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(72) Inventor: **Glover, Mark**
Chippenham, Wiltshire SN15 1JD (GB)

(74) Representative: **Emerson, Peter James et al**
Page Hargrave
Whitefriars
Lewins Mead
Bristol BS1 2NT (GB)

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(71) Applicant: **Westinghouse Brake and Signal Holdings Limited**
London
Greater London SW1X 7AW (GB)

(54) **Train information exchange**

(57) A method of exchanging information between train-carried equipment, said equipment being provided for operation of the train, and a remote location external to said train, comprises the steps of: providing a portable device, said portable device comprising data storage means, data input means for writing data to said data storage means and data output means for outputting data from said data storage means to an external location;

providing train connection means at the train-carried equipment enabling communication with said portable device for the exchange of data therewith, the connection means enabling said data exchange when the portable device is correctly located within the train; and providing auxiliary connection means at the remote location enabling communication with the portable device for the exchange of data therewith.

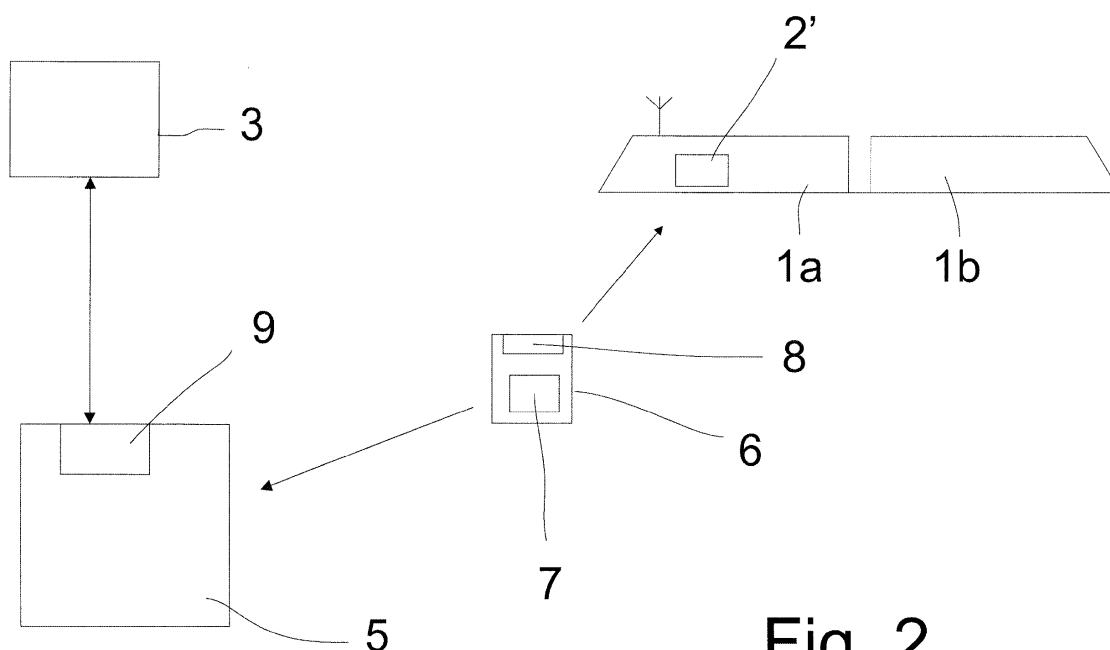


Fig. 2

Description

Summary of the invention

[0001] The present invention relates to a method of exchanging information between train-carried equipment, said equipment being provided for operation of the train, and a remote location external to said train, a method for enabling operation of a train, a method of implementing automatic train protection / operation for an automatic train protection / operation equipped train, a portable device for use with the method of any preceding claim, and train-carried equipment.

Background

[0002] Modern ATP and ATO systems require data to be provided to them relating to, for example:

- Geographical / map data relating to the railway (gradients, stations, points, etc.). Map data is information that the train needs in order to drive safely from place to place. Vital data may include the position of sets of points, the length of the track, the positions of speed restrictions, the ends of the line, routes that are not in use etc. Non-vital information may include station stopping positions, coast levels set for the day etc. Map data is either fixed and held on the train, or sent dynamically over a communications medium such as radio, and both approaches are commonly used.
- Train consist data, such as train length, train weight, adhesion levels (based for example on day to day weather predictions), brake rates (which may depend on adhesion levels, for example if frost or heavy rain is forecast, a lower brake rate may be assumed).
- Trip information (crew number, train number, etc.).

