(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 619 401 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **93120016.6**

(51) Int. Cl.[5]: **E01B 35/10**

(22) Date of filing: **11.12.93**

(30) Priority: **11.01.93 SE 9300058**

(43) Date of publication of application:
12.10.94 Bulletin 94/41

(84) Designated Contracting States:
BE DE DK ES FR GB IT NL

(71) Applicant: **AB BEWAG**
Box 9024
S-200 39 Malmö (SE)

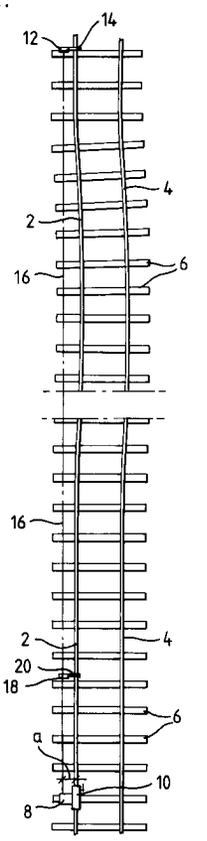
(72) Inventor: **Linde, Bertil**
Sarturnusgatan 113
260 35 Odakra (SE)

(74) Representative: **Linde, Leif**
Vernamo Patentbyra AB,
Persegard
S-274 93 Skurup (SE)

(54) A method and a device for adjusting the position of elongated elements, especially railway tracks.

(57) In a method for adjusting the position of elongated elements, preferably the rails of a railway track, a laser equipment (8) is fixed to the elongated element (2) and there is from the laser equipment emitted a laser beam against a first reflector (12), which is fixed at at distance from the laser equipment along the elongated element (2). Thereby there is defined a straight reference plane (16). The section of the elongated element positioned between the laser equipment (8) and the first reflector (12) is then adjusted into correct position by displacing said section in lateral direction to a predetermined distance from the reference plane (16) by means of a second reflector (18). A device for adjusting the position of elongated element, preferably the rails of a railway track, comprises a laser equipment (8) and at least one reflector (12) for receiving the laser beam from the laser equipment and reflecting the beam back to the laser equipment.

Fig.1a.



EP 0 619 401 A1

The present invention relates to a method for adjusting the position of elongated elements, preferably the rails of a railway track, in at least one plane and a device for carrying out the method.

When laying railway tracks the rails are placed on and fixed to sleepers in approximately the position which the track shall finally have. After the laying operation the track is adjusted to the exactly correct position by lateral displacement or slewing of the sleepers supporting the rails. The adjustment of the position is according to conventional technique conducted by means of conventional levelling instruments requiring a time-consuming and laborious operation. Also in respect of the accuracy of the adjustment operation the previously known technique involves certain shortcomings which is a drawback especially when laying railway tracks for traffic with high train speeds.

In recent times one has begun to use laser technique for adjusting the position of railway tracks but the laser technique has been used according to the same principle as in the use of conventional levelling instruments. This, it has by means of the use of the laser technique been possible to improve the accuracy of the adjustment of the position of the railway tracks while the use of the laser technique has not provided any solution to the other drawbacks of the previously known technique.

The object of the invention is to provide a method for adjusting the position of elongated elements, preferably rails of railway tracks, in at least one plane and a device for carrying out the method, wherein the use of the laser technique provides for a rapid, accurate and labour-saving adjustment operation.

In order to comply with this object the method according to the invention is characterized in that a laser equipment comprising a laser source and a receiver is fixed to the elongated element, preferably a railway rail, for emitting towards a first reflector and receiving therefrom a laser beam, the source and the receiver being thereby positioned in a predetermined lateral position in relation to the elongated element, that the first reflector is fixed at a distance from the laser equipment along the elongated element in a position in which it is hit by and reflects the laser beam emitted by the laser equipment so as to define a straight reference plane positioned between the laser source and the first reflector, and that the section of the elongated element positioned between the laser equipment and the first reflector is adjusted with regard to its position by fixing a second reflector to the elongated element at a desired number of successive points and at each point is adjusted in a predetermined lateral position in relation to the elongated element and the elongated element is laterally displaced in order to position the second reflector in the reference plane defined by the laser beam and thereby for adjusting said points of the elongated element in the predetermined position in relation to the reference plane.

