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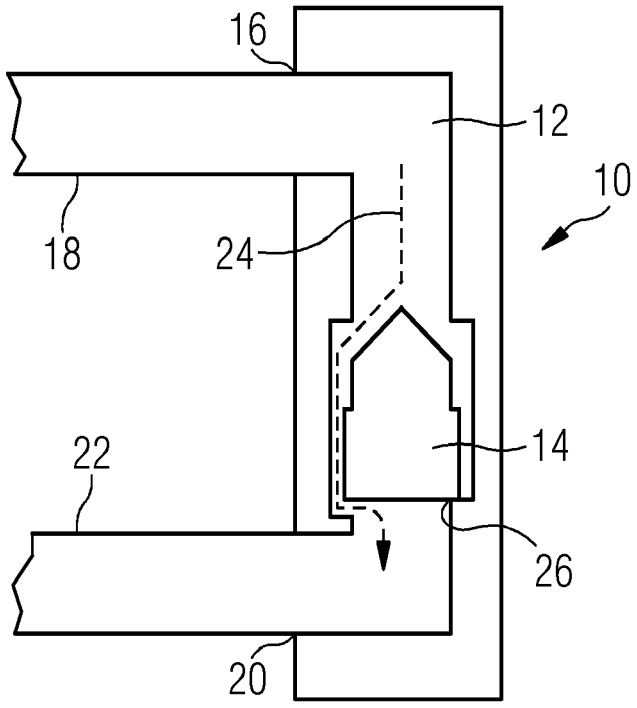
(54) **TRAIN INTEGRITY PROVING DEVICE AND METHOD**

(57) A device (10) is provided for performing a train integrity check on a train comprising a number of wagons, each wagon provided with air brakes operable by a pressure difference between a brake pipe (18) and a main reservoir pipe (22). The device comprises a spring-biased one-way valve, comprising an air path (12) having a first end (16) arranged to connect with the brake pipe (18) and a second end (20) arranged to connect with the main reservoir pipe (22).

FIG 2



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Description

[0001] The present invention relates to methods and apparatus for determining the integrity of a train, in particular a freight train or passenger train formed of individual coaches.

[0002] It is a requirement of safe signalling of railways that proof of train integrity can be determined, that is, proof that the train has been correctly assembled as one unit, and has remained as one unit, not split into two or more sections. This is usually provided by the use of an end-of-train marking device, such as a tail lamp or marker board so that an observer or a camera for remote observation can determine that an actual rearmost wagon of a train is indeed intended to be the rearmost wagon.

[0003] Conventional arrangements for detecting train integrity include detection systems such as track circuits or axle counters. However, planned upgrades such as European Train Control System (ETCS) level 3 require removal of trackside train detection equipment. This allows improvements due to reduced infrastructure cost and maintenance burden. Such planned upgrades also introduce the possibility of increased capacity by allowing trains to run closer together.

[0004] The present invention aims to provide a train integrity proving device, and a corresponding method, which enables a control system within a locomotive to determine the integrity of the train, without relying on trackside equipment or external observers.

[0005] The present invention accordingly provides methods and apparatus as defined in the appended claims.

[0006] The above, and further, objects, characteristics and advantages of the present invention will become more apparent from the following description of certain embodiments thereof, in conjunction with the accompanying drawings, wherein:

Fig. 1 represents a normal condition of a device according to an embodiment of the present invention; and

Fig. 2 illustrates the device of Fig. 1, in a second state.

[0007] Currently, a majority of passenger coaches and freight wagons are fitted with air brakes operated with a twin pipe system.

[0008] A main reservoir pipe (MRP) is held at a high pressure. In some example systems, this high pressure may be 10 Bar (1MPa). This pressure fills air reservoirs aboard wagons and maintains a high pressure to brake cylinders. A second pipe, the brake pipe (BP) is at a pressure which is controlled by the locomotive and is also linked to brake cylinders of the wagons. When the brake pipe BP is at the same pressure as the main reservoir pipe MRP, there is no differential pressure applied to the brake cylinders, and the brakes are off. When the locomotive reduces the pressure within the brake pipe BP, the brake cylinders are subjected to a differential pressure, and this differential pressure causes the brakes to be applied. The air reservoirs help in maintaining the high pressure within the MRP and are essential in applying brakes in case wagons become detached from the locomotive.

[0009] Very simply, then, main reservoir pipe (MRP) is held at a high pressure. Brake pipe (BP) at high pressure means the brakes are OFF; brake pipe (BP) at low pressure means the brakes are ON.

