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(54) METHOD TO PREVENT RUPTURE OF STEEL SPRING

(57) A vertical backstop for preventing steel spring break, wherein the vertical backstop (1) is located in the steel spring (2), characterized in that the vertical backstop (1) comprises a rubber main body (11), a rubber convex platform (12) and a pedestal (13), wherein a revolve solid shaped rubber convex platform (12) is provided above the rubber main body (11), the rubber main body (11) is provided with an annular straight section and an annular arc section (115), the rubber convex platform (12) is connected with the rubber main body (11) via the annular arc section (115), a pedestal (13) is provided underneath the rubber main body (11), and the bottom of the rubber main body (11) is provided with a cavity (114), wherein the rubber main body (11), the rubber convex platform (12) and the pedestal (13) are an entirety.

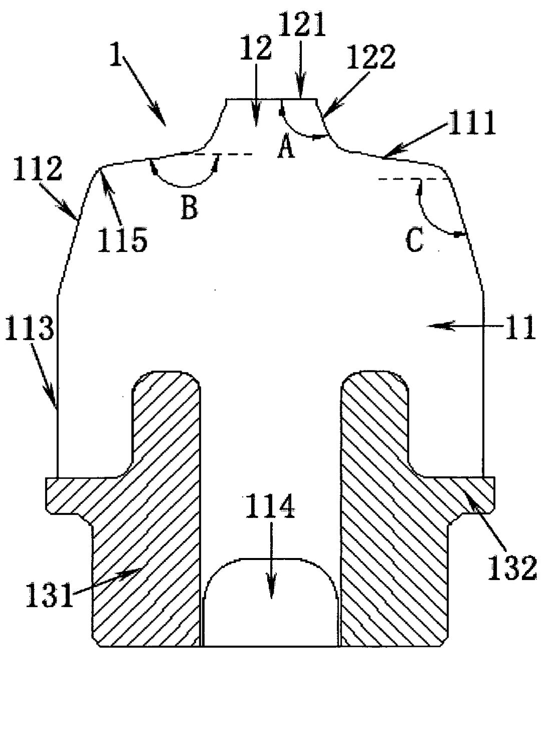

Fig. 1

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Description

Technical Field:

[0001] The present invention is related to shock absorber used on vehicles, and especially related to a vertical backstop of a suspension system of a buffer locomotive.

Technical Background:

[0002] At present, during the manufacture of railway locomotive, springs are widely used for weight bearing and vibration attenuation. As one of the critical parts of a locomotive, springs have a great impact on the dynamics performance as well as the operation quality of the vehicles. With the implementation of railway acceleration and heavy load, there are an increasing number of accidents caused by the break of the springs. The stability of locomotive operation has been reduced and hidden danger has increased.

[0003] The steel spring right above the locomotive axle box is one of the main parts of the bogie. The rigidity of the transmission vertical force is called the vertical rigidity of primary suspension. In addition, the longitudinal rigidity and horizontal rigidity of the primary suspension are transmitted to the bogie frame. The vertical rigidity, longitudinal rigidity and the horizontal rigidity have to be appropriately selected in order to ensure good dynamics properties.

[0004] Steel springs work under a complicated environment where the load constantly changes. Among the vertical, longitudinal and horizontal forces, the constantly changing vertical force is the main factor which produces metal fatigue of the steel spring. The vibration and the change of the load during locomotive operation can both make the steel spring to bear a changing vertical pressure. This changing vertical pressure can produce metal fatigue in part of the steel spring after a long time accumulation, which produces small cracks in part of the steel spring. The small cracks gradually extend and finally lead to the partial break of the steel spring.

[0005] In order to prevent the break of steel spring, in addition to improve the manufacture method and materials for the steel spring itself, an elastic buffering device can be installed in the primary suspension system in order to reduce the vertical load born by the steel spring and reduce the metal fatigue produced in the steel spring and the steel spring break can be finally avoided.

[0006] Although nowadays rubber blocks are used as a vertical backstop in the locomotive to buffer the vertical pressure in the primary suspension, their form and material are unified, and therefore they are in lack of variable rigidity and their adjustment of the rigidity is very limited. However, the variable rigidity is very important for preventing the break of the steel spring as well as the comfort for the passengers on the locomotive: when the range of the variable rigidity is too big, the anti-vibration properties of the locomotive are bad; when the range of the variable rigidity is too small, although the anti-vibration properties are good, they cannot share the vertical load born by the steel spring, and therefore the steel spring break cannot be avoided.

[0007] As a result, there is a need to develop a vertical backstop with an appropriate variable rigidity and rigidity, so that the steel spring break can be avoided without compromising the comfort of the passengers. The increasing requirements of the locomotives can be met and the implementation of railway acceleration and heavy load strategy can be realized.

[0008] According the search of the Chinese prior art, the following patent applications resemble the present application:

[0009] The utility model with the application No. 201420559352.6 and the title of "a locomotive bogie and its single level type primary suspension structure" discloses a locomotive bogie and its single level type primary suspension structure. The single level type primary suspension structure comprises a frame, an axle box, a primary spring and a primary vertical backstop. The frame is provided with a guiding groove and a first location hole. The axle box is provided with a backstop installation table. The primary spring includes a primary spring seat and a steel spring group. The primary steel spring seat is provided with a limitation protrusion that is limited within the first location hole at one side, whereas it is provided with a backstop guiding column on the other side. It also includes a first buffering cushion between the upper cover plate and the primary spring seat, which coats the limitation protrusion, as well as a second buffering cushion. The head face of the axle box, which is close to the upper cover plate, is provided with an installation groove. The second buffering cushion is installed in the installation groove. One side of the steel spring group rests against the primary spring seat, whereas the other side of the steel spring group rests against the second buffering cushion. The utility model buffers the force born by the primary spring through the first buffering cushion and the second buffering cushion, in order to buffer the vertical vibration of the primary spring, so that the shelf life of the primary spring is increased.

[0010] The utility model, 201020542266.6, with the name "locomotive primary elastic location device" discloses a railway locomotive primary elastic location device. The utility model uses a composite structure which combines the elastic location with a primary backstop in order to optimize the positioning rigidity of the axle box and to ensure the high critical instability speed of the bogie. Adding the elastic buffering stop in the primary vertical spring device is to avoid the relative big rigid impulse onto the wheel set and the axle box when the primary vertical load is too big or the primary vibration reducing parts are not working. The primary elastic positioning device is provided between the bogie frame and the vertical direction of the wheel axis. It includes a rotary arm axle box body as well as a primary spring device on the top of the axle box body. One side of the axle box body is installed onto the frame through a rubber elastic node, whereas the other side of the axle box is connected with the frame through a vertical vibration reducer. Said primary spring device comprises an upper board and a lower board as well as a double coil spring between the upper board and the lower board. A rubber stop is connected with the inner ring of the double coil spring and the bottom of the upper board through the overall vulcanization process.

