



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

(43) Date of publication:  
**02.10.2024 Bulletin 2024/40**

(21) Application number: **22897602.3**

(22) Date of filing: **08.11.2022**

(51) International Patent Classification (IPC):  
**B61D 7/22 (2006.01)**

(52) Cooperative Patent Classification (CPC):  
**B61D 7/22**

(86) International application number:  
**PCT/CN2022/130531**

(87) International publication number:  
**WO 2023/093519 (01.06.2023 Gazette 2023/22)**

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA**  
Designated Validation States:  
**KH MA MD TN**

(30) Priority: **25.11.2021 CN 202122911044 U**

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(54) **SEALED HOPPER CAR BOTTOM DOOR**

(57) The present invention discloses a sealed bottom door of a hopper car, including a bottom door frame and a bottom door, and further including a slideway. The bottom door is slidably disposed on the slideway, the bottom door frame is in contact fit with the bottom door, a support portion on the slideway has a support height gradually increasing along a closing direction, and/or a lifting portion of the bottom door has a lifting height gradually increasing along an opening direction. According to the present invention, automatic change in a gap between

the bottom door and the bottom door frame when the bottom door is opened and closed is achieved through contact combination of three rollers, a bottom door plate and a sealing adjustment plate, so as to effectively improve sealing of the bottom door, resolve inertia problems of rain and snow infiltration and cargo leakage caused by structural gaps in bottom doors of existing hopper cars, and reduce manufacturing difficulties and maintenance cost.

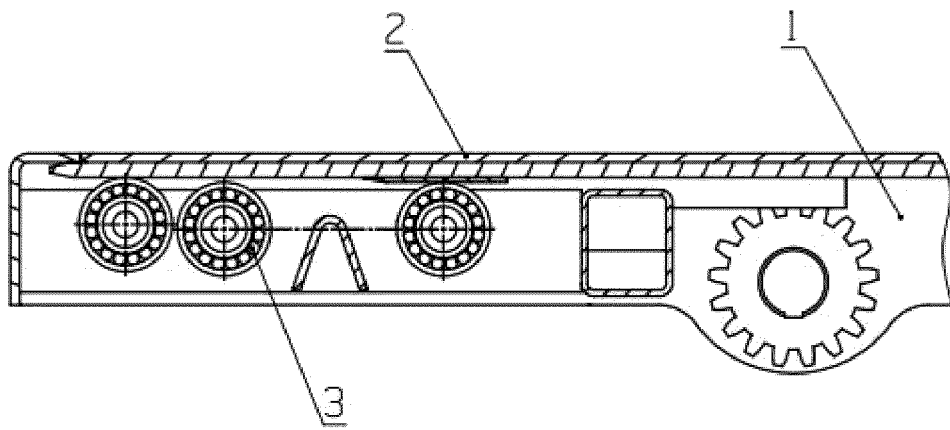


FIG. 1

## Description

### Technical Field

**[0001]** The present invention relates to the technical field of sealing equipment of a hopper car, and in particular to a sealed bottom door of a hopper car.

### Background of the Invention

**[0002]** A hopper car is a bottom dump car, and a bottom door is usually installed at the bottom of the car for transporting bulk goods. After the car arrives at a destination, the bulk goods are unloaded by bottom unloading.

**[0003]** To avoid leakage of bulk materials from the bottom door during transportation, it is usually necessary to seal the bottom door. In the prior art, to achieve a better sealing effect of the bottom door, one approach is to add an elastic component to a sealing end face of the bottom door, and although the bottom door can achieve a better sealing effect under the action of the elastic component, the elastic component is prone to deformation, wear, or aging and failure.

**[0004]** Another approach is to minimize these gaps in terms of manufacturing processes, but cannot fundamentally resolve the above problems.

### Summary of the Invention

**[0005]** One object of the present invention is to provide a sealed bottom door of a hopper car, which resolves the problem of poor sealing of a bottom door of an existing hopper car.