[0010] The brake pipe and the main reservoir pipe are made up of pipes fitted to each wagon, which pipes are joined together when wagons are assembled into a train. When all pipes are joined together, both main reservoir pipe (MRP) and brake pipe (BP) are continuous air conduits from a locomotive to a rear of a rearmost wagon of the train. Conventionally, the MRP and BP are respectively sealed at the rear of the rearmost wagon of the train. The individual continuity of each pipe is required to allow the train brake to function. Any loss of continuity will result in the train brake being applied in all portions of the train.

[0011] The present invention provides a device which is attached to the MRP and BP at the rear of the train. The device of the present invention fulfils the function of sealing both MRP and BP at the rear of the rear-most wagon of the train. The device of the present invention will be attached to the rear of the train in place of, or possibly in addition to, if preferred, the conventional tail lamp or marker board.

[0012] The device of the present invention will attach to both the brake pipe and the main reservoir pipe, of the rear-most wagon and will preferably attach in such a way that prevents the wagon's rear coupling from being connected to another vehicle. In this way, the device of the present invention can only be attached to a rearmost wagon.

[0013] The device will attach in such a way that both valves for the main reservoir pipe and brake pipe must be open to attach the device. This is to prevent undetected removal. Removal of the device of the invention can therefore only take place with the respective valves open, meaning that both MRP and BP will be at atmospheric pressure only. Such reduction in pressure would be detected by control systems within the locomotive.

[0014] Figs. 1 and 2 illustrate a schematic example of a device of the present invention. Only the air-pressure related aspects are illustrated. Physical requirements for mounting to pipes, and for obstructing the rear coupling of a wagon, will vary according to the type of coupling concerned, but will be apparent to those skilled in the art.

[0015] The device illustrated in the examples of Figs. 1 and 2 is essentially a one-way valve, with a closure element biased into the "closed" position.

[0016] In Fig. 1, the device 10 includes an air path 12 and a closure element 14 biased into a "closed" position, as shown, by a bias spring (not illustrated). A first end 16 of the air path 12 is arranged to be connected to the brake

pipe BP 18 of the rearmost wagon of a train. A second end 20 of the air path 12 is arranged to be connected to the main reservoir pipe MRP 22 of the rearmost wagon of a train.

[0017] Fig. 1 represents a normal condition of the device 10. In this status, the device will cause no difference to the operation of the brake system. During normal operation, air pressure within the main reservoir pipe MRP is always at least as much as air pressure within the brake pipe BP. When brakes are off, the MRP 22 and BP 18 are at a same pressure. When the brakes are on, the MRP 22 is at a higher pressure than the BP 18. Closure element 14 is biased into the "closed" position, as shown, and whether the brakes are on or off, in normal operation, there will be no differential pressure which tends to displace the closure element from the illustrated "closed" position. The two pipes BP 18, MRP 22 remain isolated from each other.

[0018] Under normal operation the pressure within brake pipe BP 18 will never be greater than the pressure within the main reservoir pipe MRP 22. However, during assembly of wagons into a train, conventional setting up operations can be amended to include a situation where the pressure within brake pipe BP 18 will be at a greater pressure than the main reservoir pipe MRP 22, and this feature can be exploited to prove train integrity.

[0019] Fig. 2 illustrates the device of Fig. 1, in a second state, as it is used to demonstrate train integrity during setting up of a train composed of a plurality of wagons and a locomotive. In the state illustrated in Fig. 2, and as part of the normal testing of the train brake, a high-pressure air supply from the locomotive is connected to the brake pipe BP 18 only. This will require a modification to the locomotive, as it is not currently a valid locomotive function; it is envisaged that this functionality would be provided through fitment of the on-board European Vital Computer (EVC) system required to operate on ETCS operated railway systems. The main reservoir pipe MRP 22 will be completely drained. The differential pressure between first end 16 and second end 20 of the air path 12 of the device 10 will displace closure element 14 from its normal "closed" position, into an "open" position, in which an air path 24 will open between brake pipe BP 18 and main reservoir pipe MRP 22, as illustrated. Although MRP 22 should be drained, and at atmospheric pressure, air will flow from the high pressure supply connected to BP 18, through the device of the present invention 10 to the MRP 22. The appearance of this pressure within the MRP 22 will be detected by sensors at the locomotive, and this may be interpreted, in a method of the present invention, as a confirmation that the train is correctly composed, and of confirmed integrity. An increase in pressure within the MRP 22 can only result from a complete air path from the locomotive, through all wagons to the device 10, past closure element 14 into MRP 22 and back to the locomotive. Correct composition of the train is thereby indicated. The device 10 of the present invention should be designed such that a significant pressure difference is required to move the closure element 14 from its spring-biased "closed" position. As 1MPa may be available within the BP 18, and only a fraction of that is required within the MRP 22 to provide sufficient signal to be detected by the locomotive, any a small opening of the closure element 14 is sufficient.

