(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 098 511 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
07.12.2022 Bulletin 2022/49

(21) Application number: **21917031.3**

(22) Date of filing: **06.07.2021**

(51) International Patent Classification (IPC):
B61L 23/00 *(2006.01)* ***B61L 5/00*** *(2006.01)*
B61L 27/00 *(2022.01)*

(86) International application number:
PCT/CN2021/104727

(87) International publication number:
WO 2022/147987 (14.07.2022 Gazette 2022/28)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **11.01.2021 CN 202110029254**

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(54) **METHOD AND SYSTEM FOR PROTECTING SIDE SURFACES OF TRAINS IN STATION FROM COLLISIONS**

(57) The present invention relates to a method and system for preventing a train side collision at a station. The method includes: starting a side collision prevention in a main line/branch line direction when a train departure route meets a route condition, and enabling a train to enter a track in the main line direction for operation. The system includes an interlock system, a side protection switch, and the side protection signal. The interlock system is configured to control a train departure route; and the side protection switch and the side protection signal are configured to control the side collision prevention in the main line/branch line direction. The method for preventing a train side collision at a station provided by the present invention effectively prevents a train in entering a route from colliding with another train coming from another direction, and therefore is beneficial to improve the safety level of the train operation at stations.

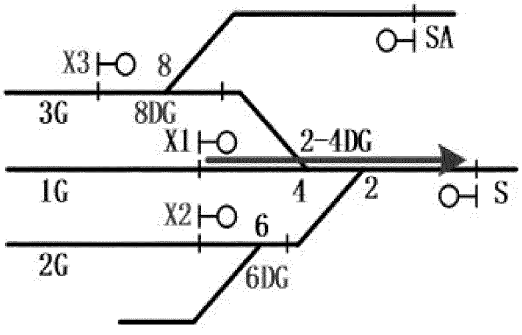

FIG. 3

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Description

TECHNICAL FIELD

[0001] The present invention relates to the rail transport field, and in particular to a method and system for preventing a train side collision at a station.

BACKGROUND ART

[0002] The interlock is equipment configured to ensure the safety of trains and shunting operations at railway stations, and establish a mutual restriction relationship among signals, switches, and routes through technical means. According to the intention of the station attendant, the interlock equipment arranges the routes for the trains by turning the switch, and checking the position of the switch as well as the cleared condition of the track section, and clears the train signal at the beginning of the route after the route locking and a hostile condition meet the route signal clearing requirement. The train operates according to the signal display.

[0003] In the engineering design of railway signal system, designers use the interlock table to reflect the interlocking relationship among signallers, switches, track sections, and routes. When designing the interlock table in China engineering, the designers focus on the interlocking relationship between the equipment of the route and other routes overlapping with a current route, without considering a scenario that in a case that a route has not been set up for a train on another adjacent line, the train may enter the current route, and has a side collision with the train on the current route. It is only checked whether an out-of-gauge section is cleared when the out-of-gauge section exists at a joint between the adjacent line and this route. When there is a switch of the adjacent line facing this route, the switch is driven towards the direction of the another line. However, during the driving, it is not checked whether the switch is driven to an expected position and is locked. As a result, the risk of foregoing collision may occur.

[0004] Each interlocking manufacturer uses his own interlock logic to prevent a side collision. However, the logics are inconsistent, and the output results (provided alarm information or system downtime) are inconsistent either when a danger occurs, which affects the availability of the system to some extent.

SUMMARY

[0005] To resolve the foregoing problem, the present invention provides a method for preventing a train side collision at a station, including the following steps:
starting a side collision prevention in a main line/branch line direction when a train departure route meets a route condition, and enabling a train to enter a track in the main line direction.

[0006] When the train departure route is in the main line direction or the branch line direction, the side collision prevention is performed in one of the following two manners:

- in a first manner: a side protection signal is enabled to be in a stop state, and all track sections from the side protection signal to the train departure route are cleared; and
- in a second manner: a side protection switch is turned toward a direction in which the train departure route is not set.

