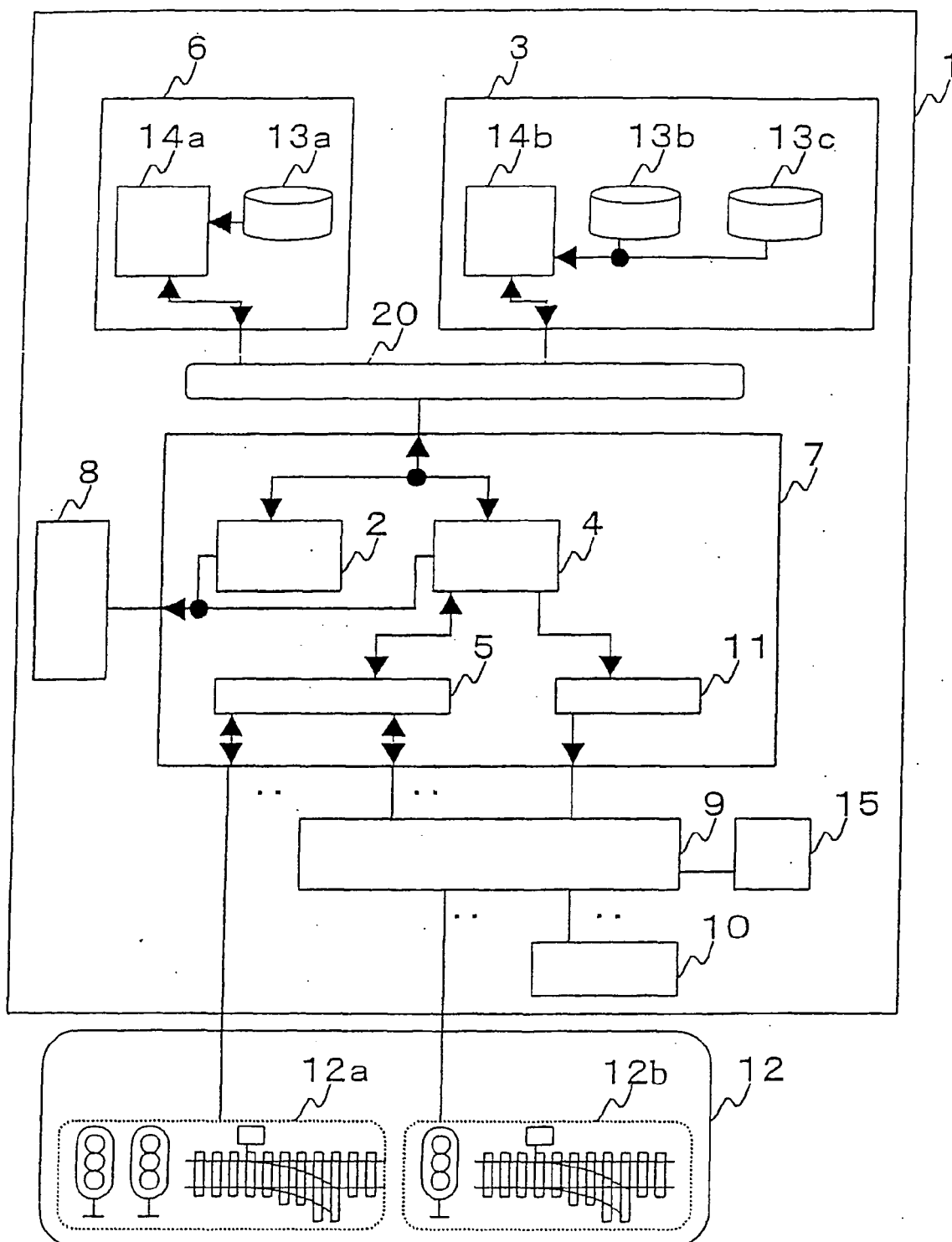


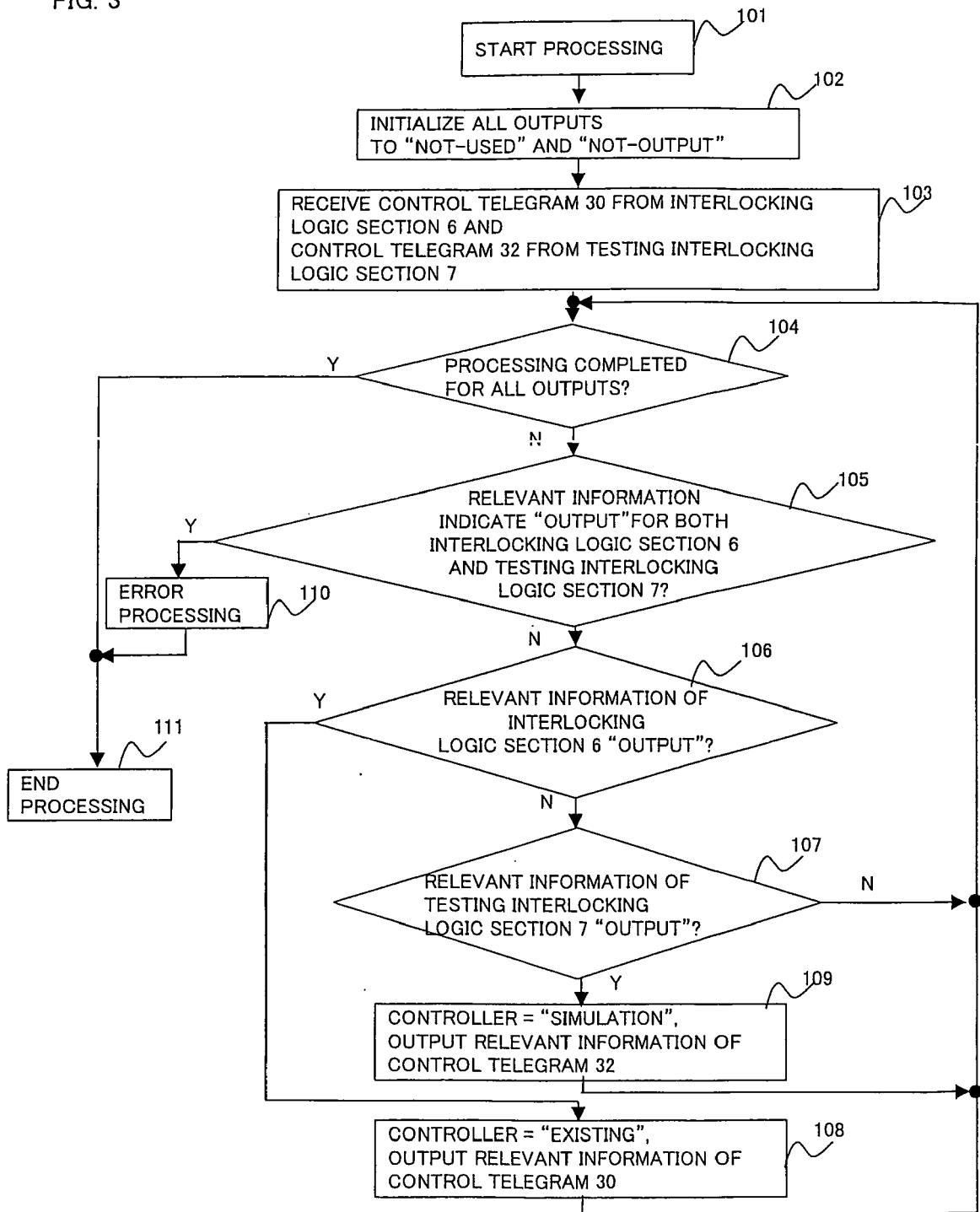
FIG. 2

OPERATION MODE OF INTERLOCKING LOGIC SECTION 6
CONTROL MODE
HALT

OPERATION MODE OF TESTING INTERLOCKING LOGIC SECTION 3
FOLLOW MODE
INDEPENDENT MODE
HALT

STATE OF FIELD CONTROL TERMINAL 7	PRECONDITION	
	OPERATION MODE OF INTERLOCKING LOGIC SECTION 6	OPERATION MODE OF TESTING INTERLOCKING LOGIC SECTION 3
FOLLOWING TEST MODE	CONTROL MODE	FOLLOW MODE
ERROR	CONTROL MODE	INDEPENDENT MODE
NORMAL MODE	CONTROL MODE	HALT
ERROR	HALT	FOLLOW MODE
INDEPENDENT TEST MODE	HALT	INDEPENDENT MODE
HALT	HALT	HALT

FIG. 3





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 06 25 0898

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Place of search Munich		Date of completion of the search 30 May 2006	Examiner Janhsen, A
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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