Because of the fact the laser equipment and at least the second reflector are fixed directly to the elongated element the adjustment of the position thereof can be conducted in a rapid, accurate and labour-saving way.

When the elongated elements are constituted by railway rails which shall be positioned on a straight line the second reflector is positioned in the same lateral position in relation to one of the railway rails as the source and receiver of the laser equipment and this position is retained at all points where the reflector is fixed to the railway rail, the railway rail being laterally displaced for adjusting the second reflector in the reference plane defined by the laser beam. When laying railway rails on a straight line the distance between the laser equipment and the first reflector may amount to about 200 meters.

When laying railway rails in curved shape the second reflector is positioned at each point where the reflector is fixed to the railway rail at a position in lateral direction in relation to the railway rail which position is adapted to the distance of the second reflector from the laser equipment and the desired curvature of the railway rail.

The invention also relates to a device for carrying out the method according to the invention, and this device comprises a laser equipment having a laser source and a receiver for a laser beam and at least one reflector for reflecting the beam from the laser equipment back to the laser equipment, a retainer device by means of which the laser equipment is fixable to the elongated element with the laser source and the receiver in a predetermined or adjustable lateral position in relation to the elongated element, and a fastener for the reflector by means of which the reflector is fixable to the elongated element in a predetermined or adjustable lateral position in relation thereto.

Preferably the device comprises two reflectors which by means of one fastener each are fixable to the elongated element in a predetermined or adjustable lateral position in relation thereto.

The method according to the invention and an embodiment of a device for carrying out the method shall be described in the following with reference to the accompanying drawings.

Figs. 1a and 1b show the method according to the invention in laying a railway track, fig. 1a showing the initial stage of the adjustment of the position of a certain railway distance and fig. 1b showing the final stage of the adjustment of the position of the same distance.

Fig. 2 shows the method according to the invention when adjusting the position of a railway track in a curve.

Figs. 3a, 3b and 3c are an end view, a plan view and a side view, respectively, of a laser equipment and a retainer device thereof included in the device according to the invention.

Figs. 4a and 4b are an end view and a plan view, respectively, of a first reflector and a fastener thereof included in the device according to the invention.

Figs. 5a and 5b are an end view and a plan view, respectively, of a second reflector and a fastener thereof included in the device according to the invention.

Figs. 1a and 1b illustrate the method and the use of the device according to the invention for adjusting the position of a railway track when laying a straight section of the track. The railway track consists in the usual way of two parallel rails 2 and 4 which are fixed to sleepers 6. When laying the track the rails 2 and 4 are positioned on and fixed to the sleepers 6 in approximately the position which the rails shall have in the final railway track. After this positioning the track is adjusted to exactly the correct position by laterally displacing or slewing the sleepers 6 supporting the rails. The railway track shown in Figs. 1a and 1b extends along a distance of about 200 meter, and the track shown in Fig. 1a is laid in approximately the position which the track shall finally have. The lower end of the track according to Fig. 1a takes an exactly correct position and the section of the track between the lower end of the figure and the upper end of the figure shall by means of the method and the device according to the invention be adjusted to exactly straight position.

