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(71) Applicant: **CRSC Research & Design Institute Group Co., Ltd.**
**Beijing 100070 (CN)**

(72) Inventors:
- **CHEN, Zhiqiang**
  **Beijing 100070 (CN)**
- **ZHANG, Youbing**
  **Beijing 100070 (CN)**
- **WANG, Jianmin**
  **Beijing 100070 (CN)**
- **ZHANG, Guozhen**
  **Beijing 100070 (CN)**
- **YU, Xiaona**
  **Beijing 100070 (CN)**
- **BAO, Pengyu**
  **Beijing 100070 (CN)**
- **MENG, Fanyong**
  **Beijing 100070 (CN)**
- **ZHAO, Shanhe**
  **Beijing 100070 (CN)**
- **ZENG, Jingjing**
  **Beijing 100070 (CN)**

(74) Representative: **Würmser, Julian**
**Meissner Bolte Patentanwälte**
**Rechtsanwälte Partnerschaft mbB**
**Postfach 86 06 24**
**81633 München (DE)**

# (54) VEHICLE-MOUNTED DEVICE CAPABLE OF HIGHLY EFFICIENT SHUNTING AND METHOD THEREOF

(57) The present invention relates to on-board equipment and a method capable of efficient shunting. The on-board equipment has a shunting mode and a passive shunting mode, when the on-board equipment is in the passive shunting mode, a driver activates a bridge, the on-board equipment directly enters the shunting mode, and shunting operation may be conducted immediately, so that a process of electrifying the on-board equipment and entering the shunting mode are saved, thereby greatly improving working efficiency. With only one set of on-board equipment equipped, a train may also realize the efficient shunting operation, save cost, and also save mounting space.

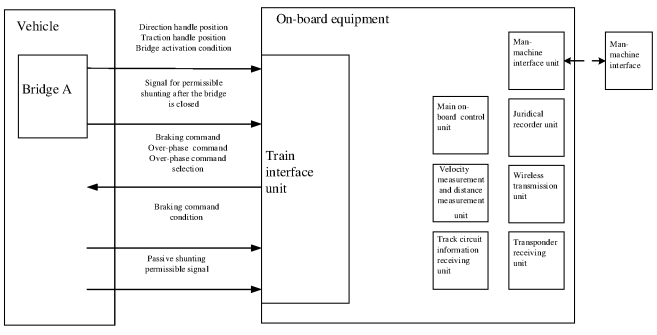


Fig. 1

EP 3 943 362 A1

## Description

### FIELD OF TECHNOLOGY

**[0001]** The present invention belongs to the field of train control, and particularly relates to on-board equipment and a method capable of efficient shunting.

### BACKGROUND

**[0002]** During shunting of an existing high-speed train, on-board equipment at one end is in a shunting mode while on-board equipment at the other end is under a power-off condition. A driver operates a train at the end in the shunting mode, and then turns off on-board equipment at the end after shunting. Then the driver arrives at the other end of the train to electrify the on-board equipment at the end, and operates to make the on-board equipment enter the shunting mode and then continuously conduct shunting operation. Every time the driver goes to the other end for continuous shunting operation, the driver needs to execute processes of electrifying the on-board equipment and entering the shunting mode, which costs a large amount of time. If the shunting operation is complex, it is also required to execute the shunting operation at the two ends of the train repeatedly and execute the processes of electrifying the on-board equipment and entering the shunting mode by the driver, which is more time-consuming. It is obvious that the existing shunting operations have low driving efficiency, occupy rail resources for a long time, and further increase train operation cost.

### SUMMARY

**[0003]** In order to solve the above problems, the present invention provides on-board equipment and a method capable of efficient shunting, enormously improving shunting efficiency.

**[0004]** On-board equipment capable of efficient shunting includes a train interface unit, a main on-board control unit, a velocity and distance measurement unit, a track circuit information receiving unit, a man-machine interface unit, a juridical recorder unit, a wireless transmission unit, a transponder receiving unit and a man-machine interface; the on-board equipment is arranged at a train cab, and the on-board equipment communicates with a bridge of the train cab by means of the train interface unit; the main on-board control unit communicates with the man-machine interface by means of the man-machine interface unit; the on-board equipment has two modes, that is a shunting mode and a passive shunting mode, and the main on-board control unit may determine whether a train is switched into the shunting mode or the passive shunting mode according to a current train mode, receiving train interface information and ground information; and when the on-board equipment is in the passive shunting mode, a driver activates the bridge, and the on-board equipment is directly switched into the shunting mode.

