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(71) Applicant: **CRRC Qiqihar Rolling Stock Co., Ltd.**
Qiqihar, Heilongjiang 161002 (CN)

(72) Inventors:
- **Xu, Shifeng**
  Qiqihar, Heilongjiang 161002 (CN)
- **Gao, Peng**
  Qiqihar, Heilongjiang 161002 (CN)
- **Zhang, Derong**
  Qiqihar, Heilongjiang 161002 (CN)
- **Shao, Wendong**
  Qiqihar, Heilongjiang 161002 (CN)
- **Duan, Shihui**
  Qiqihar, Heilongjiang 161002 (CN)
- **Liu, Xinqiang**
  Qiqihar, Heilongjiang 161002 (CN)
- **Du, Wei**
  Qiqihar, Heilongjiang 161002 (CN)
- **Zhao, Zengchuang**
  Qiqihar, Heilongjiang 161002 (CN)

(74) Representative: **Epping - Hermann - Fischer**
Patentanwaltsgesellschaft mbH
Schloßschmidstraße 5
80639 München (DE)

(54) RAILWAY VEHICLE AND VIBRATION DAMPING AND SUSPENSION DEVICE THEREOF

(57) A railway vehicle and a vibration damping and suspension device thereof are provided according to the present application. The vibration damping and suspension device includes a top cover, an elastic annular member and an outer sleeve. The top cover has an inner positioning pillar and an outer gland, the outer sleeve is fixedly connected to the elastic annular member and the inner positioning pillar is fixedly inserted in the elastic annular member. Both the outer sleeve and the elastic annular member are provided with a gap extending in a radial direction, thus the outer gland can pre-press the elastic annular member against the inner positioning pillar in the radial direction by the outer sleeve. The vibration damping and suspension device has a great universality and can function as a primary suspension device, a secondary suspension device and/or an elastic side bearing. When the vibration damping and suspension device is subjected to a vertical downward outer loading, the elastic annular member generates an elastic deformation to drive the top cover to slide downward with respect to the outer sleeve, thereby realizing the vibration damping function and forming an upward vertical frictional damping at the same time. When the vehicle vibrates, the elastic annular member moves upward to drive the outer sleeve to move upward, to form a downward vertical frictional damping, thereby improving the stability and safety of the vehicle running at a high speed.

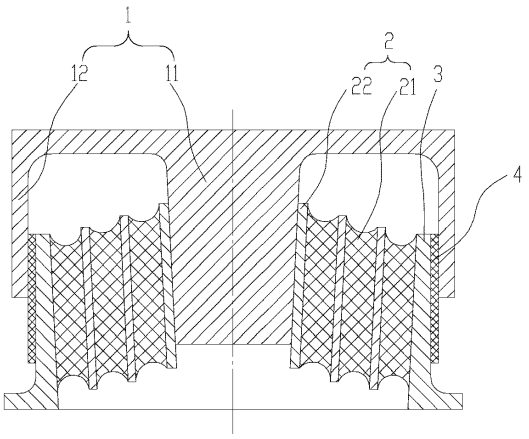

Fig. 1

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Description

FIELD

[0001] The present application relates to the technical field of a vibration damping and suspension structure for a railway vehicle, particularly to a railway vehicle and a vibration damping and suspension device.

BACKGROUND

[0002] A railway vehicle is generally driven by a locomotive or a power car to run on two parallel tracks. For ensuring the operational safety of the railway vehicle, a running portion, that is a bogie, is required to allow the vehicle to make a translational motion along the tracks by the rotation of a wheel set. As one of core structures of the bogie, a vibration damping and suspension device has a critical influence on the stability and safety of the vehicle running at a high speed.

[0003] According to the mounting position, the vibration damping and suspension device of the railway vehicle can be divided as a primary suspension device, a secondary suspension device and an elastic side bearing.

[0004] The primary suspension device is installed between an axle box and a bogie frame, and is used to transfer a force between the wheel set and the bogie and has a positioning function. A specific structure of a conventional primary suspension device can refer to a Chinese utility model No. ZL200620147882.5 titled "BOGIE POSITIONING DEVICE FOR RAILWAY HIGH SPEED WAGON".

[0005] The secondary suspension device is installed between the bogie frame and a swing bolster and is used for buffering impacts, damping vibrations and improving the operational stability of the vehicle. A specific structure of a conventional secondary suspension device can refer to a Chinese patent No. ZL201110000333.0 titled "CENTRAL SUSPENSION AND HIGH SPEED WAGON BOGIE HAVING THE SAME".

[0006] The elastic side bearing is installed between the vehicle body and the bogie swing bolster.

[0007] When the bogie generates a rotation motion around a vertical axis with respect to the vehicle body, a rotation resistance torque is generated between the bogie and the vehicle body by the elastic side bearing, and the rotation resistance torque can restrain and damp the rotation vibration of the bogie with respect to the vehicle body, thereby controlling a yawing vibration of the vehicle body and improving the operational stability of the running vehicle. A specific structure of a conventional elastic side bearing can refer to a Chinese utility model No. ZL201020554552.4 titled "ELASTIC STOPPING PLATE AND ELASTIC SIDE BEARING".

[0008] However, a vertical damping of each of these three types of suspension and vibration damping devices only depends on a deformation amount of an elastic member thereof, and the vibration damping effect is not ideal. Furthermore, these three types of suspension and vibration damping devices use different structures and thus having a low universality.

[0009] In view of this, it is urgent for the person skilled in the art to improve the conventional vibration damping and suspension device to solve the problems that the conventional vibration damping and suspension device has a small vertical damping and a low universality.

SUMMARY

[0010] An object of the present application is to provide a vibration damping and suspension device for a railway vehicle to solve the problems that the conventional vibration damping and suspension device has a small vertical damping and a low universality. On this basis, a railway vehicle having the vibration damping and suspension device is further provided according to the present application.