[0007] When the train operates on the departure route in a first branch line direction, the side collision prevention is performed in the following manner:
a side protection signal is enabled to be in a stop state, and all track sections from the side protection signal to the train departure route are cleared.

[0008] When the train operates on the departure route in the main line direction or a second branch line direction, the side collision prevention is performed in one of the following two manners:

- in a first manner: a side protection signal is enabled to be in a stop state, and all track sections from the side protection signal to the train departure route are cleared; and
- in a second manner: a side protection switch is turned toward a direction in which the train departure route is not set.

[0009] From the perspective of preventing train side collisions, because the switch can separate different lines, even if the train does not operate according to the signal displayed by the signaller (that is, it may pass through the signal indicating the red light), the method can also ensure that the train does not have a side collision with another train on the route that the attendant intends to handle. Therefore, when the train starts along the main line or the second branch line direction, considering the side collision prevention, it is preferred to turn the side protection switch to the direction in which the train departure route is not set. When the side protection switch cannot be turned to the designated position due to other reasons, for example, the another route is being used, it is checked whether the side protection switch is turned off and all track sections from the side protection signal to the train departure route are cleared.

[0010] The present invention further provides a system for preventing a train side collision at a station, including an interlock system, a side protection switch, and a side protection signal, where

- the interlock system is configured to control a train departure route; and

the side protection switch and the side protection signal are configured to control a side collision prevention in a main line/branch line direction.

[0011] The train departure route is in the main line direction or the branch line direction.

[0012] The side collision prevention includes: stopping the side protection signal, and clearing all track sections from the side protection signal to the train departure route; or turning the side protection switch toward a direction in which the train departure route is not set.

[0013] When the interlock system controls a train to operate on the departure route in a first branch line direction, the side protection signal is stopped, and all track sections from the side protection signal to the train departure route are cleared.

[0014] When the interlock system controls a train to operate on the departure route in the main line direction or in a second branch line direction, the side protection signal is stopped, and all track sections from the side protection signal to the train departure route are cleared; or the side protection switch is turned toward a direction in which the train departure route is not set.

[0015] Preferably, when the interlock system controls the train to operate on the departure route in the main line/second branch line direction, the side protection switch is turned toward a direction in which the train departure route is not set.

[0016] To sum up, when the routes are arranged, increasing the check conditions for the train side collision prevention helps to improve the safety level of the train operation at the station. When it is checked that the relevant side collision prevention conditions are not met, the routes are not locked, and the signals at the beginning of the routes are not cleared either, which can effectively prevent the train on the route from colliding with another train coming from the other side.

[0017] Other features and advantages of the present invention are described in the specification, and some of them are apparent from the description, or may be learned by practice of the present invention. The objectives and other advantages of the present invention may be implemented and obtained by using the structure described in the specification, claims, and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] To describe the technical solutions in the embodiments of the present invention or in the prior art more clearly, the following briefly describes the accompanying drawings required for describing the embodiments or the prior art. Apparently, the accompanying drawings in the following description show some embodiments of the present invention, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

FIG. 1 is a schematic diagram of a station yard according to the related art.

FIG. 2 is a schematic diagram of a side collision prevention on a route X3-S according to an embodiment of the present invention.

FIG. 3 is a schematic diagram of a side collision prevention on a route X1-S according to an embodiment of the present invention.

FIG. 4 is a schematic diagram of a side collision prevention on a route X2-S according to an embodiment of the present invention.

FIG. 5 is a schematic diagram of a system for preventing a train side collision at a station according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0019] In order to make the objectives, technical solutions and advantages of the embodiments of the present invention clearer, the technical solutions in the embodiments of the present invention are clearly and completely described below in conjunction with the drawings in the embodiments of the present invention. Apparently, the described embodiments are some rather than all of the embodiments of the present invention. All other embodiments obtained by a person of ordinary skill in the art on the basis of the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

[0020] In the present invention, when the train routes are set up, elements (switches, signals, and track sections) that may cause a side collision are checked, and some protection conditions are also set, thereby providing a method and system for preventing a train side collision at a station, to make the interlocking relationship stricter and reduce the risk of train side collisions.