**[0005]** The bridge is provided with a continuous shunting button capable of continuous shunting after the bridge is closed; and when the train provides apermissible signal of passive shunting of passive shunting to the on-board equipment and the on-board equipment is in the shunting mode, the driver presses the continuous shunting button, then the bridge is closed, and the on-board equipment enters the passive shunting mode.

**[0006]** There may be one set or two sets of on-board equipment, and when one set of on-board equipment is provided, the on-board equipment communicates with a bridge A and a bridge B at two ends of the train separately; and when the driver may relieve braking of the train by means of the activated bridge A or the activated bridge B, the train always provides the permissible signal of passive shunting to the on-board equipment. When the driver conducts shunting operation at the bridge A, the on-board equipment is in the shunting mode; the driver completes the shunting operation at the bridge A and then presses, at the bridge A, the continuous shunting button capable of continuous shunting after the bridge is closed, and closes the bridge A, so that the on-board equipment enters the passive shunting mode; when the driver arrives at the bridge B and activates the bridge B, the on-board equipment is switched into the shunting mode immediately and continuously executes a shunting task; the driver completes the shunting operation at the bridge B and then presses, at the bridge B, the continuous shunting button capable of continuous shunting after the bridge is closed, and closes the bridge B, so that the on-board equipment enters the passive shunting mode again; and the driver may conduct the shunting operation at the bridge A and the bridge B separately.

**[0007]** Two sets of on-board equipment may be provided, including on-board equipment A and on-board equipment B, wherein the on-board equipment A communicates with the bridge A at one end of the train, and the on-board equipment B communicates with the bridge B at the other end of the train; and when the driver may relieve the braking of the train by means of the activated bridge A or the activated bridge B, the train always provides the permissible signal of passive shunting to the on-board equipment. When the driver conducts shunting operation at the bridge A, the on-board equipment A enters the shunting mode; the driver completes the shunting operation at the bridge A and then presses, at the bridge A, the continuous shunting button capable of continuous shunting after the bridge is closed, and closes the bridge A, so that the on-board equipment A enters the passive shunting mode; when the driver conducts the shunting operation at the bridge B, the on-board equipment B enters the shunting mode, and the driver completes the shunting operation at the bridge B and then presses, at the bridge B, the continuous shunting button capable of continuous shunting after the bridge is closed, and closes the bridge B, so that the on-board equipment B enters

the passive shunting mode; and the driver may conduct the shunting operation at the bridge A and the bridge B alternately. The on-board equipment A or the on-board equipment B enters the shunting mode in the following two modes that 1) when the on-board equipment A or the on-board equipment B is in the passive shunting mode, the driver activates the corresponding bridge A or bridge B, and the on-board equipment A or the on-board equipment B enters the shunting mode; and 2) when the on-board equipment A or the on-board equipment B is under a power-off condition, a power switch of the corresponding on-board equipment A or on-board equipment B is turned on to electrify the corresponding on-board equipment A or on-board equipment B so as to start the corresponding on-board equipment A or on-board equipment B, and then the driver operates on-board equipment to enter the shunting mode.

**[0008]** When the on-board equipment is at a CTCS-2 class or below, under a shutdown condition, the driver presses a shunting key on a DMI of the man-machine interface, and the on-board equipment is automatically switched into the shunting mode.

**[0009]** When the on-board equipment is at a CTCS-3 class, under the shutdown condition, the driver presses the shunting key on the man-machine interface, the on-board equipment sends a shunting request to a radio block center (RBC) which is ground equipment, and if the RBC determines that the train is in a shunting permissible area, shunting permissible information is replied to the on-board equipment and the on-board equipment is automatically switched into the shunting mode; and if the RBC determines that the train is not in a shunting area, shunting rejection information is replied to the on-board equipment and the on-board equipment cannot be switched into the shunting mode. A transponder is mounted at an edge of the shunting area, and shunting danger information is provided to the on-board equipment by means of the transponder; and during the shunting operation, if the on-board equipment receives the shunting danger information sent by the transponder, the on-board equipment applies emergency braking, and the train is prevented from entering an impermissible shunting area.

**[0010]** In the shunting mode, the on-board equipment monitors a shunting mode ceiling permissible velocity so as to ensure that the train operates at a velocity not exceeding the shunting mode ceiling permissible velocity, and when the velocity of the train exceeds the shunting mode ceiling permissible velocity, the on-board equipment applies braking. When the on-board equipment is in the shunting mode, if the on-board equipment cannot receive the permissible signal of passive shunting from the train, or the driver does not press the continuous shunting button on the activated bridge, or the driver does not close the activated bridge, the on-board equipment exits the shunting mode and then is switched into a standby mode, and in the mode, the on-board equipment always applies the braking to the train to prevent the train from moving.