**[0006]** The object of the present invention is achieved by the following technical solution:

A sealed bottom door of a hopper car, including a bottom door frame and a bottom door, and further including a slideway, wherein the bottom door is slidably disposed on the slideway, the bottom door frame is in contact fit with the bottom door, a support portion on the slideway has a support height gradually increasing along a closing direction, and/or a lifting portion of the bottom door has a lifting height gradually increasing along an opening direction. The bottom door is raised and supported by the slideway, or the bottom door is raised and lifted by itself, so that the bottom door is close to the bottom door frame when it is closed, and away from the bottom door frame when it is opened, which can not only ensure sealing fit, but also reduce friction and facilitate opening.

**[0007]** Further, the bottom door frame includes left and right transverse bottom door frames, a lateral bottom door frame and a cross beam are connected between the transverse bottom door frames, and a hopper opening is formed among the lateral bottom door frame, the transverse bottom door frames and the cross beam, so that the hopper opening is sealed when the bottom door is closed, and the bottom door is opened for unloading.

**[0008]** Further, the bottom door includes a bottom door

plate, the bottom door plate is slidably disposed on the slideway, and the bottom door plate is connected to a sliding drive mechanism. Horizontal sliding of the bottom door plate is achieved by the driving mechanism to achieve opening and closing functions of the bottom door plate.

**[0009]** Further, the sliding drive mechanism includes racks, the racks are disposed on the bottom door plate, the racks are engaged with a gear, and the gear is disposed on a bottom door shaft, so that the gear and the racks are engaged through rotation of the bottom door shaft to achieve transmission sliding of the bottom door plate. Similarly, the sliding drive mechanism may be of other structural types.

**[0010]** Further, the bottom door plate is provided with two parallel racks, and the left and right racks can ensure synchronization and stability of sliding.

**[0011]** Further, an upper portion of the slideway is provided with a low support portion and a high support portion, and a height difference between the low support portion and the high support portion is  $h$ ; and a lower portion of the bottom door is provided with a low lifting portion and a high lifting portion, and a height difference between the low lifting portion and the high lifting portion is  $h$ . The height difference of the support portion is consistent with the height difference of the lifting portion, thereby enabling compensatory stable raising or lowering.

**[0012]** Further, the slideway is a roller way, the roller way includes left and right joists, a pin shaft is disposed between the joists, a rotatable roller is disposed on the pin shaft as a support portion, and the roller is used as a support and sliding component of the slideway.

**[0013]** Further, a connecting plate is connected between the left and right joists.

**[0014]** Further, the roller includes a first roller acting as the high support portion, and further includes a second roller and a third roller acting as the low support portion, and the rollers with different height differences form a stepped support arrangement.

**[0015]** Further, the bottom door plate is provided with a sealing adjustment plate as the high lifting portion, a lower end face of the bottom door plate is provided as the low lifting portion, the sealing adjustment plate has a height of  $h$ , and the sealing adjustment plate is used as a backing plate to form a stepped lifting arrangement.

**[0016]** Further, the bottom door plate is provided with at least two parallel slideways to ensure stability of sliding lifting.

**[0017]** The beneficial effects of the present invention are as follows:

1. Support portions with different heights are arranged in the slideway. When the bottom door is opened and closed, automatic change in a gap between the bottom door and the bottom door frame when the bottom door is opened and closed is achieved through contact combination between the

bottom door plate and the sealing adjustment plate.

2. When closing the door, the first roller and the third roller are in contact with and compress the bottom door plate, and there is no gap between the bottom door plate and the bottom door frame, thereby completely sealing goods.

3. When opening the door, the first roller is disengaged from the bottom door plate, the second roller and the third roller are in contact with and support the bottom door plate, and a gap is formed between the bottom door plate and the bottom door frame to facilitate opening.

4. Structural design of the bottom door is simple and reasonable, which improves sealing performance and service life of the whole car.

**[0018]** The aforementioned main solution of the present invention and further alternatives thereof may be combined freely to form a plurality of solutions, all of which may be adopted and claimed in the present invention; moreover, in the present invention, (non-conflicting alternatives) alternatives may be combined freely with each other and with other alternatives. Multiple combinations are clear to those skilled in the art based on the prior art and the common knowledge after understanding the solutions of the present invention, all of which are technical solutions to be protected by the present invention and are not exhaustive here.

#### **Brief description of the Drawings**

##### **[0019]**

FIG. 1 is a front view (sectional view) of a structure according to the present invention.

