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(54) METHOD FOR INITIALIZING THE FS MODE FOR THE MOVEMENT OF A TRAIN ON A RAILWAY EQUIPPED WITH AN ERTMS/ETCS SIGNALING SYSTEM

(57) This method for initializing the Full Supervision - FS - mode for the movement of a train (4) on a railway (2) equipped with a signaling system (1) complying with the ERTMS/ETCS Level 2 or Level 3 standards, comprises the steps of:
- Identifying the signaling block (A6-A3) in which the train was located when an Embedded Vital Computer - EVC - on board the train disconnects from a Radio Bloc Center - RBC - of the signaling system;
- monitoring said block by checking periodically that at least one logical constraint that no other train enters in said block is verified, the logical constraint being elaborated from events on the railway in the vicinity of said block; and, when the result of the checking is negative, updating an attribute associated with said block, the attribute switching from the value "FREE" to the value "NOT FREE";
- when the EVC reconnects to the RBC, the RBC reads the attribute and if it has the value "FREE", sends a movement authority to the train to supervise its movement according to the FS mode, at least on said block.

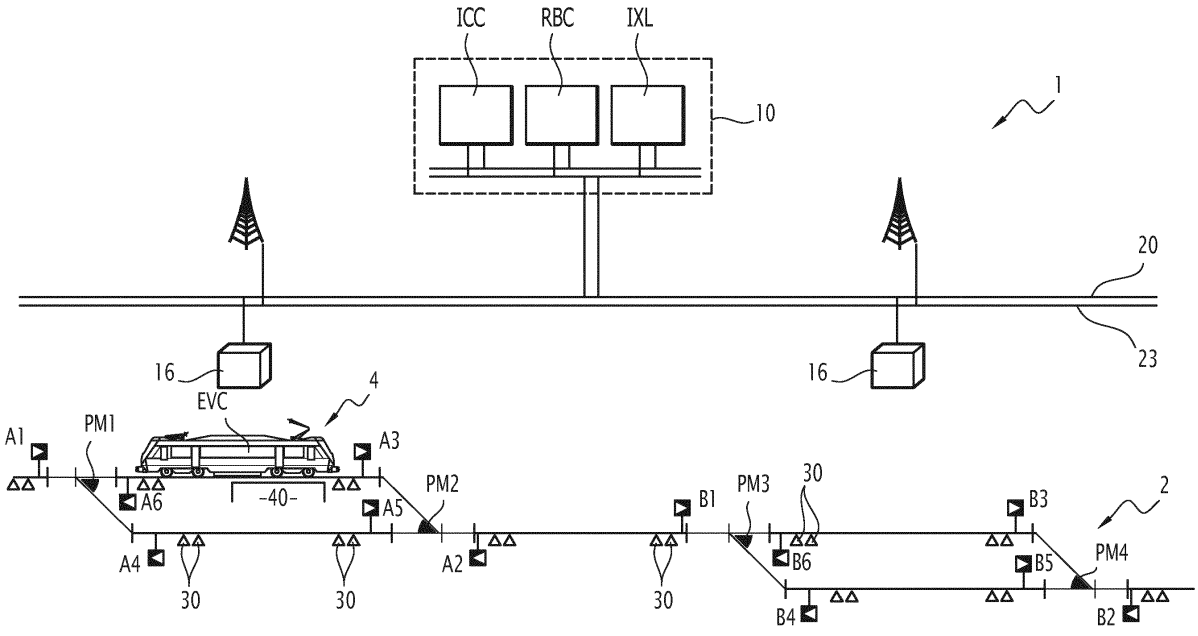

FIG.1

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Description

[0001] The present invention concerns a method for initializing the Full Supervision mode for the movement of a train on a railway equipped with a signaling system complying with the ERTMS/ETCS Level 2 or Level 3 standards, as defined by UNISIG.

[0002] According to the ETCS Level 2 standard, and as illustrated in figure 1, a signaling system 1 of a railway 2 comprises, on-board each train, such as train 4, an EVC (for "European Vital Computer"), and, on the ground, in a control center 10, a RBC (for "Radio Block Centre"), an interlocking system, called IXL, and a supervision system, called ICC (for "Integrated Control Centre"), and, along the tracks of the railway 2, various trackside equipment connected to object controllers 16.