[0020] As illustrated in Fig. 2, a mechanical stop 26 may be provided, to limit the range of movement of the closure element 14. The particular form of the air path 12, closure element 14 and mechanical stop 26, as well as the spring bias arrangement not illustrated, may take any form as may be apparent to those skilled in the art while offering the described functionality.

[0021] The method and device of the present invention provides for air being admitted from the brake pipe BP 18 into the main reservoir pipe MRP 22. The resulting increase in main reservoir pipe pressure will be detectable by the locomotive such that positive confirmation of correct fitment of the device is provided. There is no possibility that main reservoir pipe MRP 22 pressure can increase, while it is disconnected from the locomotive's compressor, other than through the end-of-train device 10 of the present invention. Confirmation of correct composition of the train is thereby provided.

[0022] As preparation of the train continues, and as described in the introduction above, a high-pressure air supply will be provided by the locomotive to the main reservoir pipe MRP 22. The closure element 14 of the device 10 of the present invention will return to its normal state as illustrated in Fig. 1.

[0023] Any subsequent disconnection of the end-of-train device 10 of the present invention from the locomotive, such as will result from the loss on integrity of the train, will result in a loss of pressure within brake pipe BP 18. Although main reservoir pipe 22 will also lose pressure, the air pressure reservoirs aboard each wagon will retain air pressure, and the differential pressure between the air pressure reservoirs and the brake pipe 18 will cause the brakes on the respective wagons to operate, resulting in the wagons coming to a stand. The locomotive will detect loss of pressure in the brake pipe BP 18 and main reservoir pipe 22 and will also come to a stand. Should the train come to an unexpected stand - that is one not initiated by the locomotive such as an unintentional loss of train integrity - an on-board system carried by the locomotive will record the location of the first reduction in air pressure, such that the location of the train can be communicated to a signalling system.

[0024] The present invention accordingly provides apparatus and methods for verifying the integrity of a train, at the locomotive end, requiring no modification to the wagons and requiring no electrical power to the device of the invention. The device of the invention is robust, being a spring-loaded one-way valve which may be of all-metal construction. The present invention is driven, and provides results, by the existing braking system conventionally and necessarily fitted to the train. Other than the device 10 itself, the present invention requires no

hardware changes or modifications to wagons. Any such hardware changes or modification may be prohibitively expensive and difficult to complete, as the change or modification would need to be performed on each of tens of thousands of trucks to provide a network-wide solution. The alterations required to the locomotive can be efficiently provided during the required fitment of the European Vital Computer.

[0025] The device of the present invention is inherently failsafe, relying on the same proven technology used to provide a continuous failsafe train brake. The closure element 14 is firmly spring-biased into a "closed" position, where brake pipe BP 18 and main reservoir pipe MRP 22 are separate from one another. Provided that main reservoir pipe MRP 22 maintains an air pressure at least equal to that of the brake pipe BP 18, which is the case in all operational scenarios, then the closure element 14 will not move, and will not interfere with proper and normal operation of the train brakes.

[0026] Known alternative solutions all rely on an electronic devices mounted on the rearmost wagon, requiring both power and communication.

Claims

1. A device (10) for performing a train integrity check on a train comprising a number of wagons, each wagon provided with air brakes operable by a pressure difference between a brake pipe (18) and a main reservoir pipe (22), the device comprising:

   a spring-biased one-way valve, comprising an air path (12) having a first end (16) arranged to connect with the brake pipe (18) and a second end (20) arranged to connect with the main reservoir pipe (22); and
   a closure element (14) which is spring-loaded into a "closed" position, blocking the air path between its first end (16) and its second end (20) and arranged such that pressure within main reservoir pipe (22) which is in excess of pressure within brake pipe (18) urges the closure element (14) to its "closed" position, and arranged such that pressure within brake pipe (18) which is in excess of pressure within main reservoir pipe (22) urges the closure element (14) away from its "closed" position against the spring bias, towards an "open" position in which an air path (24) is provided from the brake pipe (18) to the main reservoir pipe (22).