[0011] The utility model, 200820186834.6, with the title of "primary suspension spring structure of railway vehicle bogies", discloses a primary suspension spring structure of railway vehicle bogies, which includes concentric inside and outside springs as well as upper and lower spring positioning seats. The upper spring positioning seat is connected with the frame of the bogie. The lower spring positioning seat is connected with the positioning turning arm of the bogie, and is provided with an elastic block, which is fixed on the lower spring positioning seat and is installed with the same axle of the spring. When unloaded, the sum of the distance between the elastic block and the upper spring positioning seat and the maximum compression deformation distance of the elastic block is smaller than the maximum compression deformation distance of the spring. When the vehicle is overloaded or the dynamic load is too big, the elastic block can buffer the vertical pressure, in order to avoid the break of the spring, and therefore the vertical rigidity and the life of the spring can be prolonged. When the spring breaks by accident, the elastic block can serve as a safe support in order to ensure the safe operation of the vehicle.

[0012] Although all of the above patents have an elastic buffering device inside the steel spring, these elastic buffering devices feature simple structures and cannot realize variable rigidity, and the adjustment of the rigidity is also limited by its structure. The patent, 201420559352.6, mentioned "the first buffering pad and the second buffering pad can buffer the impact force on the primary spring, whereby the vertical vibration of the primary spring can be buffered, and therefore the life of the primary spring can be prolonged." The patent, 201020542266.6, mentioned that "an elastic buffering backstop is added into the primary vertical spring device, in order to avoid that, when the vertical load is too big, or when the vibration reduction component is not working, the wheel set and the axel box receive too much rigid impulse. The patent, 200820186834.6, mentioned that "when the spring breaks by accident, the elastic block can serve as safe support to ensure safe operation of the vehicle." It can thus be concluded that, since the various elastic buffering devices above do not have structures to adjust variable rigidity, and also their simple structures limit the adjustment of the rigidity, and therefore they can hardly effectively reduce the metal fatigue of the steel spring as well as significantly improve the anti-breakage ability of the steel spring. As a result, there is still need to research how to prevent the breakage of the steel springs more effectively.

Technical Problems:

[0013] The technical problem of the present invention is: in view of the problems that, the change of load and vibration during vehicle operation can change the vertical pressure on the steel spring, and the changing vertical pressure can produce metal fatigue in the steel spring in the long run and produce small cracks in parts of the steel spring, and the small cracks can gradually extend and lead to partial break of the steel spring, it is advised to install vertical backstop in the steel spring to prevent the break of the steel spring.

Technical Solution:

[0014] For the above mentioned problems, the current invention provides a solution as follows: A constant contact method for preventing steel spring break, characterized in that a revolve solid shaped rubber convex platform is provided above the rubber main body. When the locomotive is non-loaded, the rubber convex platform touches the frame tank. By adjusting the diameter or the height of the rubber convex platform, the rigidity of the vertical backstop can be adjusted, and by adjusting the diameter or the height of the rubber main body, the rigidity of the vertical backstop can also be adjusted. The rubber main body is provided with an annular straight section and an annular arc section, the variable rigidity of the vertical backstop can be adjusted by adjusting the angle between the annular straight section and the annular arc section. The rubber convex platform is connected with the rubber main body via the annular arc section. By adjusting the number of segments of the annular arc section of the vertical backstop, the number of the variable rigidity of the vertical backstop can be adjusted. The pedestal is embedded in the rubber main body of the vertical backstop, so that the pedestal can limit the vertical backstop, and by adjusting the height of the pedestal, the rigidity as well as the positioned limited of the vertical backstop can be adjusted. By adjusting the rigidity, the variable rigidity as well as the positions limited by the vertical backstop, the vertical load born by the steel spring is reduced, the metal fatigue produced by the steel spring during the locomotive running is reduced, so that the break of the steel spring is avoided.

[0015] Furthermore, the revolve solid shaped rubber convex platform that is provided above the rubber main body is: the revolve solid shaped rubber convex platform is of the form of a truncated cone, wherein the rubber convex platform contains the top of the convex platform and the outside of the truncated cone. The rigidity of the vertical backstop can be increased by increasing the diameter of the rubber convex platform, the rigidity of the vertical backstop can be reduced by increasing the height of the rubber convex platform. The diameter of the top of the convex platform is 15mm to 50mm, and the height of the rubber convex platform is 6mm to 30mm. The angle between the top of the convex platform and the outside of the convex platform is more than 90°. By reducing the angle between the top of the convex platform and the outside of the truncated cone, the range of the variable rigidity of the vertical backstop can be increased, wherein the angle between the top of the convex platform and the outside of the convex platform is between 100° and 150°.

[0016] Furthermore, the revolve solid shaped rubber convex platform that is provided above the rubber main body is: the generatrix of the revolve solid shaped rubber convex platform is an outward smooth curve. By increasing the diameter of the rubber convex platform, the rigidity of the vertical backstop can be increased, whereas the rigidity of the vertical backstop can be decreased by increasing the height of the rubber convex platform. The diameter of the rubber convex platform is 20mm to 60mm, and the height of the rubber convex platform is 6mm to 30mm.

[0017] Furthermore, the rubber main body is provided with an annular straight section and an annular arc section, wherein the angle between the annular straight section and the horizontal plane equals to or is bigger than 90°, and by reducing the angle between the annular straight section and the horizontal plane, the range of the variable rigidity of the vertical backstop can be increased, and by increasing the number of segments of the annular arc section of the vertical backstop, the number of the variable rigidity of the vertical backstop can be increased.

[0018] Furthermore, by increasing the diameter of the rubber main body, the rigidity of the vertical backstop can be increased, and by increasing the height of the rubber main body, the rigidity of the vertical backstop can be reduced, and the diameter of the rubber main body is 80mm to 95mm.

[0019] Furthermore, the metal pedestal is embedded underneath the rubber main body, and when the rubber main body and the rubber convex platform are deformed due to vertical load and move downwards, the pedestal can limit the downward movement of the rubber main body and the rubber convex platform to carry out its vertical limit function. By adjusting the height of the pedestal, the limiting position of the vertical backstop can be adjusted, and by increasing the height of the pedestal, the rigidity of the vertical backstop can be increased, and the height of the pedestal is 30mm to 70mm.

[0020] A Vertical backstop for preventing steel spring break, wherein the vertical backstop is located in the steel spring. The vertical backstop comprises a rubber main body, a rubber convex platform and a pedestal, wherein a revolve solid shaped rubber convex platform is provided above the rubber main body. The rubber main body is provided with an annular straight section and an annular arc section, the rubber convex platform is connected with the rubber main body via the annular arc section. A pedestal is provided underneath the rubber main body, and the bottom of the rubber main body is provided with a cavity, wherein the rubber main body, the rubber convex platform and the pedestal are an entirety.

[0021] Furthermore, the revolve solid shaped rubber convex platform that is provided above the rubber main body is: the revolve solid shaped rubber convex platform is of the form of a truncated cone, wherein the rubber convex platform contains the top of the convex platform and the outside of the truncated cone, wherein the diameter of the top of the convex platform is 15mm to 50mm, and the height of the rubber convex platform is 6mm to 30mm, and the angle between the top of the convex platform and the outside of the convex platform is more than 90°.

[0022] Furthermore, the revolve solid shaped rubber convex platform that is provided above the rubber main body is: the generatrix of the revolve solid shaped rubber convex platform is an outward smooth curve, wherein the diameter of the rubber convex platform is 20mm to 60mm, and the height of the rubber convex platform is 6mm to 30mm.