**[0011]** The on-board equipment is switched into the passive shunting mode from the shunting mode under the following conditions that: 1) the on-board equipment is in the shunting mode; 2) the on-board equipment receives the permissible signal of passive shunting from the train; 3) the driver presses the continuous shunting button on the activated bridge; and 4) the driver closes the activated bridge; and after all of the above four conditions are satisfied, the on-board equipment connected to the bridge is switched into the passive shunting mode from the shunting mode.

**[0012]** The on-board equipment is switched into the shunting mode from the passive shunting mode under the following conditions that: 1) the on-board equipment is in the passive shunting mode; 2) the on-board equipment does not receive information of "stopping shunting after opening the bridge"; and 3) the driver activates the bridge; and after all of the above three conditions are satisfied, the on-board equipment connected to the bridge is switched into the shunting mode from the passive shunting mode.

**[0013]** According to the method and the equipment of the present invention, the on-board equipment has the shunting mode and the passive shunting mode, when the on-board equipment is in the passive shunting mode, the driver activates the bridge, the on-board equipment directly enters the shunting mode, and the shunting operation may be conducted immediately, so that an electrifying process and a process of entering the shunting mode of the on-board equipment are saved, thereby greatly improving working efficiency. With only one set of on-board equipment equipped, the train may also realize the efficient shunting operation, save cost, and also save mounting space.

**[0014]** Other features and advantages of the present invention will be explained in the following specification, part of which will be obvious in the specification, or may be known through implementation of the present invention. The objective and other advantages of the present invention may be realized and obtained by means of the structure pointed out by the specification, the claims and the drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0015]** In order to more clearly illustrate technical solutions in the embodiments of the present invention or in the prior art, a brief introduction to the accompanying drawings required for the description of the embodiments or the prior art will be provided below. Obviously, the accompanying drawings in the following description are some of the embodiments of the present invention, and those of ordinary skill in the art would also be able to derive other drawings from these drawings without making creative efforts.

Fig. 1 shows a structural diagram of on-board equipment capable of efficient shunting according to the

present invention.

Fig. 2 shows an equipment arrangement diagram according to embodiment 1 of the present invention.

Fig. 3 shows a schematic diagram of a train set in which a plurality of trains are connected in series according to the embodiment 1 of the present invention.

Fig. 4 shows an equipment arrangement diagram according to embodiment 2 of the present invention.

## DESCRIPTION OF THE EMBODIMENTS

**[0016]** In order to make objectives, technical solutions and advantages of embodiments of the present invention more obvious, the technical solutions in the embodiments of the present invention will be clearly and completely described with reference to the accompanying figures in the embodiments of the present invention. Obviously, the described embodiments are some, rather than all of the embodiments of the present invention. Based on the embodiments of the present invention, all other embodiments obtained by those of ordinary skill in the art without making creative efforts fall within the scope of protection of the present invention.

**[0017]** As shown in Fig. 1, on-board equipment capable of efficient shunting includes a train interface unit, a main on-board control unit, a velocity measurement and distance measurement unit, a track circuit information receiving unit, a man-machine interface unit, a juridical recorder unit, a wireless transmission unit, a transponder receiving unit and a man-machine interface; the on-board equipment is arranged at a train cab, and the on-board equipment communicates with a bridge of the train cab by means of the train interface unit; and the main on-board control unit communicates with the man-machine interface by means of the man-machine interface unit. The bridge provides a direction handle position, a traction handle position, a bridge activation condition, a braking command condition, a signal for permissible shunting after the bridge is closed, and a permissible signal of passive shunting to the on-board equipment, and the on-board equipment outputs information of a braking command, a neutral section passing command and a neutral section passing selection to a train.

**[0018]** The on-board equipment has a passive shunting function and may efficiently execute shunting operation; the train provides the permissible signal of passive shunting to the on-board equipment; and the bridge is additionally provided with a continuous shunting button capable of continuous shunting after the bridge is closed, a driver presses the button and then sends information for continuous shunting after the bridge is closed to the on-board equipment, the information is one of conditions under which the on-board equipment is switched into a passive shunting mode, and the information is disposable, so after the on-board equipment is switched into the passive shunting mode, the information is invalid.

**[0019]** In order to support the passive shunting function of the on-board equipment so as to efficiently execute the shunting operation, the train also needs to provide the permissible signal of passive shunting to the on-board equipment, and when the driver may relieve braking of the train by means of any of bridges at two ends of the train, the train should always provide the permissible signal of passive shunting to the on-board equipment.

**[0020]** The main on-board control unit of the on-board equipment determines whether the train is switched into a shunting mode or the passive shunting mode according to a current train mode, receiving train interface information and ground information, so as to ensure traffic safety.

