

Description

Title of Invention: Rail Damper Mounting Apparatus and Rail Damper Systems Containing the Same

Technical Field

[0001] This invention relates to railway installations, and in particular to rail damper structures for reduction of rail vibration and noise generated from the railway.

Background Art

[0002] Over the past two decades, railway dampers have been widely used to reduce railway noises in newly developed railway lines and as an improved noise reduction measure in operating railways. Rail dampers are generally designed to cover a large surface area on rail foot and rail web at both sides of the rail by a thin layer of resilient interface material. However, track engineers would like to have clear views on the rail surface during routine maintenance inspections. A rail damper with a small contact area on the rail is needed so that more rail surface is visible during routine maintenance inspections.

[0003] For safety concern on rail integrity, bolts through rails are normally not allowed for mounting of rail dampers. Adhesives on the other hand normally cannot provide a rigid connection for retrofitting dampers onto operating rails due to adhesive resilient property, uncontrolled rust surface and unknown profile tolerance.

[0004] In the railway industry, spring clips with hooks (sometimes also with adhesive applied at the interface between the damper and the rail) is a common method for installation of rail dampers. However, mounting clips with a hook in conventional designs cannot utilize its maximum clipping force because the installation process always exerts additional stress on the clip during the locking process of the hook.

[0005] When the Tuned Mass Damper (TMD) type of rail dampers vibrates with the rail, its reaction damping force is amplified to several times its weight. A higher TMD amplification factor provides a higher damping force at a frequency-narrower bandwidth, but it also requires a higher mounting force. Rail damper mounting clips in conventional designs (even with the adhesive applied) cannot provide sufficient mounting force to overcome the amplified TMD reaction force. In general, mounting force is required to be more than 1 ton per damper in the case of a strong rail vibration (~50g rail vibration acceleration after damper installation; for example, a 300g rail vibration being reduced to around 50g by the damper installation). Clips currently used in the industry only provide a mounting force up to a few hundred kilograms per damper. Existing rail dampers would be temporarily disengaged from the rail by a few micrometers (or fractions of micrometers) in case of a strong rail vibration due to insufficient mounting

force to overcome the acceleration force at peaks of oscillation cycles.

Summary of Invention

Technical Problem

- [0006] An improved design of the damper mounting clip is, therefore, required to avoid applying additional stress to the mounting clip during damper installation. In addition, a mounting clip with a higher mounting force is desired.

Solution to Problem

Technical Solution

- [0007] Accordingly, the present invention, in one aspect, is a rail damper mounting apparatus that contains a clipping device adapted to clip onto a rail, and a mounting device adapted to allow an oscillator to secure thereto. The rail damper mounting apparatus forms at least three clipping points with a rail when the rail damper mounting device is installed to the rail.
- [0008] In some embodiments, the mounting apparatus forms two clipping points located above a plane defined by foot tips on of the rail on two sides of the rail, and one clipping point below the plane, when the rail damper mounting apparatus is installed to the rail.
- [0009] In some embodiments, the clipping device contains a rail web contact member and a rail foot contact member. The rail web contact member forms respectively a first clipping point and a second clipping point above the plane at a foot and a web of the rail respectively, when the rail damper mounting apparatus is installed to the rail. The rail foot contact member forms a third clipping point below the plane at the foot of the rail.
- [0010] In some embodiments, the rail web contact member has a side edge in a curved shape that faces the web of the rail when the rail damper mounting apparatus is installed to the rail.
- [0011] In some embodiments, the rail web contact member is formed as a single piece with the rail foot contact member. The side edge forms the first and second clipping points when the rail damper mounting apparatus is installed to the rail.
- [0012] In some embodiments, the rail web contact member is formed as a single piece with the mounting device, where the side edge at least partially follows the contour of an oscillator installed to the mounting device.
- [0013] In some embodiments, the first and second clipping points are located on the side edge at substantially the same radial distance from a rotating center defined by an intersection of two lines respectively normal to tangential lines at the first and second clipping points.
- [0014] In some embodiments, the mounting apparatus forms one clipping point located

above a plane defined by foot tips of the rail on two sides of the rail, and two clipping points below the plane, when the rail damper mounting apparatus is installed to the rail.

