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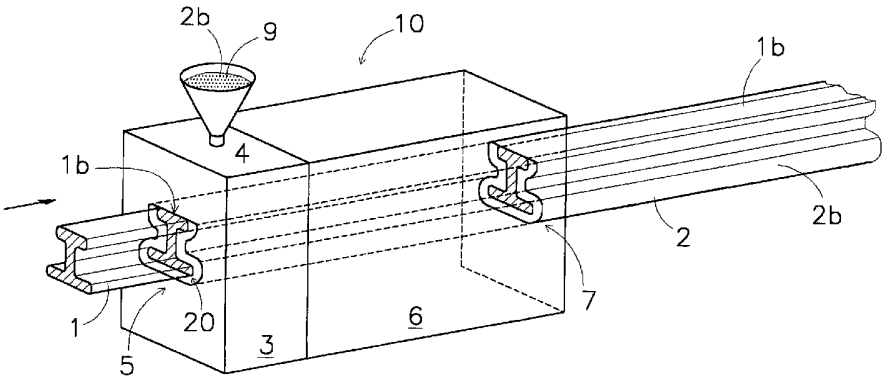
(54) Title: RAIL CONSTRUCTION HAVING A COATING STRUCTURE




(57) Abstract: The invention relates to a production method for producing a rail construction having a coating structure for rail-bound vehicles, especially for a tram or train, which rail construction comprises a steel rail (1) having a rail surface-forming head, a web and a foot, the steel rail being provided with a coating structure which at least partially consists of a hardened liquid coating material (9). A mould (10) is herein utilized, coating through which at least a rail is guided and to which liquid coating material can be fed. As the rail and the mould are moved relative to each other, the rail is coated with coating material. Hardening of the liquid coating material takes place in the mould.

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Rail construction having a coating structure

A first aspect of the present invention relates to a method for producing a rail construction having a coating structure for rail-bound vehicles, especially for an underground rail network, tram or train, which rail construction comprises a steel rail having a rail surface-forming head, a web and a foot, the steel rail being provided with a coating structure which at least partially consists of a hardened liquid coating material.

From the prior art, various coating structures for the coating of rails are known. Thus coating structures are applied, for example, which form part of the fastening of the rail to the substructure and/or have an electrically insulating and/or sound-damping and/or vibration-insulating action.

In rails which are continuously supported, the steel rail, over substantially the whole of its length in the region of the foot and at least a part of the web of the rail, is provided with a coating structure which leaves at least the rail surface of the steel rail free. There are also discretely supported rails, for example having sleepers, wherein the coating structure coats part-regions of the rail situated at an axial distance apart.

From the prior art it is known to utilize a gutter-shaped mould having the length of a rail, a liquid coating material being poured all around the rail in the mould, after which hardening of the coating material takes place. Once the coating material is sufficiently hardened, it can be wholly removed from the mould. It is also known to install the whole of rail, coating and mould on a substructure, in which case the mould might serve to anchor the rail in a (concrete) bed. With this method, it is also known to place additional elongated elements, such as, for example, resonance parts, also in the mould. These are then held in place by spacers and cast together with the rail in the liquid coating material.

Drawbacks of this known production method are the size of the

mould which is needed and the laboriousness, for example with respect to the one-by-one coating and tempering of the rails. Moreover, the possibilities for on-the-spot coating of previously installed rails are limited.

The object of the first aspect of the present invention is to provide an alternative production method for producing a rail construction.

The first aspect of the invention achieves this object with a method according to claim 1. The first aspect of the invention further relates to a rail construction with coating structure according to claim 10.

The first aspect of the invention is based on the use of a mould through which at least a rail is guided and to which liquid coating material can be fed. As the rail and the mould are moved relative to each other, the rail is coated with coating material. During the period of residence of the rail in the mould, the coating material can harden, although the final hardening can also take place at a later stage outside the mould.

According to the invention, coating takes place as the mould and the rail are moved relative to each other. This implies that, on the one hand, the rail can be moved through a stationary mould, which can be advantageous at a rail-making production site. On the other hand, the mould can also be moved along a stationary rail, which can be advantageous when the rail is coated in situ. The relative movement of mould and rail can take place continuously or step by step. The movement can also proceed batch by batch, for example where the mould is very long.

Hardening of the liquid coating material already takes place in the mould. When the coated rails leave the mould, the coating material is preferably at least hardened such that it is bonded to the rail. Once the coating material has fully hardened, it forms the coating structure of the rail.

The second aspect of the present invention relates to a rail system having a substructure and a rail, which is fixed thereto by a fastening system, for rail-bound vehicles, especially an underground rail network, tram or train.

In the case of the second aspect of the invention, the steel rail has a rail surface-forming head, a web and a foot. The fastening system comprises a coating structure with which the steel rail is coated over substantially the whole of its length or over one or more axial part-regions in the region of the foot and at least a part of the web of the rail, which coating structure leaves at least the rail surface of the steel rail free and forms together with the rail a rail construction.

The second aspect especially relates to a rail system having an embedding substructure, in which the rail construction is at least partially embedded.

In rail systems of this kind, the coating structure serves to transmit forces generated by the rail-bound vehicle to the substructure.

From the prior art, as previously stated, it is known to coat beforehand or in situ the rail to be embedded, by casting it in suitable liquid coating material.

This method produces restrictions as regards the properties of the coating structure.

The object of the second aspect of the invention is to provide an alternative rail system by which the aforementioned problem can be resolved.

The second aspect of the invention achieves this object with a rail system according to claim 11, wherein the coating structure comprises one or more layers applied in a spraying process.

Preferably, the embedding substructure comprises a slab, preferably a concrete slab. The slab is possibly supported on

the surrounds by elastic means.

The third aspect of the invention relates to a rail construction having an improved coating structure comprising one or more layers applied in a spraying process, according to claim 14.

The measures according to follow-up claims 15-44 can find application within the framework of the rail system according to the first and/or second and/or third aspect of the invention.

The second and third aspect of the invention are based on the insight that the spray-application of one or more layers is an expedient and practicable technique in terms of putting together a desired coating structure. The one or more layers can in this case acquire properties which are optimally tailored to the stated requirements, in addition to which different properties can be attractively combined within one coating structure.

A fourth aspect of the invention relates to a rail system according to claim 45, wherein the coating structure comprises one or more preformed elements having a shape substantially complementary to the rail.

The invention further relates to a method for producing a rail construction in accordance with the second, third and/or fourth aspect of the invention.

Various advantageous embodiments of the methods, rail systems and rail constructions according to the invention are described in the follow-up claims and in the following description with reference to the drawing, in which:

Fig. 1 shows a projection of an embodiment of the mould according to the invention,
Fig. 2 shows a cross-section of another embodiment of the mould having a plurality of pass-through channels and a plurality of feed channels,
Fig. 3 shows a cross-section of another embodiment of the mould having a plurality of feed channels and a plurality of mould

cavities,

Fig. 4 shows a front projection of another embodiment of the mould according to the invention,

Figs. 5a and b show cross-sections of other embodiments of the mould in which, in addition to the rail, a plurality of elongated elements are guided through the pass-through channel,

Fig. 6 shows a top view of a mould and a curved rail,

Figs. 7a-c show various realizations of the method according to the second and third aspect of the invention,

Figs. 8a-c show in sectional view rail constructions obtained with the methods according to Figures 7a-c,

Figs. 9a, 9b show examples of rail constructions having a multi-layered coating structure,

Figs. 10a, 10b show examples of rail constructions having a sprayed-on layer and a preformed coating element,

Figs. 11a, 11b show examples of rail constructions having a thickened rib, obtained by having been sprayed on, close to the head of the rail,

Figs. 12a-e show examples of rail constructions wherein spray-application and preformed elements are used to make the coating structure,

Figs. 13a-c show examples of rail constructions wherein the coating structure is provided with grip-enhancing particles,

Figs. 14a, 14b show examples of rail constructions provided with an elastic element beneath the rail foot,

Figs. 15a, 15b show examples of rail constructions wherein the coating structure has an outermost layer with low friction coefficient,

Figs. 16a-d show examples of sound-damping rail constructions,

Figs. 17a-c show rail constructions according to the second aspect of the invention, embedded in a concrete slab,

Fig. 18 shows a rail construction fastened to a substructure,

Fig. 19 shows an example of a rail construction according to the fourth aspect of the invention, and

Fig. 20 shows another example of a rail construction according to the fourth aspect of the invention.

Fig. 1 shows in diagrammatic representation a front view of an embodiment of a mould 10 which can be used in a method according

to the first aspect of the invention. On the left in Figure 1 can be discerned an entrance 5 of a pass-through channel 8. In this Figure 1, an uncoated steel rail 1 for an underground rail network, tram or train or other rail-bound vehicles is already introduced into the pass-through channel 8. A mould cavity 20 is clearly visible between the rail 1 and the mould 10. In a left-hand part 3 of the mould 10 there is an inlet 4 for a liquid coating material 9. In a right-hand part 6 of the mould 10, the coating material can harden, whereby at an exit 7, here on the right-hand edge, of the mould 10, a rail 2 coated with coating material 2b emerges from the pass-through channel 8.