[0011] The vibration damping and suspension device according to the present application includes a top cover, an elastic annular member and an outer sleeve. The top cover has an inner positioning pillar and an outer gland, the outer sleeve is fixedly connected to an outer peripheral wall of the elastic annular member and the inner positioning pillar is fixedly inserted in the elastic annular member. Both the outer sleeve and the elastic annular member are provided with a gap extending in a radial direction, to allow the outer gland to pre-press the elastic annular member against the inner positioning pillar in the radial direction by means of the outer sleeve.

[0012] Optionally, a wearing ring is arranged between the outer sleeve and the outer gland and the wearing ring is provided with a gap extending in the radial direction.

[0013] Optionally, the wearing ring is a non-metal wearing ring.

[0014] Optionally, the number of the gap is two, and the two gaps are bilaterally symmetrical with respect to a longitudinal central line of the elastic annular member.

[0015] Optionally, the elastic annular member is a conical elastic annular member.

[0016] Optionally, the elastic annular member includes a plurality of elastic members and a plurality of bushings, which are superposed alternately in the radial direction and fixedly connected, the inner positioning pillar is fixedly inserted into an innermost bushing, and the outer sleeve is fixedly connected with an outermost elastic member.

[0017] Besides the vibration damping and suspension device, a railway vehicle is further provided according to the present application, which includes a primary suspension device, a secondary suspension device and/or an elastic side bearing, wherein each of the primary suspension device, the secondary suspension device and the elastic side bearing is the above vibration damping and suspension device;

in a case that the vibration damping and suspension device functions as the primary suspension device, the top cover is configured to be fixedly connected to a bogie swing bolster of the railway vehicle and the outer sleeve is configured to be fixedly connected to the axle box of the railway vehicle;

in a case that the vibration damping and suspension device functions as the secondary suspension device, the top cover is configured to be fixedly connected to a bogie swing bolster or a sleeper beam of the railway vehicle and the outer sleeve is configured to be fixedly connected to the bogie frame of the railway vehicle; and

in a case that the vibration damping and suspension device functions as the elastic side bearing, the top cover is configured to form a fraction pair with a side bearing wearing plate of a train body of the railway vehicle, and the outer sleeve is configured to be fixedly connected to the bogie swing bolster of the railway vehicle.

[0018] When the vibration damping and suspension device functions as the primary suspension device and the secondary suspension device and is subjected to a vertical downward outer loading, the elastic annular member generates an elastic deformation and drives the top cover to slide downward by a predetermined displacement with respect to the outer sleeve, thereby realizing the vibration damping function and form an upward vertical frictional damping at the same time. When the railway vehicle vibrates, the elastic annular member moves upward and drives the outer sleeve to move upward, to form a downward vertical frictional damping, and thus the stability and safety of the railway vehicle running at a high speed are improved. When the vibration damping and suspension device functions as the elastic side bearing, not only an effect of rotation damping and vertical damping is formed between the top cover and the outer sleeve but also a shear deformation occurs on the elastic annular member under the action of the outer loading. Therefore, the deformation travel is large and a side bearing force has a low sensitiveness to the permanent deformation, and thus the trains have a strong long-distance running ability.

[0019] Optionally, the top cover is detachably connected with the bogie frame, the bogie swing bolster and/or the sleeper beam.

[0020] Optionally, the top cover is in an interference fit with the bogie frame, the bogie swing bolster and the sleeper beam by a connecting pillar and a connecting hole which matches with each other, one of the connecting pillar and the connecting hole is arranged on the top cover, and the other one of the connecting pillar and the connecting hole is arranged on the bogie frame, the bogie swing bolster and the sleeper beam.

[0021] Optionally, the top cover is connected with the bogie frame, the bogie swing bolster and the sleeper beam by a fastener, the top cover has a top cover flange which is formed by extending outward in a horizontal direction, and the top cover flange is provided with a top cover mounting hole configured to cooperate with the fastener.

[0022] Optionally, the outer sleeve is detachably connected with the axle box, the bogie frame and the bogie swing bolster.

[0023] Optionally, the outer sleeve is in the interference fit with the connecting hole of each of the axle box, the bogie frame and the bogie swing bolster.

[0024] Optionally, the outer sleeve is connected with the axle box, the bogie frame and the bogie swing bolster by the fastener, the outer sleeve has an outer sleeve flange which is formed by extending outward in a horizontal direction, and the outer sleeve flange is provided with an outer sleeve mounting hole configured to cooperate with the fastener.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Fig. 1 is a front axial sectional view which schematically shows the structure of an embodiment of a vibration damping and suspension device according to the present application;

Fig. 2 is a bottom view which schematically shows the structure of the vibration damping and suspension device in Fig.1;

Fig. 3a is a front axial sectional view which schematically shows the structure of a first embodiment of a top cover, and Fig. 3b is a bottom view which schematically shows the structure of the top cover;

Fig. 4a is a front axial sectional view which schematically shows the structure of a second embodiment of a top cover, and Fig. 4b is a bottom view which schematically shows the structure of the top cover;

Fig. 5a is a front axial sectional view which schematically shows the structure of an embodiment of an assembly of an elastic annular member and an outer sleeve, and Fig. 5b is a bottom view which schematically shows the structure of the assembly of the elastic annular member and the outer sleeve;

Fig. 6a is a front axial sectional view which schematically shows the structure of another embodiment of an assembly of an elastic annular member and an outer sleeve, and Fig. 6b is a bottom view which schematically shows the structure of the assembly of the elastic annular member and the outer sleeve; and

Fig. 7a is a front axial sectional view which schematically shows the structure of a wearing ring according to an embodiment and Fig. 7b is a bottom view which schematically shows the structure of the wearing ring.