- [0015] In some embodiments, the clipping device includes a rail foot contact member and a hook member. The rail foot contact member forms respectively a first clipping point and a second clipping point with the foot of the rail, when the rail damper mounting apparatus is installed to the rail. The hook member forms a third clipping point with the foot of the rail.
- [0016] In some embodiments, the rail foot contact member and the hook member are located on the two sides of the rail, and are connected through an extension arm that runs parallel to a bottom face of the foot of the rail when the rail damper mounting apparatus is installed to the rail.
- [0017] In some embodiments, the hook member forms an inward tip which is adapted to contact the foot of the rail to form the third clipping point.
- [0018] In some embodiments, the hook member includes a hook portion having an opening substantially toward a direction away from the foot of the rail when the rail damper mounting apparatus is installed to the rail.
- [0019] In some embodiments, the hook member contains a hook portion having an opening substantially toward an opposite direction to that of the recess of the hook member.
- [0020] In some embodiments, the extension arm is at least partially resilient so that the clipping device can be clipped onto the rail by moving the hook member in a direction substantially perpendicular to a longitudinal direction of the extension arm using an external tool.
- [0021] In some embodiments, the rail foot contact member contains a slot for receiving the foot of the rail from a side direction. The second clipping point is formed between a bottom face of the foot of the rail and the slot when the rail damper mounting apparatus is installed to the rail.
- [0022] In some embodiments, the second and third clipping points are located at the bottom face of the foot of the rail when the rail damper mounting apparatus is installed to the rail.
- [0023] In some embodiments, the mounting device has a plate shape. The mounting device is adapted to allow two oscillators to secure thereto at two sides of the plate shape.
- [0024] In some embodiments, the rail damper mounting apparatus is adapted to be connected to a similar rail damper mounting apparatus on an opposite side of the rail by an extension arm.
- [0025] According to another aspect of the invention, there is disclosed a rail damper system containing a plurality of rail damper mounting apparatus as mentioned above, which are installed to a railway, and oscillators installed to each rail damper mounting

apparatus. The plurality of rail damper mounting apparatus is positioned along a longitudinal direction of a rail, and/or positioned symmetrically on two rails of the railway.

Advantageous Effects of Invention

Advantageous Effects

- [0026] There are many advantages to the present invention. Firstly, with at least three clipping points/areas with the rail formed by each rail damper mounting apparatus, it provides a strong clipping force compressing the wedge-liked rail foot by a very stiff clip, where the bending stiffness of the clip at the top surface clipping point/area is roughly in the order of a fraction of a ton per millimeter to a few tons per millimeter. A strong clip compression force is applied to the foot of the rail to ensure a rigid connection for vibration energy transmission from the rail to the oscillator (e.g. a TMD oscillator) for dissipation.
- [0027] In addition, the rail damper mounting apparatus has a modular design, which means that each such apparatus is independently installed onto a rail, or two rails of a railway, such that the number of mounting apparatuses can be adjusted flexibly to suit the site conditions. The repetitive modular design simplifies rail damper assembling process and enhances large scale production for cheaper manufacturing. In this way, any desired length between the sleeper spacing of the rail may be equipped with the rail damper mounting apparatuses according to the invention, and these rail damper mounting apparatuses together form a rail damper system. In one example of the rail damper system, pairs of rail damper mounting apparatuses can be installed symmetrically on one of the two rails of a railway, along the length of the railway. In another example of the rail damper system, pairs of rail damper mounting apparatuses can be installed symmetrically on each rail of a railway so that along a lateral direction of the railway there are in total four damper mounting apparatuses installed.
- [0028] The design of the rail damper mounting apparatus with a small area at the contact interface provides fewer obstructions to the inspecting staffs for routine visual inspections maintenance comparing with conventional rail damper products in the market.
- [0029] According to some embodiments of the invention, the number of dampers installed on each rail can be chosen from only one to a few (for example, it can be 1, 2 or 3 oscillators), and for example oscillators can be connected to two sides of a circular mounting device in the form of a plate. Such a mounting device is a metal plate without a joint, which is integrated with a stiff clipping device (and sometimes also including an integrated hook member). The clipping device contains a rail foot contact member (and sometimes also including a rail web contact member) that provides a

strong vertical mounting force when it is dragged by a horizontal force by the hook member pulling (or pushing) the rail foot contact member into a wedge-shaped rail foot tip. The clipping device is maintained at the clipping location by a horizontal pulling force by a locking hook hooked to the other side rail foot tip.