In accordance with the invention a laser equipment 8 is by means of a retainer device 10 fixed to the rail 2 of the railway track at a section of the track positioned in the lower part of Fig. 1a, this section being previously adjusted to correct position. Thereby the retainer device 10 is designed so that the laser source and the laser receiver of the laser equipment 10 take an exactly predetermined lateral distance "a" from the rail 2 when the laser equipment is fixed to the rail 2. In the embodiment shown the distance a amounts to 25 cm but of course the distance can be of any other desired size. Thereupon, there is at a distance of about 200 meters from the laser equipment 8, i.e. at the upper section of the railway according to Fig. 1a, fixed a reflector 12 to the rail 2 by means of a fastener 14 at the same lateral distance a from the rail 2 as the laser equipment, i.e. a distance of 25 cm from the rail 2. The laser equipment 8 is adjusted by means of the retainer device 10 in the plane of the railway track so that a laser beam emitted from the laser equipment 8 is reflected by the reflector 12 back to the laser equipment 8. When this adjustment is satisfied the laser equipment 8 generates an indicator signal in an acoustic way. After conducting these adjustment operations the laser beam emitted by the laser equipment 8 towards the reflector 12 and received by the laser equipment 8 from the reflector 12 will define a straight reference plane. The reference plane 16 defined by the laser beam is used for adjusting the position of the distance of the railway track position between the laser equipment 8 and the reflector 12. This is provided by fixing a second reflector 8 supported by a fastener 20 to the rail 2 in the vicinity of the laser equipment 8, the fastener 20 being such that the reflector 18 thereby takes the same lateral position from the rail as the laser equipment 8 and the reflector 12, i.e. the distance "a" which in the embodiment shown amounts to 25 centimeters. After the second reflector 18 has been fixed to the rail 2 the sleepers 6 and thereby the rails 2 and 4 are laterally displaced until the second reflector 18 take a position in which it is positioned in the reference plane 16 defined by the laser beam. This position is indicated by the fact that the reflector 18 reflects the laser beam to the laser equipment 8 which reflection is acoustically or in any other way indicated by the laser equipment 8. Thereupon, the reflector 18 is positioned on the rail 2 at a successively larger distances from the laser equipment 8 and the described adjustment operation is repeated until the complete distance between the laser equipment 8 and the reflector 12 has been laterally adjusted, i.e. been adjusted so that the rails 2 and 4 are parallel with the reference plane 16. The adjustment of the position of the railway track is then continued by adjusting the position of a further distance of about 200 meters in the same way, whereby the laser equipment 8 is displaced to the vicinity of the reflector 12 and the reflector 12 is advanced about 200 meters. Thereupon, the method described above is repeated.

In Fig. 2 there is shown the adjustment of the position of the railway track in a curve. The adjustment operation is conducted in principally the same way as described above with reference to Figs. 1a and 1b, i.e. the laser equipment 8 is fastened to the rail 2 by means of the retainer device 10 at a predetermined lateral distance from the rail 2, preferably 25 cm, and the first reflector 12 is fixed to the rail 2 by means of the fastener 14 at a distance from the laser equipment 8. When adjusting the position of the railway rail in a curved shape the distance between the laser equipment 8 and the reflector 12 is usually shorter than when the railway track is laid on a straight line, the distance in question for example amounting to about 80 meters. The lateral distance between the

reflector 12 and the rail 2 is adapted with regard to the desired radius of curvature of the railway track. The value of the lateral distance can be taken from tables stating the lateral deviation of the rail for a certain distance and a certain radius of curvature. When the laser equipment 8 and the reflector 12 have been fixed to the rail 2 there is established a reference plane 21, thus extending along a straight line between the laser equipment 8 and the reflector 12.

The adjustment of the distance of the rail between the laser equipment 8 and the reflector 12 thereupon takes place by fixing the second reflector 18 by means of the fastener 20 to the rail 2 at a distance of for example 3 meters from the laser equipment 8, the distance between the reflector 18 and the rail 2 being adjusted by means of the fastener 20 with regard to the desired radius of curvature and the actual distance from the laser equipment 8. In the left curve shown in Fig. 2 the distance between the reflector 18 and the rail 2 will successively decrease in relation to the distance between the laser equipment 8 and the rail 2, i.e. said distance will succesively with larger and larger values be less than 25 cm. Like in the adjustment operation according to Figs. 1a and 1b the track is after the fastening of the reflector 18 to the rail 2 displaced to a position in which the reflector 18 reflects the laser beam from the laser equipment 8 which means that the reflector is positioned in the reference plane 21. The reflector 18 is successively advanced up to the reflector 12 while the lateral position of the track is adjusted, the distance between the reflector 18 and the rail 2 being in each point of fixation adjusted with regard to the distance from the laser equipment 8 and the radius of curvature.