[0026] Corresponding relationships between the reference numerals and the components in Figs. 1 to 7b:

1	top cover:		
11	inner positioning pillar,	12	outer gland,
13	top cover connecting pillar,	14	top cover flange,
14o	top cover mounting hole;		
2	elastic annular member:		
21	elastic member,	22	bushing;
3	outer sleeve:		
31	outer sleeve flange,	31o	outer sleeve mounting hole;
4	wearing ring;	O	gap.

DETAILED DESCRIPTION

[0027] A vibration damping and suspension device adapted to a railway vehicle is provided according to the present application and has a vertical frictional damping. On this basis, a railway vehicle having the vibration damping device is further provided according to the present application.

[0028] For those skilled in the art to better understand the technical solutions of the present application, the present application will be further described in detail in conjunction with drawings and embodiments.

[0029] It should be noted that, terms indicating direction and position, such as front and back, up and down, and left and right, are all defined with reference to a railway vehicle. A direction in parallel with a running direction of the railway vehicle is defined as the longitudinal direction. In the longitudinal direction, a direction that the running direction points to is defined as front, and a direction opposite to the running direction is defined as back. In a plane in parallel with a running track plane of the railway vehicle, a direction perpendicular to the longitudinal direction is a transverse direction. In the transverse direction, viewed in the running direction, a direction at the left hand side is defined as left and a direction at the right hand side is defined as right. A direction perpendicular to the running track plane of the railway vehicle is defined as a vertical direction. In the vertical direction, a direction close to the running track plane is defined as down and a direction away from the running track plane is defined as up.

[0030] Reference is made to Figs. 1 and 2. Fig. 1 is a front axial sectional view which schematically shows the structure of an embodiment of a vibration damping and suspension device according to the present application, and Fig. 2 is a bottom view which schematically shows the structure of the vibration damping and suspension device in Fig.1.

[0031] In conjunction with Figs. 1 and 2, the vibration damping and suspension device includes a top cover 1, an elastic annular member 2 and an outer sleeve 3. The top cover 1 has an inner positioning pillar 11 and an outer gland 12 which are formed by extending downward from a lower end surface of the top cover 1. The outer sleeve 3 is fixedly connected to an outer circumferential wall of the elastic annular member 2. The elastic annular member 2 is fixedly sleeved on the inner positioning pillar 11 of the top cover 1. Both the outer sleeve 3 and the elastic annular member 2 are provided with a gap O extending in a radial direction, thus the elastic annular member 2 can be pre-pressed against the inner positioning pillar 11 in the radial direction under the action of the outer gland 12.

[0032] The vibration damping and suspension device can function as any of a primary suspension device, a secondary suspension device and an elastic side bearing of the railway vehicle. For example, when it functions as the primary suspension device, the top cover 1 is fixedly connected to a bogie frame of the railway vehicle, and the outer sleeve 3 is configured to be fixedly connected to an axle box of the railway vehicle. When it functions as the secondary suspension

device, the top cover 1 is fixedly connected to a bogie swing bolster of the railway vehicle, and the outer sleeve 3 is configured to be fixedly connected to the bogie frame of the railway vehicle. When it functions as the elastic side bearing, a fraction pair is formed by the top cover 1 and a side bearing wearing plate of the railway vehicle body, and the outer sleeve 3 is fixedly connected to the bogie swing bolster of the railway vehicle.

[0033] When the vibration damping and suspension device functions as the primary suspension device and the secondary suspension device and is subject to a vertical downward outer loading, the elastic annular member 2 generates an elastic deformation and drives the top cover 1 to slide downward by a predetermined displacement with respect to the outer sleeve 3, thereby realizing the vibration damping function and form an upward vertical frictional damping at the same time. When the railway vehicle vibrates, the elastic annular member 2 moves upward and drives the outer sleeve 3 to move upward, to form a downward vertical frictional damping, and thus the stability and safety of the railway vehicle running at a high speed are improved. When the vibration damping and suspension device functions as the elastic side bearing, not only an effect of rotation damping and vertical damping is formed between the top cover 1 and the outer sleeve 3 but also a shear deformation occurs on the elastic annular member 2 under the action of the outer loading. Therefore, the deformation travel is large and a side bearing force has a low sensitiveness to the permanent deformation, and thus the trains have a strong long-distance running ability.

[0034] It should be noted that the top cover 1 of the vibration damping and suspension device is detachably fixed to the bogie frame or the bogie swing bolster by a common means in the mechanical field such as an interference fit or a fastener and the like, so as to facilitate examining and maintaining.

[0035] In detail, referring to Figs. 3a and 3b, Fig. 3a is a front axial sectional view schematically showing the structure of an embodiment of a top cover, and Fig. 3b is a bottom view schematically showing the structure of the top cover, an upper end surface of the top cover 1 protrudes upwards to form a top cover connecting pillar 13 which extends upward in a vertical direction. Accordingly, the bogie frame and the bogie swing bolster are both provided with a connecting hole matching with the top cover connecting pillar 13 at corresponding positions. The top cover connecting pillar 13 is in an interference fit with the connecting holes, to realize a detachable connection between the top cover 1 and the bogie frame and between the top cover 1 and the bogie swing bolster.

[0036] It can be understood that, on the premise of meeting the requirements of the machining and assembling processes, the connecting pillar and the connecting hole can be arranged reversely, that is, the connecting pillar is arranged on the bogie frame and the bogie swing bolster and the connecting hole is arranged on the top cover 1.