**[0021]** When the on-board equipment is at a CTCS-2 class or below, under a shutdown condition, the driver presses a shunting key on a DMI of the man-machine interface, and the on-board equipment is automatically switched into the shunting mode.

**[0022]** When the on-board equipment is at a CTCS-3 class, under the shutdown condition, the driver presses the shunting key on the man-machine interface, the on-board equipment sends a shunting request to a radio block center (RBC) which is ground equipment, and when the RBC determines that the train is in a shunting permissible area, shunting permissible information is replied to the on-board equipment and the on-board equipment is automatically switched into the shunting mode; and when the RBC determines that the train is not in a shunting area, shunting rejection information is replied to the on-board equipment and the on-board equipment cannot be switched into the shunting mode.

**[0023]** In the shunting mode, the on-board equipment monitors a shunting mode ceiling permissible velocity, so that the driver may drive the train to operate at a velocity not exceeding the shunting mode ceiling permissible velocity, and if the velocity of the train exceeds the shunting mode ceiling permissible velocity, the on-board equipment applies braking so as to ensure the traffic safety. Meanwhile, the train usually executes the shunting operation in a station, defines the shunting permissible area in the station, and mounts a transponder at an edge of the shunting area, and shunting danger information is provided to the on-board equipment by means of the transponder. During the shunting operation, if the on-board equipment receives the shunting danger information from the ground, the on-board equipment applies emergency braking, and the train is prevented from entering an impermissible shunting area.

**[0024]** The on-board equipment is switched into the passive shunting mode under the following conditions that: 1) the on-board equipment is in the shunting mode currently; 2) the on-board equipment may receive the permissible signal of passive shunting from the train; 3) the driver presses, on the activated bridge, the continuous shunting button capable of continuous shunting after the bridge is closed; and 4) the driver closes the activated bridge. After all of the above four conditions are satisfied, the on-board equipment connected to the bridge is switched into the passive shunting mode from the shunt-

ing mode.

**[0025]** The on-board equipment is switched into the shunting mode from the passive shunting mode under the following conditions that: 1) the on-board equipment is in the passive shunting mode; 2) the on-board equipment does not receive information of "stopping shunting after opening the bridge"; and 3) the driver activates the bridge. After all of the above three conditions are satisfied, the on-board equipment connected to the bridge is switched into the shunting mode from the passive shunting mode.

**[0026]** A process of switching, by the on-board equipment, into the passive shunting mode from the shunting mode generally comprises the following steps that: 1) the on-board equipment is in the shunting mode currently, and the driver drives the train to complete the shunting operation and stops; 2) a vehicle always provides the "permissible signal of passive shunting" to the on-board equipment, that is, a permissible condition that the "permissible signal of passive shunting" is provided is satisfied; and 3) if the driver further plans to use the bridge for the shunting operation later, the continuous shunting button capable of continuous shunting after the bridge is closed may be pressed at the bridge, the on-board equipment collects a "signal for continuous shunting after the bridge is closed", and when the driver closes the bridge, the on-board equipment is automatically switched into the passive shunting mode.

**[0027]** When the on-board equipment is in the shunting mode, if the on-board equipment cannot receive the permissible signal of passive shunting from the train, or the driver does not press, on the activated bridge, the continuous shunting button capable of continuous shunting after the bridge is closed, after the driver closes the activated bridge, the on-board equipment is switched into a standby mode rather than the passive shunting mode, and in the mode, the on-board equipment always applies the braking to the train to prevent the train from moving.

**[0028]** There may be one set or two sets of on-board equipment.

Embodiment 1

**[0029]** According to a shunting method when the train is provided with one set of on-board equipment, an arrangement diagram of which is shown in Fig. 2, the on-board equipment is connected with each of a bridge A and a bridge B, when the driver may relieve the braking of the train by means of the activated bridge A or the activated bridge B, the train always provides the permissible signal of passive shunting to the on-board equipment.

**[0030]** The driver conducts the shunting operation at the bridge A, and the on-board equipment is in the shunting mode. The driver completes the shunting operation at the bridge A and then presses the continuous shunting button at the bridge A, and closes the bridge A, so that the on-board equipment enters the passive shunting mode.

**[0031]** The driver arrives at the bridge B, since the on-board equipment has already been in the passive shunting mode, the driver activates the bridge B, and the on-board equipment is switched into the shunting mode immediately and continuously executes a shunting task. The driver completes the shunting operation at the bridge B and then presses the continuous shunting button at the bridge B, and closes the bridge B, so that the on-board equipment enters the passive shunting mode.