[0023] Furthermore, the pedestal is a revolved body, and the pedestal comprises a pedestal main body and a convex rim, wherein the thickness of the upper part of the pedestal main body is smaller than the thickness of the lower part of the pedestal main body. The middle part of the outside of the pedestal main body is provided with the convex rim, wherein the convex rim protrudes outwards, and wherein the height of the pedestal is 30mm to 70mm and the corners of the pedestal embedded in the rubber main body are all smooth circular arc chamfering.

Advantageous Effects:

[0024] The advantageous effects of the present invention are:

1. By adding the rubber convex platform on the rubber main body, the height of the vertical backstop is thereby increased. The vertical backstop can therefore touch the frame tank when the locomotive is non-loaded, thereby the backstop can partially bear the vertical load from empty load to the maximum load of the vehicle. The metal fatigue of the metal spring during vehicle operation can maximally be reduced and the break of the steel spring is avoided.
2. The vertical backstop is in the steel spring, and the rubber convex platform of the vertical backstop touches the frame tank when the locomotive is non-loaded. The relative sliding between the vertical backstop and the frame tank is reduced. Hence, the abrasion caused by the relative sliding between the rubber convex platform and the frame tank can be reduced, and the operating life of the vertical backstop can be prolonged.
3. The vertical backstop is composed of the rubber main body, rubber convex platform and the pedestal. The rubber main body and the rubber convex plat-

form are an integral rubber piece. The rubber main body is glued to the pedestal and are vulcanized into an integral piece under a certain temperature and pressure, thereby the entire vertical backstop has a tight and robust structure.

4. By adjusting the angle between the rubber main body and the rubber convex platform, the variable rigidity of the vertical backstop can be adjusted. By adjusting the diameter and the height of the rubber main body, the rigidity of the vertical backstop can be adjusted, so that the vertical backstop has relatively small variable rigidity and small rigidity under small load, and therefore the comfort of the passengers can be increased. In the meantime, the vertical backstop has relatively variable rigidity and big rigidity under heavy load, so that the vertical backstop bears more vertical load and the metal fatigue of the steel spring can be reduced, thereby the break of the steel spring can be effectively avoided.

5. The rubber main body is embedded with the pedestal made of metal. By adjusting the height of the pedestal, the limiting position of the vertical backstop can be adjusted. As a result, even the break of the steel spring occurs, the vertical backstop can serve as a safe support to ensure the safe operation of the railway locomotive.

6. For vertical backstop: by adjusting the diameter and the height of the rubber main body and the rubber convex platform as well as the height of the pedestal, the rigidity of the vertical backstop can be adjusted. The variable rigidity of the vertical backstop can be adjusted by adjusting the angle between the annular straight section and the horizontal plane. By adjusting the number of segments of the annular arc section of the vertical backstop, the number of the variable rigidity of the vertical backstop can be adjusted. By adjusting the height of the pedestal, the positions limited by the vertical backstop can be adjusted. By adjusting the variable rigidity, rigidity as well as the positions limited, the vertical backstop can be applied to different types of locomotives as well as locomotives with different loading capacities. As a result, such vertical backstop can be more widely applied.

Figures:

[0025]

Fig. 1 is a first section view of example 1.
Fig. 2 is a second section view of example 1.
Fig. 3 is a 3D view of example 1.
Fig. 4 is a rigidity curve of example 1.
Fig. 5 is a structure of the steel spring in example 1.
Fig. 6 is a first 3D section view of example 2.
Fig. 7 is a second 3D section view of example 2.

[0026] In the figures:

1. Vertical backstop; 11 rubber main body; 111 first annular straight section; 112 second annular straight section; 113 third annular straight section; 114 cavity; 115 annular arc section; 12 rubber convex platform; 121 the top of the truncated cone; 122 the outside of the truncated cone; 123 generatrix; 13 pedestal; 131 pedestal main body; 132 pedestal convex rim; 2 steel spring; 3 frame tank; 4 positioning pedestal; 5 axle box; 6 bogie frame.

Preferred Embodiments of the Invention:

[0027] The present invention is further illustrated by the following embodiments and figures.

Embodiment 1:

[0028] As shown in Fig. 5, the positioning pedestal 4 is installed above the axle box 5. A steel spring 2 in the form of a double coil is installed above the positioning pedestal 4. The steel spring 2 supports the weight of the locomotive on the bogie frame 6. In order to reduce the vertical load of the steel spring 2 and the metal fatigue of the steel spring 2 produced during the operation of the locomotives as well as to prevent the break of the steel spring 2, the steel spring 2 is provided with a vertical backstop 1. The pedestal convex rim 132 of the vertical backstop 1 rests against the positioning pedestal 4. Since both the vertical backstop 1 and the positioning pedestal 4 are revolved solid, therefore the vertical backstop 1 can be stuck in the positioning pedestal 4. A frame tank 3 is provided right above the vertical backstop 1. When the locomotive is non-loaded, the rubber convex platform 12 of the vertical backstop 1 contacts the frame tank 3. From non-loaded to maximum loading, the load of the primary suspension system is all be born together by the steel spring 2 and the vertical backstop 1, so that the vertical backstop 1 can better reduce the vertical load born by the steel spring 2.

[0029] Although by increasing the rigidity of the vertical backstop 1, the vertical load born by the steel spring 2 can be better reduced, however, when the rigidity of the vertical backstop 1 is too big, the locomotive can derail, and the vibration reduction and noise reduction effect of the locomotive are compromised, so as the comfort of the passengers. Therefore, in order for the vertical backstop 1 to avoid the derailment of the locomotive, to increase the vibration and noise reducing effect of the locomotive as well as to ensure the comfort of the passengers, also in order to well reduce the vertical load born by the steel spring 2 and effectively avoid the break of the steel spring 2, the following requirements need to be fulfilled: the initial rigidity of the vertical backstop 1 has to be small and the initial range of the variable rigidity also has to be small, so that the vertical backstop 1 can have very good vibration reducing effect from the beginning. With the further downward pushing of the frame tank 3, the rigidity of the vertical backstop 1 should increase continuously, and at this time, the speed of the increase of the rigidity should be fast, and the range of the variable rigidity should also increase, so that after the frame tank 3 push downwards for some distance, the vertical backstop 1 can share relatively big vertical load, the vertical load born by the steel spring 2 can be reduced, and the position relation between the driving unit and the wheel set is ensured and not worsened during over loading.

[0030] During the whole process from non-loaded to maximum loaded, the load of the primary suspension system is born together by the steel spring 2 and the vertical backstop 1, so that the vertical backstop 1 can better share the load of the primary suspension system. As a result, the metal fatigue of the steel spring 2 produced during locomotive operation can be better reduced, and the break of the steel spring 2 can better be avoided. The rigidity of the vertical backstop 1 of this embodiment is the ratio of the load born by the vertical backstop 1 to the downward moving distance of the top of the convex platform121 of the vertical backstop 1. The rigidity curve 4 of the vertical backstop 1 is shown in Fig. 4. The deformation of the vertical backstop 1 in Fig. 4 refers to downward moving distance of the top of the convex platform121 of the vertical backstop 1.

[0031] As shown in Fig. 4, when the load on the vertical backstop 1 increases from 0, the rigidity curve is very gentle and the curve is close to linear. That is to say, the initial rigidity of the vertical backstop 1 is relatively small, the speed of the rigidity increase is very slow. This characteristic can let the vertical backstop 1 have very good vibration reducing effect, and prevent locomotive derailment, and the passengers can have very good riding comfort.