[0037] In another example, referring to Figs. 4a and 4b, Fig. 4a is a front axial sectional view schematically showing the structure of another embodiment of a top cover, and Fig. 4b is a bottom view schematically showing the structure of the top cover, the top cover 1 has a top cover flange 14 which is formed by extending outward in a horizontal direction. The top cover flange 14 is provided with a top cover mounting hole 14o. Accordingly, the bogie frame and the bogie swing bolster are each provided with a matching fastener mounting hole such as a threaded hole or a through hole, thus the top cover 1 can be detachably connected with the bogie frame or the bogie swing bolster by the fastener such as a bolt assembly or a screw assembly.

[0038] Similarly, for the same purpose, the outer sleeve 3 of the vibration damping and suspension device is detachably connected with an axle box, the bogie frame and the bogie swing bolster by interference fit or the fastener.

[0039] In detail, referring to Figs. 5a and 5b, Fig. 5a is a front axial sectional view schematically showing the structure of an embodiment of an assembly of an elastic annular member and an outer sleeve, and Fig. 5b is a bottom view schematically showing the structure of the assembly of the elastic annular member and the outer sleeve, an outer peripheral wall of the outer sleeve 3 can be in direct interference fit with a mounting hole of the bogie frame or the bogie swing bolster.

[0040] Alternatively, referring to Figs. 6a and 6b, Fig. 6a is a front axial sectional view schematically showing the structure of another embodiment of an assembly of an elastic annular member and an outer sleeve, and Fig. 6b is a bottom view schematically showing the structure of the assembly of the elastic annular member and the outer sleeve, a lower end portion of the outer sleeve 3 has an outer sleeve flange 31 which is formed by extending outward in a horizontal direction. The outer sleeve flange 31 is machined to form an outer sleeve mounting hole 31o, such as a threaded hole or an unthreaded hole, thus the top cover 1 can be detachably connected with the bogie frame or the bogie swing bolster by the fastener such as a bolt assembly or a screw assembly.

[0041] Reference is further made to Figs. 1 and 2, the elastic annular member 2 includes multiple elastic members 21 and multiple bushings 22 which are superposed alternately in the radial direction and are fixedly connected. The inner positioning pillar 11 of the top cover 1 is fixedly inserted into an innermost bushing 22 of the elastic annular member 2, and the outer sleeve 3 is fixedly connected with an outermost elastic member 21. The elastic members 21 and other bushings 22 except for the innermost bushing 22 are all provided with a gap O extending in the radial direction, thus the outer gland 12 can pre-press the elastic members 21 and the bushings 22 against the inner positioning pillar 11 of the top cover 1 in the radial direction.

[0042] Compared with an elastic annular member 2 merely made by an elastic member, for example, rubber, the assembled elastic annular member 2 has a strong deformability and a better vibration damping effect.

[0043] In addition, it should be noted that, there are three elastic members 21 and three bushings 22 in this embodiment. However, the number of the two subassemblies of the elastic annular member 2 is not limited to the number as shown in the embodiment and can be adjusted by the person skilled in the art according to the practical requirements. Of course, on the basis of meeting the requirements of vibration damping and the processes of machining and assembling, the elastic annular member 2 can also be embodied as the elastic member 21 only.

[0044] The elastic annular member 2 in the embodiment is a conical elastic annular member, which has a strong deformability under the action of a shear force and thus can bear a larger shear force.

[0045] Reference is further made to Figs. 1 and 2, a wearing ring 4 is further arranged between the outer gland 12 and the outer sleeve 3 in the vibration damping and suspension device according to this embodiment. The wearing ring 4 is also provided with a gap O extending in the radial direction, thus the elastic annular member 2 may generate an elastic deformation under the action of the outer gland 12 and thus being pre-pressed against the inner positioning pillar 11. For better understanding the specific structure of the wearing ring 4, reference is also made to Figs. 7a and 7b. Fig. 7a is a front axial sectional view which schematically shows the structure of an embodiment of the wearing ring 4 and Fig. 7b is a bottom view which schematically shows the structure of the wearing ring 4.

[0046] Thus, the top cover 1 and the wearing ring 4 are in sliding friction cooperation, thereby avoiding an abrasion caused by the contact friction between the outer sleeve 3 and the top cover 1 and increasing the working life of the overall vibration damping and suspension device.

[0047] Preferably, the wearing ring 4 is a non-metal wearing ring, which has a high wearing coefficient and a steady wearing performance and thus can increase the stability of the vertical friction damping.

[0048] At last, reference is further made to Fig. 2, each of the wearing ring 4, the outer sleeve 3 and the elastic annular member 2 is provided with two gaps O, and the two gaps O are bilaterally symmetrical with respect to a longitudinal central line of the elastic annular member 2.

[0049] With such an arrangement, a longitudinal rigidity of the vibration damping and suspension device is larger than its transverse rigidity, and the vibration damping and suspension device has a larger vertical deflection, which not only improves the stability of the railway vehicle running at a high speed but also reduces a dynamical force of a wheel set and thus reducing the abrasion of a wheel track.

[0050] Finally, it should be noted that, as set forth, when the vibration damping and suspension device functions as the secondary suspension device of the railway vehicle, the top cover 1 is fixedly connected to the bogie swing bolster of the railway vehicle, and the outer sleeve 3 is configured to be fixedly connected to the bogie frame of the railway vehicle. When the vibration damping and suspension device functions as the secondary suspension device of the railway vehicle, on the premise of realizing the function of suspension and vibration damping, the top cover 1 can also be fixedly connected to a sleeper beam of the railway vehicle. The top cover 1 can be fixedly connected to the sleeper beam in the same way as it is fixedly connected to the bogie swing bolster, which can be realized by the person skilled in the art according to the above disclosure and will not be described hereinafter.

[0051] The above descriptions are only preferable embodiments of the present application and do not limit the scope of the present application. Any modifications, equivalent replacements and improvements without departing from the spirit and principle of the present application all fall into the scope of the present application defined by the claims.