FIG. 2 is an axial view of a structure of a bottom door frame according to the present invention.

FIG. 3 is a front view (sectional view) of a structure of a bottom door according to the present invention.

FIG. 4 is an axial view of a structure of a bottom door according to the present invention.

FIG. 5 is an axial view of a structure of a roller way according to the present invention.

FIG. 6 is a front view (sectional view) of a structure of a roller way according to the present invention.

FIG. 7 is a schematic diagram of an opening process of a bottom door according to the present invention.

FIG. 8 is a schematic diagram of a bottom door in an open state according to the present invention.

FIG. 9 is a schematic diagram of a bottom door in a closed state according to the present invention.

**[0020]** In the figures: 1 - bottom door frame, 2 - bottom door, 3 - roller way, 11 - lateral bottom door frame, 12 - transverse bottom door frame, 13 - cross beam, 21 - bottom door plate, 22 - sealing adjustment plate, 23 - rack, 24 - bottom door shaft, 25 - gear, 31 - joist, 32 - pin shaft, 33 - connecting plate, 34 - roller, 341 - first roller, 342 -

second roller, 343 - third roller.

#### **Detailed Description of Embodiments**

5 **[0021]** The present invention will be further described with reference to specific embodiments and accompanying drawings.

10 **[0022]** Referring to FIG. 1 to FIG. 6, there is shown a sealed bottom door of a hopper car, which includes a bottom door frame 1, a bottom door 2 and a slideway, where the bottom door 2 is slidably disposed on the slideway, the bottom door frame 1 is in contact fit with the bottom door 2, a support portion on the slideway has a support height gradually increasing along a closing direction, and a lifting portion of the bottom door 2 has a lifting height gradually increasing along an opening direction.

15 **[0023]** Therefore, at the time of closing, because the support height of the slideway to the bottom door 2 is increasing and the lifting height of the bottom door 2 is increasing, a gap between the bottom door 2 and the bottom door frame 1 becomes smaller until they are in contact fit. At the time of opening, because the support height of the slideway to the bottom door 2 is decreasing and the lifting height of the bottom door 2 is decreasing, the gap between the bottom door 2 and the bottom door frame 1 becomes larger, which reduces friction between the bottom door 2 and the bottom door frame 1 and facilitates opening of the bottom door 2.

20 **[0024]** Specifically, the bottom door frame 1 includes left and right transverse bottom door frames 12, a lateral bottom door frame 11 and a cross beam 13 are connected between the transverse bottom door frames 12, and a hopper opening is formed among the lateral bottom door frame 11, the transverse bottom door frames 12 and the cross beam 13.

25 **[0025]** The bottom door 2 includes a bottom door plate 21, the bottom door plate 21 is slidably disposed on the slideway, and the bottom door plate 21 is connected to a sliding drive mechanism. The sliding drive mechanism includes racks 23, two parallel racks 23 are fixed on the bottom door plate 21 by a screw, the racks 23 are engaged with a gear 25, the gear 25 is connected to a bottom door shaft 24 through a pin key and may rotate about a central axis of the bottom door shaft 24, and the bottom door shaft 24 may be driven to rotate by an external power to drive the gear 25 to rotate and engage with the racks 23, so as to achieve forward and backward movement of the bottom door plate 21.

30 **[0026]** The bottom door plate 21 is provided with at least two parallel slideways to ensure stability of sliding support for the bottom door 2. The slideways are roller ways 3, the roller ways 3 each include left and right joists 31, a pin shaft 32 is disposed between the joists 31, a rotatable roller 34 is disposed at an upper portion of the pin shaft 32 as a support portion, and a connecting plate 33 is welded between the left and right joists 31 to connect the left and right joists 31 together.

**[0027]** The support portion includes a low support portion and a high support portion, a first roller 341 acts as the high support portion, a second roller 342 and a third roller 343 with the same height act as the low support portion, and a height difference between the low support portion and the high support portion is  $h$ . A lower portion of the bottom door 2 is provided with a low lifting portion and a high lifting portion; the bottom door plate 21 is fixedly provided with a sealing adjustment plate 22 as the high lifting portion, a lower end face of the bottom door plate 21 is the low lifting portion, and a height difference between the low lifting portion and the high lifting portion, namely, the height of the sealing adjustment plate 22, is  $h$ .