[0030] The foregoing summary is neither intended to define the invention of the application, which is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

Brief Description of Drawings

Description of Drawings

[0031] The foregoing and further features of the present invention will be apparent from the following description of embodiments which are provided by way of example only in connection with the accompanying figures, of which:

[0032] Fig. 1a is a front view of a rail damper mounting apparatus according to a first embodiment of the invention when it is installed to a rail, in which a mounting device for dampers is not shown.

[0033] Fig. 1b is a perspective view of the rail damper mounting apparatus installed in the rail in Fig. 1a.

[0034] Fig. 2a is a front view of a rail damper mounting apparatus according to a second embodiment of the invention without showing the rail.

[0035] Fig. 2b is a perspective view of the rail damper mounting apparatus in Fig. 2a, without any dampers installed.

[0036] Fig. 2c and 2d show respectively two circular oscillators installed to the rail damper mounting apparatus, and three circular oscillators installed to two rail damper mounting apparatuses of Fig. 2a in perspective views.

[0037] Figs. 3a-3c show different steps of a method of clipping a rail damper mounting apparatus of Figs. 2a-2c onto a rail using an external tool, in front views.

[0038] Figs. 4a-4c correspond respectively to Figs. 3a-3c, and show the steps of the method in bottom views.

[0039] Figs. 5a-5c correspond respectively to Figs. 3a-3c, and show the steps of the method in perspective views.

[0040] Figs. 6a-6d show different views of a rail damper mounting apparatus according to a third embodiment of the invention when it is installed to a rail, with three oscillators installed to a mounting device in the rail damper mounting apparatus.

[0041] Figs. 7a-7b show different views of a rail damper mounting apparatus according to a fourth embodiment of the invention when it is installed to a rail, with two oscillators installed to a mounting device in the rail damper mounting apparatus.

[0042] Fig. 8a shows two rail damper mounting apparatuses according to a fifth embodiment

of the invention when they are installed to two sides of a rail, in a front view.

[0043] Fig. 8b shows the configuration in Fig. 9a in a perspective view.

[0044] Fig. 9a and Fig. 9b respectively show the front view and perspective view of a rail damper mounting apparatus in Fig. 8a.

[0045] Figs. 10a-10c show different steps of a method of clipping two rail damper mounting apparatuses of Fig. 8a to a rail.

[0046] In the drawings, like numerals indicate like parts throughout the several embodiments described herein.

Mode for the Invention

Mode for Invention

[0047] In the claims which follow and in the preceding description, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

[0048] As used herein and in the claims, “couple” or “connect” refers to electrical coupling or connection either directly or indirectly via one or more electrical means unless otherwise stated.

[0049] Terms such as “horizontal”, “vertical”, “upwards”, “downwards”, “above”, “below” and similar terms as used herein are for the purpose of describing the invention in its normal in-use orientation and are not intended to limit the invention to any particular orientation.

[0050] Figs. 1a-1b show a rail damper mounting apparatus according to a first embodiment of the invention when it is attached to a rail **20**. The rail **20** has a typical flat-bottom profile that is standard to most modern railway systems in the world. The rail **20** has a foot **20c**, a web **20b**, and a head **20a**. In the embodiment of Figs 1a-1b, it is the foot **20c** of the rail **20** onto which the rail damper mounting apparatus is clipped. The rail damper mounting apparatus is installed to the outer side of the rail **20b**, i.e. the side adjacent to an end of the sleeper (not shown). The rail damper mounting apparatus includes a clipping device **22** and a hook member **24**, which is connected by an extension arm **28**. The clipping device **22** forms a substantially “U” shape, which defines a slot **30** for receiving one end of the foot **20c** of the rail **20** from a side direction. The clipping device **22** is therefore also referred to as a rail foot contact member in this embodiment. The side direction of the rail **20** is defined as the direction that is parallel to the flat bottom face of the foot **20c**, and that is substantially perpendicular to the web **20b**. The slot **30** has a substantially uniform width between its two side walls **21a**, **21b** which are almost parallel to each other, despite that the foot