[0003] Additionally, information may be gathered on the train during the course of operation which needs to be relayed to central systems such as fault management and maintenance systems. Such information will typically include:

- Train status information, which is used for condition monitoring applications.
- Information (such as lateral or vertical acceleration) which may be used to derive condition information about track formation, requirements for maintenance, etc.
- Train event information, to monitor efficient operation of trains around the rail network.

[0004] Currently, this information is exchanged wirelessly between train-carried equipment and a remote location, as shown schematically in Fig. 1. Here, a train is shown, comprising two carriages 1a, 1b, with train-carried

equipment 2 being located in carriage 1a. The train-carried equipment 2 communicates wirelessly with a remotely located control system 3 via a wireless communications link 4. This wireless data exchange requires either 'hotspots' where data can be downloaded, or expensive radio backbones. The cost of providing full radio bandwidth necessary for this information exchange may be prohibitive. This is particularly the case with so-called 'light' systems where a full featured radio system is not economically viable. In light rail systems, speed restrictions and track layouts may change on a very regular basis, but the cost of providing full radio bandwidth is disproportionate.

[0005] It is an aim of the present invention to overcome these problems. This aim is achieved by employing a portable data storage device, which may for example be carried by a driver of the train, to enable information exchange between the train-carried equipment and a remote location.

Description of the invention

[0006] According to a first aspect of the present invention, there is provided a method of exchanging information between train-carried equipment, said equipment being provided for operation of the train, and a remote location external to said train, comprising the steps of:

- a) providing a portable device, said portable device comprising data storage means, data input means for writing data to said data storage means and data output means for outputting data from said data storage means to an external location;
- b) providing train connection means at the train-carried equipment enabling communication with said portable device for the exchange of data therewith, the connection means enabling said data exchange when the portable device is correctly located within the train; and
- c) providing auxiliary connection means at the remote location enabling communication with the portable device for the exchange of data therewith.

[0007] According to a second aspect of the present invention there is provided a method according to the first aspect, for providing information to the train-carried equipment, further comprising the steps of:

- d) at the remote location writing information to the data storage means of the portable device via the auxiliary connection means and data input means;
- e) transporting the portable device into the train;
- f) communicatively engaging the portable device with the train connection means at the train-carried equipment; and
- g) passing said information from the data storage means of the portable device to the train-carried equipment via the data output means and train con-

nection means.

[0008] According to a third aspect of the present invention there is provided a method for enabling operation of a train, comprising providing information to train-carried equipment of the train in accordance with the second aspect, wherein the information passed in step g) comprises identity information, and further comprising the steps of:

- h) correlating the identity information with information previously stored at the train-carried equipment; and
- i) enabling operation of the train if the correlation is successful.

[0009] According to a fourth aspect of the present invention there is provided a method of implementing automatic train protection / operation for an automatic train protection / operation equipped train, comprising providing information to train-carried equipment of the train in accordance with claim 2, wherein the information comprises information required for the operation of a train-carried automatic train protection / operation system.

[0010] According to a fifth aspect of the present invention there is provided a method according to the first aspect, for obtaining information from the train-carried equipment, further comprising the steps of:

- j) transporting the portable device into the train;
- k) communicatively engaging the portable device with the train connection means at the train-carried equipment; and
- l) passing said information from the train-carried equipment to the data storage means of the portable device via the train connection means and data input means.

[0011] In accordance with a sixth aspect of the present invention there is provided a portable device for use with the method of any preceding aspect.

[0012] In accordance with a seventh aspect of the present invention there is provided train-carried equipment for use with the method of any of the first to fifth aspects.

[0013] The following are exemplary features and advantages which may be enabled by this invention:

- i) A removable device that carries map data for trains operating under automatic train protection / operation (ATP / ATO)
- ii) A device / methodology for identifying that the train operator is seeking to activate the correct train.
- iii) A device / methodology for ensuring that time-accurate map data or train data is provided to the train.
- iv) A device / methodology for ensuring that the train operator is at the correct position within the train.

v) A device / methodology for storage of, and removal from the train of train management and recording data in a low cost, efficient manner.

vi) A device / methodology for tracking the location of personnel operating trains.

vii) The removal of the need to transmit map data over radio, thus reducing the bandwidth required of the radio system.

viii) A methodology particularly well suited to 'light' applications, e.g. light rail, where speed restrictions and track layouts may change on a very regular basis, but the cost of providing full radio bandwidth is prohibitive.