The parts 3 and 6 of the mould 10 have a different function but the mould 10 can be one whole. In another embodiment, it can be desirable for the parts 3 and 6 to be separate, joined-together mould parts. If the coating material is, for example, thermoplastic, that is to say that it becomes plastic at higher temperatures and hardens when cooled, then it is desirable for part 3 to be insulating. Thus, the coating material in this intake portion remains as far as possible liquid. Hardening must take place in the part 6 and the heat must therefore be dissipated as quickly as possible. In order to have both processes proceed optimally, part 3 and part 6 can be made from different materials. With other types of coating materials, such as thermohardeners, hardening can take place under the influence of a raised temperature. In this case, the part 6 must therefore be and remain warm for full hardening. Another group of coating materials are materials which harden when two elements are mixed. An example of this is rapid-hardening polyurethane. In Figure 1 it can be seen that the rail surface 1b of the rail 1 remains uncoated because this part of the rail butts against the mould 10; there is no mould cavity present between the rail surface 1b and the mould.

Fig. 2 is a cross-section of another embodiment of the mould 10, in which two pass-through channels 8 and 108 are made. In the pass-through channels 8 and 108, the rails 1 and 101 and the mould cavities 20 and 120 are respectively visible. Advantageously, a plurality of pass-through channels are made if

mass production of coated rails is taking place. A plurality of inlet points 4 for liquid coating material are also visible in Figure 2. Advantageously, a plurality of inlet points are used if parts of the mould cavity 8 are difficult to reach or if the liquid coating material has relatively poor flow characteristics.

In Fig. 3, three mould cavities 21, 22, 23 are visible in the pass-through channel 8 of the mould 10 next to the uncoated rail 1. All mould cavities are provided with separate feed channels: mould cavity 21 has feed channels 4a-4c, mould cavity 22 has the feed channels 40a and b and mould cavity 23 the channel 41. Advantageously, a plurality of mould cavities are used if different coating material is required for various parts of the rail. If it is undesirable to coat the rail surface of the rail, no coating material needs to be fed to the mould cavity 23. It is conceivable for a coating material to be used which is specifically suited to the rail surface. In this case, the separate mould cavity 23 is suitable for the purpose.

In Fig. 4, a mould 10 is shown in which a plurality of mould cavities 20, 220 and 320 situated one behind the other in the pass-through direction, for filling with liquid coating material 109, 209 and 309, are made. The elongated rail element 1 is introduced into the first part of the mould 110, on the left in the figure. Here there is a mould cavity 20 present between the element and the mould, to which coating material 109 can be fed through the feed 4. After the coating material 109 has hardened, the coated element has a larger cross-section. In the second part of the mould, 210, a new mould cavity 220 of yet larger cross-section is present. In this mould cavity, feeding of the coating material 209 takes place. In the third part of the mould, 310, a mould cavity 320 of even larger cross-section is present, to which coating material 309 can be fed. In this way, it is possible, with one mould, to provide a rail with several layers of coating material. This is also possible by utilizing a plurality of moulds in series. Of course, the various layers do not need to fully cover one another. For instance, it can be envisaged that a layer which is first to be applied coats the

underside of the foot and subsequently, in a second mould part, coating layers are provided on both sides of the web of the rail. The material and/or the properties of the coating material can in this case be optimally chosen for each layer.

Figs. 5a and b show cross-sections of embodiments of the mould 10, in which, alongside the rail 1, a plurality of elongated elements are fed through the pass-through channel. Examples of elements which can be fed through next to the rail are resonance parts 60, cable troughs 61 or foam parts 62 and 63. As a result of the coating technique used, no consideration needs to be given to the detachability of the components from the mould and, hence, all sorts of shapes of elements can be guided through the pass-through channel of the mould. Another possibility is the joint transportation of an anti-bonding substrate, for example a film which can prevent the coating from bonding to the mould. Another possibility is a jointly transported medium having anchoring members on the outside, allowing improved bonding to, for example, concrete.

Fig. 6 shows a long, curved rail and a relatively short mould 10. Where the curvature of the curved rail is slight and the mould relatively short, it is also possible, as depicted, to coat curved rails in the above-described manner.

In Figure 7a, in a view from the head, an elongated steel tram rail 1' can be recognized, having a head 2', forming a rail surface 3', a web 4' and a foot 5'.

In Figure 7a, three spray nozzles 7', 8', 9' are shown in diagrammatic representation, by which one or more layers 11' are applied to the foot 5' and the side edges of the web 4' and the head 2' over substantially the whole of the length of the rail 1', which layer(s) form(s) the coating structure of the tram rail construction 10' as shown in Figure 8a. In the present example, this layer/these layers 11' form(s) the entire coating structure and leave(s) the top side of the head 2' of the rail 1' free.

In a variant (not shown), the coating structure is envisaged to extend over several mutually spaced, axial part-regions, for example because the rail is designed for discrete support by the use of sleepers.

In the realization according to Figure 7b, a steel track rail 15' having a head 16', web 17' and foot 18' is also coated, by means of spray nozzles 19', 20', 21', with one or more layers 22', as shown in the cross section of Figure 8b of a rail construction 25'. In this case, the top side of the head 16' and a side edge of the head 16' are covered with a cover body 23' during the spraying.

Figures 7c and 8c show a variant of Figures 7b, 8b, wherein both side edges of the head 16' are covered by a cover body 23a during the spraying, so that a rail construction 26' is obtained.

The one or more layers can be sprayed on in a workshop or at the site of the construction, reconditioning or repair of the rail. Because of the possibility of controlling the conditions, the spray-application will preferably be performed in a suitable workshop.

The spraying-on may possibly be preceded by a removal of the rolling skin and/or corrosion, dirt contamination, for example by sand or grit blasting, and a (chemical) pre-treatment may possibly take place, for example the application (preferably spraying) of a primer.

In the methods according to Figures 7a-c, a layer applied in a spraying process bonds directly to the steel rail 1', 15', the layer having a controlled thickness.

In order to obtain sound-damping and/or vibration-insulating properties for the rail construction, a layer applied in a spraying process shall preferably be made of an elastic material.

The second aspect of the invention arranges that a rail to be embedded, for example a rail to be embedded in concrete, is coated with an elastic coating structure by means of the spraying technique which is here described in greater detail. To this end, the coating structure has substantially vibration-insulating properties.

For the prevention of rusting and within the framework of electrical insulation, a layer applied in a spraying process shall preferably be watertight.

With practical advantage, a layer applied in the spraying process is a plastics layer, for example the layer contains polyurethane or a related plastic, such as a polyurea.

In another advantageous realization, a layer applied in a spraying process is made of a viscoelastic material.

Preferably, a layer applied in a spraying process is electrically insulating.

Preferably, if the coating structure is composed of one or more layers, this structure has at least a 2-millimetre thickness, especially preferably a thickness between 4 and 20 millimetres, most preferably between 5 and 15 millimetres. This range of thickness is especially desirable if the coating structure aims at an elastic effect.

In a possible realization, a layer applied in a spraying process contains fill particles, for example foam pellets, glass beads, metal particles, etc.

Advantageously it is envisaged that a plurality of layers applied in a spraying process are arranged one on top of the other with mutually different properties. In an advantageous version thereof, the stiffness properties of the layers are mutually different.

In a possible embodiment, the coating structure is composed of

one or more layers sprayed directly onto the rail and the coating structure, in a zone close to the steel rail, has a lesser density than in a more outer zone of the coating structure. Fill particles are possibly used to obtain the density which is sought.

In a possible embodiment, the coating structure is fully composed of one or more layers applied in a spraying process, the coating structure containing pores and the pore size in a zone close to the steel rail being greater than in a more outer zone of the coating structure.

In the rail constructions 10', 25' represented in Figures 8a-8c, the web of the rail 1', 15' is in each case fully coated on both side edges by the coating structure. It is also conceivable, however, for the coating structure to coat only the foot of the rail and a lowermost portion of the web of the steel rail.

In Figures 9a and 9b, rail constructions 29', 30' are shown, wherein two layers, respectively 29a, 29b and 30a, 30b are applied to the steel rail 1', 15', for example an electrically insulating layer and an elastic layer, or an elastic layer, for example a foam layer, and over this, a solid, less elastic layer.