Claims

1. A vibration damping and suspension device for a railway vehicle, comprising a top cover (1), an elastic annular member (2) and an outer sleeve (3), wherein the top cover (1) has an inner positioning pillar (11) and an outer gland (12), the outer sleeve (3) is fixedly connected to an outer peripheral wall of the elastic annular member (2), the inner positioning pillar (11) is fixedly inserted in the elastic annular member (2), both the outer sleeve (3) and the elastic annular member (2) are provided with a gap (O) extending in a radial direction, to allow the outer gland (12) to pre-press the elastic annular member (2) against the inner positioning pillar (11) in the radial direction by means of the outer sleeve (3).

2. The vibration damping and suspension device according to claim 1, wherein a wearing ring (4) is arranged between the outer sleeve (3) and the outer gland (12), and the wearing ring (4) is provided with a gap (O) extending in the radial direction.

3. The vibration damping and suspension device according to claim 2, wherein the wearing ring (4) is a non-metal wearing ring (4).

4. The vibration damping and suspension device according to any one of claims 1 to 3, wherein the number of the gap (O) is two, and the two gaps (O) are bilaterally symmetrical with respect to a longitudinal central line of the elastic

annular member (2).

5. The vibration damping and suspension device according to claim 4, wherein the elastic annular member (2) is a conical elastic annular member (2).

6. The vibration damping and suspension device according to claim 4, wherein the elastic annular member (2) comprises a plurality of elastic members (21) and a plurality of bushings (22) which are superposed alternately in the radial direction and are fixedly connected, the inner positioning pillar (11) is fixedly inserted into an innermost bushing (22), and the outer sleeve (3) is fixedly connected with an outermost elastic member (21).

7. A railway vehicle, comprising a primary suspension device, a secondary suspension device and/or an elastic side bearing, wherein each of the primary suspension device, the secondary suspension device and the elastic side bearing is the vibration damping and suspension device according to any one of claims 1 to 6;
in a case that the vibration damping and suspension device functions as the primary suspension device, the top cover (1) is configured to be fixedly connected to a bogie frame of the railway vehicle, and the outer sleeve (3) is configured to be fixedly connected to an axle box of the railway vehicle;
in a case that the vibration damping and suspension device functions as the secondary suspension device, the top cover (1) is configured to be fixedly connected to a bogie swing bolster or a sleeper beam of the railway vehicle, and the outer sleeve (3) is configured to be fixedly connected to the bogie frame of the railway vehicle; and
in a case that the vibration damping and suspension device functions as the elastic side bearing, the top cover (1) is configured to form a fraction pair with a side bearing wearing plate of a vehicle body of the railway vehicle, and the outer sleeve (3) is configured to be fixedly connected to the bogie swing bolster of the railway vehicle.

8. The railway vehicle according to claim 7, wherein the top cover (1) is detachably connected with the bogie frame, the bogie swing bolster and/or the sleeper beam.

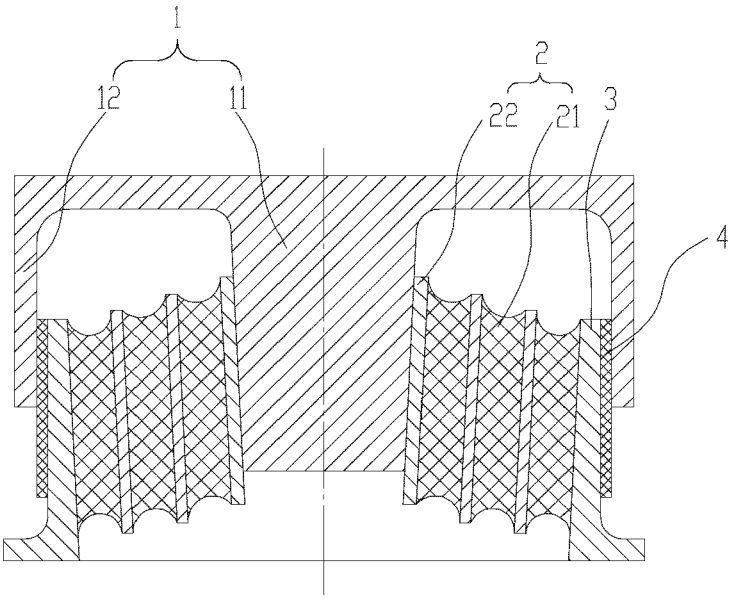
9. The railway vehicle according to claim 8, wherein the top cover (1) is in an interference fit with the bogie frame, the bogie swing bolster and the sleeper beam by a connecting pillar and a connecting hole which match with each other, one of the connecting pillar and the connecting hole is arranged on the top cover (1), and the other one of the connecting pillar and the connecting hole is arranged on the bogie frame, the bogie swing bolster and the sleeper beam.

10. The railway vehicle according to claim 8, wherein the top cover (1) is connected with the bogie frame and the bogie swing bolster by a fastener, the top cover (1) has a top cover flange (14) which is formed by extending outward in a horizontal direction, and the top cover flange (14) is provided with a top cover mounting hole (14o) configured to cooperate with the fastener.

11. The railway vehicle according to claim 7, wherein the outer sleeve (3) is detachably connected with the axle box, the bogie frame and the bogie swing bolster.

12. The railway vehicle according to claim 11, wherein the outer sleeve (3) is in an interference fit with a connecting hole of each of the axle box, the bogie frame and the bogie swing bolster.

13. The railway vehicle according to claim 11, wherein the outer sleeve (3) is connected with the axle box, the bogie frame and the bogie swing bolster by a fastener, the outer sleeve (3) has an outer sleeve flange (31) which is formed by extending outward in a horizontal direction, and the outer sleeve flange (31) is provided with an outer sleeve mounting hole (31o) configured to cooperate with the fastener.