15 Detailed description

[0014] The invention is now described with reference to the accompanying drawings, of which:

Fig. 1 schematically shows a known railway system; and

Fig. 2 schematically shows an embodiment of the present invention.

[0015] Fig. 2 schematically shows a preferred embodiment of the present invention. Where appropriate, similar items as in Fig. 1 have retained that numbering system. Therefore, as in Fig. 1, a train is shown comprising two carriages 1a, 1b. Here, train-carried equipment 2' is located in carriage 1a. As in the prior art, it is required that information is exchanged between the train-carried equipment 2 and a control system 3.

[0016] Here, the information exchange is effected by use of a portable device 6, which includes a data storage means 7, such as an integrated memory unit, ROM, RAM, flash etc, or a removable unit such as an SD card or the like. The portable device 6 further comprises, in this embodiment, a combined data input / output means 8, for inputting / outputting data from the data storage means 7, for example a universal serial bus (USB) connection, Bluetooth (RTM) transceiver, radio frequency transceiver. Suitable examples of a portable device 6 include a USB key, smartcard or radio frequency identification (RFID) tag.

[0017] Whichever type of portable device 6 is used, the train-carried equipment 2' must be adapted to communicate with the device, for example by provision of a USB connection, Bluetooth transceiver, radio frequency transceiver as appropriate.

[0018] The portable device 6 is adapted for data exchange with remotely located control system 3, in this case via a remote satellite location 5, which is in data communication with control system 3. As described below, the satellite location 5 may be a location where train personnel attend at the beginning and end of their working shifts, e.g. a crew rostering area.

[0019] A preferred use of this equipment is set out below.

[0020] Initially, the portable device 6 is located at remote satellite location 5, for example within a docking station 9 including auxiliary connection means such as a USB / Bluetooth or Wifi connection. Here it is provided with information, from control system 3, via the data input / output means 8, which enables operation of the train and its ATP / ATO functioning. Examples of such information include:

- i) Driver identity information - i.e. a unique data signature which identifies an individual train driver for a specific day. As will be described subsequently, this information may be required to enable operation of the train. Other train personnel information may also be stored.
- ii) Geographical / map data relating to the railway, in particular those sections of the railway in which the train in question will be passing. This information may include, for example, track gradient information, location and lay-out of stations, location and arrangement of points etc. This information is required to enable the onboard ATP system to operate the train safely, and the ATO system (if fitted) to operate the train efficiently. Calculations of train performance are continually made in order for the train to be operated safely.
- iii) Train consist data, e.g. train length (number of carriages etc), train weight, adhesion levels, brake rates etc. This information is required for ATP / ATO.
- iv) Trip information, e.g. crew number, train number / ID, etc. This information is required for ATP / ATO.

[0021] This information is stored within data storage means 7. In addition, the portable device 6 is assigned with a 'time validity', which specifies the time extent for which the information, particularly the driver ID information, will be valid.

[0022] The portable device 6, pre-loaded with this information, will be picked up by a train driver at the commencement of the shift. The train driver should pick up the device which contains his unique driver identity information. This is equivalent to "checking-in", and acts as proof that the driver has arrived for work.

[0023] The driver then transports the portable device 6 onto a train, the ID of which should correspond to the train number / ID stored at iv) above. When the driver is at the correct location on board the train, the data stored within storage means 8 may be outputted to the train-carried equipment 2', for example by physically connecting the portable device 6 to the train-carried equipment 2' via USB train connection means, or by being close enough to the train-carried equipment to enable RF or Bluetooth (RTM) communication to be established automatically via such train connection means. If the train driver is determined not to be in the cab, or in an appropriate part of the train, for example there is no such communication, then the train system can be forced to take a particular action — e.g. if the train driver is not proved

to be in the train, then it cannot start. This step constitutes a first check, i.e. is the driver in the correct part of the train? For example, if the driver is incorrectly in carriage 1B, then such communication cannot occur, and therefore the train will remain inoperable.