In Figures 10a and 10b, rail constructions 35', 38' are shown, wherein on the steel rail 1', 15', in the region of the foot and the side edges of the web, and in Figure 10a also the head, a thin layer 36', 39' of plastics material has been sprayed, which bonds to the rail. In the period during which this layer 36' 39' has not yet hardened, as quickly as possible after the spray-application, a flexible, preformed coating element 37', 40' is applied around the foot and along the side edges of the rail 1', 16'. For example, the elements 37', 40' are made from a suitable rubber or elastomer in a mould. The layer 36', 39' then acts as a sprayed-on bonding layer for the preformed coating element.

The illustrated elements 37', 40' are constructed in one piece and extend over substantially the length of the rail. In a

variant, the elements 37', 40' occupy only a part of the length of the rail.

In Figures 11a, 11b rail constructions 41', 42' are represented, wherein a thickened rib 11a, 29c is formed on the two side edges of the head of the rail 1', 15' by the spray-application of suitable material.

In Figures 12a-e, rail constructions 50, 51, 52, 53, 54 are represented, wherein for the making of the coating structure use is made of spraying of one or more layers and of preformed elements, which, by means of a sprayed-on layer, are bonded to the rail 1', 15' and are coated by a sprayed-on layer.

In Figures 12a, 12b, 12e, resonance elements 55 have been fastened on both sides of the web of the rail 1' by firstly spraying a layer of suitable plastics material, for example, onto the rail 1', 16'. After this, the resonance elements 55 have been embedded into the plastic, as it were, by renewed spraying, whereupon the resonance elements are covered.

Of course, it is also conceivable to make the first layer in a different material from the following layer or layers.

In Figures 12c and 12d, hollow cylindrical bodies 57 are provided in the same way as illustrated above.

It is also conceivable for the bodies 55, 57 to have solely the function of a fill body in order to save on material and spraying costs. For example, foamed plastic elements can then be used as preformed elements.

In Figures 12a-d, rail constructions are shown, wherein the coating structure extends into the region of a side edge of the head of the rail and wherein grip-enhancing particles 58 are embedded in the uppermost part of the coating structure at the side edge of the head.

In Figures 14a and 14b, rail constructions 60, 62 are

represented, wherein an elastic element 61, 63 is provided beneath the foot of the steel rail 1', 15'. The element 63 extends even along the side edges of the foot.

In a possible realization, the elastic element is preformed and coated with a layer 11' applied in a spraying process.

In another version, the elastic element 61, 63 is formed by a layer applied in a spraying process.

In Figures 15a and 15b, rail constructions 65, 66 are shown, wherein an outermost layer 67, 68 of the coating structure has a low friction coefficient, for example a layer of PTFE.

Figures 16a-d show sound-damping rail constructions, wherein the rail 15' is provided with a sound-damping coating structure. In Figure 16a, preformed elements 75, made of foamed plastic, for example, are fitted on both sides of the web of the rail 15'. For this purpose, a bonding layer has preferably been sprayed on the rail 15'. The outer side of the preformed elements 75 (core blocks) and of the foot of the rail, together with a region on the bottom of the head of the rail, are coated with one or more layers in a spraying process. For example, a single layer 76 of several millimetres thickness, for example more than 5 millimetres, of an elastic plastic, such as, for example, a polyurethane, is applied.

In Figure 16b, sound damping is provided by means of resonance bodies 77, which lie next to the web of the rail embedded in a layer 78 of deformable material, for example a layer of plastic. This whole has then be recoated with an outermost sprayed-on layer 79. Figure 16c also involves damping with a sandwich structure having rigid bodies 80, which extend at a distance apart along the web and the foot of the rail. In this case, a layer 81 of a viscoelastic material, for example a layer of plastic, has been sprayed against both sides of the web and the top side of the foot, as well as the bottom side of the head of the rail. Before this layer 81 hardens, the bodies 80 are applied, which then, by way of the sprayed-on layer 81, bond to

the rail. Next an outermost cover layer 82 is applied, which fills the outwardly open recess in the bodies 80 and, at the same time, fully coats the bodies 80 and the foot of the rail. This layer 82 is, for example, different in quality from the layer 81. For example, the layer 81 is very elastic, whilst the layer 82 is watertight and electrically insulating.

Figure 16d shows a variant, wherein on both sides of the web of the rail a plurality of resonance bodies 84, 85 are provided, which, by means of sprayed-on layers 86, 87, are bonded to the rail and are coated by a sprayed-on outermost layer 88.

Figure 17a shows a realization of the embedding of two rail constructions 10' alongside each other in a concrete slab 100, an elastic mat 101 being placed between the concrete slab 100 and the surroundings to reduce vibration nuisance for the surroundings.

In Figure 17b, the mat 101 is replaced by strips 102 or other moulded parts made of elastic material, and in Figure 17c by springs 103.

Figure 18 shows a possible fastening of a rail construction to a substructure (not represented), prior to being embedded in, for example, concrete.

Figure 19 shows a rail construction according to the second aspect of the invention, in diagrammatic representation during the assembly. The steel tram rail 1' can be recognized. The coating structure is composed of preformed elements, which are here constructed as shell parts 110, 110, which are placed against the rail 1' on both sides such that the shell parts 110, 110 extend beneath the foot of the rail and join up there. In addition, each shell part 110 has a vertical wall conforming to the contour of the rail, so that the side edges of the rail, in any event of the lowermost part of the web of the rail, are coated. In the illustrated example, the side edges of the rail are wholly coated by the shell parts 110. In this example, the shell parts are smaller in length than the steel rail, resulting

in greater ease of handling. At the lowermost longitudinal margins and at the end faces, the shell parts 110 are provided with a coupling formation so that no open seams are formed between the shell parts.

Preferably it is envisaged that the shell parts are fastened by a bonding layer on the rail to be sprayed. To this end, a mobile or portable spraying device might be utilized. As previously stated, it is conceivable for the shell parts 110, having been placed against the rail, still to be coated with one or more layers in a spraying process. The rail construction according to Figure 13 can finally be embedded in, for example, a concrete slab, asphalt road surface or the like.

Figure 20 shows a variant of Figure 19, wherein the rail 1' is likewise provided with a coating structure with preformed shell parts 120, which rail construction is then embedded in a concrete slab 100.

CLAIMS

1. Method for producing a rail construction having a coating structure for rail-bound vehicles, especially for an underground rail network, tram or train, which rail construction comprises a steel rail having a rail surface-forming head, the rail being provided with a coating structure which at least partially consists of a hardened liquid coating material, **characterized in that** a mould is utilized which:

- has an elongated pass-through channel having an entry and an exit, which pass-through channel is arranged to allow at least a rail to pass through it, the pass-through channel having a cross-section such that at least one mould cavity is present between the rail and the mould,
- has at least one feed channel for liquid coating material, so that coating material can be fed to each mould cavity via at least one associated feed channel,

in which method the rail is introduced into the pass-through channel and the rail and the mould are moved one relative to the other, the mould cavity being fed with hardenable liquid coating material, so that the hardened coating material bonds to the rail.

2. Method according to claim 1, characterized in that at least the rail surface of the steel rail remains uncoated.

3. Method according to one of claims 1-2, wherein the relative movement of the rail and the mould takes place substantially continuously.

4. Method according to one of claims 1-3, wherein the mould is one whole.

5. Method according to one of claims 1-4, wherein the mould comprises a plurality of joined-together parts.

6. Method according to claim 5, wherein the parts of the mould are made of different construction material.

7. Method according to one or more of the preceding claims,

wherein the mould comprises a plurality of mould cavities situated one behind the other, viewed in the pass-through direction for the rail, for filling with liquid coating material, so that different coating materials can be successively applied, for example overlapping layers and/or layers on different parts of the rail.

8. Method according to one or more of the preceding claims, wherein the pass-through channel is arranged in the mould so as to accept, alongside the rail, also one or more additional elongated elements, such as, for example, a resonance part, a cable trough, a foamed part, an anti-bonding substrate to prevent bonding to the mould, a medium having anchoring members on the outside, etc., in which method the rail and the one or more additional elongated elements are moved simultaneously relative to the mould.

9. Method according to one or more of the preceding claims, wherein the mould is such that a curved rail can be moved relative to the mould and a curved rail is moved relative to the mould.

10. Rail construction having a coating structure for rail-bound vehicles, especially for an underground rail network, tram or train, which rail construction comprises a steel rail having a rail surface-forming head, the rail being provided with a coating structure which at least partially consists of a hardened liquid coating material, characterized in that the coating structure is applied with the method according to one or more of the preceding claims.

11. Rail system having a substructure and a steel rail, fixed thereto by a fastening system, for rail-bound vehicles, especially an underground rail network, tram or train, for example an embedding substructure, in which the rail is at least partially embedded, which rail has a rail surface-forming head, a web and a foot, the fastening system comprising a coating structure with which the steel rail, over substantially the whole of its length or over one or more axial part-regions in

the region of the foot and at least a part of the web of the rail is coated, which coating structure leaves at least the rail surface of the steel rail free and forms with the rail a rail construction, characterized in that the coating structure comprises one or more layers applied in a spraying process.