[0003] In figure 1, an example of trackside equipment is given by the axle counters 30 at each end of the blocks subdividing the railway 2. A set of axle counters allows the RBC to determine the occupancy status of the corresponding block, which can take the value "OCCUPIED" or "NOT OCCUPIED". It is to be noted that the ends of a block, Ai or Bi in figure 1 (with index i between 1 and 6) are indicated by associated panels. Another example of trackside equipment is given by point machines PM1 to PM4 for locking the corresponding point systems either in a straight position or a diverted position.

[0004] A backbone 20 links the objects controller 16 to the control center 10.

[0005] A radio communication infrastructure, for example of the GSM type, referenced by numeral 22 in figure 1, allows a bidirectional communication between EVCs on board each trains and the RBC.

[0006] The ICC is in charge of defining a route for a train in order this latter to complete its mission.

[0007] The IXL is in charge of opening the route in front of the train, according to the route defined by the ICC. The IXL thus commands the pieces of trackside equipment to set them in the appropriate position or status.

[0008] The RBC is in charge of supervising the movement of the train, by sending regularly movement authorities. A movement authority informs the train that it can move safely forward from its current point to an end point of the movement authority. The movement authority is determined from the occupancy status of the blocks making up the route opened in front of the train.

[0009] On reception of the movement authority, the EVC onboard the train calculates speed curves and brake profiles in order to control the train movement. The train being completely supervised is said to be in Full Supervision mode, or FS mode.

[0010] Beside the FS mode, the ETCS level 2 defines a Staff Responsible mode, SR mode, and an on-sight mode, OS mode, in which a train can enter onto a block whose occupancy status is "OCCUPIED".

[0011] In the SR mode, the driver has to drive the train under his own responsibility, at a low speed.

[0012] In the OS mode, the driver has to drive the train on-sight at a reduced speed and the EVC onboard the train controls a few parameters, for example that the train remains inside the occupied block. The driver is responsible for checking the track occupancy when moving the train, because the track may be occupied.

[0013] This SR/OS mode is useful in case of anomalies, such as an axle counter not counting the right number of axles of a passing train so that the RBC considers the corresponding block as occupied, while it is in fact not occupied. This OS mode is also useful for train composition, when a locomotive has to enter a block already occupied with coaches to which this locomotive has to be coupled.

[0014] At start-up of a train, for a new mission, the EVC registers itself to the RBC. But, before the RBC is capable of sending a first movement authority to the train in order for it to operate in the FS mode, the RBC has to ensure that there is no other train or other vehicle between the current position of the train and the end point of the current block.

[0015] Indeed, the current block being in the occupancy status "OCCUPIED", due to the presence of the train considered, another train could also be present inside this current block. In this condition, the RBC cannot send a movement authority including the end of the current block, while it is capable to send a movement authority once the train has reached the end point of this current block, knowing that the next block is in the occupancy state "NOT OCCUPIED". Consequently, the driver has to move the train to the end of the current block in the SR or OS mode.

[0016] It has also been proposed to send a movement authority for the full supervision of the train before the train reaches the end point of the current block, when the RBC can receive a confirmation that the track ahead the train is free as far as the end of the current block. This information is called TAF information, for Track Ahead Free.

[0017] Several mechanisms are proposed by UNISIG to guarantee that the track ahead is free:

- In a first mechanism, called TAF request mechanism, and disclosed in the subset 26 version 3.4.0, § 5.9.6.2.3 of the ERTMS/ETCS Level 2 standard, the RBC sends a TAF request to the EVC, which in turn displays this request onto an appropriate screen in the train driver cabin. If the driver confirms that the track is free up to the end of the current block, the EVC will transmit this TAF information back to the RBC. The RBC can then send a movement authority for switching the operative mode of the EVC into the FS mode, this movement authority extending over the end portion of the current block and the next block.
- In a second mechanism, the known Automatic TAF solution, proposed by UNISIG in its ETCS Engineering guidelines (Informative Specification, reference ERA/ERTMS/040054), can be used in an ATAF

mechanism to provide the TAF information without any input from the driver. This is done through a combination of reported train position and trackside information.