1
12
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2
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4

Fig. 1

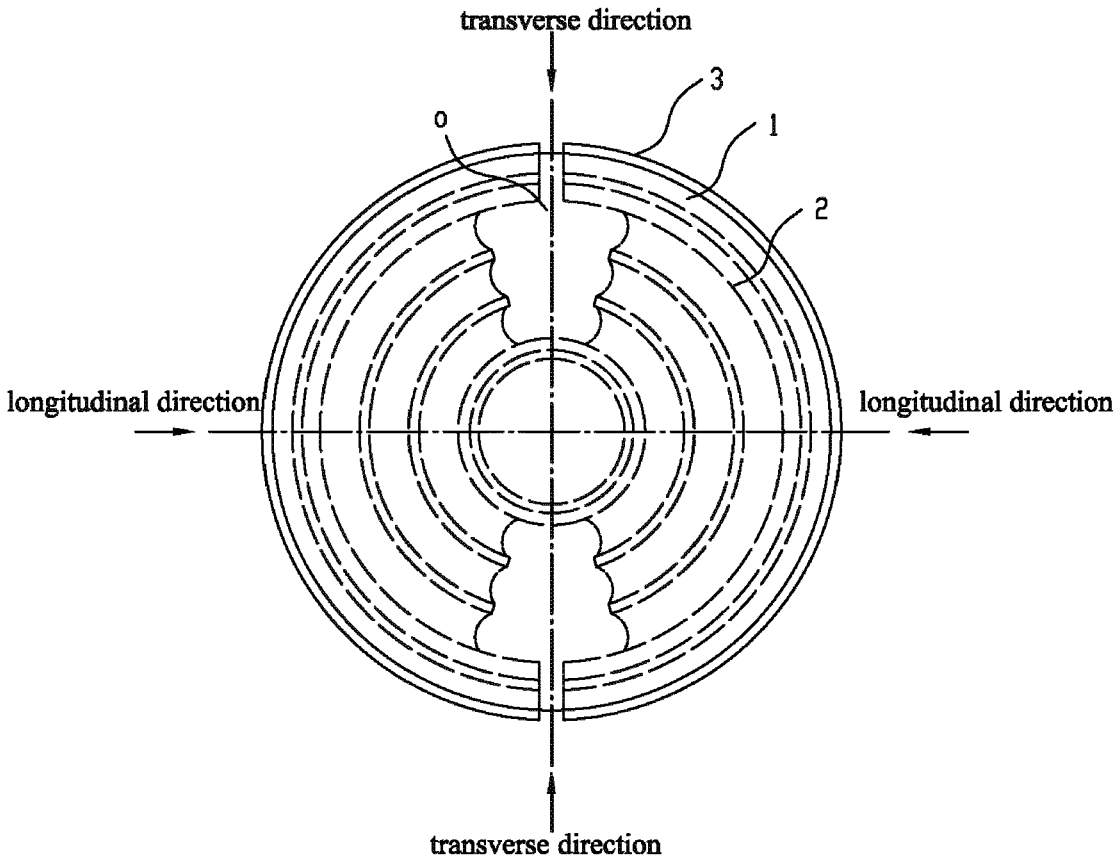
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Fig. 2