12. Rail system according to claim 11, wherein the embedding substructure comprises a slab, preferably a concrete slab.

13. Rail system according to claim 12, wherein the slab is supported relative to the other substructure by elastic means.

14. Rail construction for rail-bound vehicles, especially an underground rail network, tram or train, which rail construction comprises a steel rail having a rail surface-forming head, a web and a foot, the steel rail being provided over substantially the whole of its length or over one or more axial part-regions in the region of the foot and at least a part of the web of the rail with a coating structure, which leaves at least the rail surface of the steel rail free, characterized in that the coating structure comprises one or more layers applied in a spraying process.

15. Rail construction according to one of claims 11-14, wherein a layer applied in a spraying process bonds directly to the steel rail.

16. Rail construction according to one of claims 11-15, wherein a layer applied in a spraying process is made of an elastic material.

17. Rail construction according to one or more of the preceding claims 11-16, wherein a layer applied in a spraying process is watertight.

18. Rail construction according to one or more of the preceding claims 11-17, wherein a layer applied in a spraying process is a plastics layer.

19. Rail construction according to one or more of the preceding claims 11-18, wherein a layer applied in a spraying process is made of a viscoelastic material.

20. Rail construction according to one or more of the preceding claims 11-19, wherein a layer applied in a spraying process is electrically insulating.

21. Rail construction according to one or more of the preceding claims, wherein a plurality of layers are applied one over the other, having mutually different properties.

22. Rail construction according to one or more of the preceding claims, wherein the stiffness properties of the layers are mutually different.

23. Rail construction according to one or more of the preceding claims, wherein the coating structure is fully composed of one or more layers, preferably having a thickness of at least 2 millimetres, especially preferably a thickness between 4 and 20 millimetres, more especially between 5 and 15 millimetres.

24. Rail construction according to one or more of the preceding claims, wherein the coating structure, in a zone close to the steel rail, has a lesser density than in a more outer zone of the coating structure.

25. Rail construction according to one or more of the preceding claims, wherein the coating structure is fully composed of one or more layers, the coating structure containing pores and the pore size in a zone close to the steel rail being greater than in a more outer zone of the coating structure.

26. Rail construction according to one or more of the preceding claims, wherein the coating structure fully coats the web of the steel rail.

27. Rail construction according to one or more of the preceding claims, wherein the coating structure at least partially coats

the side edges of the head of the rail.

28. Rail construction according to one or more of the preceding claims, wherein the coating structure further comprises one or more preformed elements.

29. Rail construction according to one of claims 11-20, wherein the coating structure comprises a layer applied directly to the steel rail in a spraying process and wherein the one or more preformed elements bind to the layer applied in a spraying process.

30. Rail construction according to one or more of the preceding claims, wherein a one-piece preformed element extends over substantially the length of the rail.

31. Rail construction according to one or more of the preceding claims, wherein a series of preformed elements, preferably fitting close together, extend over substantially the length of the rail.

32. Rail construction according to claim 30 or 31, wherein a preformed element or a series of preformed elements extends along the web of the rail.

33. Rail construction according to one or more of the preceding claims 30-32, wherein the one or more preformed elements are covered with one or more layers applied in a spraying process.

34. Rail construction according to one or more of the preceding claims, wherein the one or more preformed elements are made of plastic.

35. Rail construction according to one or more of the preceding claims, wherein the one or more preformed elements are made of foamed plastic.

36. Rail construction according to one or more of the preceding

claims, wherein the one or more preformed elements form one or more rigid bodies, for example resonance bodies or bodies which form a sandwich structure with the rail.

37. Rail construction according to one or more of the preceding claims, wherein an elastic element is provided beneath the foot of the steel rail.

38. Rail construction according to claim 37, wherein the elastic element is preformed and is coated with a layer applied in a spraying process.

39. Rail construction according to claim 38, wherein the elastic element is formed by a layer applied in a spraying process.

40. Rail construction according to one or more of the preceding claims, wherein a layer applied in a spraying process contains polyurethane.

41. Rail construction according to one or more of the preceding claims 11-20, wherein a layer applied directly to the steel rail in a spraying process has a thickness of 2 millimetres at least.

42. Rail construction according to one or more of the preceding claims, wherein the layer applied in a spraying process contains fill particles.

43. Rail construction according to one or more of the preceding claims, wherein the coating structure extends into the region of a side edge of the head of the rail and wherein grip-enhancing particles are embedded in the uppermost part of the coating structure at the side edge of the head.

44. Rail construction according to one or more of the preceding claims, wherein the coating structure contains an outermost layer of a material with low friction coefficient.

45. Rail system having a substructure and a rail construction,

fixed thereto by a fastening system, for rail-bound vehicles, especially an underground rail network, tram or train, for example an embedding substructure, in which the rail contstruction is at least partially embedded, which rail construction comprises a steel rail having a rail surface-forming head, a web and a foot, the fastening system comprising a coating structure with which the steel rail, over substantially the whole of its length or over one or more axial part-regions in the region of the foot and at least a part of the web of the rail is coated, which coating structure leaves at least the rail surface of the steel rail free, characterized in that the coating structure comprises one or more preformed elements having a shape substantially complementary to the rail.

46. Rail construction according to claim 45, wherein the coating structure comprises preformed elements placed against the steel rail on both sides.

47. Rail construction according to claim 46, wherein the coating structure comprises a flexible preformed element having a one-piece elongated body, which is arranged to be placed around the foot and the web of the steel rail.

48. Rail construction according to claim 46, wherein a series of preformed elements is placed against the rails on both sides, which preformed elements join up by their end faces.

49. Rail construction according to one or more of claims 45-48, wherein the preformed elements are coated with a layer applied in a spraying process.