[0032] In the present embodiment, with the increase of load born by the vertical backstop 1, and when the load exceeds 2KN, the rigidity increases nonlinearly. That is to say, it gradually presents variable rigidity. When the load exceeds 2KN, for each addition of the downward moving distance of the top of the convex platform121, such as for every addition of 1mm, the corresponding addition of load is relatively small. That is to say, the range of the variable rigidity of the vertical backstop is relatively small, and the speed of the rigidity increase is relatively slow. Such property can provide the vertical backstop 1 with good vibration reducing effect. The passengers can thereby have good comfort and the break of the steel spring can be effectively avoided.

[0033] When the vertical backstop 1 bears heavy load, such as more than 8KN, for each addition of the downward moving distance of the top of the convex platform121, such as for every addition of 1 mm, the corresponding addition of load is relatively big. That is to say, the range of the variable rigidity of the vertical backstop is relatively big, and the speed of the rigidity increase is relatively high. Such property can let the vertical backstop 1 share more load, and better reduce the vertical load born by the steel spring, and break of the steel spring can be effectively avoided.

[0034] In addition, since different type of locomotives have different load when being non-loaded, and the maximum loads of different types of locomotives are also different, and therefore, their requirements of the initial rigidity and variable rigidity of the vertical backstop are also different. Also different locomotives have different requirements of the rigidity change caused by the increase of the load. As a result, the variable rigidity and rigidity of the vertical backstop 1 need to be adjusted flexibly in order to meet the concrete requirements of different locomotives.

[0035] As shown in Fig. 1 and 3, the vertical backstop 1 is a symmetric revolve solid, and comprises the rubber main body 11, the rubber convex platform 12 and the pedestal 13, wherein the rubber convex platform 12 comprises the top of the convex platform 121 and the outside of the convex platform 122, and the rubber convex platform 12 has the form of a truncated cone. The angle between the top of rubber convex platform 121 and the outside of the convex platform 122 is A. The angle between the first annular straight section 111 and the horizontal plane is B. By decreasing the angles and A and B, the range of the variable rigidity and the vertical backstop 1 can be increased. On the contrary, by increasing the angles and A and B, the range of the variable rigidity and the vertical backstop 1 can be decreased.

[0036] As shown in Fig. 1 and Fig. 2, the diameter of the rubber convex platform 12 is D1 and the height of the rubber convex platform 12 H. The diameter of the rubber main body 11 is D2. By increasing D1 and D2, the rigidity of the vertical backstop 1 can be increased. By increasing the height of the rubber main body 11 and H, the rigidity of the vertical backstop 1 can be reduced. Conversely, by reducing D1 and D2, the rigidity of the vertical backstop 1 can be reduced. By decreasing the height of the rubber main body 11 and H, the rigidity of the vertical backstop 1 can be increased.

[0037] The vertical backstop 1 should meet the requirement mentioned above "the initial rigidity of the vertical backstop 1 needs to be small, and the initial variable rigidity also needs to be small". In the initial stage, the frame tank 3 pushes downwards and makes the rubber convex platform 12 deform first in order to provide the vertical backstop 1 with rigidity and variable rigidity. Hence, the rubber convex platform should rationally distribute the values of D1 and H, so that the initial rigidity of the vertical backstop 1 can be small. The angles A and B should be relatively big, so that the initial range of variable rigidity of the vertical backstop can be small. As shown in Fig. 1-3, the preferred value of D1 is 15mm to 50mm. The preferred value of D2 is 80mm to 95mm. The preferred value of H is 6mm to 30mm. The preferred value of angle A is 100° to 150°. The preferred value of angle B is 135° to 165°.

[0038] The rubber convex platform 13 and the rubber main body 11 of the vertical backstop 1 are in integral rubber piece. The rubber main body 11 is glued to the pedestal 13 and are vulcanized into an integral piece under a certain temperature and pressure. The main rubber body 11 is provided with more than 2 annular straight sections. And the neighboring annular straight sections are connected via the annular arc section 115. The rubber convex platform 12, the rubber main body 11 and the pedestal 13 are an integral piece.

[0039] As shown in Fig. 2, by increasing the height of the rubber main body 11, the rigidity of the vertical backstop 1 can be reduced. By increasing the diameter of the rubber main body 11, the rigidity of the vertical backstop 1 can be increased. Conversely, by reducing the height of the rubber main body 11, the rigidity of the vertical backstop 1 can be increased. By reducing the diameter of the rubber main body 11, the rigidity of the vertical backstop 1 can be reduced. There are three annular straight sections in this embodiment. The first annular straight section 111 has a vertical length H1. The second straight section 112 has a vertical length H2. The third annular straight section 113 has a length H3. H1 is preferred to be from 5mm to 10mm. H2 is preferred to be from 10mm to 40mm. H3 is preferred to be from 15mm to 60mm.

[0040] Each annular straight section and the horizontal plane has an angel in between, so that the rigidity of rubber main body 11 can have nonlinear change when the rubber main body is pushed down by the frame tank 3. That is to say, the variable rigidity of the rubber main body can be produced. Different sections can have different angles with the horizontal plane, so that the rubber main body 11 produces multiple variable rigidity. The angle between each annular straight section and the horizontal plane equals to or is bigger than 90°. By increasing the angle between the annular straight section and the horizontal plane, the range of the variable rigidity of the vertical backstop 1 can be reduced, so that the vibration reducing effect of the vertical backstop 1 can be increased and the comfort of the passenger can be increased. Conversely, by decreasing the angle between the annular straight section and the horizontal plane, the range of the variable rigidity of the vertical backstop 1 can be increased, so that when the top of the convex platform 121 moves downwards and the distance is small, the rigidity can be increased fast.

[0041] As shown in Fig. 1 and 2, in this embodiment, the angle between the first annular straight section 111 and the horizontal lane is B. The angle between the second annular straight section 112 and the horizontal lane is C. The angle between the third annular straight section 113 and the horizontal lane is 90°. It was mentioned above that the initial rigidity of the locomotive has to be small and the initial range of the variable rigidity has also to be small. By increasing the angle between the annular straight section and the horizontal plane, the range of the variable rigidity of the vertical backstop 1 can be reduced. In addition, since the deformation of the rubber main body 11 starts from the top of the convex platform, and therefore it is more close to the angle B of the top of the convex platform and is bigger than angle C, so that the vertical backstop 1 can have relatively small initial variable rigidity. Angle B is preferably to be between 135° and 65°. Angle C is preferably to be between 100° and 140°.

[0042] The number of the angles between the rubber main body 11 and the rubber convex platform 12 on the vertical backstop 1 equals to the number of the variable rigidity of the vertical backstop 1. By increasing the number of the segments of the annular straight section of the vertical backstop 1, the number of the variable rigidity of the vertical backstop 1 can be increased. In the present embodiment, the number of segments of the annular straight section of the rubber main body 11 is 3. The three segments of the annular straight section form 2 angles. The rubber convex platform 12 is connected with the rubber main body via the annular arc section 115 of segment 1, and there is also one angle formed here. In addition, the top of the convex platform 121 and the outside of the convex platform 122 form an angle A. Therefore, there are altogether 4 angles on the rubber main body 11 and the rubber convex platform 12 of the vertical backstop 1. As a result, the number of the variable rigidity of the vertical backstop 1 in this embodiment is 4.