[0018] But, for both of these mechanisms, it is only possible to guarantee that the track ahead is free when the train is close enough to the end of the current block (at sighting distance for the TAF request mechanism, and inside a distance guaranteed as free for the ATAF mechanism).

[0019] Thus, at the start-up of a train, the practical method is to move the train in SR or OS mode, from the current point to a point close enough to the end of the current block so that a TAF request mechanism or an ATAF mechanism be able to compute TAF information inside the RBC, as recommended in the Start of Mission in Level 2 Guideline (Informative Specification, reference ERA/ERTMS/040054).

[0020] This is not an optimized solution due to obvious safety and operational reasons, in particular for blocks of great length where the end point is far away.

[0021] The invention therefore aims at overcoming this problem.

[0022] To this end, the object of the invention is to provide a method as defined by the claims. With this method, it is possible to start automatically a train in the FS mode, as defined in ERTMS/ETCS Level 2 or Level 3, even if the train is not close to the end of the current block.

[0023] The invention and its advantages will be better understood upon reading the description which will follow, provided solely by way of example with reference made to the accompanying drawings in which:

- Figure 1 is a general schematic representation of a railway equipped with a ERTMS/ETCS signaling system; and,
- Figure 2 is a block diagram of the preferred embodiment of the method according to the invention.

[0024] The principle of the method consists in, as soon as the train of interest (called the first train in the following) disconnects from the RBC at the end of a mission, while being located inside a signaling block (called the current block in the following), monitoring continuously if another train or vehicle (called the second train in the following) enters or has the possibility to enter into said signaling block, until the first train connects again to the RBC for a new mission. Then, if the first train reports a current position compatible with the current block and if no second train has entered or has had the possibility to enter into the current block, the RBC is able to send immediately a movement authority to place the first train into the FS mode, this movement authority extending from the current position of the first train and covering the end portion of the current block.

[0025] An embodiment of the method according to the invention will now be given in reference to figure 1 and 2.

[0026] In step 110 of the method 100, the first train 4, supervised according to the FS mode, enters block A6-A3, corresponding to a platform 40 of a station, and stops along the platform 40.

[0027] In step 120, to allow other trains to pass the platform 40, the first switch PM1 is set in the deviated position A1-A4, and the second switch PM2 is set in the direct position A5-A2. Thus, no other train can enter inside the block A6-A3, from A3.

[0028] In step 130, the first train 4 ends its mission. The EVC on board train 4 disconnects from the RBC, while reporting current position of train 4 inside block A6-A3, which is then considered as the current block for train 4.

[0029] Immediately, in step 140, the RBC launches a monitoring function of the status of the current block associated to train 4.

[0030] This function monitors if a second train has the possibility to enter into bloc A6-A3, from A3.

[0031] This function is based on the periodic verification of at least one logical constraint about events affecting the railway in the vicinity of the current block A6-A3.

[0032] If the or each logical constraint is verified a TAF attribute of the current block, maintained by the RBC, keeps the value "FREE", otherwise it takes the value "NOT FREE".

[0033] For example, in step 142, the RCB receives, form the IXL, the positions of the first and second point machines PM1 and PM2 and the occupancy status of the blocks adjacent to the current block A6-A3, i.e. blocks A3-A5-A2 and A1-A6-A4.

[0034] In step 143, the RBC checks that logical constraints are still verified.

[0035] If for example, block A3-A5-A2 becomes occupied while the position of the second point machine PM2 has been modified to its diverted position, A3-A2, it cannot be guaranteed anymore that the track ahead train 4 is free until A3, as a train may have entered bloc A6-A3 from A3. In this case, the TAF attribute for current block A6-A3 is set to the value "NOT FREE".

[0036] Once the TAF attribute has the value "NOT FREE", it can only be reinitialized at the value "FREE" when the occupancy status of the current signaling block A6-A3 becomes "NOT OCCUPIED", i.e. when the current train and possibly other trains have left the current block.

[0037] Steps 142 and 143 are repeated at a high frequency, for example every second, until the EVC of the first train 4 connects again to the RBC.

[0038] In step 150, when the first train 4 performs its start of mission and connects to the RBC, it sends a position report indicating its current position to the RBC.

[0039] In step 160, the RBC verifies that the position report is valid, i.e. that the first train 4 having ended its mission in block A6-A3, is starting a new mission from this same block.