2. A device according to claim 1, wherein the device further comprises a mechanical stop (26) to limit the range of motion of the closure element (14) away from its "closed" position.

3. A device according to any preceding claim, for attachment to a rearmost wagon of a train, the device being configured such that attachment thereof prevents the rearmost wagon's rear coupling from being connected to another vehicle.

4. A method for performing a train integrity check on a train comprising a locomotive and a number of wagons, each wagon provided with air brakes operable by an air pressure difference between a brake pipe (18) and a main reservoir pipe (22), the method comprising:

   - joining brake pipes (18) and main reservoir pipes (22) of the locomotive and wagons such that the brake pipe (18) and the main reservoir pipe (22) each provides a continuous air conduit from the locomotive to a rear of a rearmost wagon;
   - attaching a device (10) according to claim 1 to the rear of the rearmost wagon, between the brake pipe (18) and the main reservoir pipe (22);
   - at the locomotive, applying a higher air pressure to the brake pipe (18) than to the main reservoir pipe (22), a difference in said air pressures being sufficient to displace urges the closure element (14) away from its "closed" position against the spring bias, to an "open" position in which a air path (24) is provided from the brake pipe (18) to the main reservoir pipe (22); and
   - at the locomotive, detecting a resultant increase in air pressure within the main reservoir pipe (22) as validation of train integrity.

5. A method according to claim 4 further comprising:

   - at the locomotive, applying a high-pressure air supply to the main reservoir pipe (22), ensuring that the closure element (14) of the device (10) returns to its "closed" position.

FIG 1

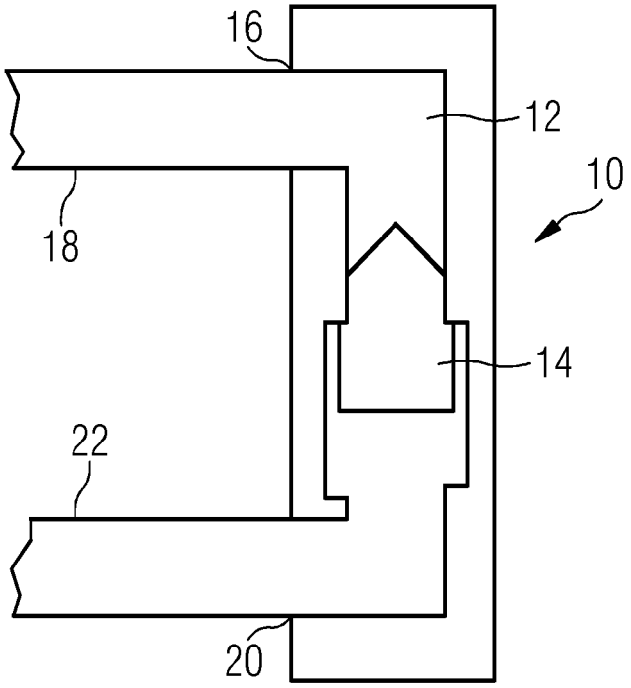
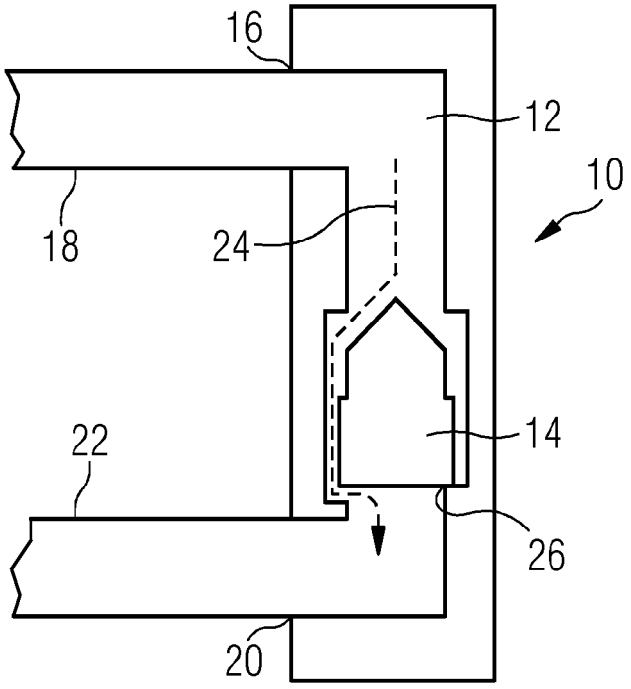


FIG 2



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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 9341

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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	29 August 2022	Massalski, Matthias

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