**[0032]** The driver goes back to the bridge A, since the on-board equipment has already been in the passive shunting mode, the driver activates the bridge A, and the on-board equipment is switched into the shunting mode immediately and continuously executes the shunting task.

**[0033]** If two trains are connected in series to form a long-marshalling train (as shown in Fig. 3), the two trains are only in mechanical connection, instead of electrical connection. If a traditional shunting mode is used for the shunting operation, one train may enter the shunting mode while the on-board equipment of the other train may only be in an isolation mode (that is, the whole on-board equipment is isolated, which means that the train is not provided with the on-board equipment and further does not have a monitoring function of the on-board equipment), otherwise, the on-board equipment of the train will always apply the braking command to the train, resulting in incapacity of movement of a whole train set. However, after the passive shunting mode is added, the other train may enter the passive shunting mode while one train enters the shunting mode, the on-board equipment entering the passive shunting mode does not apply the braking to the train and allows the train to move, the whole train set may conduct shunting freely, and after the bridge is activated, the on-board equipment may be switched into the shunting mode from the passive shunting mode, so that procedures of electrifying and starting and a process of entering the shunting mode of the on-board equipment are omitted, and a novel shunting method solves a problem that cannot be solved through the traditional shunting method, can ensure the safety and also has high driving efficiency.

Embodiment 2

**[0034]** According to a shunting method when the train is provided with two sets of on-board equipment, an arrangement diagram of which is shown in Fig. 4, the train is equipped with the two sets of on-board equipment, on-board equipment A is connected to a bridge A, on-board equipment B is connected to a bridge B, the braking of the train may be relieved by means of the activated bridge A or the activated bridge B, and the train always provides the permissible signal of passive shunting to the on-board equipment.

**[0035]** The driver conducts the shunting operation at the bridge A, the on-board equipment A is in the shunting

mode, and the on-board equipment B is under a power-off condition (if the on-board equipment B is originally under the power-off condition to describe the whole process; and if the on-board equipment B is originally in the passive shunting mode, a process of entering the shunting mode and then entering the passive shunting mode is omitted). The driver completes the shunting operation at the bridge A and then presses the continuous shunting button at the bridge A, after closing the bridge A, the on-board equipment A enters the passive shunting mode.

**[0036]** The driver arrives at the bridge B and electrifies the on-board equipment B (by turning on a power switch of the on-board equipment), the on-board equipment B enters a working condition, after completing the starting procedure, the driver selects and enters the shunting mode, and the driver drives the train to continuously execute a shunting task. The driver executes the shunting operation in the shunting area, and whether or not the end completes the shunting operation is determined by the driver. The driver completes the shunting operation at the bridge B and then presses the continuous shunting button at the bridge B, after closing the bridge B, the on-board equipment B enters the passive shunting mode.

**[0037]** The driver arrives at the bridge A, since the on-board equipment A has already been in the passive shunting mode, the driver activates the bridge A, and the on-board equipment A is switched into the shunting mode immediately and continuously executes the shunting task. The driver completes the shunting operation at the bridge A and then presses the continuous shunting button at the bridge A, after closing the bridge A, the on-board equipment A enters the passive shunting mode.

**[0038]** The driver arrives at the bridge B, since the on-board equipment B has already been in the passive shunting mode, the driver activates the bridge B, and the on-board equipment B is switched into the shunting mode immediately and continuously executes the shunting task.

**[0039]** Although the present invention is described in detail with reference to the above-mentioned embodiments, those of ordinary skill in the art should understand that they may still make modifications to the technical solutions described in the above-mentioned embodiments or equivalent replacements to part of technical features therein; and these modifications or replacements do not make the essence of the corresponding technical solutions depart from the spirit and scope of the technical solutions of the embodiments of the present invention.

## Claims

1. On-board equipment capable of efficient shunting, **characterized in that** the on-board equipment comprises a train interface unit, a main on-board control unit, a velocity and distance measurement unit, a track circuit information receiving unit, a man-machine interface unit, a juridical recorder unit, a wireless transmission unit, a transponder receiving unit and a man-machine interface; the on-board equipment is arranged at a train cab, and the on-board equipment communicates with a bridge of the train cab by means of the train interface unit; the main on-board control unit communicates with the man-machine interface by means of the man-machine interface unit; the on-board equipment has two modes, that is a shunting mode and a passive shunting mode, and the main on-board control unit may determine whether a train is switched into the shunting mode or the passive shunting mode according to a current train mode, receiving train interface information and ground information; and when the on-board equipment is in the passive shunting mode, a driver activates the bridge, and the on-board equipment is directly switched into the shunting mode.