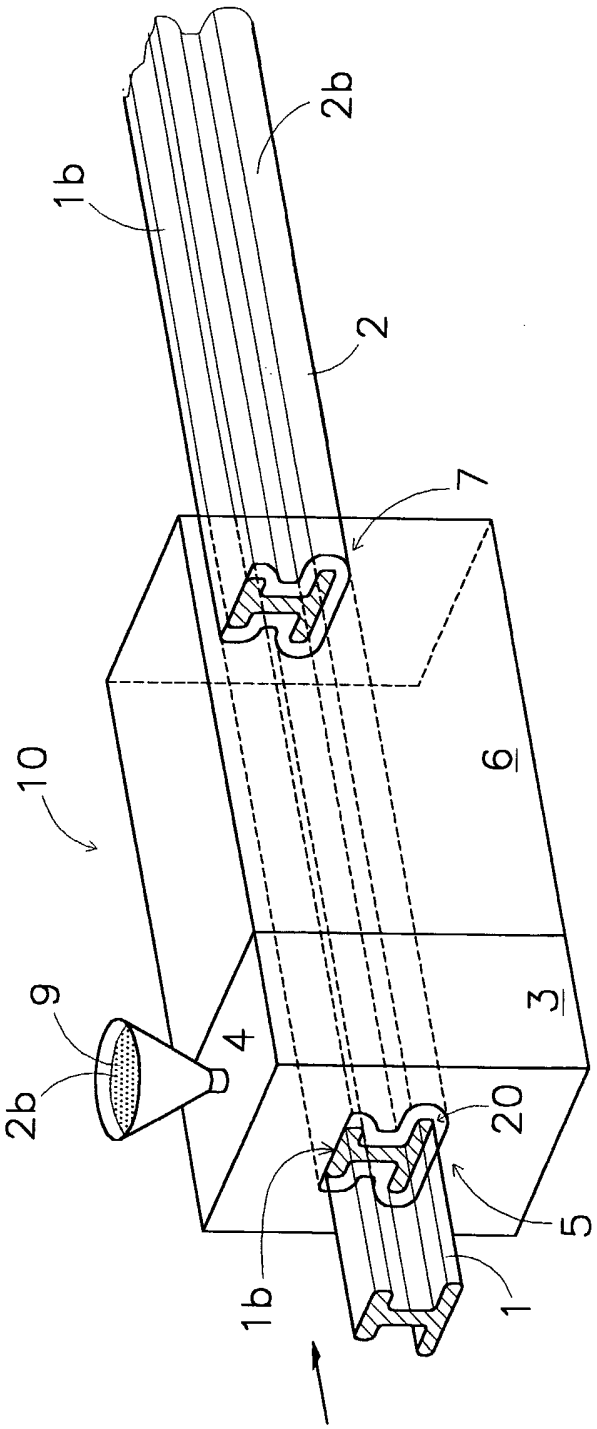



Fig 1

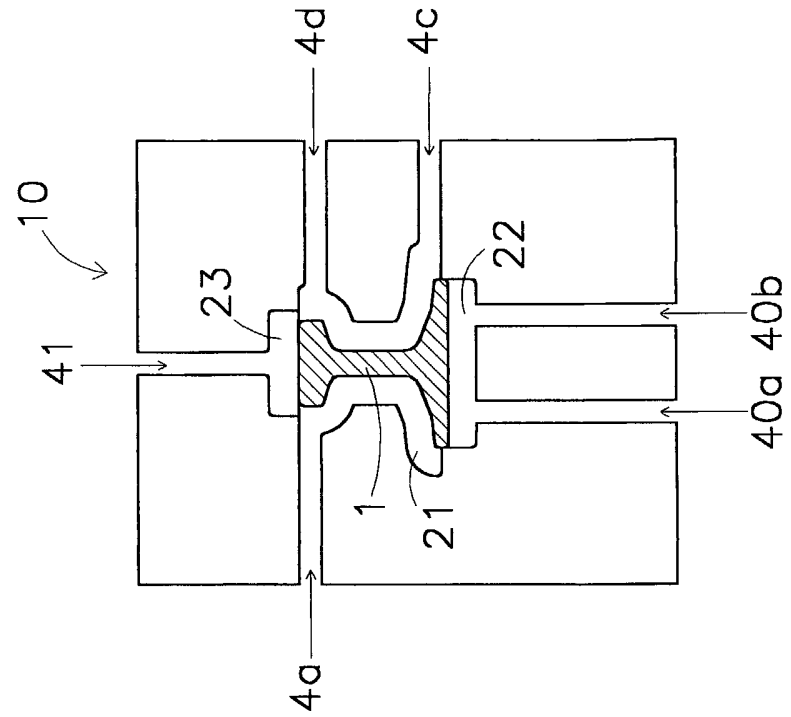
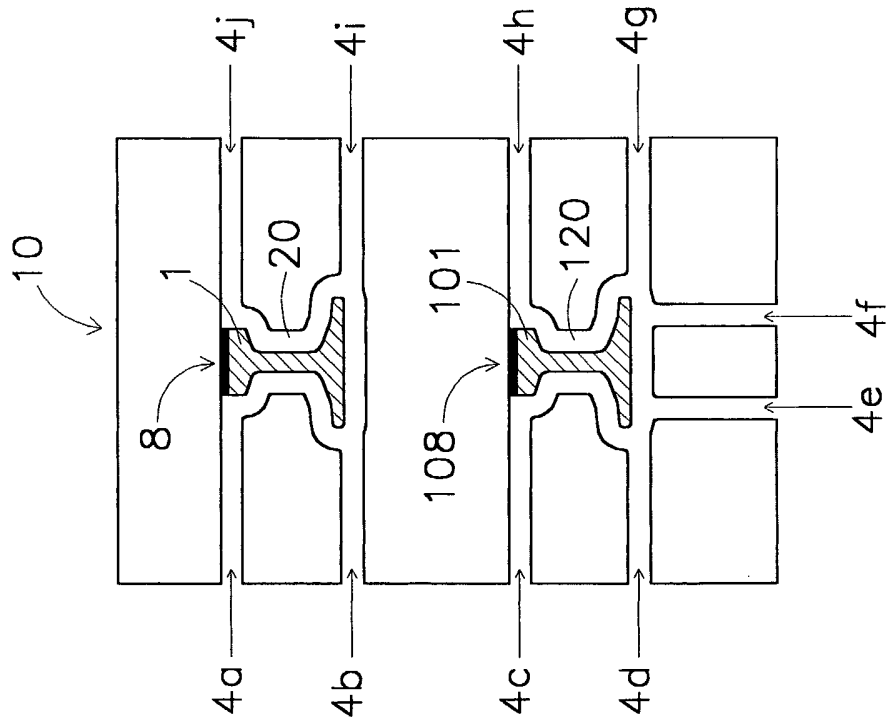

4d
4c
10
23
22
41
40b
40a
1
21
4a

Fig 3


4j
4i
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4f
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108
4e
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4b
4c
4d