The method according to the invention can be modified within the scope of the claims. For example, it is possible to provide the reference plane defined by the laser beam by fastening the reflector 12 in another way than by fastening the reflector to the rail 2. It is also possible to use just one reflector by using the same reflector for defining the reference plane and for the adjustment operations which according to the embodiment shown in Figs. 1, 1b and 2 are conducted by means of the reflector 18.

The laser equipment 8 and the fastening device 10 thereof are in Figs. 3a, 3b and 3c shown from the end, in plan view and in side view, respectively. The fastening device 10 comprises an angular element 22 consisting of a horizontal plate 24 and a vertical plate 26 which are connected with each other at the corner of the angular element. At the ends of the horizontal plate 24 the angular element 22 has a pair of support elements 28 in the form of short pieces of flat iron bars which are vertically adjustable in relation to the angular element 22 by being at their end portions supported by bolts 30, engaging threaded holes in the horizontal plate 24 of the angular element 22 and being lockable in relation thereto by means of locking nuts 32. The support elements 28 rest on the upper surface of the rail 2, and by adjustment of the height position of the support elements 22 by turning the bolts 30 it is possible to arrange the fastening device 10 and the laser equipment 8 supported thereby in a desired height position in relation to the rail 2.

The upper surface of the horizontal plate 24 of the angular element 22 is at its end portions provided with transversely extending sleeves 34 by means of which clamping devices 36 are connected with the angular element 22.

The clamping devices 36 are designed as adjustable clamps which in a conventional way each consists of an angular portion forming one fixed shank 38 and the web portion 40 of the clamp and a second shank 42 displacably connected with the web portion 40 and supporting at its opposite end in relation to the web portion 40 the clamping bolt 44 of the clamping device 36.

The web portion 40 of each clamping device 36 is displacably received in one sleeve 34 each.

The end portion of the fixed shank 38 of the clamping devices 36 engages the head 46 of one bolt 48 each. The bolts 48 adjustably engage an inner thread of a thickened portion 50 arranged at the free edge of the vertical plate 26 of the angular element 22. The bolts 48 are adjusted so that the ends 52 thereof engage the opposite surface of the web portion 56 of the rail 2 in the position in which the surface 54 of the vertical plate 26 of the angular element 22, which faces the head 58 of the rail engages the head 58 of the rail. The surface 54 on the vertical plate 26 of the angular element 22 can be considered to define the exact lateral position of the retainer device 10 in relation to the rail 2. When the clamping bolts 44 of the clamping device 36 are tightened against the side of the web portion 56 opposite from the bolts 48 the retainer device 10 will be forced against the side surface of the rail 2 with the surface 54 of the vertical plate 26 of the angular element 22 and the end 52 of the bolts 48. Thereby there is provided an exact determination of the position of the retainer device in relation to the rail in lateral direction as well as a fixing of the retainer device to the rail.