2. The on-board equipment capable of efficient shunting according to claim 1, **characterized in that** the bridge is provided with a continuous shunting button capable of continuous shunting after the bridge is closed; and when the train provides apermissible signal of passive shunting of passive shunting to the on-board equipment and the on-board equipment is in the shunting mode, the driver presses the continuous shunting button, then the bridge is closed, and the on-board equipment enters the passive shunting mode.

3. The on-board equipment capable of efficient shunting according to claim 2, **characterized in that** one set of the on-board equipment is provided, the on-board equipment communicates with a bridge A and a bridge B; and when the driver may relieve braking of the train by means of the activated bridge A or the activated bridge B, the train always provides the permissible signal of passive shunting to the on-board equipment.

4. The on-board equipment capable of efficient shunting according to claim 2, **characterized in that** the on-board equipment comprises on-board equipment A and on-board equipment B, wherein the on-board equipment A communicates with a bridge A of the train, and the on-board equipment B communicates with a bridge B of the train; and when the driver may relieve braking of the train by means of the activated bridge A or the activated bridge B, the train always provides the permissible signal of passive shunting to the on-board equipment.

5. The on-board equipment capable of efficient shunting according to claim 1, **characterized in that** when the on-board equipment is at a CTCS-2 class or below, under a shutdown condition, the driver presses a shunting key on a DMI of the man-machine interface, and the on-board equipment is automatically

switched into the shunting mode.

6. The on-board equipment capable of efficient shunting according to claim 1, **characterized in that** when the on-board equipment is at a CTCS-3 class, under a shutdown condition, the driver presses a shunting key on the man-machine interface, the on-board equipment sends a shunting request to a radio block center, RBC, which is ground equipment, and if the RBC determines that the train is in a shunting permissible area, shunting permissible information is replied to the on-board equipment and the on-board equipment is automatically switched into the shunting mode; and if the RBC determines that the train is not in a shunting area, shunting rejection information is replied to the on-board equipment and the on-board equipment cannot be switched into the shunting mode.

7. The on-board equipment capable of efficient shunting according to claim 5 or 6, **characterized in that** in the shunting mode, the on-board equipment monitors a shunting mode ceiling permissible velocity so as to ensure that the train operates at a velocity not exceeding the shunting mode ceiling permissible velocity, and when the velocity of the train exceeds the shunting mode ceiling permissible velocity, the on-board equipment applies braking.

8. The on-board equipment capable of efficient shunting according to claim 5 or 6, **characterized in that** a transponder is mounted at an edge of the shunting area, and shunting danger information is provided to the on-board equipment by means of the transponder; and during shunting operation, if the on-board equipment receives the shunting danger information sent by the transponder, the on-board equipment applies emergency braking, and the train is prevented from entering an impermissible shunting area.

9. The on-board equipment capable of efficient shunting according to claim 2, **characterized in that** the on-board equipment is switched into the passive shunting mode under the following conditions that: 1) the on-board equipment is in the shunting mode; 2) the on-board equipment receives the permissible signal of passive shunting from the train; 3) the driver presses the continuous shunting button on the activated bridge; 4) the driver closes the activated bridge; and after all of the above four conditions are satisfied, the on-board equipment connected to the bridge is switched into the passive shunting mode from the shunting mode.

10. The on-board equipment capable of efficient shunting according to claim 9, **characterized in that** the on-board equipment is switched into the shunting mode from the passive shunting mode under the following conditions that: 1) the on-board equipment is in the passive shunting mode; 2) the on-board equipment does not receive information of "stopping shunting after opening the bridge"; 3) the driver activates the bridge; and after all of the above three conditions are satisfied, the on-board equipment connected to the bridge is switched into the shunting mode from the passive shunting mode.

11. The on-board equipment capable of efficient shunting according to claim 9, **characterized in that** when the on-board equipment is in the shunting mode, if the on-board equipment cannot receive the permissible signal of passive shunting from the train, or the driver does not press the continuous shunting button on the activated bridge, or the driver does not close the activated bridge, the on-board equipment exits the shunting mode and then is switched into a standby mode, and in the mode, the on-board equipment always applies braking to the train to prevent the train from moving.

12. A train shunting method of the on-board equipment capable of efficient shunting according to claim 3, **characterized in that** when a driver conducts shunting operation at a bridge A, the on-board equipment is in a shunting mode; the driver completes the shunting operation at the bridge A and then presses a continuous shunting button capable of continuous shunting after the bridge is closed at the bridge A, and closes the bridge A, so that the on-board equipment enters a passive shunting mode; when the driver arrives at a bridge B and activates the bridge B, the on-board equipment is switched into the shunting mode immediately and continuously executes a shunting task; the driver completes the shunting operation at the bridge B and then presses the continuous shunting button capable of continuous shunting after the bridge is closed at the bridge B, and closes the bridge B, so that the on-board equipment enters the passive shunting mode again; and the driver may conduct the shunting operation at the bridge A and the bridge B separately.