[0024] Once the portable device 6 is in communication with train-carried equipment 2' via the train connection means, a second check is made in order to enable operation of the train, namely that the driver and train IDs stored within each of the portable device 6 and train-carried equipment 2' correlate, and that the data validity period is confirmed, and that train data is within appropriate ranges. Preferably, portable device 6 outputs the driver and train ID information to the train-carried equipment 2', which correlates this information with corresponding information stored within it, and therefore checks that the correct driver is on board the correct train at the correct time. If the validation is successful, then the train-carried equipment 2' enables operation of the train. In an alternative embodiment, required driver / train ID and data information may be input to the device 6 from the train-carried equipment 2' via the train connection means, and the device 6 itself correlates the information. If this is validated, i.e. the IDs and train data match, and fall within the validity period, then the device 6 outputs an enabling signal to the train-carried equipment 2' which causes the train to be operable, subject to the train data also being within the appropriate range. In this case, the device 6 must contain suitable processing means (not shown), which enable the correlation to be performed. In alternative embodiments, such processing is carried out distributed between the portable device 6 and train-carried equipment 2'.

[0025] If required, for example if there is a discrepancy between the IDs, then the driver confirmation can be sought by override means (not shown) If this confirmation is valid, then the train may be authorised to operate.

[0026] The ATP / ATO required information stored on portable device 6 is output to the train-carried equipment 2', such that ATP / ATO functionality is enabled.

[0027] During operation of the train, the train-carried equipment 2' outputs monitored information to the portable device 6 via the data input / output means 8. This information is gathered during the course of operation, and is useful for fault management and maintenance systems. The information may include for example:

- i) Train status information including for example: traction or braking faults, achieved brake rates, event recording of traction / brake demand at a given position, faults or events within the signalling system etc, which is used for condition monitoring applications.
- ii) Information (such as lateral or vertical acceleration) which may be used to derive condition information about track formation, requirements for maintenance, etc.
- iii) Train event information, to track efficient operation

of train around network, including for example: average station dwell time, records of driver performance, energy usage vs. time or position, areas of low adhesion etc.

[0028] The information is stored in the data storage means 7.

[0029] At the end of the driver's shift, he removes the portable device 6 from the train, and returns it to the docking station 9 at satellite location 5. Once returned, the monitored information is output from portable device 6 and sent to control system 3, where it is processed as required. Return of the portable device 6 to the satellite location 5 is equivalent to "checking-out", and indicates that the driver has finished his shift. The portable device 6 may then be reset with new initialisation information for the next shift. The train meanwhile will be inoperable until a new portable device is located correctly within it.

[0030] The above-described embodiments are exemplary only, and various modifications and alternatives will be apparent to those skilled in the art.

[0031] For example, although with the above embodiment the portable device is used for exchanging information including driver / train ID, map information, monitoring information etc, not all such data need be exchanged by the portable device, i.e. a composite exchange system utilising both the portable device and other methods may be employed. For example, data may be downloaded to or from the train over a radio system. Fixed map data may be stored on all trains, and each train visited individually when any map information changes, such as geographic changes to the railway layout, including addition of a new set of points, signals, permanent speed restrictions etc.

[0032] Data extracted from the portable device may be stored locally, e.g. at satellite location 5 and sent to control system 3 at regular intervals.

Claims

1. A method of exchanging information between train-carried equipment, said equipment being provided for operation of the train, and a remote location external to said train, comprising the steps of:

- a) providing a portable device, said portable device comprising data storage means, data input means for writing data to said data storage means and data output means for outputting data from said data storage means to an external location;
- b) providing train connection means at the train-carried equipment enabling communication with said portable device for the exchange of data therewith, the connection means enabling said data exchange when the portable device is correctly located within the train; and

c) providing auxiliary connection means at the remote location enabling communication with the portable device for the exchange of data therewith.

2. A method according to claim 1, for providing information to the train-carried equipment, further comprising the steps of:

- d) at the remote location writing information to the data storage means of the portable device via the auxiliary connection means and data input means;
- e) transporting the portable device into the train;
- f) communicatively engaging the portable device with the train connection means at the train-carried equipment; and
- g) passing said information from the data storage means of the portable device to the train-carried equipment via the data output means and train connection means.

3. A method for enabling operation of a train, comprising providing information to train-carried equipment of the train in accordance with claim 2, wherein the information passed in step g) comprises identity information, and further comprising the steps of:

- h) correlating the identity information with information previously stored at the train-carried equipment; and
- i) enabling operation of the train if the correlation is successful.

4. A method according to claim 3, wherein the identity information comprises information relating to the identity of train personnel.

