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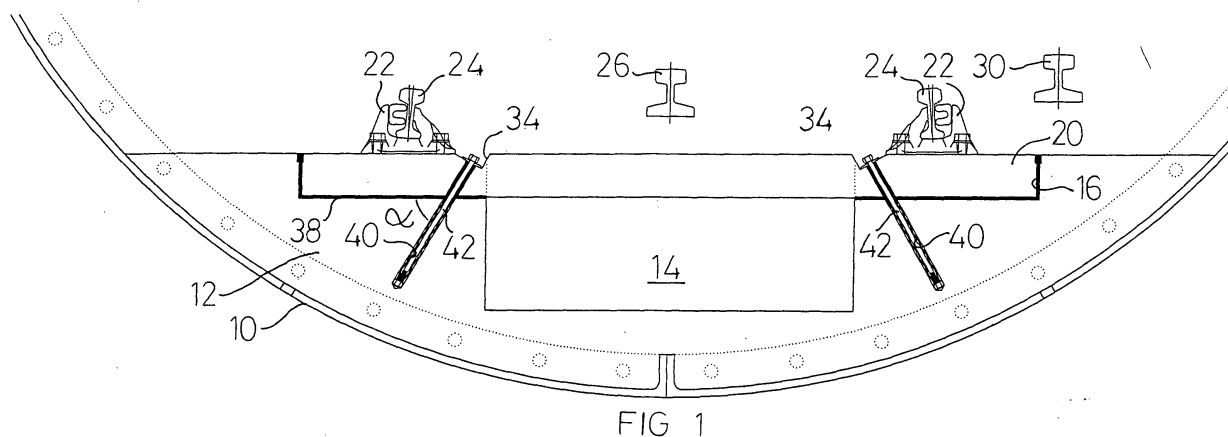
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(54) **Method and apparatus for refurbishing parts of a railway track**

(57) This invention relates to a method of refurbishing parts of a railway track, and in particular a railway track in which the sleepers are embedded in a concrete base. According to the invention, the method of refurbishing the railway track includes the steps of: {i} infilling

the gap between a sleeper and the sleeper recess in the concrete base, {ii} drilling a hole (40) into the concrete base, {iii} inserting a fixing bolt (42; 142) into the drilled hole, and {iv} tightening the fixing bolt so as to secure the sleeper to the concrete base.



Description

FIELD OF THE INVENTION

[0001] This invention relates to a method and apparatus for refurbishing parts of a railway track, and in particular a railway track in which the sleepers are embedded in concrete.

BACKGROUND TO THE INVENTION

[0002] The metal rails of a railway track are typically supported upon sleepers which are arranged at spaced locations along the length of the track. With underground railways in particular, the sleepers are often embedded in concrete, the concrete in which the sleepers are embedded forming part of the tubular tunnel through which the trains can pass. Typically, the concrete has recesses into which the sleepers can be fitted, such a concrete structure being known as a "concrete invert".

[0003] When newly installed, the sleepers are a tight fit within the recesses of the concrete invert, but over time the sleepers can become loose because of the stress and vibration induced by the passing trains. Loose sleepers are more likely to occur adjacent corners in the track. When the sleepers become loose, there is an increase in the wear upon the rails, an increase in the noise created by a passing train, a loss of gauge, and consequently a reduction in the speed and comfort of the train.

DESCRIPTION OF THE PRIOR ART

[0004] When the track has become damaged in this way it is necessary to replace the affected sections of track, or at least to replace the loose sleepers and repair the damaged concrete invert, and this is expensive and also time consuming, usually resulting in disruption of the train service. Because of the problems associated with repairing a damaged track, such repairs are often not undertaken until absolutely necessary, so that the speed reductions and/or discomfort experienced by the train users is prolonged.

SUMMARY OF THE INVENTION

[0005] It is an object of the present invention to provide a method of refurbishing the track which avoids or reduces the above-stated problems. In addition, where possible the refurbishing method makes use of the existing sleepers, so that replacement sleepers do not need to be prepared and transported to the refurbishment location.

[0006] According to the invention, there is provided a method of refurbishing a railway track including the steps of: {i} infilling the gap between a sleeper and the recess in the concrete invert, {ii} drilling a hole into the concrete invert, {iii} inserting a fixing bolt into the drilled

hole, and {iv} tightening the fixing bolt to secure the sleeper to the concrete invert.