At its upper surface the horizontal plate 24 of the angular element 22 supports an angle plate 60 consisting of horizontal plate 62 and vertical plate 64. The horizontal plate 62 is rotatably connected with a horizontal plate 24 of the angular element 22 by menas of a bolt 66 which means that the angle plate 60 is rotatable in the horizontal plane. The

laser equipment 8 is connected with the vertical plate 64 of the angle plate 60 by means of a clamping element 68 extending into engagement with the laser equipment 8 through an opening in the vertical plate 64 of the angle plate 60 and forcing a surface of the laser equipment 8 against the surface 70 on the vertical plate 64 of the angle plate 60 for providing an accurate positioning of the laser equipment 8. The surface 70 of the vertical plate 64 is positioned in the same plane as the surface 54 on the vertical plate 26 of the angular element 22, and when the surface 54 engages the side surface of the head 58 of the rail 2 this means that the laser equipment is provided with an exact positioning in relation to the rail. As mentioned, the angle plate 60 is adjustable in the horizontal plane by being rotated around the bolt 66 which defines the rotational axis which is positioned in the vertical symmetry plane of the laser equipment. As is most clearly evident from Fig. 3b the adjustability of the angle plate 60 is provided by the fact that a tension spring 70 is connected between the end portion of the vertical plate 64 and the upper surface of the horizontal plate 24 of the angular element 22 and by the fact that an adjustment bolt 72 is rotatably received in an ear 74 firmly connected with the horizontal plate 24 of the angular element 22 and engaging with its free end the vertical plate 64 loaded by means of the tension spring 70. The adjustment bolt 72 supports a locking nut 76 which by tightening against the ear 74 locks the adjustment bolt 72 in the adjusted position.

By means of the retainer device shown in Figs. 3a, 3b and 3c it is possible to connect the laser equipment 8 with the rail 2 in an exactly predetermined position in relation thereto while it is at the same time possible to adjust the rotational position of the laser equipment 8 so that the laser beam hits the reflector when establishing the reference planes 16 and 20 for conducting the operations described with reference to Figs. 1 and 2.

Figs. 4a and 4b show the fastener 14 for supporting the reflector 12 on the rail 2. The fastener 14 comprises an angular piece 80 having a horizontal portion 82 and a vertical portion 84. The horizontal portion 82 is provided with downwardly extending support pins 86 having lower surfaces which engage the upper surface of the head 58 of the rail 2 in order to define the height position of the angular piece 80 and thereby of the fastener and the reflector 12. If desired, the support pins 86 can be replaced by a support plate and adjustable bolts in the same way as in the retainer device for the laser equipment 8. A clamping device 88 of in principle the same design as the clamping devices 36 in the retainer device 10 is connected with the angular piece 80 by the fact that the web portion 90 of the clamping device 88 is displacably received in a socket 92 which is firmly connected with the upper surface of the horizontal portion 82 of the angular piece 80. A fixed shank 94 and a displacable shank 96 are connected with the web portion 90 of the clamping device 88 in principally the same way as in an adjustable clamp.

At its end portion the fixed shank 94 engages an adjustment bolt 98 extending through an inwardly threaded bushing at the vertical portion 84 of the angular piece 80. The adjustment bolt 98 is adjusted so that the end surface 100 thereof engages the web portion 56 of the rail 2 in the position in which the surface 102 of the vertical portion 84 of the angle piece 80, facing the rail engages the side surface of the head 58 of the rail. Due to the engagement of the surface 102 with the head of the rail there is provided an exact definition of the position of the fastener in the lateral direction in relation to the rail. When the clamping device 88 is tightened by turning the clamping bolt 104 of the clamping device which bolt engages the opposite side of the web portion of the rail in relation to the adjustment bolt 98 the vertical portion 84 of the angular piece 80 and the adjustment bolt 98 are forced against the side surface of the rail.

The angle piece 80 supports a rod 106 welded to the upper surface of the sleeve 92, the rod thus extending transversely of the longitudinal direction of the rail 2. The rod 106 supports the reflector 12, the housing of the reflector engaging by means of a U-shaped element 108 the rod 106 and being by means of a clamping bolt 110 lockable to the rod. The rod 106 is provided with a setting scale 112 having its zero point in the plane of the surface 102 and being usable for positioning the reflector at the desired lateral distance from the rail 2.