5. A method according to claim 3, wherein the identity information comprises information relating to the identity of the train.

6. A method of implementing automatic train protection / operation for an automatic train protection / operation equipped train, comprising providing information to train-carried equipment of the train in accordance with claim 2, wherein the information comprises information required for the operation of a train-carried automatic train protection / operation system.

7. A method according to claim 6, wherein the information comprises geographical data.

8. A method according to either of claims 6 and 7, wherein the information comprises train consist data.

9. A method according to any of claims 6 to 8, wherein the information comprises trip information.

10. A method according to any preceding claim, wherein the information received by the train-carried equipment is validated by the train-carried equipment.
11. A method according to claim 1, for obtaining information from the train-carried equipment, further comprising the steps of: 5
- j) transporting the portable device into the train; 10
 - k) communicatively engaging the portable device with the train connection means at the train-carried equipment; and
 - l) passing said information from the train-carried equipment to the data storage means of the portable device via the train connection means and data input means. 15
12. A method according to claim 11, for train monitoring, wherein the information comprises train status information. 20
13. A method according to either of claims 11 and 12, for train monitoring, wherein the information comprises train acceleration information. 25
14. A method according to any of claims 11 to 13, for train monitoring, wherein the information comprises train event information.
15. A portable device for use with the method of any preceding claim. 30
16. A device according to claim 15, storing information required for the operation of a train-carried automatic train protection / operation system. 35
17. Train-carried equipment for use with the method of any of claims 1 to 14.

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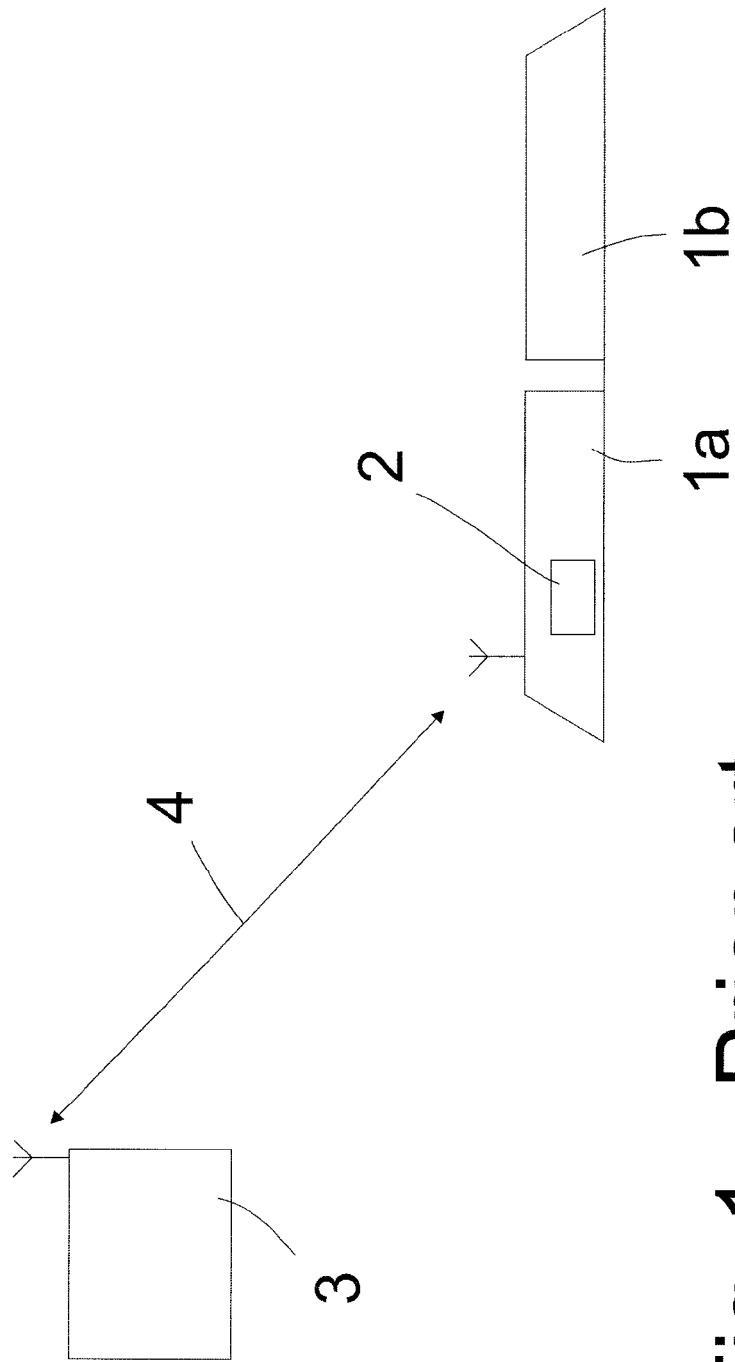