**[0028]** Referring to FIG. 7 to FIG. 9, the workflow of the present invention is as follows:

Opening of the bottom door: Before opening, the first roller 341 is in contact with the bottom door plate 21, with a gap  $h$  between the second roller 342 and the bottom door plate 21, and the third roller 343 is in contact with the sealing adjustment plate 22, so that the bottom door plate 21 is fit to the bottom door frame 1 without a gap. When opening, the bottom door shaft 24 rotates, driving the gear 25 to rotate in the same direction; and the gear 25 is engaged with the racks 23, converting the rotation into translation, and driving the bottom door plate 21 to move a distance  $l$  to the right as shown in the figure. The first roller 341 is disengaged from the bottom door plate 21, the third roller 343 is disengaged from the sealing adjustment plate 22, and the bottom door plate 21 moves vertically downwards and forms a gap  $h$  with the bottom door frame 1. The second roller 342 and the third roller 343 are in contact with the bottom door plate 21, and the bottom door plate 21 continues to move to the right until it is opened.

**[0029]** Closing of the bottom door: Before closing, the third roller 343 is in contact with the bottom door plate 21, with a gap  $h$  between the bottom door plate 21 and the bottom door frame 1. When closing, the bottom door shaft 24 rotates, driving the gear 25 to rotate in the same direction, and the gear 25 is engaged with the racks 23, converting the rotation into translation, and driving the bottom door plate 21 to move to the left as shown in the figure. During the movement, the second roller 342 is in contact with the bottom door plate 21, when moving to a position, the first roller 341 is in contact with the bottom door plate 21, the third roller 343 is in contact with the sealing adjustment plate 22, and the bottom door plate 21 moves vertically upwards and is fit to the bottom door frame 1 without a gap. The second roller 342 is disengaged from the bottom door plate 21, and the bottom door plate 21 continues to move to the left until it is closed.

**[0030]** The foregoing basic examples of the present invention and further alternative examples thereof may be combined freely to form a plurality of embodiments, all of which may be adopted and claimed in the present invention. In the solutions of the present invention, each alternative example may be combined arbitrarily with any other basic example and alternative example.

**[0031]** The foregoing descriptions are only preferred embodiments of the present invention and are not intended to limit the present invention. Any modification, equivalent replacement, improvement, etc. made within the spirit and principle of the present invention shall fall into the protection scope of the present invention.

## Claims

1. A sealed bottom door of a hopper car, comprising a bottom door frame (1) and a bottom door (2), **characterized by** further comprising a slideway, wherein the bottom door (2) is slidably disposed on the slideway, the bottom door frame (1) is in contact fit with the bottom door (2), a support portion on the slideway has a support height gradually increasing along a closing direction, and/or a lifting portion of the bottom door (2) has a lifting height gradually increasing along an opening direction.
2. The sealed bottom door of a hopper car according to claim 1, **characterized in that**, the bottom door frame (1) comprises left and right transverse bottom door frames (12), a lateral bottom door frame (11) and a cross beam (13) are connected between the transverse bottom door frames (12), and a hopper opening is formed among the lateral bottom door frame (11), the transverse bottom door frames (12) and the cross beam (13).
3. The sealed bottom door of a hopper car according to claim 1, **characterized in that**, the bottom door (2) comprises a bottom door plate (21), the bottom door plate (21) is slidably disposed on the slideway, and the bottom door plate (21) is connected to a sliding drive mechanism.
4. The sealed bottom door of a hopper car according to claim 3, **characterized in that**, the sliding drive mechanism comprises racks (23), the racks (23) are disposed on the bottom door plate (21), the racks (23) are engaged with a gear (25), and the gear (25) is disposed on a bottom door shaft (24).
5. The sealed bottom door of a hopper car according to claim 1, **characterized in that**, an upper portion of the slideway is provided with a low support portion and a high support portion, and a height difference between the low support portion and the high support portion is  $h$ ; and a lower portion of the bottom door (2) is provided with a low lifting portion and a high lifting portion, and a height difference between the low lifting portion and the high lifting portion is  $h$ .
6. The sealed bottom door of a hopper car according to claim 1 or 5, **characterized in that**, the slideway is a roller way (3), the roller way (3) comprises left

and right joists (31), a pin shaft (32) is disposed between the joists (31), and a rotatable roller (34) is disposed on the pin shaft (32) as a support portion.