[0043] When the angle between the annular straight sections does not change, the position of the annular arc section 115 of the rubber main body 11 is determined by the length of the annular straight section. The location of the annular arc section 115 is also the location of the angle of the rubber main body 11. Therefore, by adjusting the length of any segment of the annular straight section on the rubber main body 11, the position of the variable rigidity of the vertical backstop 1 can be adjusted.

[0044] As shown in Fig.1, 2 and 3, the pedestal 13 is a revolved body, and the pedestal 13 comprises a pedestal main body 131 and a convex rim 132, wherein the thickness of the upper part of the pedestal main body 131 is smaller than the thickness of the lower part of the pedestal main body 131. The middle part of the outside of the pedestal main body 131 is provided with the convex rim 132, wherein the convex rim 132 protrudes outwards. The pedestal 13 is embedded in the rubber main body 11 and is vulcanized with the rubber main body 11 and form an integral piece. In order to reduce the stress concentration at the connection part between the pedestal 13 and the rubber main body 11 and to prevent the generation of a gap between the pedestal 13 and the rubber main 11 after long term use, the corners of the pedestal 13 embedded in the rubber main body 11 are all smooth circular arc chamfering.

[0045] The metal pedestal 13 is located beneath the rubber main body 11. When the upper part of the rubber main body 11 receives pressure from the vertical load and deforms and moves downwards, the pedestal 13 can prevent the upper part of the rubber main body 11 from moving further down, and therefore exerts its limiting function. Hence, by adjusting the height of the pedestal 13, the position limited by the vertical backstop 1 can be adjusted. The height of the pedestal 13 is preferred to be

30mm to 70mm.

[0046] The pedestal 13 is embedded in the rubber main body 11. Especially, the pedestal main body 131 above the pedestal convex rim 132 inserts into the rubber main body 11 and the distance between the top of the pedestal main body 131 and the top of the pedestal convex rim 132 is H5. The higher the H5 value, the higher the rigidity of the vertical backstop 1. That is to say, by increasing the height of the pedestal 13, especially by increasing H5, the rigidity of the vertical backstop 1 can be increased. Conversely, by decreasing the height of the pedestal 13, especially by decreasing H5, the rigidity of the vertical backstop 1 can be decreased. The preferred value of H5 is between 10mm and 45mm.

[0047] Since the pedestal 13 is made of metal with high hardness and can exert limiting function. As a result, the rubber main body 11 beneath the top of the pedestal main body 131 has no influence on the rigidity and variable rigidity of the vertical backstop 1. Therefore, for convenience, hot rubber is added during the production of the vertical backstop 1. Also in order to save material, a cavity 114 is provided in the middle of the bottom of the rubber main body 11. Although the height H4 of the cavity 114 has hardly any influence on the rigidity and the variable rigidity of the vertical backstop, however, if H4 is too big, the strength of the connection of the rubber main body 11 and the pedestal 13 would be compromised. Therefore, H4 cannot equal H6. H4 is preferably between 10mm and 30mm.

[0048] Based on the above, the rigidity of the vertical backstop 1 is adjusted by adjusting the diameter and the height of the rubber main body 11 and the rubber convex platform 12 as well as the height of the pedestal 13. By adjusting the angle between the annular straight section of the rubber main body and the horizontal plane, as well as by adjusting the angel between the outside of the convex platform 122 and the top of the convex platform 121, the variable rigidity of the vertical backstop 1 can be adjusted. By adjusting the number of the segments of the annular arc section 115, the number of the variable rigidity of the vertical backstop 1 can be adjusted. By adjusting the height of the pedestal 13, the position limited by the vertical backstop 1 can be adjusted. By adjusting the rigidity, variable rigidity, the number of the variable rigidity, the position of the variable rigidity as well as the position limited by the vertical backstop 1, the vertical load born by the steel spring 2 can be reduced. Thereby the metal fatigue in the steel spring 2 during locomotive operation can be reduced and the break of the steel spring 2 can be effectively avoided.

Embodiment 2:

[0049] As shown in Fig. 6, embodiment 2 differs from embodiment 1 in that: revolve solid shaped rubber convex platform above the rubber main body 11 is no longer in the form of a truncated cone, but rather the generatrix 123 of the revolve solid shaped rubber convex platform 12 is an outward smooth curve. As shown in Fig. 7, the diameter D3 of the rubber convex platform 12 refers to the diameter of the bottom of the rubber convex platform 12, which is different from the D1 of the rubber convex platform 12 of embodiment 1, which refers to the diameter of the top of the rubber convex platform 12. The diameter D3 of the rubber convex platform 12 of this embodiment is preferred to be between 20mm and 60mm.

[0050] The generatrix 123 of the revolve solid shaped rubber convex platform 12 is an outward smooth curve. When the load of the locomotive increases, during the process of the frame tank 3 pushing downward, the rigidity curve of the vertical backstop 1 can be more smooth, so that an abrupt increase of the rigidity of the vertical backstop 1 can be effectively avoided and the vibration can be better reduced. In the meantime, the rubber convex platform 12 of the current embodiment does not have such acute corners at the connection part of the top of the convex platform 121 and the outside of the convex platform 122 as in the embodiment 1. As a result, stress concentration can hardly occur in the present embodiment when the rubber convex platform 12 is compressed by the frame tank 3 and deforms. Thereby the life of the rubber convex platform 12 is prolonged.

[0051] As shown in Fig. 6 and 7, apart from the different shape of the rubber convex platform 12 of the vertical backstop 1 of the present embodiment and embodiment 1, the rest of the structures and parameters are all the same. Therefore the corresponding angles, values of the heights of the present embodiment are the same as those in embodiment 1.

[0052] The rigidity curve of the present embodiment can be referred to in Fig. 4. This is due to the fact that the influence of the rubber convex platform 12 on the rigidity and the variable rigidity of the vertical backstop 1 is mainly at the time of the initial small load. When the load is high, the rigidity and the variable rigidity of the rubber main body are mainly provided by rubber main body 11. Therefore the rigidity curve of the present embodiment is only different from the rigidity curve of the embodiment 1 when the initial load is small, whereas they are the same when the load is big.

Industrial Applicability:

[0053] The current invention has the following industrial applicability:

1. By adding the rubber convex platform on the rubber main body, the height of the vertical backstop is thereby increased. The vertical backstop can therefore touch the frame tank when the locomotive is non-loaded, thereby the backstop can partially bear the vertical load from empty load to the maximum load of the vehicle. The metal fatigue of the metal spring during vehicle operation can maximally be reduced and the break of the steel spring is avoided.