[0021] Description is made below by using the station yard schematic diagram in FIG. 1 as an example. The symbols in the figure correspond to different parts.

[0022] X1, X2, X3, S, and SA represent signals, where X1, X2, and X3 represents side protection signals respectively.

[0023] 2, 4, 6, and 8 are the serial numbers of switches respectively, where 8 is a serial number of a side protection switch.

[0024] 1G (a main line), 2G (a second branch line), and 3G (a first branch line) represent lines respectively.

[0025] 4DG, 6DG, and 8DG represent track sections respectively.

[0026] X1→S (a main line departure route), X2→S (a second branch line departure route), and X3→S (a first branch line departure route) represent departure routes respectively.

Embodiment 1

[0027] FIG. 2 is a schematic diagram of a side collision prevention on a route X3→S according to an embodiment of the present invention. When the first branch line departure route of X3→S is arranged, the No. 2, 4, and 8 switches are operated by the interlock system in a direction from X3 to the side protection signal S, and are locked. In this case, if a train comes from the main line 1G or the second branch line 2G to the route of X3→S, it may have a side collision with another train driven on the route of X3→S, causing a danger.

[0028] When the first branch departure route of X3→S is arranged, it is checked not only whether the position of the switch in the route is correct, the track section is cleared, and hostile signals in and outside the route are stopped, but also a side collision prevention condition from X1 and X2 to the current route.

[0029] Using the side protection signal X1 as an example, when the first branch line departure route of X3→S is arranged, it is necessary to check whether the side protection signal X1 is stopped (which is indicated with a red light), and whether all track sections (in this embodiment, the side protection signal X1 is close to the second branch line departure route X2→S) from the side protection signal X1 to the current route are cleared. In other words, no train is driven from the side protection signal X1 to the current route. The red light of the side protection signal X1 is used to stop a train that may be driven subsequently onto the current route.

[0030] Using the side protection signal X2 as an example, when the first branch line departure route of X3→S is arranged, it is necessary to check whether the side protection signal X2 is stopped (which is indicated with a red light), and whether the track section (which is 6DG in this embodiment) from the side protection signal X2 to the current route is cleared. In other words, no train is driven from the side protection signal X2 to the current route. The red light of the side protection signal X2 is used to stop a train that may be driven subsequently onto the current route.

Embodiment 2

[0031] FIG. 3 is a schematic diagram of a side collision prevention on a main line departure route X1→S according to an embodiment of the present invention. When the main line departure route of X1→S is arranged, the No. 2 and 4 switches are operated by the interlock system in a direction from X1 to the side protection signal S, and are locked. In this case, if a train comes from the second branch line 2G or the third branch line 3G to the route of X1→S, it may have a side collision with another train driven on the route of X1→S, causing a danger.

[0032] When the main line departure route of X1→S is arranged, it is checked not only whether the position of the switch in the route is correct, the track section is cleared, and hostile signals in and outside the route are stopped, but also a side collision prevention condition from X2 and X3 to the current route.

[0033] Using the side protection signal X2 as an example, when the main line departure route of X1→S is arranged, it is necessary to check whether the side protection signal X2 is stopped (the red light), and whether the track section (which is 6DG in this embodiment) from the side protection signal X2 to the current route is cleared. In other words, no train is driven from the side protection signal X2 to the current route. The red light of the side protection signal X2 is used to stop a train that may be driven subsequently onto the current route.