[0007] Preferably, the step of infilling the gap between the sleeper and the recess in the concrete invert includes the steps of {i} lifting the rails and sleepers of a damaged section of track to their correct line and level, {ii} cleaning the sleeper and the recess, {iii} injecting a debonding compound into the gap between the sleeper and the recess and allowing to dry, and {iv} injecting a settable liquid into the gap between the sleeper and the recess.

[0008] If necessary, the recess can be trimmed, and also if necessary the recess can be repaired, suitably by using fast-setting mortar.

[0009] The upper opening of the gap between the sleeper and the recess can if desired be filled with a fast-setting mortar. If the upper opening of the gap is filled in this way, this is preferably undertaken before the debonding compound is injected into the gap, holes being drilled to allow the injection of the debonding compound.

[0010] Preferably, the settable liquid is a grout. Preferably also, two fixing bolts are used for each sleeper.

[0011] In a first method according to the invention, the hole which is drilled for the fixing bolt passes through the sleeper and into the concrete invert so that the fixing bolt may secure the sleeper directly to the concrete invert. In a second method according to the invention, a support beam is provided for securement both to the sleeper and the concrete invert, the sleeper being indirectly secured to the concrete invert by way of the support beam. In the second method, the hole drilled into the concrete invert does not pass through the sleeper.

[0012] It is a particular advantage of the invention that the tools and materials necessary can be hand carried to the site of refurbishment, it often being difficult to gain access to an underground railway site for lifting equipment and transporting equipment.

[0013] It is another particular advantage that the refurbishing method incorporates modular componentry so that the refurbishment work can be scheduled to take place during the periods of shut down of the railway so as to minimise disruption to the service. A refurbishment operation can take place over many days at specific periods of daily shut down, with the railway operating normally (apart from possible speed restrictions until the refurbishment is complete) outside the periods of shut down.

[0014] Preferably, the components used in performance of the methods occupy only a small volume, so that intrusion into the normally constricted space between the rails is minimised.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

- Fig.1 shows a cross-sectional view of a section of track in a first type of underground railway, the section of track having been refurbished by a first method according to the present invention;
- Fig.2 shows a plan view of one of the sleepers of the section of track of Fig.1 (with the rails absent);
- Fig.3 shows a cross-sectional view of a section of track in a second type of underground railway, the section of track having been refurbished by a second method according to the present invention;
- Fig.4 shows a cross-sectional view of an adjacent section of track to that of Fig.3;
- Fig.5 is a plan view of the sections of track of Figs. 4 and 5;
- Fig.6 is a plan view of the support beam of the second method;
- Fig.7 is a cross-sectional view of the support beam;
- Fig.8 is a side-sectional view of the fixing bolt of the second method;
- Fig.9 is a cross-sectional view through the fixing bolt at line IX-IX of Fig.8;
- Fig.10 is a cross-sectional view through the fixing bolt at line X-X of Fig.8; and
- Fig.11 is a cross-sectional view through the fixing bolt at line XI-XI of Fig.8

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0016] The underground railway is located within a substantially circular casing 10 (only part of which is shown), usually made up of separate sections of cast iron. At the bottom of the casing 10 is located a concrete base 12 (usually termed "concrete invert"). The concrete invert 12 includes central well 14 which is filled with ballast, and spaced recesses 16, each recess locating a sleeper 20. Each sleeper carries two pandrols 22 upon which the rails 24 are securely mounted. In the embodiment shown the trains are powered by electricity which is delivered by way of a positive current rail 26 and a negative current rail 30. The insulating mountings for the power rails are not relevant to the present invention, and so are not shown in the drawings.

[0017] The above is a description of a new or unrefurbished railway, but as above indicated over time the

sleepers 20 and the recesses 16 within which they are located suffer damage due to the repeated application of vertical and perhaps horizontal loading of the passing trains. Accordingly, the sleepers 20, which are initially a tight fit within the respective recess 16, eventually begin to move relative to the recess. Movement of one sleeper increases the load upon the adjacent sleepers causing damage (or an increase in the damage) of that sleeper, and so on.