2. The vertical backstop is in the steel spring, and the rubber convex platform of the vertical backstop touches the frame tank when the locomotive is non-loaded. The relative sliding between the vertical backstop and the frame tank is reduced. Hence, the abrasion caused by the relative sliding between the rubber convex platform and the frame tank can be reduced, and the operating life of the vertical backstop can be prolonged.
3. The vertical backstop is composed of the rubber main body, rubber convex platform and the pedestal. The rubber main body and the rubber convex platform are an integral rubber piece. The rubber main body is glued to the pedestal and are vulcanized into an integral piece under a certain temperature and pressure, thereby the entire vertical backstop has a tight and robust structure.
4. By adjusting the angle between the rubber main body and the rubber convex platform, the variable rigidity of the vertical backstop can be adjusted. By adjusting the diameter and the height of the rubber main body, the rigidity of the vertical backstop can be adjusted, so that the vertical backstop has relatively small variable rigidity and small rigidity under small load, and therefore the comfort of the passengers can be increased. In the meantime, the vertical backstop has relatively variable rigidity and big rigidity under heavy load, so that the vertical backstop bears more vertical load and the metal fatigue of the steel spring can be reduced, thereby the break of the steel spring can be effectively avoided.
5. The rubber main body is embedded with the pedestal made of metal. By adjusting the height of the pedestal, the limiting position of the vertical backstop can be adjusted. As a result, even the break of the steel spring occurs, the vertical backstop can serve as a safe support to ensure the safe operation of the railway locomotive.
6. For vertical backstop: by adjusting the diameter and the height of the rubber main body and the rubber convex platform as well as the height of the pedestal, the rigidity of the vertical backstop can be adjusted. The variable rigidity of the vertical backstop can be adjusted by adjusting the angle between the annular straight section and the horizontal plane. By adjusting the number of segments of the annular arc section of the vertical backstop, the number of the variable rigidity of the vertical backstop can be adjusted. By adjusting the height of the pedestal, the positions limited by the vertical backstop can be adjusted. By adjusting the variable rigidity, rigidity as well as the positions limited, the vertical backstop can be applied to different types of locomotives as well as locomotives with different loading capacities. As a result, such vertical backstop can be more widely applied.

Claims

1. A constant contact method for preventing steel spring break, **characterized in that**

-- a revolve solid shaped rubber convex platform (12) is provided above the rubber main body (11), when the locomotive is non-loaded, the rubber convex platform (12) touches the frame tank (3);
-- by adjusting the diameter or the height of the rubber convex platform (12), the rigidity of the vertical backstop (1) can be adjusted, and by adjusting the diameter or the height of the rubber main body (11), the rigidity of the vertical backstop (1) can also be adjusted;
-- the rubber main body (11) is provided with an annular straight section and an annular arc section (115), the variable rigidity of the vertical backstop (1) can be adjusted by adjusting the angle between the annular straight section and the annular arc section;
-- the rubber convex platform (12) is connected with the rubber main body (11) via the annular arc section (115), by adjusting the number of segments of the annular arc section (115) of the vertical backstop (1), the number of the variable rigidity of the vertical backstop (1) can be adjusted;
-- the pedestal (13) is embedded in the rubber main body (11) of the vertical backstop (1), so that the pedestal (13) can limit the vertical backstop (1), and by adjusting the height of the pedestal (13), the rigidity as well as the positions limited by the vertical backstop (1) can be adjusted;
-- by adjusting the rigidity, variable rigidity as well as the position limited of the vertical backstop (1), the vertical load born by the steel spring (2) is reduced, the metal fatigue produced by the steel spring (2) during the locomotive running is reduced, so that the break of the steel spring (2) is avoided.

2. The constant contact method for preventing steel spring break according to claim 1, **characterized in that**,

-- the revolve solid shaped rubber convex platform (12) that is provided above the rubber main body (11) is: the revolve solid shaped rubber convex platform (12) is of the form of a truncated cone, wherein the rubber convex platform (12) contains the top of the convex platform(121) and the outside of the convex platform(122);
-- the rigidity of the vertical backstop (1) can be increased by increasing the diameter of the rubber convex platform (12), the rigidity of the ver-

tical backstop (1) can be reduced by increasing the height of the rubber convex platform (12);
-- the diameter of the top of the convex platform(121) is 15mm to 50mm, and the height of the rubber convex platform (12) is 6mm to 30mm;
-- the angle between the top of the convex platform(121) and the outside of the convex platform(122) is more than 90°, by reducing the angle between the top of the convex platform(121) and the outside of the convex platform(122), the range of the variable rigidity of the vertical backstop (1) can be increased, wherein the angle between the top of the convex platform(121) and the outside of the convex platform(122) is between 100° and 150°.

3. The constant contact method for preventing steel spring break according to claim 1, **characterized in that**,

-- the revolve solid shaped rubber convex platform (12) that is provided above the rubber main body (11) is: the generatrix (123) of the revolve solid shaped rubber convex platform (12) is an outward smooth curve;
-- by increasing the diameter of the rubber convex platform (12), the rigidity of the vertical backstop (1) can be increased, whereas the rigidity of the vertical backstop (1) can be decreased by increasing the height of the rubber convex platform (12);
-- the diameter of the rubber convex platform (12) is 20mm to 60mm, and the height of the rubber convex platform (12) is 6mm to 30mm.

4. The constant contact method for preventing steel spring break according to claim 1, **characterized in that** the rubber main body (11) is provided with an annular straight section and an annular arc section (115), wherein the angle between the annular straight section and the horizontal plane equals to or is bigger than 90°, and by reducing the angle between the annular straight section and the horizontal plane, the range of the variable rigidity of the vertical backstop (1) can be increased, and by increasing the number of segments of the annular arc section (115) of the vertical backstop (1), the number of the variable rigidity of the vertical backstop (1) can be increased.

5. The constant contact method for preventing steel spring break according to claim 1, **characterized in that** by increasing the diameter of the rubber main body (11), the rigidity of the vertical backstop (1) can be increased, and by increasing the height of the rubber main body (11), the rigidity of the vertical backstop (1) can be reduced, and the diameter of the rubber main body (11) is 80mm to 95mm.

6. The constant contact method for preventing steel spring break according to claim 1, **characterized in that**

-- the metal pedestal is embedded underneath the rubber main body (11), and when the rubber main body (11) and the rubber convex platform (12) are deformed due to vertical load and move downwards, the pedestal (13) can limit the downward movement of the rubber main body (11) and the rubber convex platform (12) to carry out its vertical limit function; and
-- by adjusting the height of the pedestal (13), the limiting position of the vertical backstop (1) can be adjusted, and by increasing the height of the pedestal (13), the rigidity of the vertical backstop (1) can be increased, and the height of the pedestal is 30mm to 70mm.

7. A Vertical backstop for preventing steel spring break, wherein the vertical backstop (1) is located in the steel spring (2), **characterized in that** the vertical backstop (1) comprises a rubber main body (11), a rubber convex platform (12) and a pedestal (13), wherein a revolve solid shaped rubber convex platform (12) is provided above the rubber main body (11), the rubber main body (11) is provided with an annular straight section and an annular arc section (115), the rubber convex platform (12) is connected with the rubber main body (11) via the annular arc section (115), a pedestal (13) is provided underneath the rubber main body (11), and the bottom of the rubber main body (11) is provided with a cavity (114), wherein the rubber main body (11), the rubber convex platform (12) and the pedestal (13) are an entirety.

8. The vertical backstop for preventing steel spring break according to claim 7, **characterized in that** the revolve solid shaped rubber convex platform (12) that is provided above the rubber main body (11) is: the revolve solid shaped rubber convex platform (12) is of the form of a truncated cone, wherein the rubber convex platform (12) contains the top of the convex platform(121) and the outside of the convex platform(122), wherein the diameter of the top of the convex platform(121) is 15mm to 50mm, and the height of the rubber convex platform (12) is 6mm to 30mm, and the angle between the top of the convex platform(121) and the outside of the convex platform(122) is more than 90°.