[0040] With a valid position report, in step 170, the RBC read the current value of the TAF attribute for the current block A6-A3.

[0041] When the current value of the TAF attribute is "FREE", in step 180, the RBC sends directly a FS movement authority to the first train 4. This FS movement authority comprises at least the portion of block A6-A3 from the current position of the first train to the end point of the block A6-A3, and possibly the preferably next block.

[0042] In step 190, on receipt of this FS movement authority, the first train 4 starts its mission immediately in FS mode.

[0043] If the current value of the TAF attribute is "NOT FREE", it is not possible for the RBC to guarantee that the first train is alone inside the current signaling block on which it is stopped. It is not possible for the RBC to send directly a FS motion authority to the first train 4. A backup procedure 200 using the known TAF request or ATAF mechanisms is then applied.

[0044] More advanced logical constraints may be checked periodically by the RBC to update the value of a TAF attribute of the current block associated to a train having ended its mission. Such advanced constraints may be based on information from the trackside equipment and/or other information determined by high level systems, like the ICC: train occupation and localization based on switch position, block occupancy, other train position reports, train routes management, etc.

[0045] For example, in case the first train is recomposed after the end of its mission, additional information can be gathered to allow the RBC to know if the first train is still the only train on the block. For example the information outputted by a train composition management function realized by the ICC can be taken into account to build an advanced constraint.

[0046] In another example, in case the first train is split after its mission has ended, additional information can be obtained from the train integrity management function available in ETCS Level 3.

[0047] As an alternative, in place of the RBC, other existing systems of the signaling system 1 or a new dedicated monitoring module of the signaling system could realize the monitoring function described above.

[0048] According to this method, there is no need for the systematic use of TAF request or ATAF mechanisms at starting up of a train. By monitoring the history of the events on the track around the block where the train of interest has stopped, from the time it has stopped to the time it restarts, it is possible to start the next mission immediately in the ETCS FS mode, wherever the train is located inside the current signaling block and whatever the length of this current signaling block is.

Claims

1. Method (100) for initializing the Full Supervision mode for the movement of a train (4) on a railway (2) equipped with a signaling system (1) complying with the ERTMS/ETCS Level 2 or Level 3 standards, **characterized in that** it comprises the steps of:
   - Identifying the signaling block (A6-A3) in which the train (4) was located when an Embedded Vital Computer (EVC) on board the train disconnects from a Radio Bloc Center (RBC) of the signaling system;
   - monitoring said signaling block by checking periodically that at least one logical constraint that no other train enters or can enter in said signaling block (A6-A3) is verified, the or each logical constraint being elaborated from events on the railway in the vicinity of said signaling block (A6-A3); and, when the result of the checking is negative, updating a value of an attribute (TAF) associated with said signaling block (A6-A3), the attribute (TAF) switching from the value "FREE" to the value "NOT FREE";
   - when the Embedded Vital Computer (EVC) of the train (4) reconnects to the Radio Bloc Center (RBC) for a new mission, the Radio Bloc Center reads the current value of the attribute (TAF) and, if said attribute has the value "FREE", sends a movement authority to the train (4) in order to supervise the movement of the train according to the Full Supervision mode, at least on said signaling block.

2. Method according to claim 1, wherein the or each logical constraint is elaborated from data selected in the group comprising switch position, signaling block occupancy, other train position reports and train route management.