[0018] The first method according to the invention involves lifting the rails 24 and sleepers 20 of a damaged section of track to their correct line and level. The damaged sleeper(s) 20, and the recess(es) 16, are cleaned (for example by a high pressure washer). If the recess is damaged it is repaired by trimming and/or with fast-setting concrete. A suitable fast-setting concrete is available from Natural Cement Distribution Limited, of Unit 12, Redbrook Business Park, Wilthorpe Road, Barnsley, S75 1JN, England, and sold under the trade name "LUL RAPIDSET" (TM).

[0019] A debonding compound is then injected into the gap between the sleeper 20 and the recess 16, and allowed to dry.

[0020] Notches 34 are then cut into the top of the sleeper 20.

[0021] Injection holes (not shown) are drilled at intervals around the edge of the sleeper, suitably at the locations numbered 36a and 36b in Fig.2 at each end of the sleeper (the locations 36a being approximately mid-way across the width of the sleeper and the locations 36b being approximately mid-way between the end of the sleeper and the end of the recess 16 in the concrete invert). A resin grout 38 is injected into the injection holes and hence into the gap between the sleeper 20 and the recess 16. The resin grout 38 is allowed to cure. A suitable resin grout is the epoxy adhesive sold under the trade name NATPHIL (RTM) code number EP-1310, also available from Natural Cement Distribution Limited.

[0022] Fixing holes 40 are then drilled from the notches 34, through the sleeper 20 and into the concrete invert 12, and a fixing bolt 42 inserted into each of the holes. The fixing bolt is suitably as described in the patent application WO02/099251 of ROMTECH Limited, and is better shown in Figs. 8-11. A full description of the fixing bolt can be obtained from the above-mentioned patent application, but for completeness a brief description is included herein.

[0023] The fixing bolt comprises a central bar 44, the distal end of which is threaded and carries a cooperatively-threaded nut 46. Surrounding the bar 44 is a set of deformable members 50, each of which is preformed into a zig-zag pattern with periodic points 52 lying close to (or in contact with) the bar 44 and intermediate points 54 spaced away from the bar 44. One end of each of the deformable members engages the nut 46, and in this embodiment is secured thereto by welding. The other end of each of the deformable members 50 engages a sleeve 56 (and in this embodiment is secured by welding

thereto), which sleeve surrounds a part of the bar 44. The proximal end of the bar 44 carries a bolt head 60 which is formed as a hexagon so as to receive a spanner or wrench. Between the bolt head 60 and the sleeve are located an anti-vibration washer 62 and a face plate 64.

[0024] The sleeve 56 is sufficiently long that the deformable members engage only the concrete invert 12, and specifically do not also engage the sleeper 20.

[0025] It will be understood that when relative rotation is imparted between the bar 44 and the nut 46 so as to reduce the distance between the nut 46 and the bolt head 60, the deformable members 50 are longitudinally compressed between the nut 46 and the sleeve 56. The deformable members are suitably metallic and so are substantially incompressible, so that longitudinal compression is accompanied by deformation of the members so that the points 52 are urged into or maintained in contact with the bar 44 and the points 54 are forced further away from the bar 44. It is arranged that the fixing bolt 42 is initially a sliding fit into the fixing hole 40, and axial expansion of the points 54 of the deformable members 50 forces those points into engagement with the surface of the drilled hole. Sufficient torque can be applied to the bolt head 60 to provide considerable frictional engagement between the deformable members 50 and the surface of the fixing hole to secure the fixing bolt 42 in the fixing hole 40, and so retain the sleeper 20 securely within the recess 16.

[0026] Since any gaps between the recess 16 and sleeper 20 have been infilled by resin grout, any likelihood of movement of the sleeper 20 within the recess 16 is much reduced or prevented, and the fixing bolts 42 secure these parts together and further reduce the likelihood of movement.

[0027] It is noted that the deformable members 50 are welded to the nut 46 (though another means of permanently securing these components together could be used). Thus, it is possible to impart relative rotation between the bar 44 and the nut 46 by rotating the bolt head 60 whilst the nut remains stationary (or at least rotates slower than the bolt head 60). Frictional engagement of one or more of the deformable members 50 with the surface of the fixing hole is likely to ensure that relative rotation occurs, and the frictional engagement will increase as relative rotation occurs.