9. The vertical backstop for preventing steel spring break according to claim 7, **characterized in that** the revolve solid shaped rubber convex platform (12) that is provided above the rubber main body (11) is:

the generatrix (123) of the revolve solid shaped rubber convex platform (12) is an outward smooth curve, wherein the diameter of the rubber convex platform (12) is 20mm to 60mm, and the height of the rubber convex platform (12) is 6mm to 30mm.

10. The vertical backstop for preventing steel spring break according to claim 7, **characterized in that** the pedestal (13) is a revolved body, and the pedestal (13) comprises a pedestal main body (131) and a convex rim (132), wherein the thickness of the upper part of the pedestal main body (131) is smaller than the thickness of the lower part of the pedestal main body (131), the middle part of the outside of the pedestal main body (131) is provided with the convex rim (132), wherein the convex rim (132) protrudes outwards, and wherein the height of the pedestal (13) is 30mm to 70mm and the corners of the pedestal (13) embedded in the rubber main body (11) are all smooth circular arc chamfering.

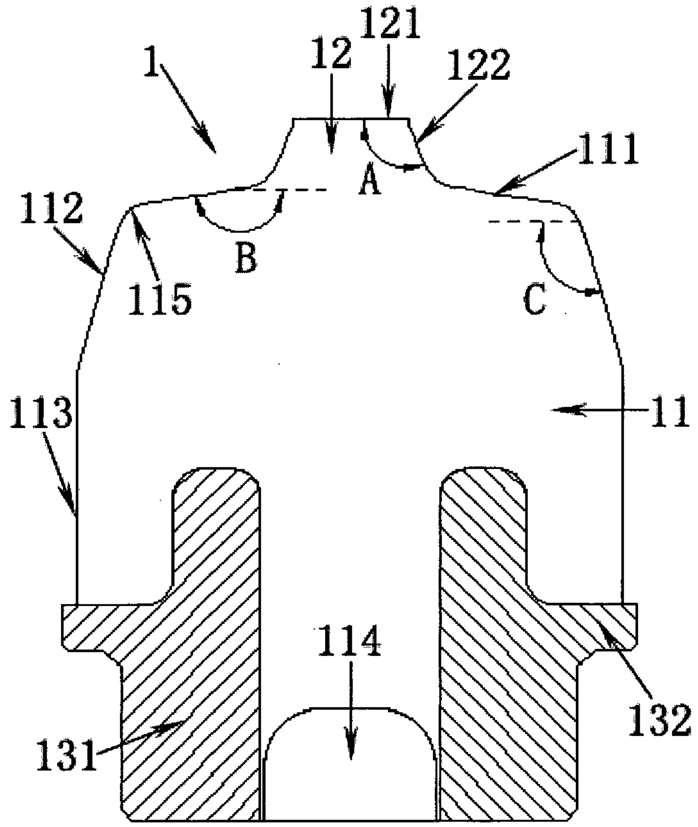

Fig. 1

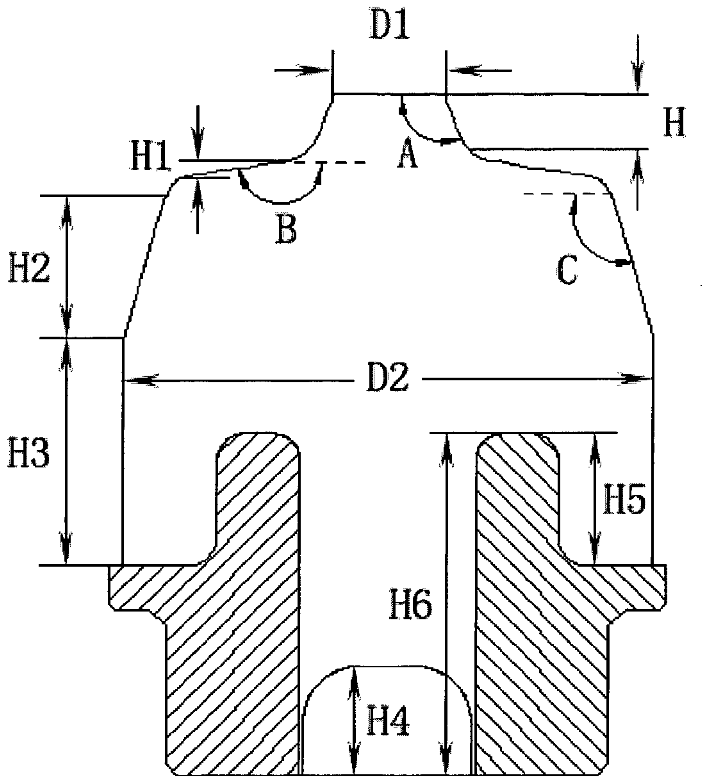
D1
H
H1
A
B
C
H2
D2
H3
H5
H6
H4

Fig. 2

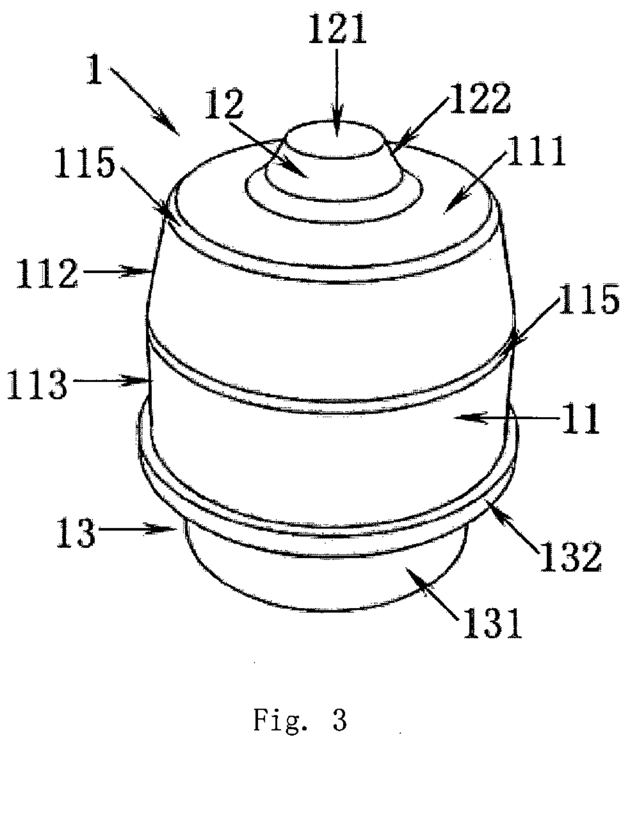
121
1
12
122
115
111
112
115
113
11
13
132
131