Fig. 1 - Prior art

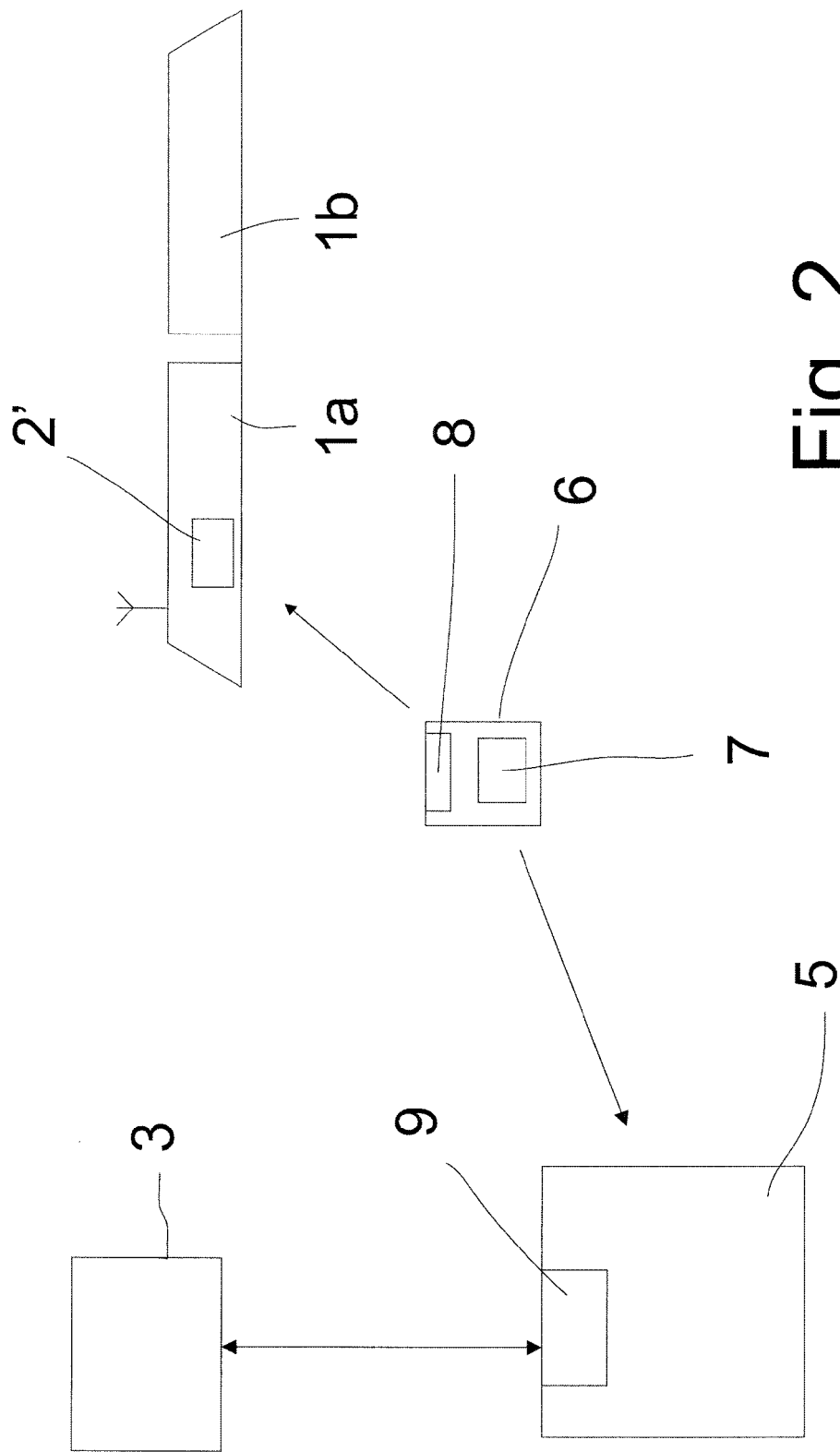


Fig. 2