20c of the rail **20** does not exhibit such a contour. Rather, the foot **20c** of the rail **20** has the flat bottom face that form-fits with the side wall **21b** of the slot **30**, but an upper face of the foot **20c** (there are two such upper faces on two sides of the web **20b**) has a curved shape that rises as it extends toward the web **20b** of the rail **20**. In this way, the clipping device **22** forms two clipping points with the foot **20c** of the rail **20** when the rail damper mounting apparatus is clipped onto the rail **20**, namely a first clipping point **26a** and a second clipping point **26b**. The first clipping point **26a** is located above a plane **40** defined by two foot tips of the foot **20c** of the rail **20**, and such a plane **40** is parallel to the bottom face of the foot **20c**. The first clipping point **26a** is located at the contact point between a free end tip of the side wall **21a** of the slot **30** and one of the upper faces of the foot **20c** when the rail damper mounting apparatus is installed. On the other hand, the second clipping point **26b** is located under the plane **40** and is located at the contact point between a bottom end tip of the foot **20c** and the side wall **21b** of the slot **30**.

[0051] To achieve a robust clipping effect for the rail damper mounting apparatus, a third clipping point is required beside the first clipping point **26a** and the second clipping point **26b**. The third clipping point **26c** is located far away from the clipping device **22**, as it is formed at the contact point between an inward end tip of a hook member **24** and a side of the foot **20c** of the rail **20**. The hook member **24** is designed to hook on the end of the foot **20c** opposite to the one to which the clipping device **22** is clipped onto. In particular, the hook member **24** is to be hooked to a tip of the foot **20c** at the other side of the rail **20** in order to provide a tension force for preventing the clipping device **22** from slipping off the foot **20c**. The hook member **24** is curved inwardly (i.e. toward the foot **20c** of the rail **20**) to form the inward tip, but the hook member **24** further extends outwardly from the inward tip in the direction substantially away from the foot **20c** of the rail **20** to form a hook portion **24b**. The hook portion **24b** is substantially along a vertical direction (i.e. perpendicular to the bottom face of the foot **20c**) and is intended to complete the clipping process of the rail damper mounting apparatus to the rail **20** by the user using an external tool as will be described later. As one can see from Fig. 1a the hook member **24** in a front view exhibits substantially the shape of an inverted “2”.

[0052] The hook member **24** is connected to the clipping device **22** via the extension arm **28** where the three are formed as a single piece. The extension arm **28** has a thinner cross-section than that of any portion of the clipping device **22**, in order to allow flexible movement of the extension arm **28** along the vertical direction while applying only minimal additional stress to the clipping device **22** (e.g. less than 1% of the yield stress of the clipping device **22**). Besides, the flexibility in vertical movement of the hook member **24** is an important feature in the installation process such that the frictional

force at the clipping locations at the wedge-shaped foot **20c** of the rail **20** would be strong enough to prevent the clipping device **22** from slipping back during the clipping process. That is, during the pulling (or pushing) of the clipping device **22** into the wedge-shaped foot **20c**, the clipping device **22** does not immediately slide back when the pulling force stops. However, if the flexibility of the vertical movement is not enough, the clipping device **22** would immediately slide back once the pulling (or pushing) force stops during the installation process. As shown in Fig. 1a, even for the extension arm **28** per se, its cross-sectional size varies from a larger size to a smaller size along the direction toward the hook member **24**. However, the top face of the extension arm **28** is made flat which completely fit to the bottom face of the rail **20** when the rail damper mounting apparatus is installed.

[0053] It should be noted that an oscillator or its mounting device is not shown in Figs. 1a-1b. However, various types of damper mounting devices can be configured with the rail damper mounting apparatus, e.g. by using a fastener or by forming the mounting device integrally with the clipping device **22** as will be illustrated in other embodiments that will be described below.

[0054] Turning to Figs. 2a-2b, which shows a rail damper mounting apparatus according to another embodiment, and in this rail damper mounting apparatus the clipping device **122**, the extension arm **128** and the hook member **124** are identical to those in Figs. 1a-1b, which will not be described in details again. What is different in the rail damper mounting apparatus as shown in Figs. 2a-2b as compared to that in Figs. 1a-1b is that a mounting device **132** for oscillator(s) is integrally formed with the upper part of the clipping device **122** in Figs. 2a-2b. The mounting device **132** has most of its perimeter in curved shape, and remaining parts of its perimeter transit to the clipping device **122**. A screw hole **134** is formed at the center of a hypothetical circle (not shown) defined by the curved edge of the mounting device **132**, so that oscillator(s) (not shown) may be mounted on the mounting device **132** using a screw (not shown in Figs. 2a-2b). The mounting device **132** is a metal plate combined with the clipping device **122** without a joint, and has the same thickness all along itself. As shown in Figs. 2a-2b, all of the mounting device **132**, the clipping device **122**, the extension arm **128** and the hook member **124** are formed as a single piece.