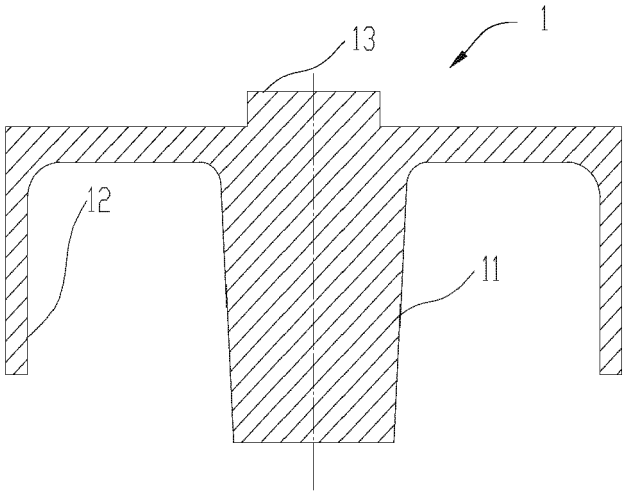

Fig. 3a

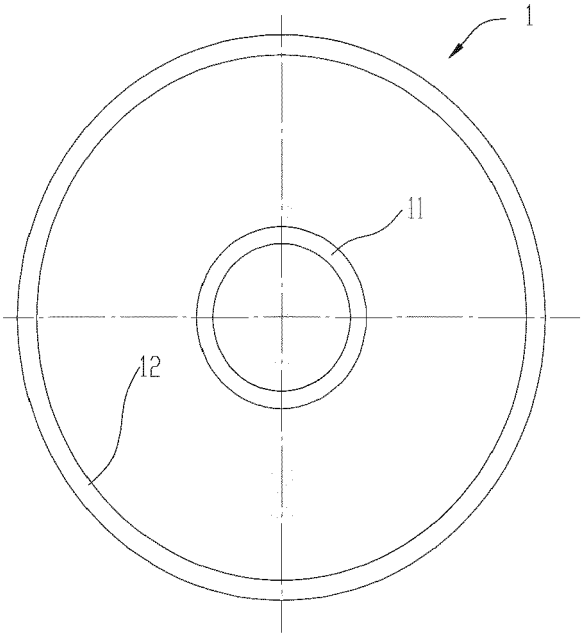

Fig. 3b

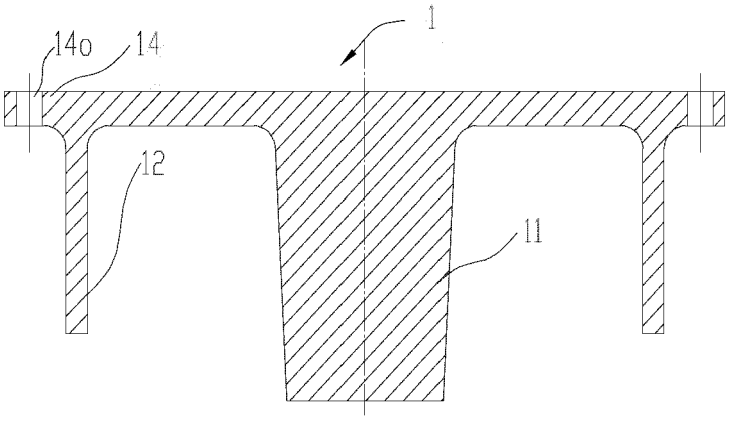

Fig. 4a

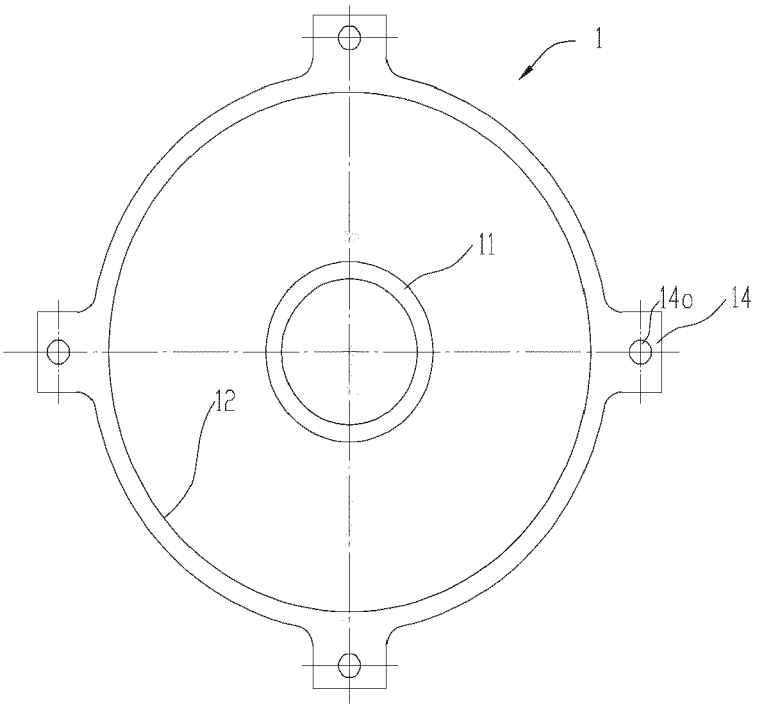

Fig. 4b

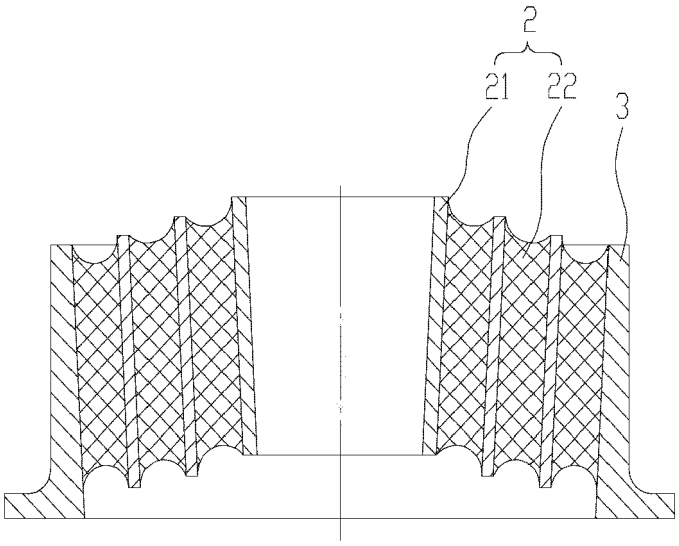

Fig. 5a

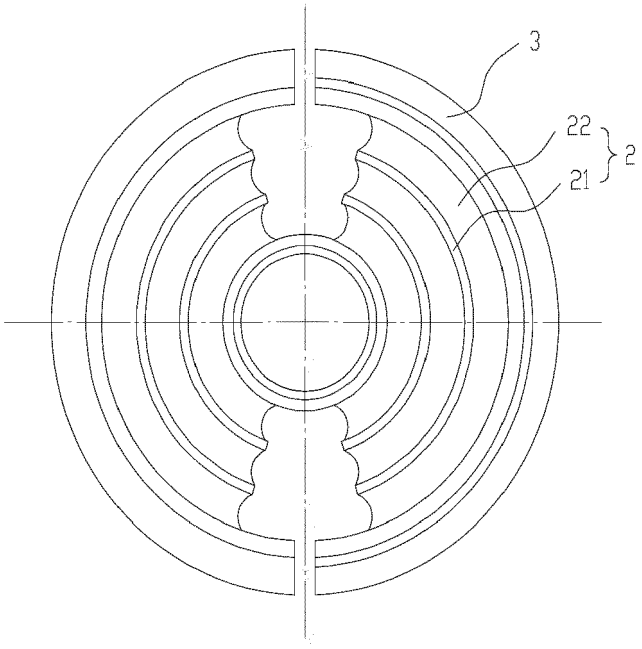

Fig. 5b

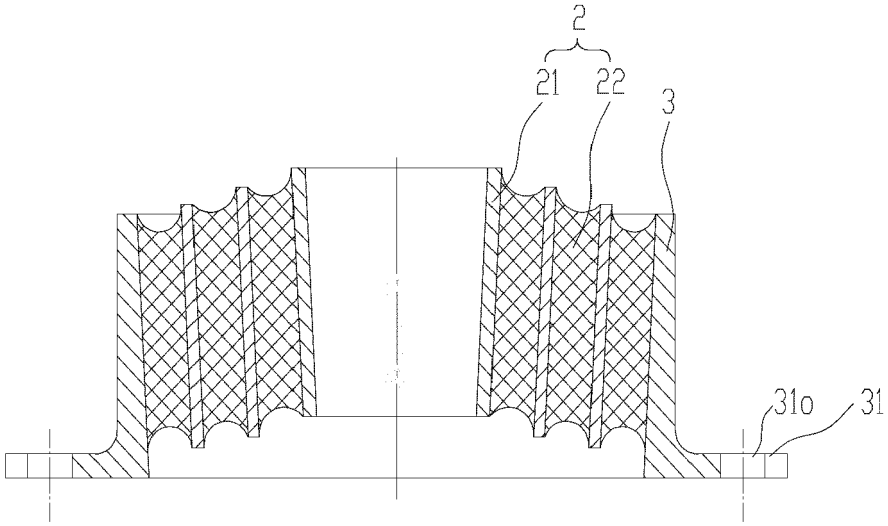

Fig. 6a