Fig 2

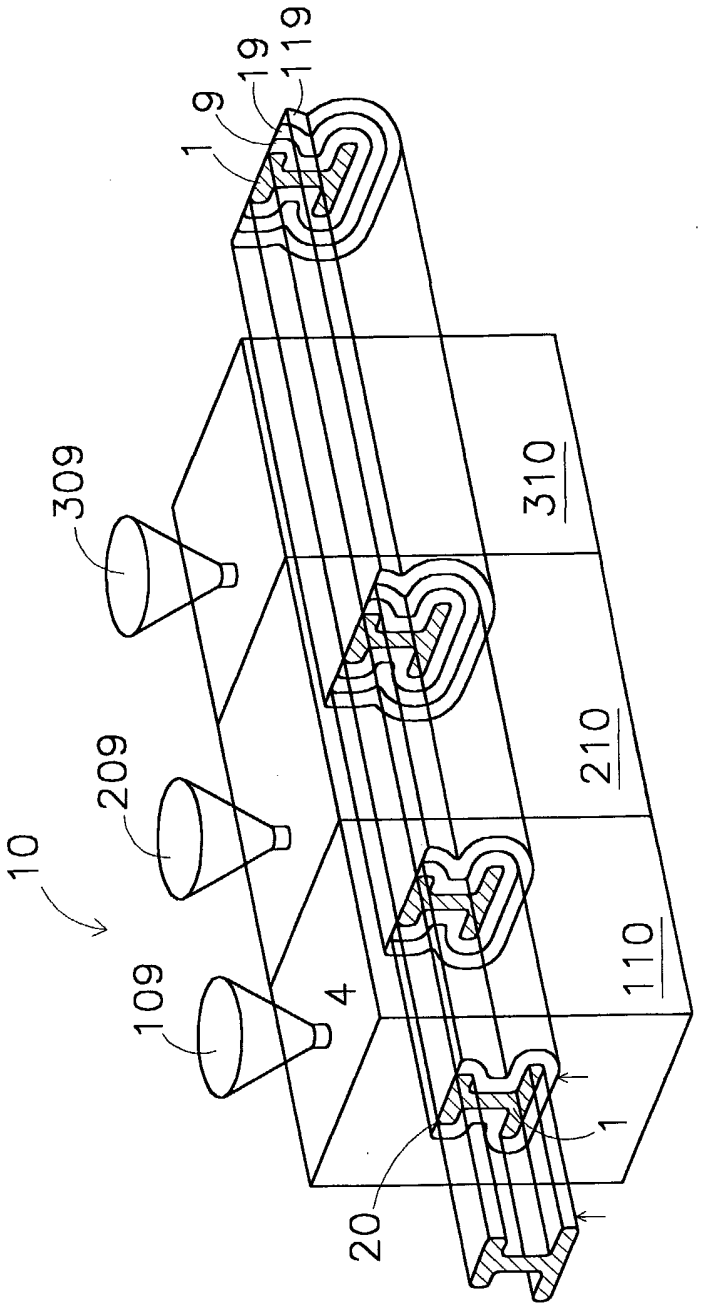


Fig 4

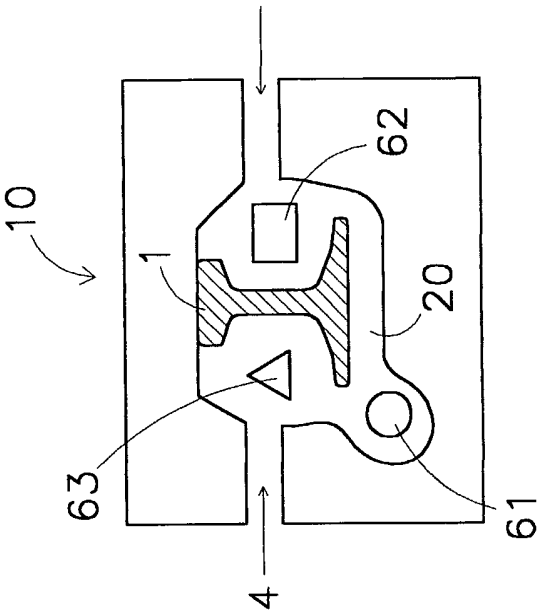


Fig 5b

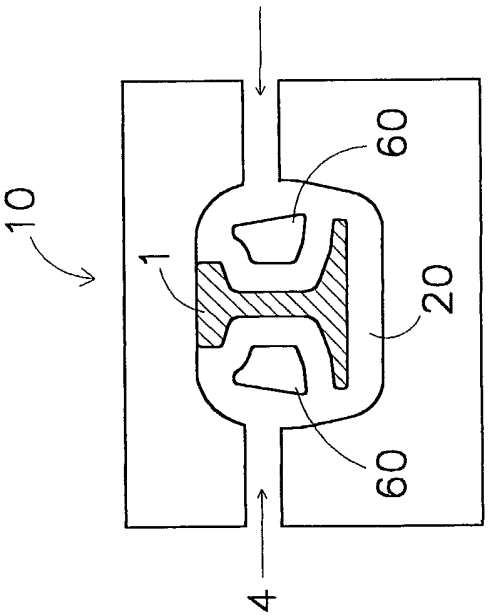


Fig 5a

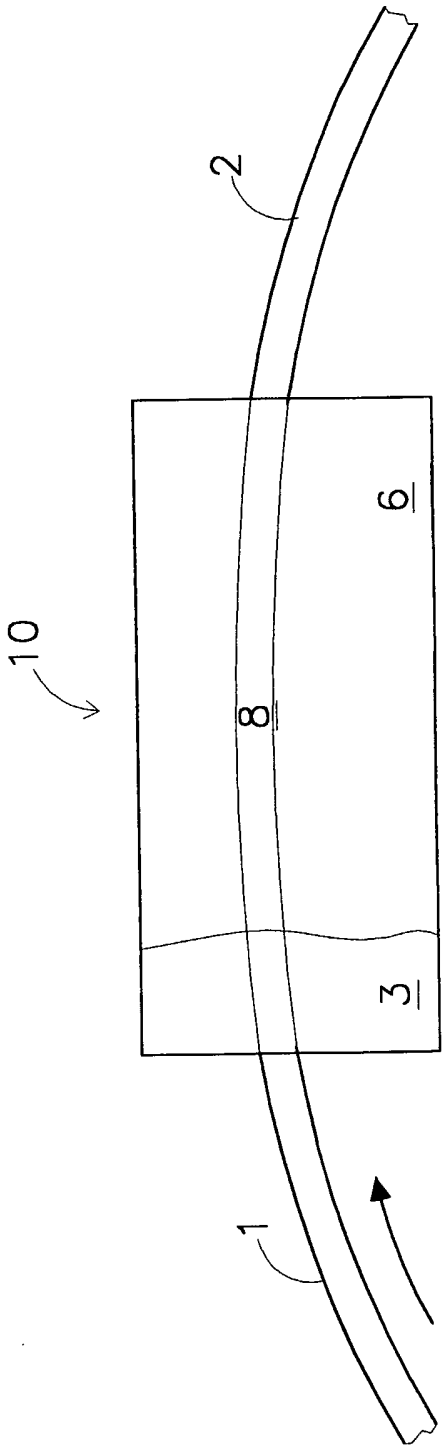


Fig 6

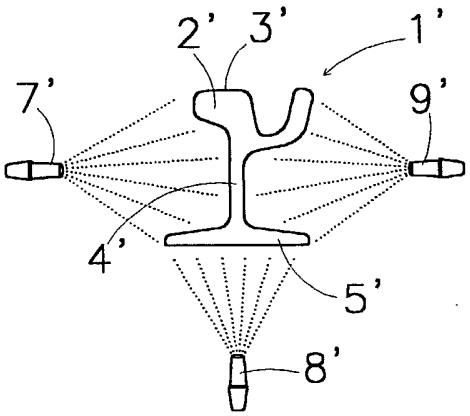


Fig 7a

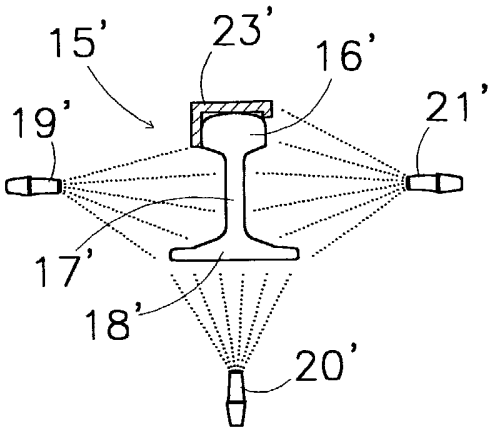


Fig 7b

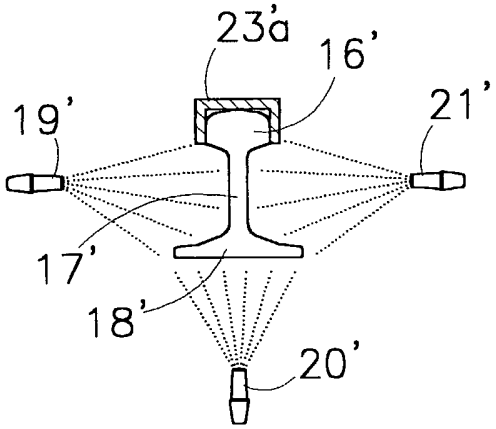


Fig 7c

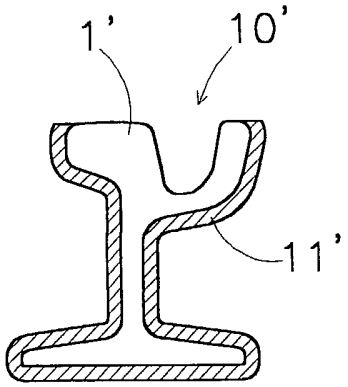


Fig 8a

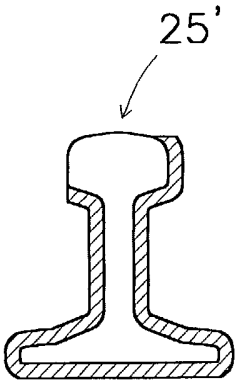


Fig 8b

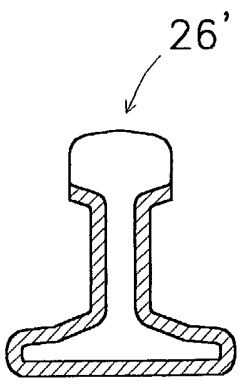


Fig 8c

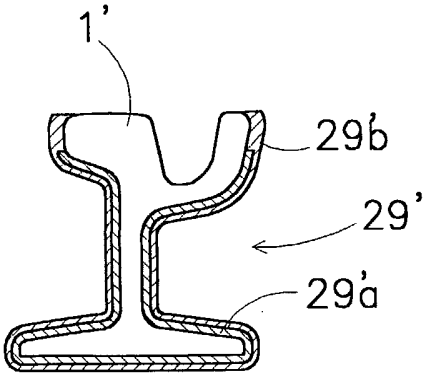


Fig 9a

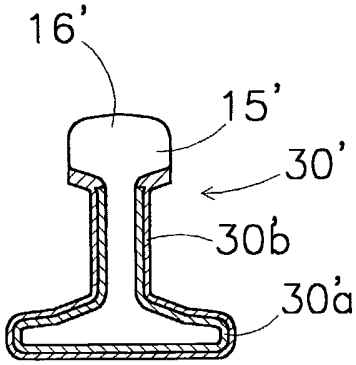


Fig 9b

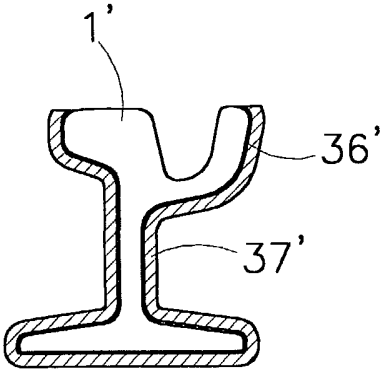


Fig 10a

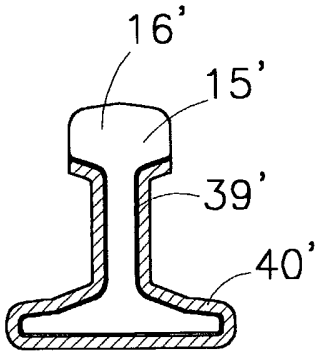


Fig 10b

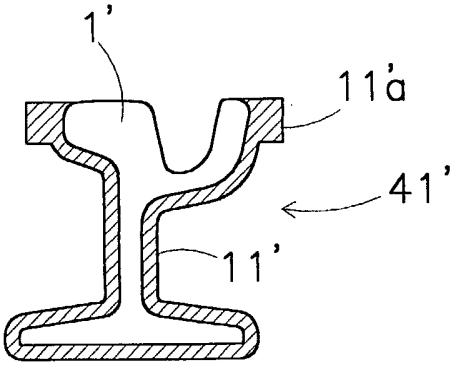


Fig 11a

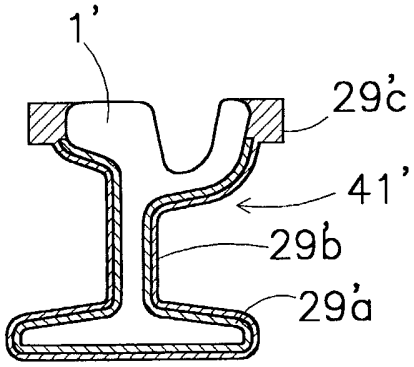


Fig 11b

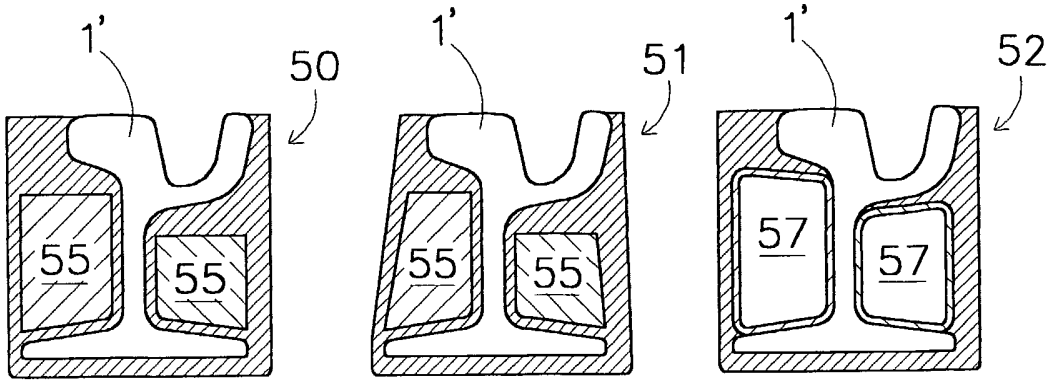


Fig 12a Fig 12b Fig 12c

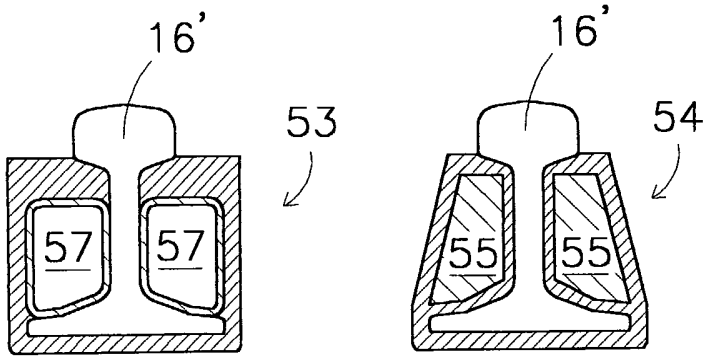


Fig 12d Fig 12e

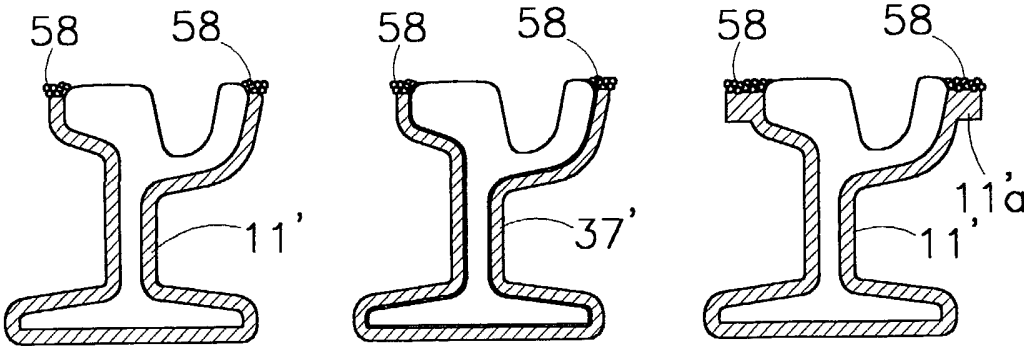


Fig 13a Fig 13b Fig 13c

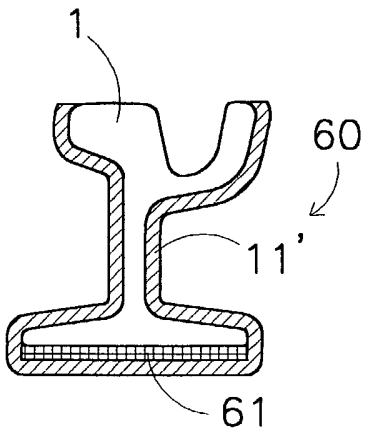


Fig 14a

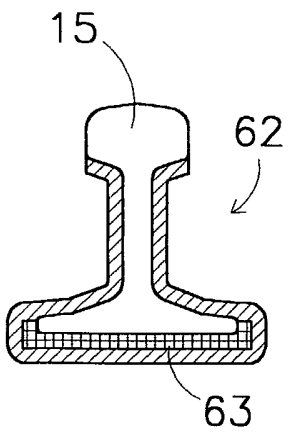


Fig 14b

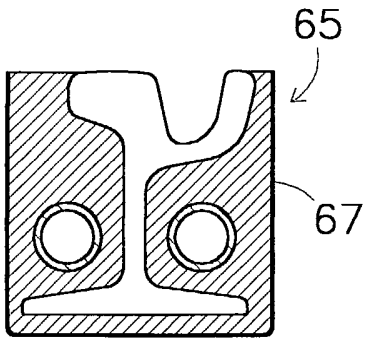


Fig 15a

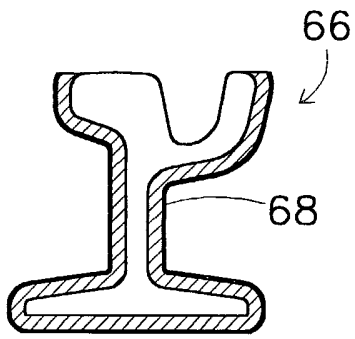


Fig 15b

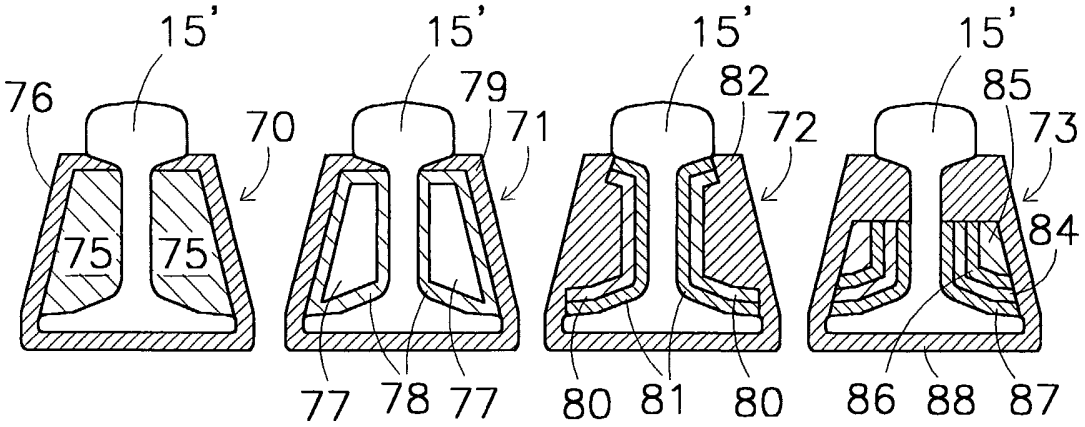


Fig 16a Fig 16b Fig 16c Fig 16d

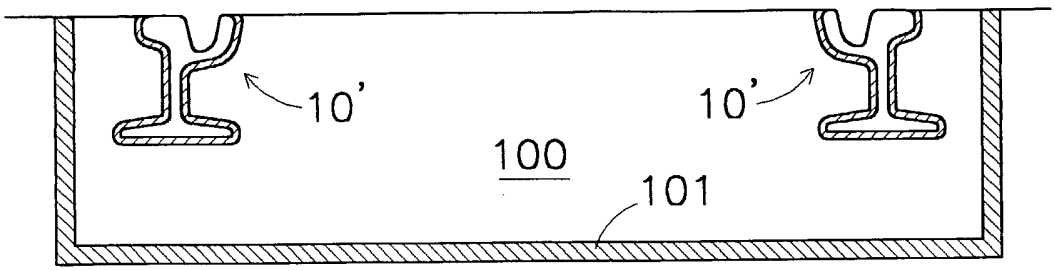


Fig 17a

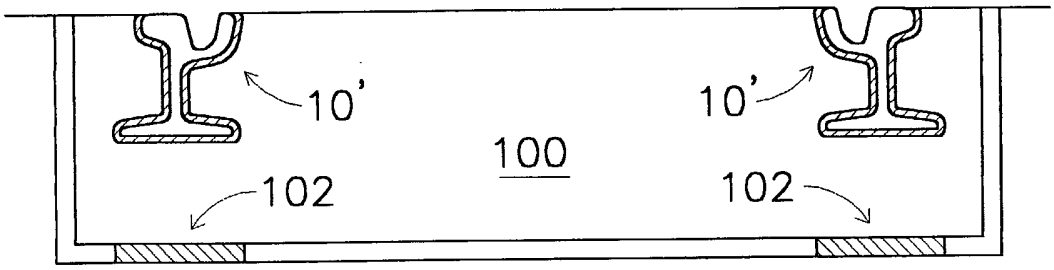


Fig 17b