3. Method according to claim 1 or claim 2, wherein the monitoring step is performed by the Radio Block Center (RBC).

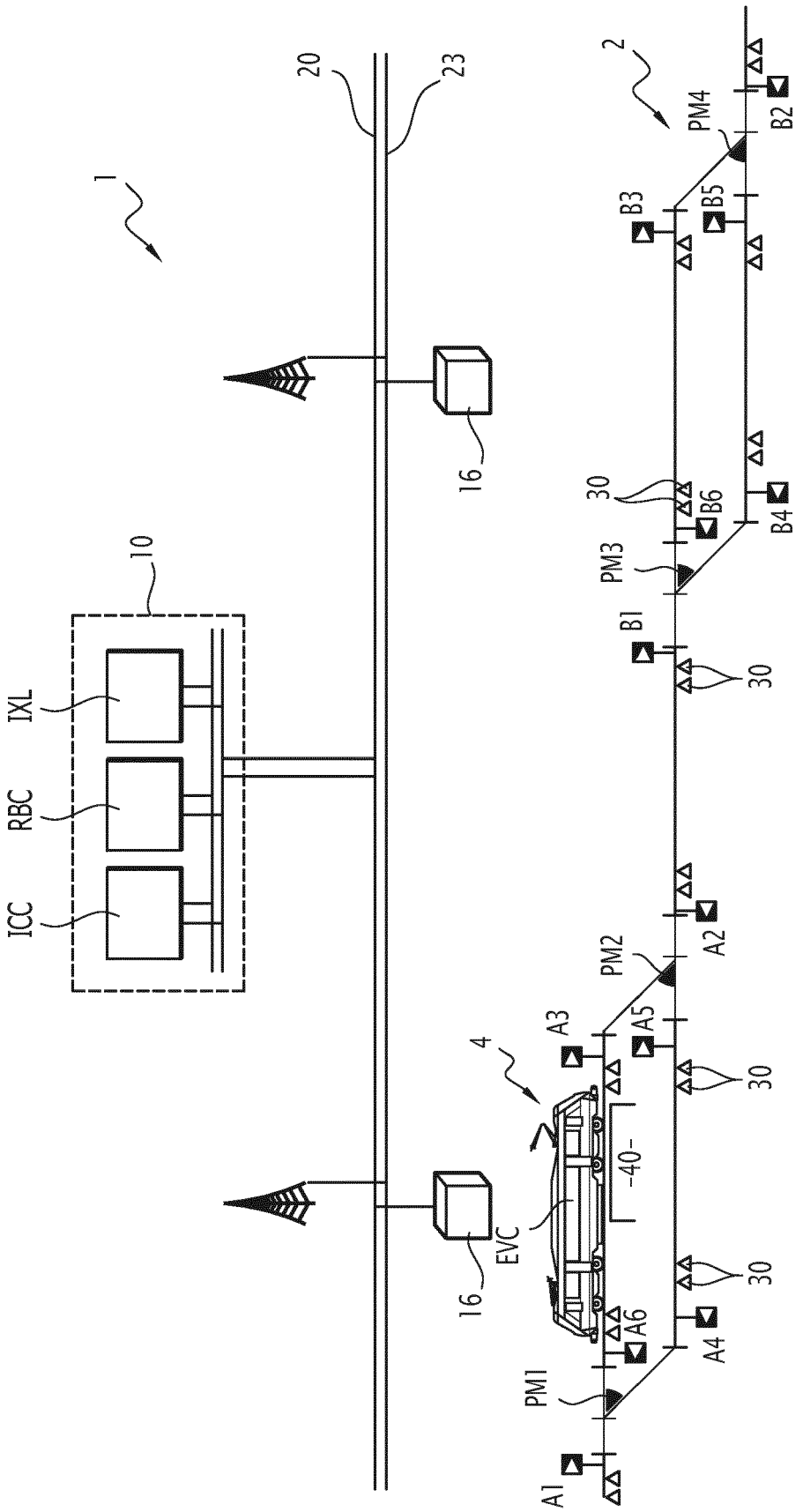
4. Method according to any one of claims 1 to 3, wherein, once the attribute (TAF) has the value "NOT FREE", the attribute is reinitialized at the value "FREE" when an occupancy status maintained by the Radio Block Center (RBC) of said signaling block is "NOT OCCUPIED".

5. Method according to any one of claims 1 to 3, wherein, when the Embedded Vital Computer (EVC) of the train (4) reconnects to the Radio Bloc Center (RBC) for a new mission, the Embedded Vital Computer sends a position report of the train (4) and the Radio Block Center (RBC) checks that the current position of the train (4) mentioned in the position report is located inside the signaling block (A6-A3) associated to the train when said train ended its mission, before reading the value of the attribute (TAF) corresponding to said signaling block (A6-A3).