7. The sealed bottom door of a hopper car according to claim 6, **characterized in that**, a connecting plate (33) is connected between the left and right joists (31). 5
8. The sealed bottom door of a hopper car according to claim 6, **characterized in that**, the roller (34) comprises a first roller (341) acting as a high support portion, and further comprises a second roller (342) and a third roller (343) acting as a low support portion. 10 15
9. The sealed bottom door of a hopper car according to claim 5, **characterized in that**, the bottom door plate (21) is provided with a sealing adjustment plate (22) as a high lifting portion, a lower end face of the bottom door plate (21) is provided as a low lifting portion, and the sealing adjustment plate (22) has a height of h. 20
10. The sealed bottom door of a hopper car according to claim 1, **characterized in that**, the bottom door plate (21) is provided with at least two parallel slide-ways. 25

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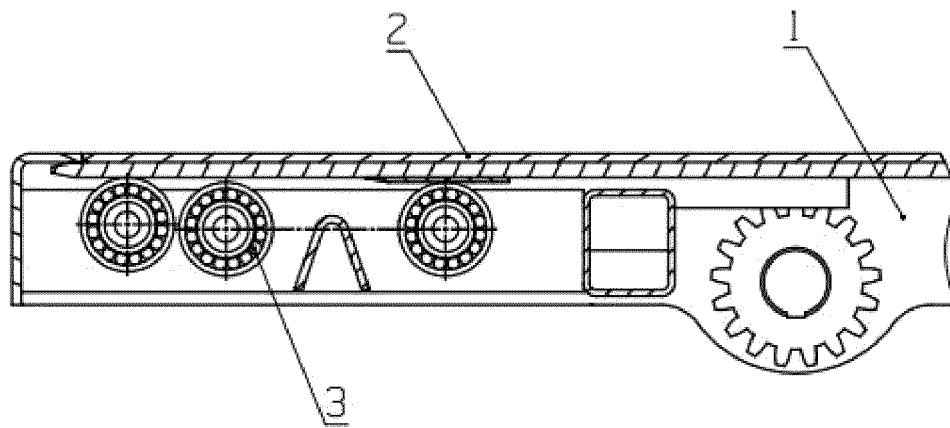