[0055] Fig. 2c shows the configuration of two oscillators **136** installed to the rail damper mounting apparatus in Figs. 2a-2b. Each oscillator **136** is a shearing TMD oscillator that is the most efficient vibration absorber for reduction of rail vibration in general, and it comes in a round shape. In Fig. 2c, the two oscillators **136** are installed to the mounting device **132** on two sides of the plate shape of the mounting device **132** in order to provide balanced inertia and TMD reaction force, and they are fastened together using a screw **142**. Between the mounting device **132** and each of the os-

cillators **136**, there is sandwiched a resilient damping material **138** for better energy dissipation by the oscillators **136**.

[0056] Fig. 2d shows the configuration of three oscillators **136** installed to two identical rail damper mounting apparatuses as shown Figs. 2a-2b. In particular, a middle oscillator **136** is sandwiched between two mounting devices **132** of the two rail damper mounting apparatuses. On another side (i.e. the open side) of each of the mounting devices **132**, there is configured an oscillator **136**, so the two mounting devices **132** are effectively sandwiched by the three oscillators **136** in an alternating manner. Again, in Fig. 3b a resilient damping material **138** is sandwiched between any mounting device **132** and its adjacent oscillators **136**.

[0057] Turning to Figs. 3a-5c, in which the steps of the user clipping the rail damper mounting apparatus in Fig. 2c onto a rail are illustrated. Note that the status of the rail damper mounting apparatus in Figs. 3a, 4a and 5a is the same, and so are Figs. 3b, 4b and 5b, and Figs. 3c, 4c and 5c. Also, in Figs. 4a-4c the rail damper mounting apparatus is shown to have been connected with two oscillators **136**, but the installation method described herein is not relevant to the number of oscillators installed to a rail damper mounting apparatus, since it is the clipping device **122** and the hook member **124** that are used to clip onto the rail **120**.

[0058] To install the rail damper mounting apparatus, the user first need to inserts the slot **130** of the clipping device **122** into one end of the foot **120c** of the rail **120**. When the clipping device **122** is installed fully by pressing it to the maximum extent toward the foot **120c**, a first clipping point **126a** and a second clipping point **126b** will be formed, which are located at the same positions as mentioned for those in Figs. 1a-1b. At this time, however, a third clipping point has not been formed yet, and because of the insertion of the slot **130** into the foot **120c**, the hook member **124** is pressed against a bottom face of the foot **120c** due to a resilience of the extension arm **128** connecting the hook member **124** to the clipping device **122**. To engage the hook member **124** properly with the foot **120c** of the rail **120**, the user uses an external tool generally in the form of a level bar **144**. The level bar has a handle portion **144a** connected to a head portion that contains an anchor pin **146** adapted to be fitted into a specifically designed anchor slot formed a hook portion **124b** of the hook member **124**. Next to the anchor pin **146**, on the head portion of the level bar **144** there is also a curved member **144b** that extends from a longitudinal direction of the level bar perpendicularly, and then forwardly as opposite to the handle portion **144a**. As best shown in Figs. 4a-5c, the head portion for the level bar **144** has a parallel-plate shape defining the curved member **144b**, and also a recess in which the hook portion **124b** can be received at least partially, and the anchor pin **146** is fixed between the parallel plates of the head portion so that it can be further received by the hook portion **124b** of the hook member

124. The lever bar **144** could for example have a lever ratio of 10 to 50 providing amplified pulling force ranging from 100 to 1000kg.