[0028] In the embodiment shown in Figs. 8-11 the fixing bolt 40 has an overall length of 425 mm, and so the fixing hole is drilled to a depth slightly greater than this. It has been determined that two fixing bolts of this length, each with four deformable members which each engage the surface of the drilled hole at five spaced locations, will provide sufficient securement for the sleeper 20. Clearly more (or fewer) than four deformable members can be provided if desired, and each deformable member can have a sharper or shallower zig-zag pattern, providing more or fewer intermediate points for engagement with the surface of the fixing hole.

[0029] In the second type of underground railway

shown in Figs. 3 and 4, however, the depth of the concrete invert is less, and it is not possible to drill a fixing hole to a depth of 425 mm without fouling the casing 110. In such an embodiment it may be possible to use the same method as above described with a shorter fixing bolt, but that is not expected to provide sufficient securement for the sleeper. Instead, therefore, a second method is provided, in which the sleeper is indirectly secured to the concrete invert by way of a support beam as shown in Figs. 3-7.

[0030] As shown in Fig. 5, a support beam 70 runs parallel to the rails 24, and lies immediately inside each of the pandrols 22. The support beam is intended to lie along the track for a distance at least as great as the section of track to be refurbished. To facilitate ease of handling, the support beam is provided in separate lengths of around 3 metres, which lengths are joined together by way of respective "fish plates" 72 (Figs. 6 and 7). A fish plate 72 is permanently secured (in this embodiment by welding at points 74 (Fig. 7)) to project from the end of each length of support beam 70. The fish plate has two pre-drilled and tapped holes 76 which can receive correspondingly threaded connecting bolts (not shown). The support beam has a number of openings 80 formed therethrough, and two connecting bolts (carrying a suitable washer to span the opening 80) can be passed through respective openings in an adjacent support beam and into the tapped holes 76, so as to secure the two lengths of support beam together.

[0031] As shown in Fig. 7, the support beam 70 is of generally L-shape in sectional view, the relative lengths of the legs of the "L" being set to determine the relative angle α (Fig. 4) at which the fixing bolt 142 will be inserted. In this embodiment, the angle α is 60°. The support beam 70 has an additional support leg 82.

[0032] As shown in Fig. 4, a fixing bolt 142 is used to secure the support beam 70 to the concrete invert. The fixing bolt 142 is similar to the fixing bolt 42 of Figs. 8-11, but is of shorter overall length (approximately 350 mm) and has a shorter sleeve so that the deformable members engage the concrete invert 112 and not the support beam 70.

[0033] As shown in Fig. 3, the support beam 70 and sleeper 20 are secured together by way of a conventional wood fixing bolt 84, which passes through an opening 80 and into the sleeper 20.

[0034] Preferably, the support beam 70 is initially assembled to its desired length. Subsequently, the holes for the respective fixing bolts 142 are drilled through appropriately-positioned openings 80, and the holes for the respective wood fixing bolts 84 are drilled through other appropriately-positioned openings 80. In this way, the support beam 70 facilitates accurate positioning and alignment of the drilled holes. The support beam 70 may be temporarily clamped to the pandrols 22 whilst the drilling operations are undertaken.

[0035] Fig. 5 shows the arrangement of bolts used to secure the sleepers 20 to the concrete invert 114 by way

of the support beams 70. The letter S signifies a wood fixing bolt by which the sleeper and support beam are secured together. The letter F signifies a fish-plate bolt by which a length of the support beam is secured to the fish plate welded to the adjacent length of the support beam. The letter C signifies a fixing bolt 142 by which the support beam 70 is secured to the concrete invert 112.

[0036] It will be seen from Fig.5 that not all of the openings 80 are utilised, and in alternative embodiments openings are only provided where required. However, the provision of regularly-spaced openings 80 throughout the length of the support beam 70 is preferred notwithstanding that some of those openings may not be utilised, since it will be easier to ensure {i} that an opening 80 overlies each of the sleepers 20 and can receive a wood fixing bolt 84, and {ii} that another opening lies between adjacent sleepers and can receive a fixing bolt 142. Also, desirably the spacing between each of the openings 80 is less than half the width of a sleeper 20, so that at least two openings overlie each sleeper, enabling the user to choose which opening to utilise, a choice possibly being necessary if the top surface of the sleeper 20 is damaged.

[0037] Whilst the invention is preferably performed with the fixing bolts according to WO02/099251, it can of course be performed with other suitable fixing bolts, such as for example resin-mounted bolts.