FIG. 1

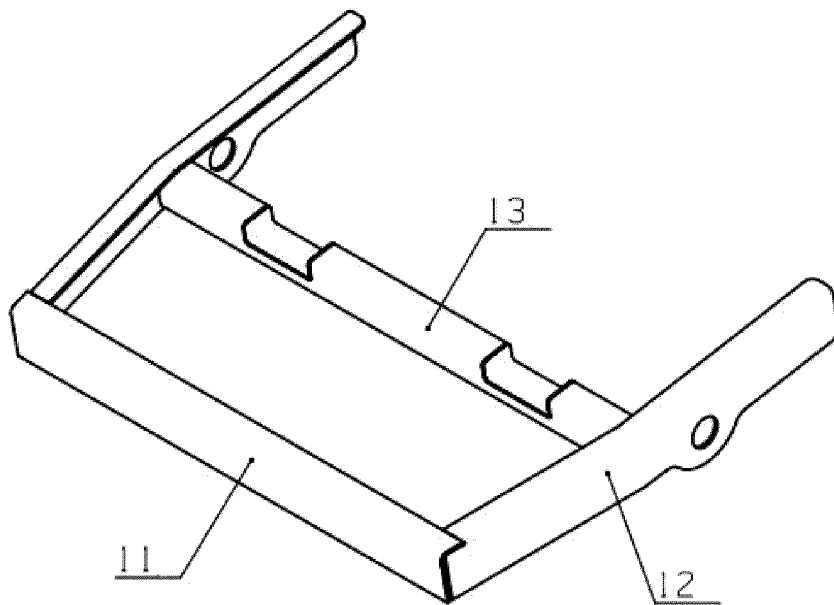


FIG. 2

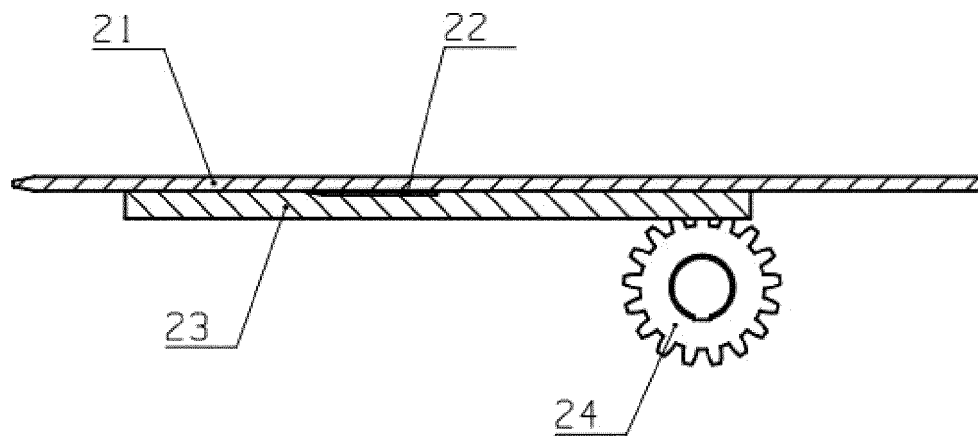


FIG. 3

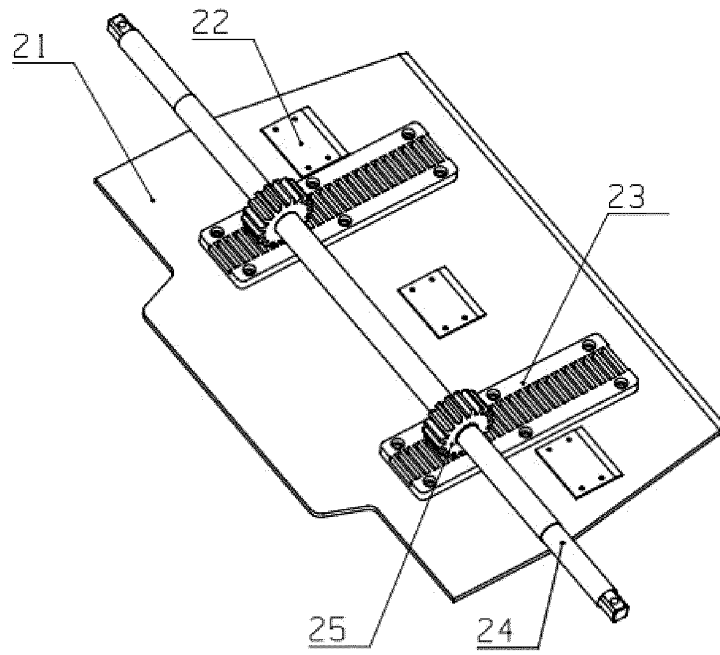


FIG. 4

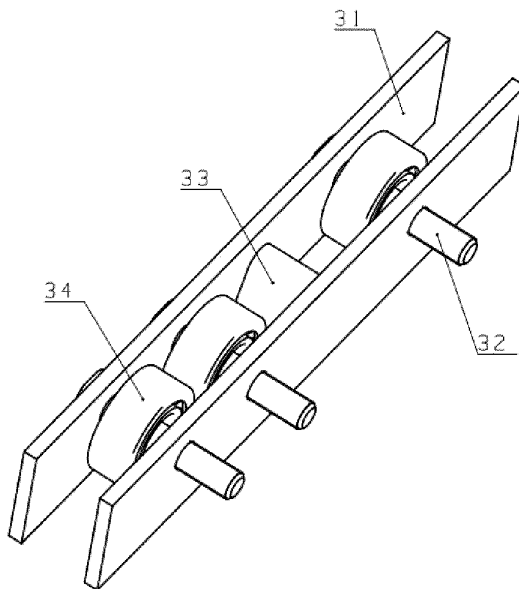


FIG. 5

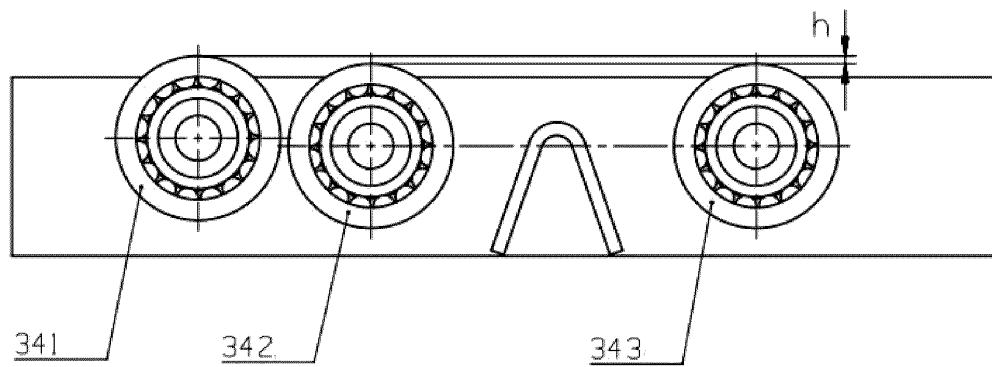


FIG. 6



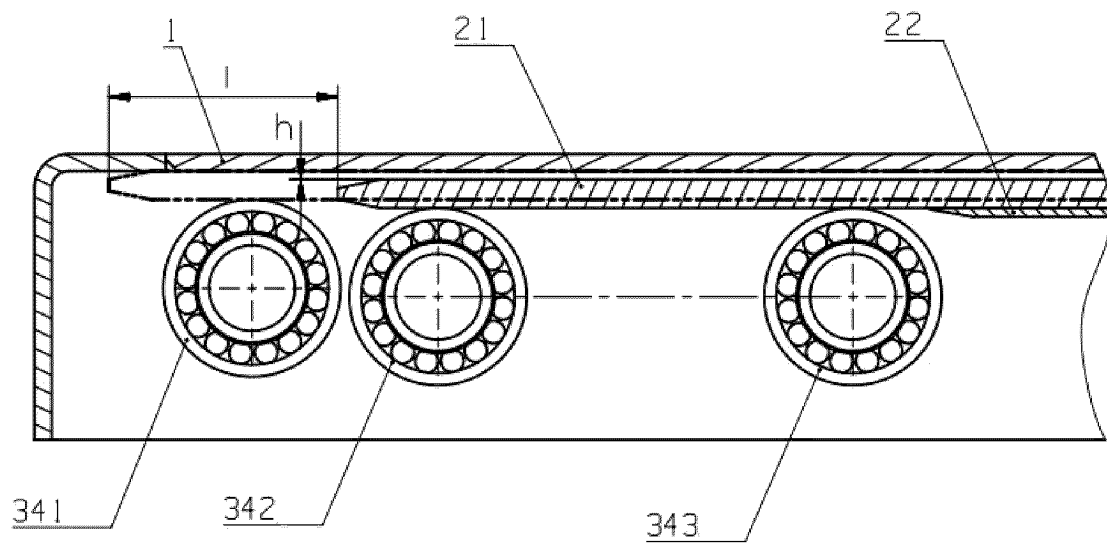


FIG. 7

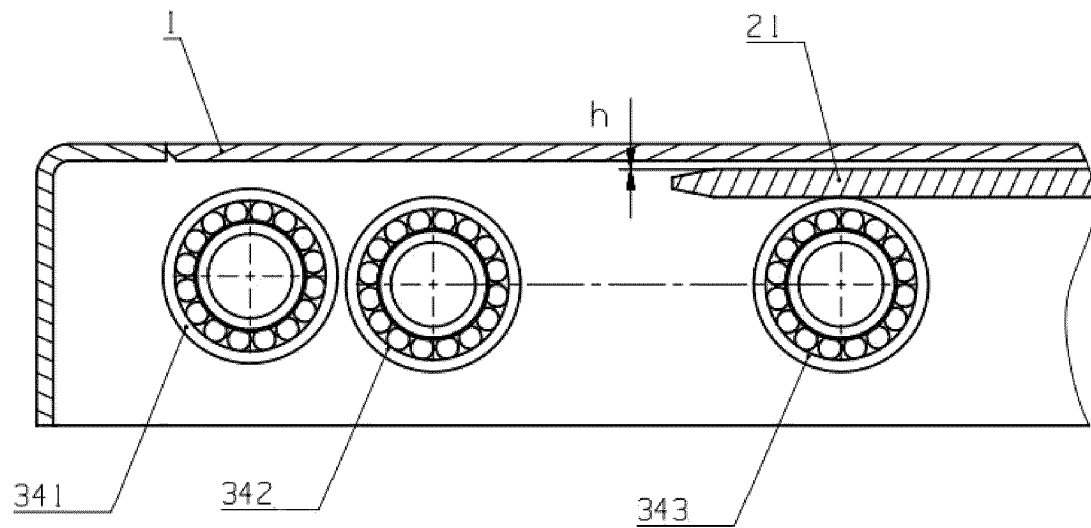


FIG. 8

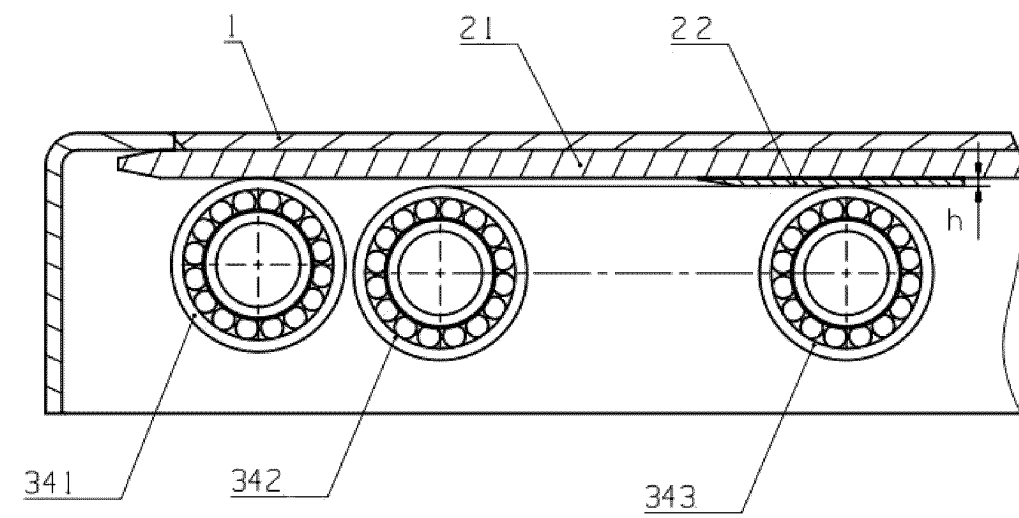


FIG. 9

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/130531

**A. CLASSIFICATION OF SUBJECT MATTER**

B61D 7/22(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)

B61D

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, DWPI, WPABS, CJFD, CNKI: 卸料, 漏斗, 门, 滑动, 齿条, 齿轮, 调节, discharge, hopper, door, slid  
+, rack, gear, adjust+**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 113978492 A (CRRC MEISHAN CO., LTD.) 28 January 2022 (2022-01-28) see claims 1-10	1-10
PX	CN 216232236 U (CRRC MEISHAN CO., LTD.) 08 April 2022 (2022-04-08) see claims 1-10	1-10
X	US 2015166079 A1 (AERO TRANSP PRODUCTS INC.) 18 June 2015 (2015-06-18) see description, paragraphs [0027]-[0034], and figures 5-6	1-4, 6-8, 10
A	CN 113386801 A (CRRC TAIYUAN CO., LTD.) 14 September 2021 (2021-09-14) see entire document	1-10
A	DE 202018100628 U1 (WBN WAGGONBAU NIESKY GMBH) 02 March 2018 (2018-03-02) see entire document	1-10

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

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Date of the actual completion of the international search

26 December 2022

Date of mailing of the international search report

19 January 2023

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INTERNATIONAL SEARCH REPORT  
Information on patent family members

International application No.  
**PCT/CN2022/130531**

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