[0059] Figs. 3a, 4a and 5a show the status where the level bar **144** has not engaged with the hook member **124**. To hook the hook member **124** to the foot **120c**, the user insert the anchor pin **146** into the recess of the hook portion **124b** of the hook member **124**, and at the same time a concave part **144c** of the curved member **144b** is pressed against an side face of the foot **120c**, as shown in Figs. 3b, 4b and 5b. Finally, from the status in Figs. 3b, 4b and 5b, the user lifts up the handle portion **144a** making the level bar **144** pivots substantially around the tip **144d** of the curved member **144b** which will contact the upper surface of the foot **120c**. Then, the pivoting of the level bar **144** results in the anchor pin **146** and in turn the hook member **124** of the rail damper mounting apparatus to also move upward, ultimately wrapping partially the end of the foot **120c** and forming the third clipping point similar to that describes in Figs. 1a-1b (but not shown in Figs. 3a-5c). The clipping of the rail damper mounting apparatus onto the rail **120** is then completed as three clipping points are formed, and similar to the status shown in Figs. 2a-2d, the upper surface of the extension arm **128** now fits to the bottom face of the foot **120c**.

[0060] Figs. 6a-6d show another embodiment of the invention, where two rail damper mounting apparatuses carry three oscillators **236** on their respective mounting devices **232**. Each of the rail damper mount apparatus in Figs. 6a-6d is substantially the same as that shown in Fig. 2d, except that there is no integral extension arm or hook member formed with the clipping device **222**. Rather, the clipping device **222** in Figs. 6a-6d now only have a length not exceeding a diameter of the oscillators **236**. In addition, the two clipping devices **222** of the rail damper mounting apparatuses are connected to a common pushing plate **250** which has a through hole (not shown) that allows a screw **248** to be threaded in. To complete the three-points clipping of the rail damper mounting apparatuses, a separate screw hook **228** is fixed to the clipping devices **222** via the pushing plate **250**. During installation of the rail damper mounting apparatuses in Figs. 6a-6d, the initial steps of clipping the clipping devices **222** onto the foot **220c** of the rail **220** are similar to that described with respect to Figs. **3a**, **4a** and **5a**. Once the clipping device **222** are clipped forming the first and second clipping points **226a**, **226b**, the user then engages the screw hook **228** with another end of the foot **220c** opposite to the clipping device **222**, thus forming the third clipping point **226c**, and then the user connect the clipping devices **222** and the screw hook **228** by fastening screw **248** into the pushing plate **250** and connecting the pushing plate **250** and the screw hook **228** together, by turning a nut **252**.

[0061] Figs. 7a-7b show another embodiment of the invention, where one rail damper mounting apparatus carries two oscillators **336** on its mounting device **332**. The

method of installing the rail damper mounting apparatus of Figs. 7a-7b is substantially the same as that in Figs. 6a-6d, but the fixing structure of the rail damper mounting apparatus is slightly different. In particular, there is no pushing plate as a separate component in Figs. 7a-7b. Rather, the lower portion **350** of the clipping device **322** of the rail damper mounting apparatus is broadened to form a circular through hole therein that allows a screw hook **328** to be inserted. A screw **348** is used to connect the screw hook **328** to the clipping device **322** of the rail damper mounting apparatus, and the screw **348** is locked by a nut **352**. The shape of the lower portion **350** is cubic. As the mounting device **332** is formed integrally with the clipping device **322**, one can see that the width of the mounting device **322** is also increased as compared to that in Figs. 1a-6d.

[0062] Turning to Figs. 8a-9b, in another embodiment of the invention a pair of the rail damper mounting apparatuses are symmetrically installed on two sides of a rail **420**. The two rail damper mounting apparatuses are connected by a screw arm **428** which is secured by a nut **452** at its tail end. The two rail damper mounting apparatuses are almost the same to each other, and both contain a through hole **456** at a lower portion of the clipping device **422**. Each damper mounting apparatus further contains a mounting device **432** to which two oscillators **436** are installed on two ends thereof. Thus, in Fig. 8b one can see that there are in total four oscillators **436**. What is different in the rail damper mounting apparatuses in Figs. 8a-9b as compared to those in previously described embodiment, is that there are a second clipping point **426c** and a first clipping point **426a** formed above a plane **440** defined by two foot tips of the foot **420c** of the rail **420**, and a third clipping point **426b** formed below the plane **440**. To achieve this, the mounting device **432** has part of its perimeter further extended radially outwardly from the rotating center at the intersection point defined by two normal lines respectively to tangential lines at the first clipping point **426a** and the second clipping point **426c**, thus forming a chamfered member **454**. The chamfered member **454** defines a side edge that has a curved shape, and when the rail damper mounting apparatus is installed as shown in Fig. 8a the side edge is pressed against the web **420b** of the rail **420** to form the second clipping point **426c** at a tip of the chamfered member **454**. Thus, the chamfered member **454** is also referred to as a rail web contact member in this embodiment. The side edge as best seen in Fig. 8a is internally tangent with a circle defined by the contour of the oscillator **436**.