Claims

1. A method of refurbishing a railway track laid on sleepers (20) mounted in respective recesses (16) of a concrete base (12; 112), the method including the steps of:

- {i} infilling the gap between a sleeper and a recess in the concrete base,
- {ii} drilling a hole (40) into the concrete base,
- {iii} inserting a fixing bolt (42; 142) into the drilled hole, and
- {iv} tightening the fixing bolt so as to secure the sleeper to the concrete base.

2. The method according to claim 1 in which the step of infilling the gap between the sleeper and the recess in the concrete base includes the steps of:

- {i} lifting the rails (24) and sleepers (20) of a damaged section of track to their correct line and level,
- {ii} cleaning the sleeper and the recess (16),
- {iii} injecting a debonding compound into the gap between the sleeper and the recess and allowing to dry, and
- {iv} injecting a settable liquid (38) into the gap between the sleeper and the recess.

3. The method according to claim 1 or claim 2 in which the step of infilling the gap between the sleeper and the recess in the concrete base includes the additional step(s) of trimming the recess, and/or repairing the recess with fast-setting mortar.

4. The method according to claim 1 in which two fixing bolts (42; 142) are used for each sleeper.

5. The method according to any one of claims 1-4 in which the hole (40) drilled for the fixing bolt (42) passes through the sleeper (20) and into the concrete base (12) so that the fixing bolt may secure the sleeper directly to the concrete base.

6. The method according to claim 5 including the step of cutting a notch (34) into the sleeper (20) for each of the fixing bolts (42).

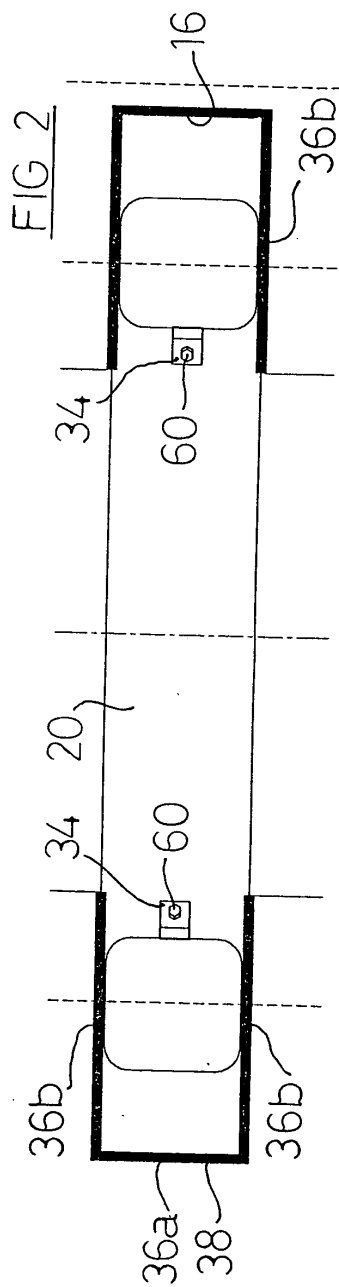
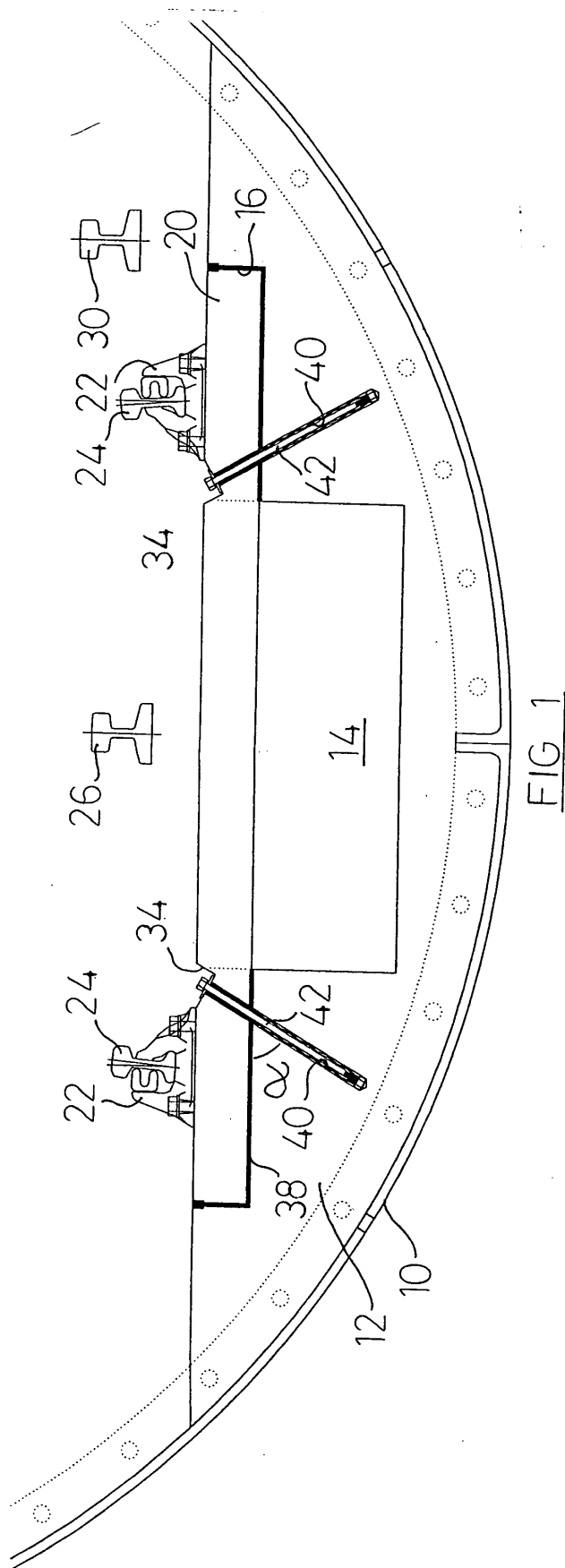
7. The method according to any one of claims 1-4 in which the hole drilled into the concrete base does not pass through the sleeper, and in which a support beam (70) is provided, the method including the further steps of securing the support beam to the sleeper (20) and to the concrete base (112), the sleeper being indirectly secured to the concrete base by way of the support beam.