[0034] Using the side protection signal X3 as an example, when the main line departure route X1→S, the protection may be performed in the following two manners:

It is checked whether the side protection signal X3 is stopped (which is indicated with a red light), and whether the track section (the 8DG in this embodiment) from the side protection signal X3 to the current route is cleared. In other words, no train is driven from the side protection signal X3 to the current route. The red light of the side protection signal X3 is used to stop a train that may be driven subsequently onto the current route.

[0035] It is checked whether the NO. 8 side protection switch is in the direction of the side protection signal SA. In this case, even if a train passes through the side protection signal X3, it does not break into the route of X1→S. Therefore, the stop state of the side protection signal X3 does need to be checked.

Embodiment 3

[0036] FIG. 4 is a schematic diagram of a side collision prevention on a route X2→S according to an embodiment of the present invention. When the second branch line departure route of X2→S is arranged, the No. 2 and 6 switches are operated by the interlock system in a direction from X2 to the side protection signal S, and are locked. In this case, if a train comes from the main line 1G or the first branch line 3G to the route of X2→S, it may have a side collision with another train driven on the second branch line departure route of X2→S, causing a danger.

[0037] When the second branch line departure route of X2→S is arranged, it is checked not only whether the position of the switch in the route is correct, the track section is cleared, and hostile signals in and outside the route are stopped (a red light), but also a side collision prevention condition from X1 and X3 to the current route.

[0038] Using the side protection signal X1 as an example, when the second branch line departure route of X2→S is arranged, it is necessary to check whether the side protection signal X1 is stopped (the red light), and whether all track sections (in this embodiment, the side protection signal X1 is close to the second branch line departure route X2→S) from the side protection signal X1 to the current route are cleared. In other words, no

train is driven from the side protection signal X1 to the current route. The red light of the side protection signal X1 is used to stop a train that may be driven subsequently onto the current route.

[0039] Using the side protection signal X3 as an example, when the second branch line departure route X2→S, the protection may be performed in the following two manners:

It is checked whether the side protection signal X3 is stopped (a red light), and whether the track section (the 8DG in this embodiment) from the side protection signal X3 to the current route is cleared. In other words, no train is driven from the side protection signal X3 to the current route. The red light of the side protection signal X3 is used to stop a train that may be driven subsequently onto the current route.

[0040] It is checked whether the NO. 8 side protection switch is in the side protection signal SA. In this case, even if a train passes through the side protection signal X3, it does not break into the second branch departure route of X2→S. Therefore, the stop state of the side protection signal X3 does need to be checked.

Embodiment 4

[0041] FIG. 5 is a schematic diagram of a system for preventing a train side collision at a station according to an embodiment of the present invention. The system includes an interlock system, a side protection switch, and a side protection signal. The interlock system is configured to control a train departure route; and the side protection switch and the side protection signal are configured to control the side collision prevention in the main line/branch line direction.

[0042] When the interlock system controls a train to operate on the departure route in a first branch line direction, the side protection signal is stopped, and all track sections from the side protection signal to the train departure route are cleared.

[0043] When the interlock system controls a train to operate on the departure route in the main line direction or in a second branch line direction, the side protection signal is stopped, and all track sections from the side protection signal to the train departure route are cleared; or the side protection switch is turned toward a direction in which the train departure route is not set.

[0044] From the perspective of preventing train side collisions, because the switch can separate different lines, even if the train does not operate according to the signal displayed by the signaller (that is, it may pass through the signal indicating the red light), the method can also ensure that the train does not have a side collision with another train on the route that the attendant intends to handle. Therefore, when the train starts along the main line or the second branch line direction, considering the side collision prevention, it is preferred to turn the side protection switch to the non-current route direction. When the side protection switch cannot be turned to the designated position due to other reasons, for example, the another route is being used, it is checked whether the side protection switch is turned off and all track sections from the side protection signal to the train departure route are cleared.

[0045] To sum up, when the routes are arranged, increasing the check conditions for the train side collision prevention helps to improve the safety level of the train operation at the station. When it is checked that the relevant side collision prevention conditions are not met, the routes are not locked, and the signals at the beginning of the routes are not cleared either, which can effectively prevent the train on the route from colliding with another train coming from the other side.