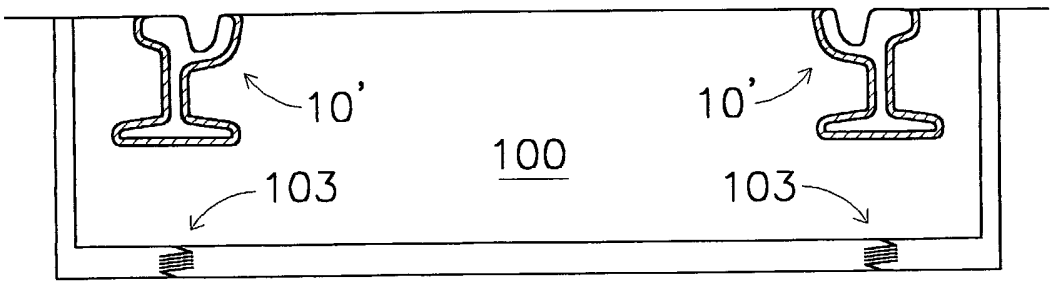


Fig 17c

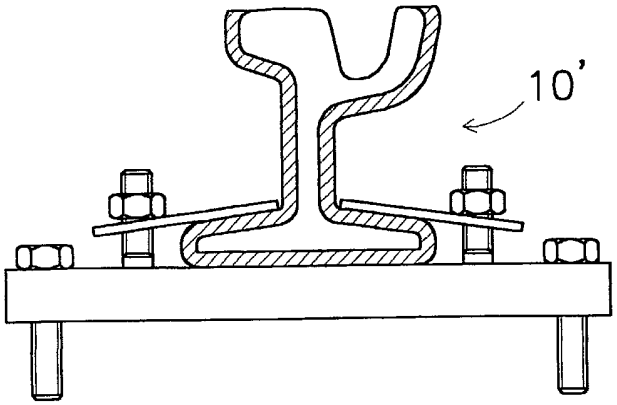


Fig 18

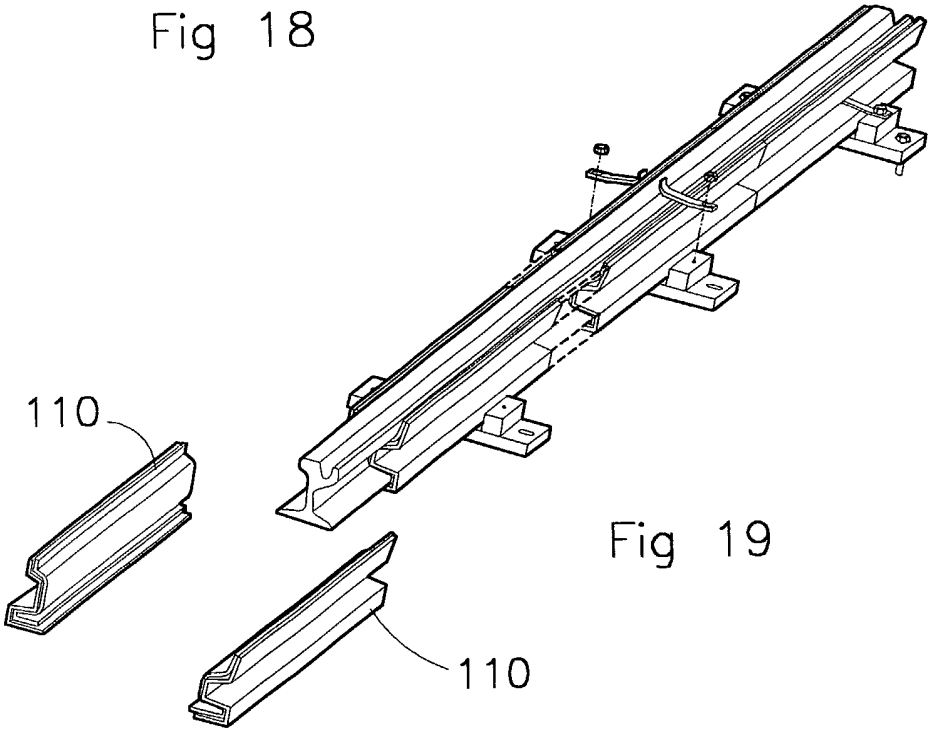


Fig 19

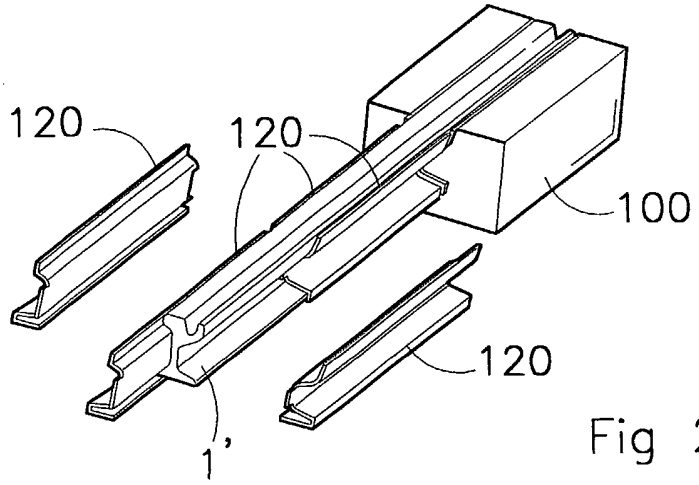


Fig 20.

# INTERNATIONAL SEARCH REPORT

In tional Application No
PCT/NL 03/00826

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E01B5/08 E01B19/00 E01B21/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 2001/028001 A1 (VENNELL ROBERT PAUL)<br>11 October 2001 (2001-10-11)<br>paragraphs '0029!-'0051!; figures 1,4-9 | 10 |
| Y | | 1-5 |
| | --- | |
| Y | PATENT ABSTRACTS OF JAPAN<br>vol. 005, no. 166 (M-093),<br>23 October 1981 (1981-10-23)<br>-& JP 56 093531 A (BUNKA SHUTTER KK),<br>29 July 1981 (1981-07-29)<br>abstract | 1-5 |
| | --- | |
| X | DE 199 11 467 A (KNAPE<br>VERMOEGENSVERWALTUNGS GM)<br>21 September 2000 (2000-09-21)<br>column 20, line 18 - line 38 | 10-12,<br>45-48 |
| A | column 16, line 60 - line 68 | 1,2 |
| | --- | |
| | -/-- | |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 14 April 2004 | 26/04/2004 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | De Neef, K |

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# INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/NL 03/00826

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | PATENT ABSTRACTS OF JAPAN<br>vol. 1999, no. 09,<br>30 July 1999 (1999-07-30)<br>-& JP 11 100801 A (NIPPON STEEL CORP;<br>KYUSHU RAILWAY CO),<br>13 April 1999 (1999-04-13)<br>abstract; figure 1 | 10,11 |