Figs. 5a and 5b are an end view and a plan view, respectively, of the second reflector 18 and the fastener 20 thereof for connecting the reflector 18 with the rail 2. The fastener 20 comprises a U-shaped element 120 having a web portion 122 and shanks 124 and 126. The U-shaped element 120 encloses the head 58 of the rail 2 and engages by means of its web portion 122 the upper surface of the head 58 and by its shank 124 one side surface of the head 58. The surface 128 by means of which the shank 124 engages the head 58 of the rail 2 defines the position of the fastener 20 and thereby the lateral position of the reflector 18 in relation to the rail, and the surface 128 is forced against the side surface of the head 58 by means of a clamping bolt 130 extending through an internally threaded bushing on the shank 126 of the U-shaped element 120.

The U-shaped element 120 supports a rod 132 welded to the upper surface of the element and extending perpendicular to the longitudinal direction of the rail 2. The reflector 18 is fastened to the

rod 132 by the fact that the housing of the reflector is provided with a U-shaped element 134 which by means of a locking bolt 136 is fixable to the rod 132 at a desired point of the length thereof. The rod 132 is provided with a scale 138 having its zero point in the plane of the surface 128 on the shank 124 of the U-shaped element 120, and this scale 138 can be used for positioning the reflector 18 at the desired lateral distance from the rail 2.

When carrying out the method according to the invention the laser equipment 8 is first fixed to the rail 2 by means of the retainer device 10, the laser equipment 8 being provided with the correct position for emitting the laser beam at a predetermined lateral distance from the rail, for example amounting to 25cm, by the fact that the surface 54 of the retainer device, which surface is positioned on the vertical plate 26 of the angular element 22 engages the side surface of the head 58 of the rail 2.

Thereupon, the reflector 12 is fixed to the rail by means of the fastener 14 at a distance of about 200 meters from the laser quipment 8, the reflector being by means of the scale positioned at a distance of 25 cm from the rod 106 and being fixed in this position by means of the clamping bolt 110.

Finally the second reflector 18 is used for adjusting the position of the rail length between the laser equipment 8 and the reflector 12 by fixing the reflector 18 by means of the fastener 20 to the rail at successive points along said distance. Before that, the reflector 18 has been fixed to the rod 132 by means of the clamping bolt 136 and by means of the scale 138 at a distance of 25 cm from the plane of the surface 128 on the shank 124 of the U-shaped element 120.

For adjusting the position of curved sections of the rail the reflectors 12 and 16 are positioned at a distance from the respective plane defined by the surfaces 102 and 128, respectively, in view of the radius of curvature.

The invention can be modified within in the scope of the following claims.

Claims

1. A method for adjusting the position of elongated elements, preferably the rails of a railway track, in at least one plane, **characterized** in that a laser equipment (8) is fixed to the elongated element (2) for emitting towards and receiving from a first reflector (12) a laser beam with the laser source and receiver of the laser equipment positioned in a predetermined lateral position in relation to the elongated element, that said first reflector (12) is fixed at a distance from the laser equipment along the elongated element (12) in a position, in which it is hit by and reflects the laser beam transmitted by the laser equipment for defining a straight reference plane (16; 21) positioned between the laser equipment and the first reflector, and that the position of the section of the elongated element extending between the laser equipment and the first reflector is adjusted by fixing to the elongated element (2) at a desired number of successive points thereof a second reflector (18), each point being positioned or being adjusted to be positioned in a predetermined lateral position in relation to the elongated element and the elongated element is laterally displaced for adjusting the reflector (18) into the reference plane defined by the laser beam and thereby for adjusting said points of the elongated element in said predetermined position in relation to the reference plane.

2. A method as claimed in claim 1, **characterized** in that the first reflector (12) is fixed to the elongated element (2) in the same lateral position in relation thereto as the laser source and receiver of the laser equipment (8).