[0063] Below the mounting device **432** there is integrally formed a clipping device **422** which defines a slot **430** for receiving one end of the foot **420c** of the rail **420** from a side direction. Unlike the case in Figs. 1a-7b, the two side walls **421a**, **421b** of the slot **430** are no longer parallel to each other. Rather, the upper side wall **421a** is part of the side edge of the chamfered member **454** and they form together a smooth curve, which

has a curvature larger than that of the top edge of the mounting device **432** (as best seen in Fig. 9a).

[0064] Turning to Figs. 10a-10c, in which the steps of the user clipping the rail damper mounting apparatus in Figs. 9a-9b are illustrated. Fig. 10a shows the status where the rail damper mounting apparatus has not contacted the rail **420**. To install the rail damper mounting apparatus in Figs. 9a-9b to the rail **420**, the user first needs to insert the slot **430** of the clipping device **422** into one end of the foot **420c** of the rail **420**, and at the same time makes the tip of the chamfered member **454** touching the web **420b** of the rail **420**. This is shown in Fig. 10b, where by the above steps the first clipping point **426a** and the second clipping point **426c** are formed. The first and second clipping points **426a**, **426c** are located on the side edge at a similar radial distance from a rotating center of the rail damper mounting apparatus that is located at the intersection point defined by two normal lines respectively to tangential lines at the first clipping point **426a** and the second clipping point **426c**. Then, the user further pushes the rail damper mounting apparatus to pivot around the tip of the chamfered member **454**, that is around the second clipping point **426c**, so that the rail damper mounting apparatus pivots along a clockwise direction from the status in Fig. 10b to that in Fig. 10c. When the clipping device **422** is installed fully by pressing it to the maximum extent toward the foot **420c**, the third clipping point **426b** will be formed, thus the three-point clipping structure has been formed. It is clear that in the installation method of Figs. 10a-10c, no external tool is required.

[0065] The exemplary embodiments are thus fully described. Although the description referred to particular embodiments, it will be clear to one skilled in the art that the invention may be practiced with variation of these specific details. Hence this invention should not be construed as limited to the embodiments set forth herein.

[0066] While the embodiments have been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only exemplary embodiments have been shown and described and do not limit the scope of the invention in any manner. It can be appreciated that any of the features described herein may be used with any embodiment. The illustrative embodiments are not exclusive of each other or of other embodiments not recited herein. Accordingly, the invention also provides embodiments that comprise combinations of one or more of the illustrative embodiments described above. Modifications and variations of the invention as herein set forth can be made without departing from the spirit and scope thereof, and, therefore, only such limitations should be imposed as are indicated by the appended claims.

[0067] It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the

common general knowledge in the art, in Australia or any other country.

- [0068] In the embodiments mentioned above, each rail damper mounting apparatus contains a single piece of mounting member in a plate shape. However, a variation of the preferred embodiments could be that the mounting device is formed by identical two mounting members of the same shape, but each with half the thickness of a mounting device in the embodiments described above. The two half mounting devices are jointed together by the compression force exerted on the resilient materials on both side of the mounting devices. This arrangement provides a better balanced mounting force by allowing relative movement between the two mounting members during the damper installation on uneven mounting surfaces. The thinner half-thickness mounting device design also facilitates the manufacturing process by using laser cutting.
- [0069] In the embodiments described above, the clipping device as a plate-like piece is directly made into contact with the wedge-liked rail foot. However, those skilled in the art should realize that the clipping device may also be made into indirect contact with other material or member at the interface.
- [0070] In the embodiments, the rail that the rail damper mounting apparatus is suitable to use with has a flat-bottom profile which is common in most modern railways. However, one should realize that other types of rails may also be suitable to be used by the rail damper mounting apparatus according to the invention which may have different cross-sectional shapes.
- [0071] In the embodiments mentioned above, one to two oscillators are installed on each rail damper mounting apparatus. However, it should be realized that any number of oscillators may be installed on a rail damper mounting apparatus depending on the type and number of mounting devices.