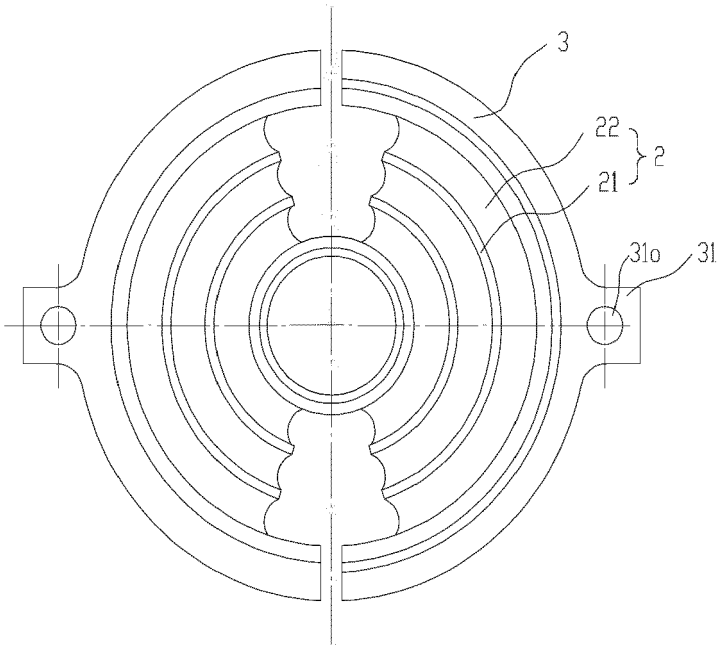

Fig. 6b

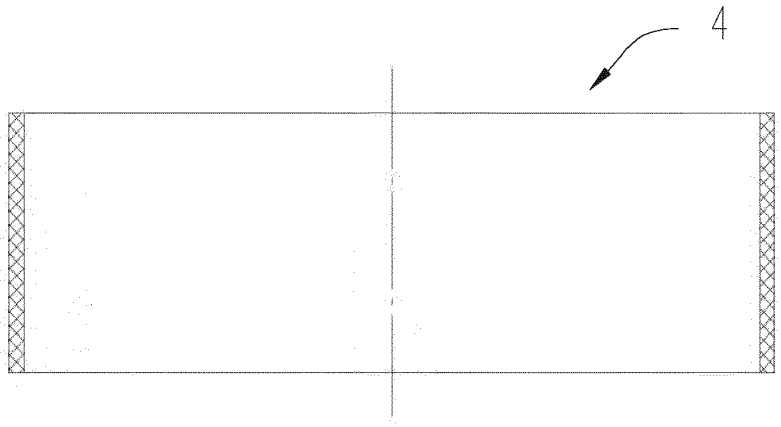

Fig. 7a

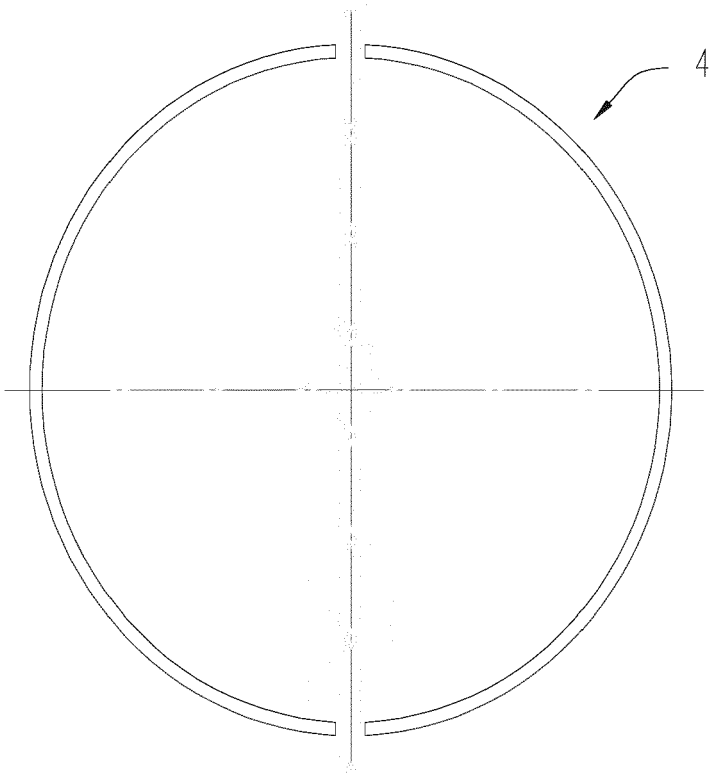

Fig. 7b

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EUROPEAN SEARCH REPORT

Application Number
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Munich	9 June 2017	Awad, Philippe

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