13. A train shunting method of the on-board equipment capable of efficient shunting according to claim 4, **characterized in that** when a driver conducts shunting operation at a bridge A, on-board equipment A enters a shunting mode; the driver completes the shunting operation at the bridge A and then presses a continuous shunting button capable of continuous shunting after the bridge is closed at the bridge A, and closes the bridge A, so that the on-board equipment A enters a passive shunting mode; when the driver conducts the shunting operation at a bridge B, on-board equipment B enters the shunting mode, and the driver completes the shunting operation at

the bridge B and then presses the continuous shunting button capable of continuous shunting after the bridge is closed at the bridge B, and closes the bridge B, so that the on-board equipment B enters the passive shunting mode; and the driver may conduct the shunting operation at the bridge A and the bridge B alternately.

**14.** The train shunting method according to claim 13, **characterized in that** the on-board equipment A or the on-board equipment B enters the shunting mode in the following two modes that 1) when the on-board equipment A or the on-board equipment B is in the passive shunting mode, the driver activates the corresponding bridge A or bridge B, and the on-board equipment A or the on-board equipment B enters the shunting mode; and 2) when the on-board equipment A or the on-board equipment B is under a power-off condition, a power switch of the corresponding on-board equipment A or on-board equipment B is turned on to electrify the corresponding on-board equipment A or on-board equipment B so as to start the corresponding on-board equipment A or on-board equipment B, and then the driver operates on-board equipment to enter the shunting mode.