3. A method according to claim 1 or 2, for adjusting the elongated element, preferably the railway track, in a straight shape, **characterized** in that the second reflector (18) is positioned in the same lateral position in relation to the elongated element as the laser source and receiver of the laser equipment (8) and that this position is maintained at all points wherein the reflector (18) is fixed to the elongated element and the elongated element is laterally displaced for positioning the second reflector in the reference plane (16, 21) defined by the laser beam.

4. A method according to claim 1 or 2, for positioning the elongated element, preferably the railway track, in a curved shaped, **characterized** in that the second reflector (18) is in each point wherein the reflector is fixed to the elongated element (2) positioned in a lateral position in relation to the elongated element, which is adapted to the distance of the second reflector from the laser equipment (8) and the desired radius of curvature of the elongated element.

5. A method as claimed in any of the preceding claims, **characterized** in that the first reflector (12) is after the establishment of the reference plane (16; 21) used as a second reflector (18) when adjusting the elongated element (2) at the predetermined lateral distance from the reference plane.

6. A device for adjusting the position of elongated element, preferably the rails of a railway track, in at least one plane according to the method as claimed in claim 1, comprising a laser equipment (8) having a laser source and a receiver for a laser beam and at least one reflector (12) for receiving the laser beam from the laser equipment and for reflecting the beam thereto, **characterized** by a retainer device (10), by means of which the laser equipment (8) is fixable to the elongated element (2) with the laser source and the receiver in a predetermined or adjustable lateral position in relation to the elongated element and by a fastener (14) for the reflector (12) by means of which the reflector is fixable to the elongated element (2) in a predetermined or adjustable lateral position in relation thereto.

7. A device as claimed in claim 6, **characterized** by two reflectors (12; 18) which by means of one fastener (14; 20) each are fixable to the elongated element (2) at different distances from the plane in a predetermined or adjustable lateral position in relation thereto.

8. A device as claimed in claim 6 or 7, **characterized** in that the fastener (14; 20) of the reflector (12; 18) or one of the reflectors has a scale (112; 138) for a direct indication of the lateral distance between the reflector (12; 18) and the elongated element (2) in a direction parallel with the plane.

9. A device as claimed in any of claims 6 - 8, **characterized** in that the retainer device (10 for the laser equipment (8) comprises a locking device (22, 36) for fixing the retainer device to the elongated element (2) and a fastener (60) supported by the fixing device for the laser equipment, said fastener being adjustably connected with the locking device.

10. A device as claimed in claim 10, **characterized** in that the fastener (60) is rotatably connected with the locking device (22, 36) in a plane parallel with the plane in which the elongated element shall be adjusted with regard to its position.

11. A device as claimed in claim 9 or 10, **characterized** in that the locking device comprises a clamping element (36), which is tightable against oppositely directed surfaces of the elongated element.

Fig.1a.