[0046] Although the present invention is described in detail with respect to the previously described embodiments, it should be appreciated by one skilled in art, the technical solutions recorded in the embodiments may be still modified, or some of its technical features may be replaced with equivalents; and such modifications or substitutions do not deviate the nature of the technical solutions from the spirit and scope of the technical solutions of the various embodiments in the present invention.

Claims

1. A method for preventing a train side collision at a station, comprising: starting a side collision prevention in a main line/branch line direction when a train departure route meets a route condition, and enabling a train to enter a track in the main line direction for operation.

2. The method for preventing a train side collision at a station according to claim 1, **characterized in that**, the train departure route is in the main line direction or branch line direction.

3. The method for preventing a train side collision at a station according to claim 1, **characterized in that**, the side collision prevention is performed in one of the following two manners:

   in a first manner: a side protection signal is enabled to be in a stop state, and all track sections from the side protection signal to the train departure route are cleared; and
   in a second manner: a side protection switch is turned toward a direction in which the train departure route is not set.

4. The method for preventing a train side collision at a station according to claim 2, **characterized in that**,

   when the train operates on the departure route in a first branch line direction, the side collision prevention is performed in the following manner:

a side protection signal is enabled to be in a stop state, and all track sections from the side protection signal to the train departure route are cleared.

5. The method for preventing a train side collision at a station according to claim 2, **characterized in that**, when the train operates on the departure route in the main line direction or a second branch line direction, the side collision prevention is performed in one of the following two manners:

in a first manner: a side protection signal is enabled to be in a stop state, and all track sections from the side protection signal to the train departure route are cleared; and
in a second manner: a side protection switch is turned toward a direction in which the train departure route is not set.

6. The method for preventing a train side collision at a station according to claim 5, **characterized in that**, when the train operates on the departure route in the main line or second branch line direction, preferably, the side collision prevention is performed in the second manner.

7. A system for preventing a train side collision at a station, comprising: an interlock system, a side protection switch, and a side protection signal, wherein

the interlock system is configured to control a train departure route; and
the side protection switch and the side protection signal are configured to control a side collision prevention in a main line/branch line direction.

8. The system for preventing a train side collision at a station according to claim 7, **characterized in that**, the train departure route is in the main line direction or branch line direction.

9. The system for preventing a train side collision at a station according to claim 7, **characterized in that**, the side collision prevention comprises:

stopping the side protection signal, and clearing all track sections from the side protection signal to the train departure route; or
turning the side protection switch toward a direction in which the train departure route is not set.

10. The system for preventing a train side collision at a station according to claim 8, **characterized in that**, when the interlock system controls a train to operate on the departure route in a first branch line direction, the side protection signal is stopped, and all track sections from the side protection signal to the train departure route are cleared.

11. The system for preventing a train side collision at a station according to claim 8, **characterized in that**, when the interlock system controls the train to operate on the departure route in the main line direction or a second branch line direction,

the side protection signal is stopped, and all track sections from the side protection signal to the train departure route are cleared; or
the side protection switch is turned toward a direction in which the train departure route is not set.

12. The system for preventing a train side collision at a station according to claim 11, **characterized in that**, preferably, when the interlock system controls the train to operate on the departure route in the main line/second branch line direction, the side protection switch is turned toward a direction in which the train departure route is not set.