| X | EP 0 365 756 A (LOFSTRAND LABS LIMITED)<br>2 May 1990 (1990-05-02)<br>column 2, line 12 -column 3, line 34;<br>figure 4 | 14-24 |
| A | | 11,12,<br>30-33,<br>37,39 |
| X | PATENT ABSTRACTS OF JAPAN<br>vol. 017, no. 008 (M-1350),<br>7 January 1993 (1993-01-07)<br>-& JP 04 238902 A (NIPPON STEEL CORP),<br>26 August 1992 (1992-08-26)<br>abstract; figures 2,4,6 | 14-23,<br>26,40,41 |
| X | PATENT ABSTRACTS OF JAPAN<br>vol. 018, no. 338 (M-1628),<br>27 June 1994 (1994-06-27)<br>-& JP 06 081301 A (BANDO CHEM IND LTD),<br>22 March 1994 (1994-03-22)<br>abstract; figure 1 | 14-21,<br>23,26,40 |
| X | EP 1 186 710 A (RESCH JOHANN)<br>13 March 2002 (2002-03-13)<br><br>paragraphs '0032!-'0035!; figure 1 | 14-20,<br>26,28,<br>29,<br>31-33,<br>36,40 |
| X | US 6 402 044 B1 (SATO SHOZABURO)<br>11 June 2002 (2002-06-11)<br>column 3, line 61 -column 4, line 2;<br>figures 1A,3 | 14,27 |
| A | US 5 443 299 A (YADA YUKIHIKO ET AL)<br>22 August 1995 (1995-08-22)<br>the whole document | 1-9 |
| A | EP 0 628 660 A (EDILON BV)<br>14 December 1994 (1994-12-14)<br>column 2, line 1 - line 9; figure 2 | 1 |

# INTERNATIONAL SEARCH REPORT

national application No.
PCT/NL 03/00826

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Int ional Application No
PCT/NL 03/00826

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