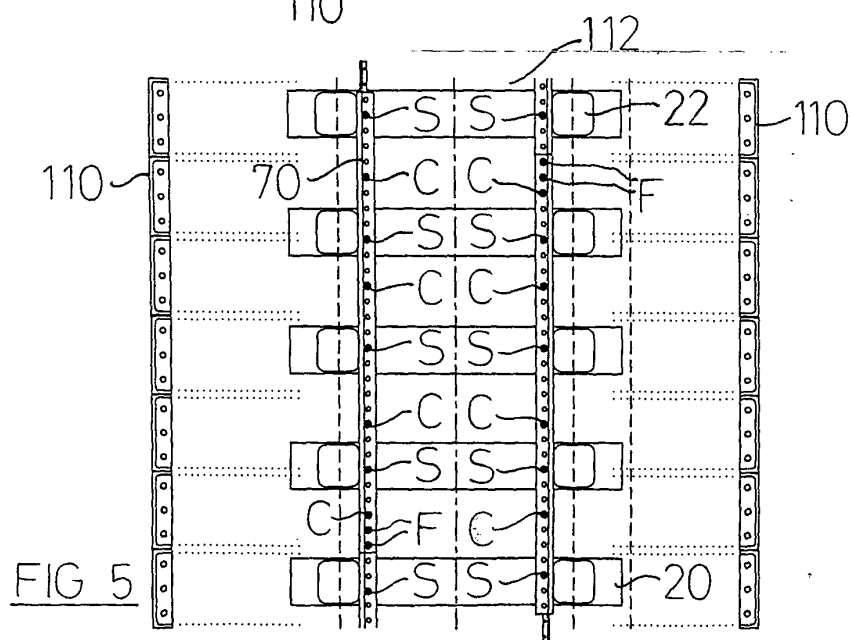
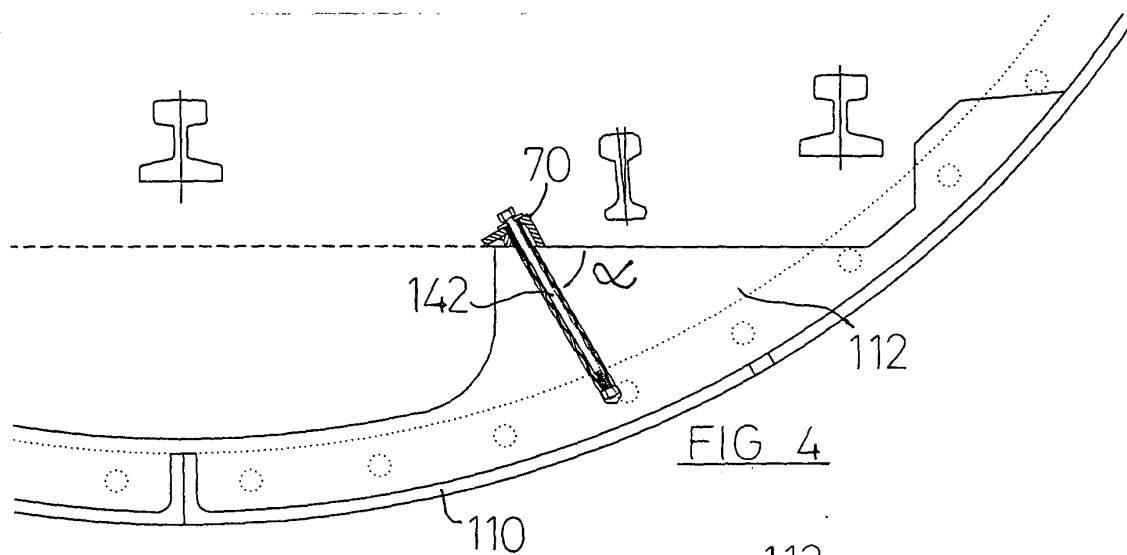
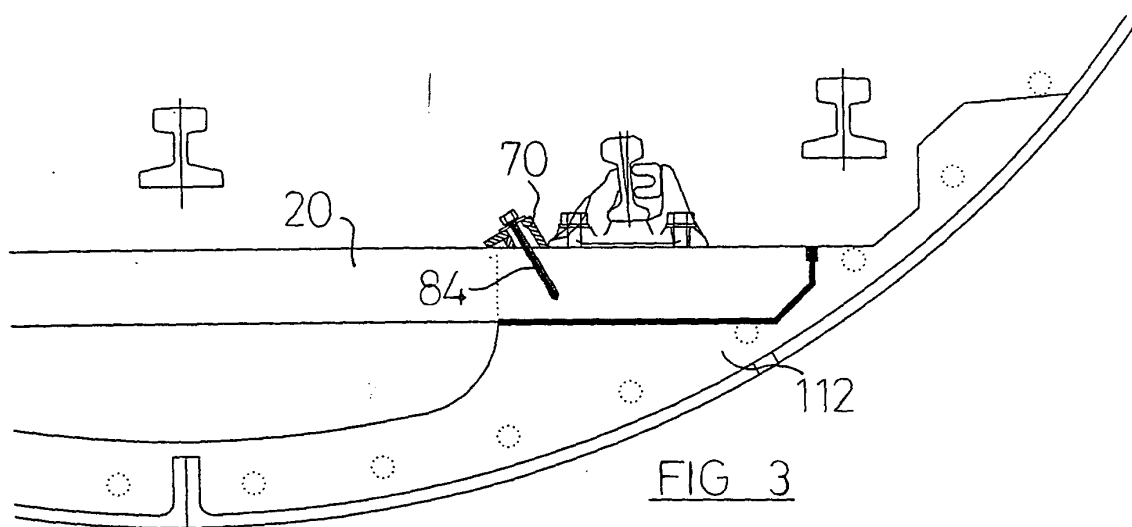
8. The method according to any one of claims 1-7 in which the hole is drilled at an angle (α).