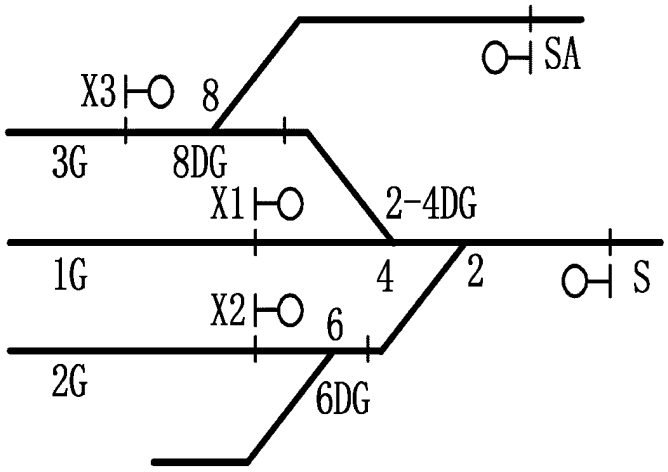

FIG. 1

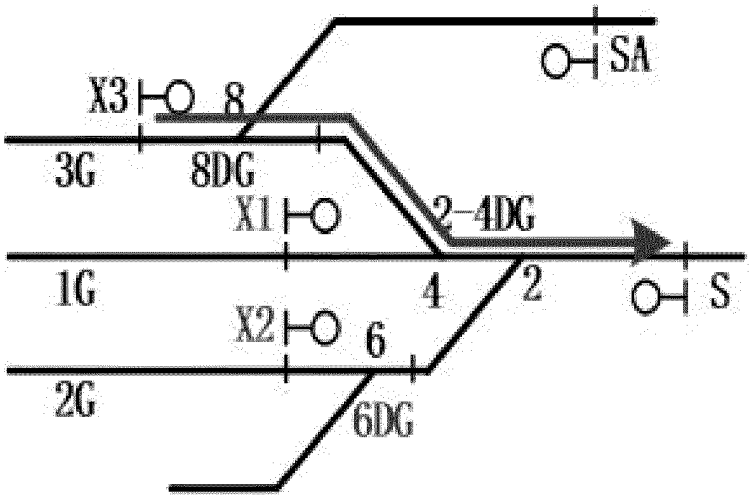

FIG. 2

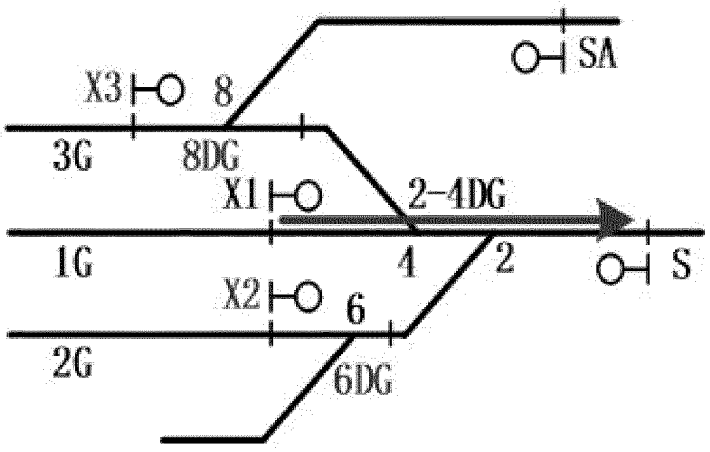

FIG. 3

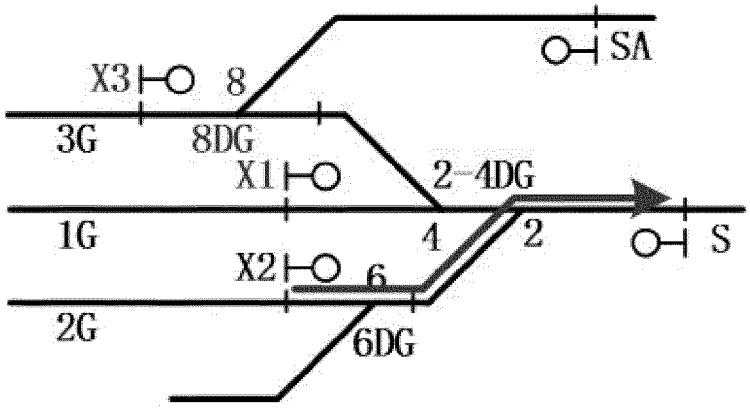
SA
X3
8
3G
8DG
X1
2-4DG
1G
4
2
S
X2
6
2G
6DG