6. Signaling system (1) complying with the ERTMS/ETCS Level 2 or Level 3 standards, for the Full Supervision of the movement of the trains circu-

lating on a railway, **characterized in that** it comprises a monitoring module capable of monitoring a signaling block associated with a train, which was located on said signaling block when an Embedded Vital Computer on board the train disconnects from a Radio Bloc Center of the signaling system, by checking periodically that at least one logical constraint that no other train enters or can enter in said signaling block is verified, the or each logical constraint being elaborated from events on the railway in the vicinity of said signaling block, and, when the result of the checking is negative, by updating a value of a TAF attribute associated with said signaling block, the TAF attribute switching from the value "FREE" to the value "NOT FREE", and **in that** the Radio Block Center is capable of reading the current value of the TAF attribute when the Embedded Vital Computer of the train reconnects to the Radio Bloc Center for a new mission, and, if the TAF attribute has the value "FREE", sends a FS movement authority to the train in order to supervise the movement of the train according to the Full Supervision mode at least on said signaling block.

7. Signaling system according to claim 6, capable of realizing a method according to any one of claims 1 to 5.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A1
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A5
A6
B1
B2
B3
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B5
B6
EVC
ICC
IXL
PM1
PM2
PM3
PM4
RBC
-40-

FIG.1

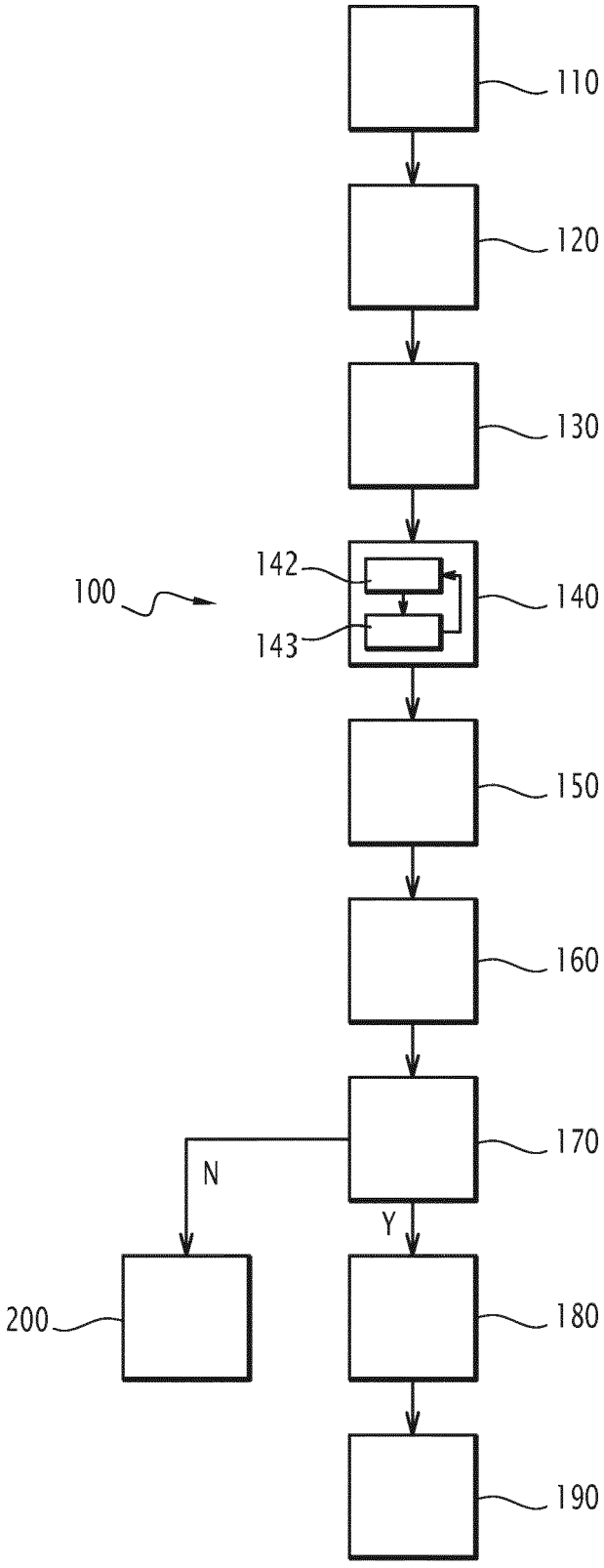

FIG.2

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EUROPEAN SEARCH REPORT

Application Number
EP 16 16 6239

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 October 2016	Janhsen, Axel

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 16 6239

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