Fig. 3

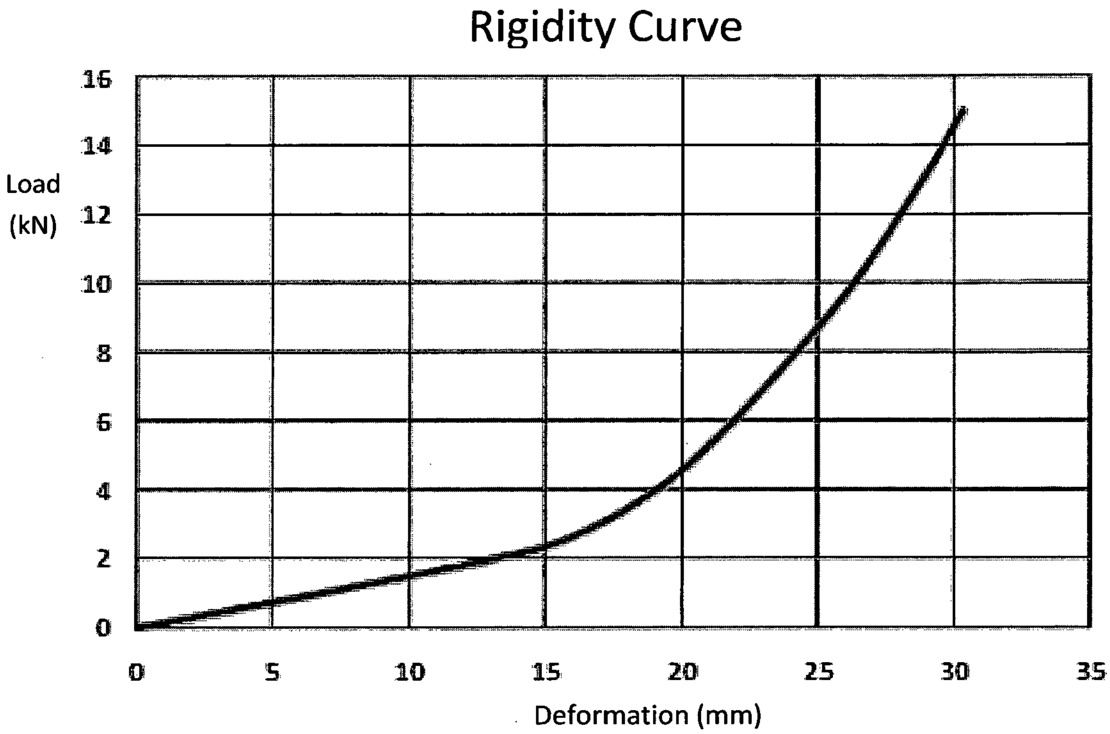
Rigidity Curve
Load
(kN)
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
35
Deformation (mm)

Fig. 4

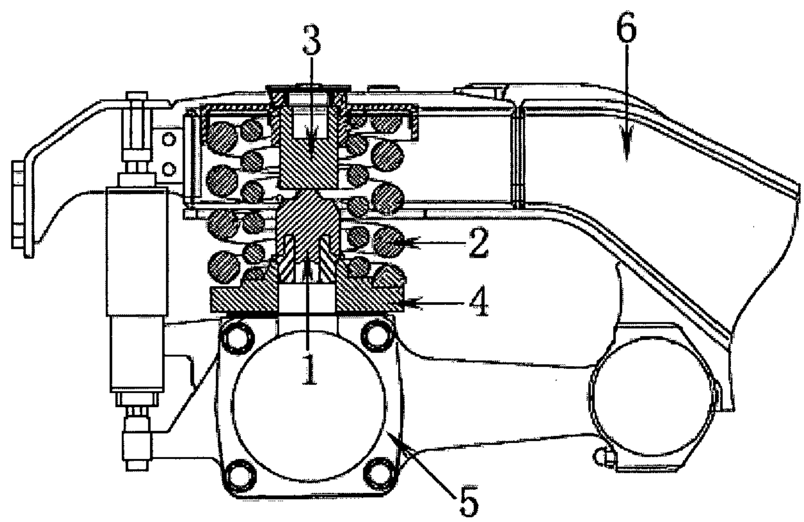
3
6
2
4
1
5

Fig. 5

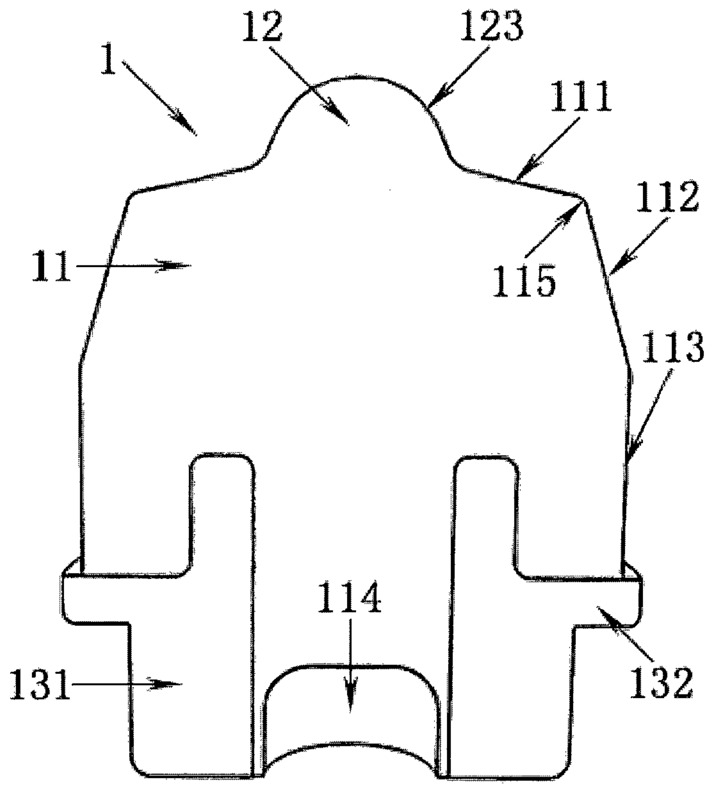

Fig. 6

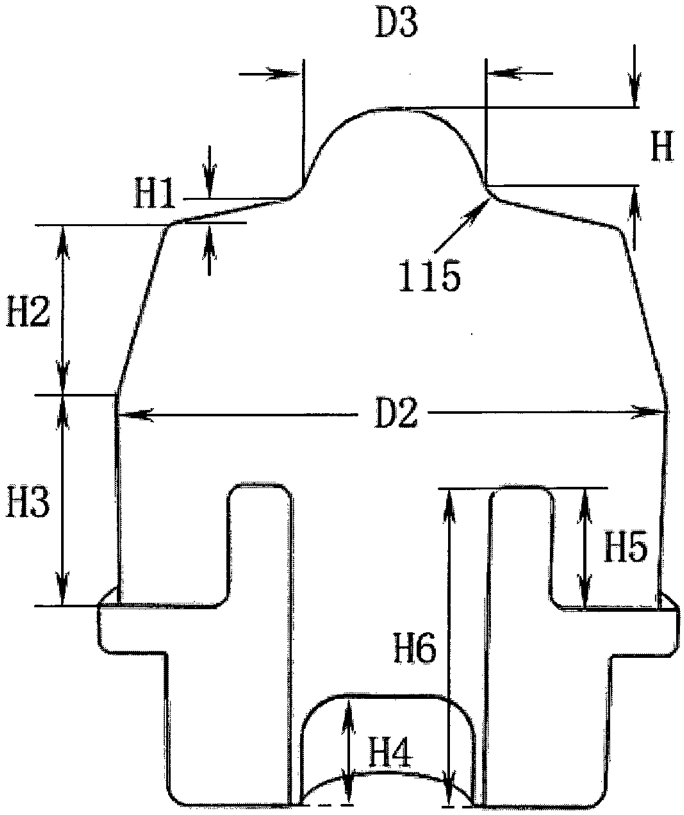

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 16 17 4694

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Place of search	Date of completion of the search	Examiner
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