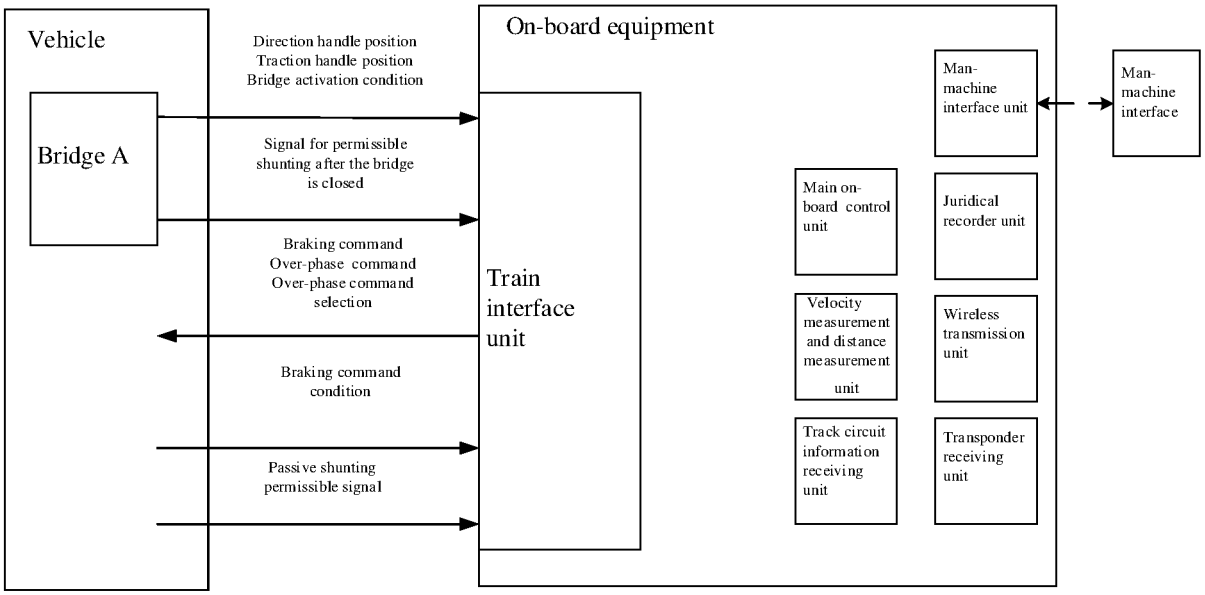


Fig. 1

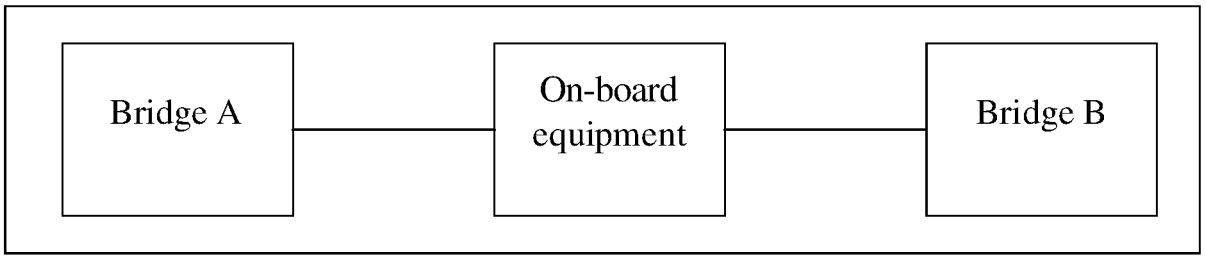


Fig. 2

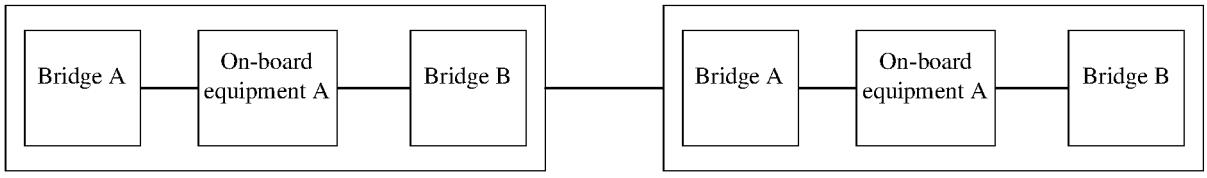


Fig. 3


Fig. 4

**INTERNATIONAL SEARCH REPORT**

International application No.
**PCT/CN2021/102921**

**A. CLASSIFICATION OF SUBJECT MATTER**

B61L 15/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

B61L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNKI, CNPAT, WPI, EPODOC: train, locomotive, shunt+, end?, rear+, tail+, head+, front, switch, deck, cab, driver, efficiency, time, again, frequency, often, saving; 列车, 机车, 火车, 调车, 两端, 一端, 第二端, 对端, 换端, 头, 尾, 驾驶台, 驾驶室, 驾驶舱, 驾驶员, 司机室, 人员, 效率, 高效, 时间, 节约, 节省, 反复, 频繁

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| PX | CN 112406955 A (BEIJING NATIONAL RAILWAY RESEARCH & DESIGN INSTITUTE OF SIGNAL & COMMUNICATION LTD.) 26 February 2021 (2021-02-26)<br>claims 1-14 | 1-14 |
| X | CN 108216303 A (TRAFFIC CONTROL TECHNOLOGY CO., LTD.) 29 June 2018 (2018-06-29)<br>description, paragraphs [0036]-[0089], and figures 1-3 | 1, 5-8 |
| X | CN 110015321 A (BYD COMPANY LTD.) 16 July 2019 (2019-07-16)<br>description, paragraphs [0040]-[0097], and figures 1-6 | 1, 5-8 |
| A | CN 110949457 A (CRRC ZHUZHOU LOCOMOTIVE CO., LTD.) 03 April 2020 (2020-04-03)<br>entire document | 1-14 |
| A | CN 107458422 A (HUNAN CRRC TIMES COMMUNICATION SIGNALS CO., LTD.) 12 December 2017 (2017-12-12)<br>entire document | 1-14 |
| A | KR 20090017293 A (HYUNDAI MOBIS CO., LTD.) 18 February 2009 (2009-02-18)<br>entire document | 1-14 |

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| **01 September 2021** | **28 September 2021** |
| Name and mailing address of the ISA/CN<br>**China National Intellectual Property Administration (ISA/CN)**<br>**No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**<br>**China** | Authorized officer |
| Facsimile No. **(86-10)62019451** | Telephone No. |

Form PCT/ISA/210 (second sheet) (January 2015)

**INTERNATIONAL SEARCH REPORT**
**Information on patent family members**

International application No.
**PCT/CN2021/102921**

| Patent document cited in search report | Publication date (day/month/year) | Patent family member(s) | Publication date (day/month/year) |
|---|---|---|---|
| CN 112406955 A | 26 February 2021 | None | |
| CN 108216303 A | 29 June 2018 | None | |
| CN 110015321 A | 16 July 2019 | US 2020331506 A1 | 22 October 2020 |
| | | CN 110015321 B | 23 February 2021 |
| | | WO 2019134558 A1 | 11 July 2019 |
| | | BR 112020013826 A2 | 01 December 2020 |
| | | IN 202037031374 A | 21 August 2020 |
| CN 110949457 A | 03 April 2020 | None | |
| CN 107458422 A | 12 December 2017 | None | |
| KR 20090017293 A | 18 February 2009 | None | |

Form PCT/ISA/210 (patent family annex) (January 2015)