FIG. 4

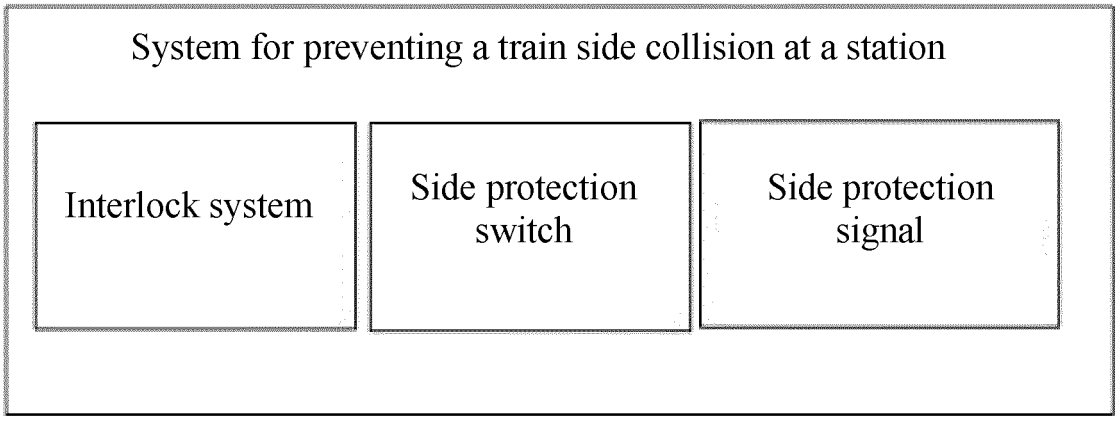
System for preventing a train side collision at a station
Interlock system
Side protection switch
Side protection signal

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/104727

A. CLASSIFICATION OF SUBJECT MATTER

B61L 23/00(2006.01)i; B61L 5/00(2006.01)i; B61L 27/00(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)

B61L23/+; B61L5/+; B61L27/+

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)

CNABS; CNTXT; VEN; CNKI: 侧冲, 侧面撞击, 侧防, 侧防信号机, 防护, 进路条件, 列车, 区段, 侧防道岔, 侧面冲撞, 正线, 侧面冲突, 信号机, 侧线, 道岔, 侧防元素, 北京全路通信信号, back side conflict, flank protect+, signal, train, switch, section

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 108116450 A (HUNAN CRRC TIMES COMMUNICATION SIGNALS CO., LTD.) 05 June 2018 (2018-06-05) description, paragraphs [0003]-[0065], and figures 1-5	1-12
X	CN 111645732 A (SHANGHAI FUXIN INTELLIGENT TRANSPORTATION SOLUTIONS CO., LTD.) 11 September 2020 (2020-09-11) description, paragraphs [0004]-[0030], and figures 1-4	1-2
X	CN 107244336 A (CASCO SIGNAL LTD.) 13 October 2017 (2017-10-13) description, paragraphs [0008]-[0039], and figures 1-4	1-2
X	CN 206900392 U (CASCO SIGNAL LTD.) 19 January 2018 (2018-01-19) description, paragraphs [0008]-[0032], and figures 1-4	1-2
PX	CN 112693499 A (BEIJING NATIONAL RAILWAY RESEARCH & DESIGN INSTITUTE OF SIGNAL & COMMUNICATION LTD.) 23 April 2021 (2021-04-23) claims 1-12	1-12
A	DE 102015210550 A1 (SIEMENS AKTIENGESELLSCHAFT) 15 December 2016 (2016-12-15) entire document	1-12

☐ 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
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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
08 October 2021	**18 October 2021**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/104727

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		WO 2016198240 A1	15 December 2016

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