9. An apparatus for performing the method of any one of claims 1-9 comprising:

- {i} delivery means for introducing a settable fluid into the gap between a sleeper and a recess in the concrete base,
- {ii} drilling means for drilling a fixing hole (40) into the concrete base,
- {iii} at least one fixing bolt (42; 142), and
- {iv} tightening means for tightening the fixing bolt so as to secure the sleeper to the concrete base.

10. The apparatus according to claim 9 in which the fixing bolt (42; 142) has a sleeve (56), the sleeve being at least as long as the depth of the sleeper (20) or support beam (70) through which the fixing bolt is to be passed.





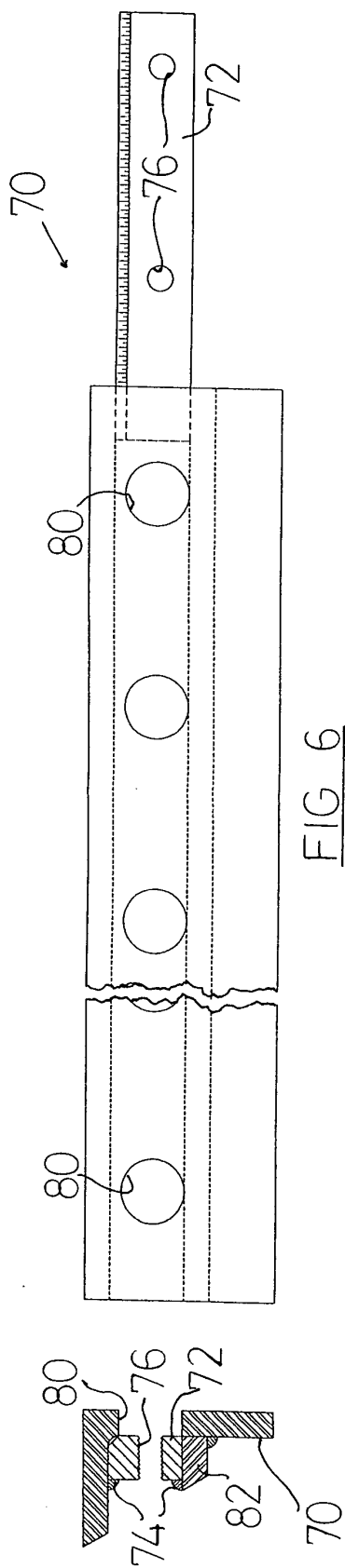


FIG 6

FIG 7

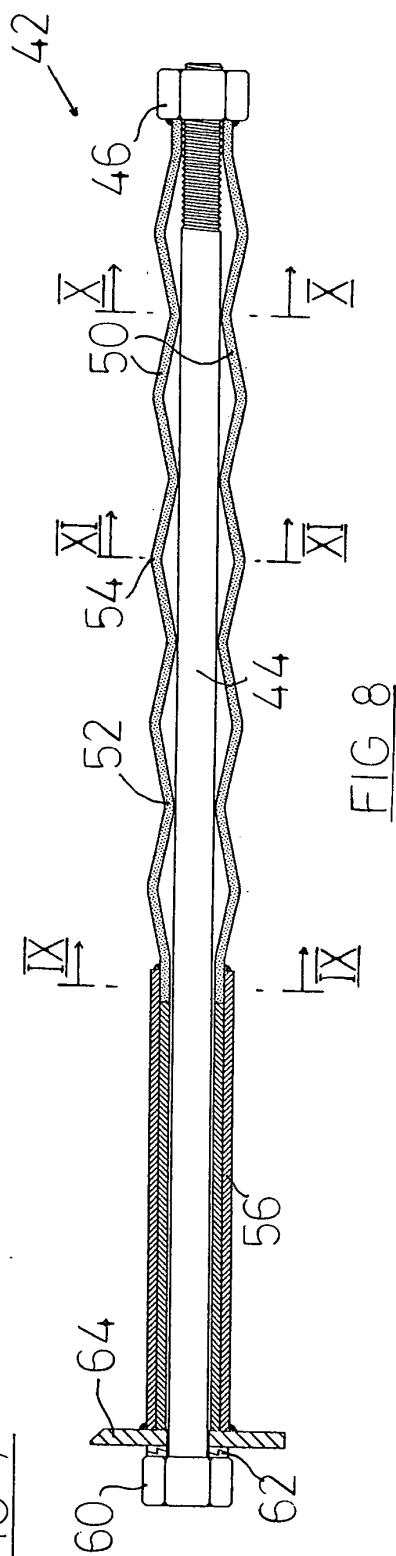


FIG 8

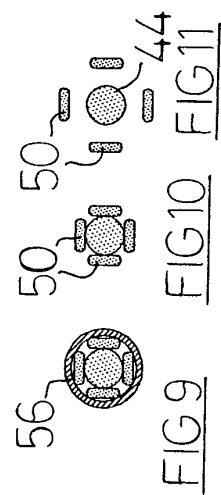


FIG 9 FIG 10 FIG 11