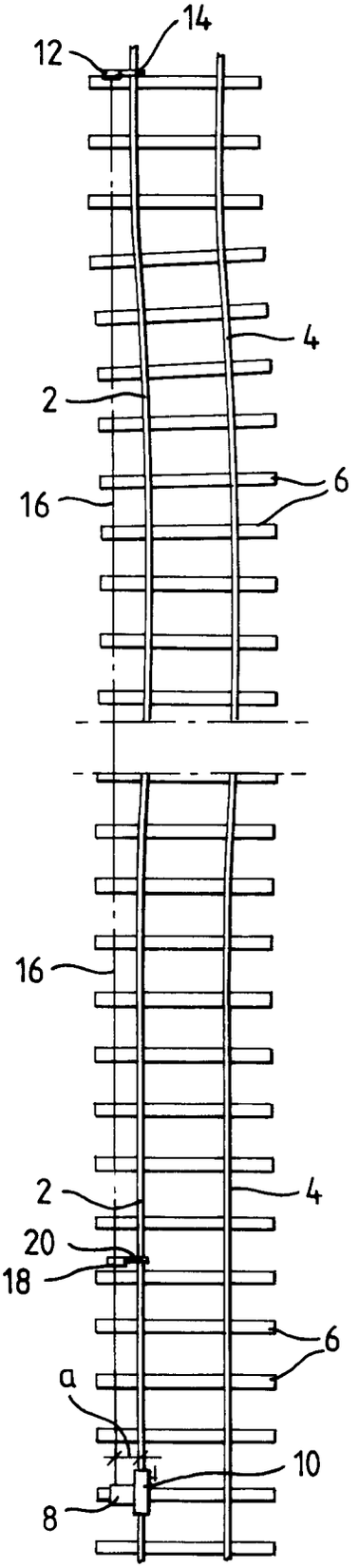


Fig.1b.

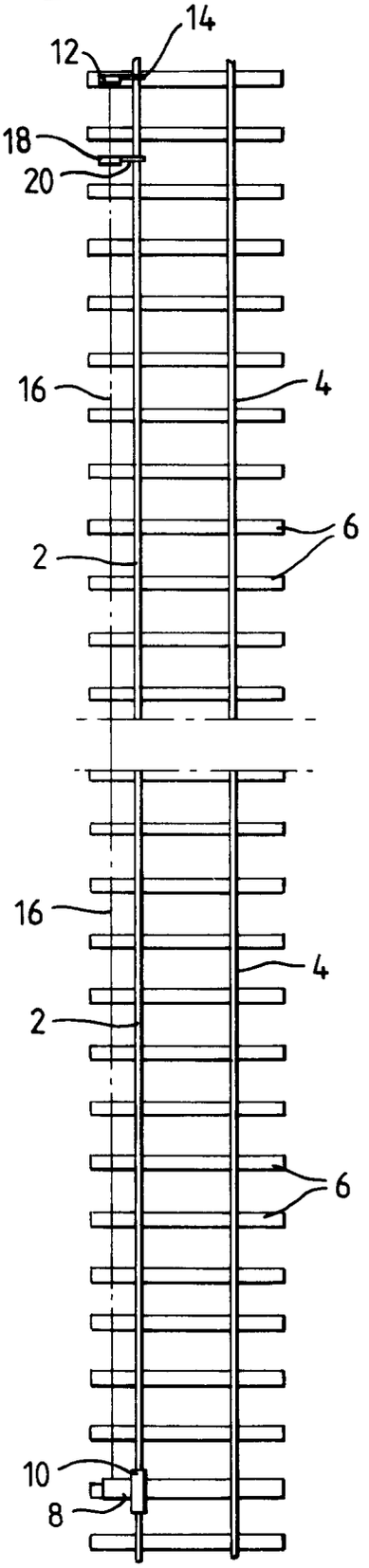


Fig.2.

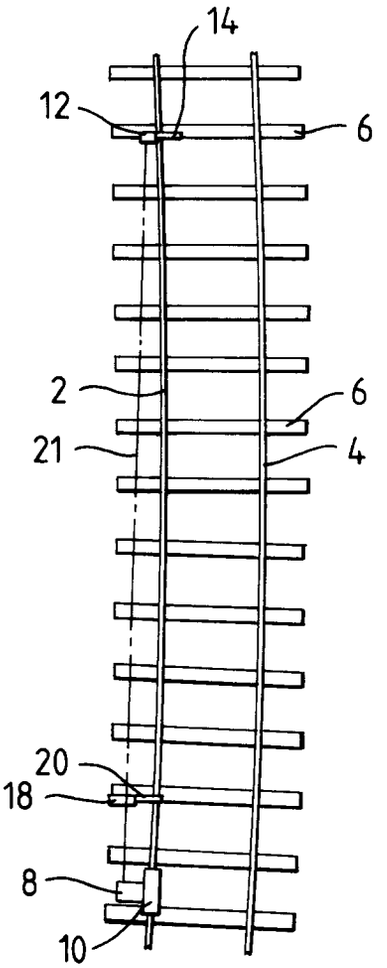


Fig.3a.

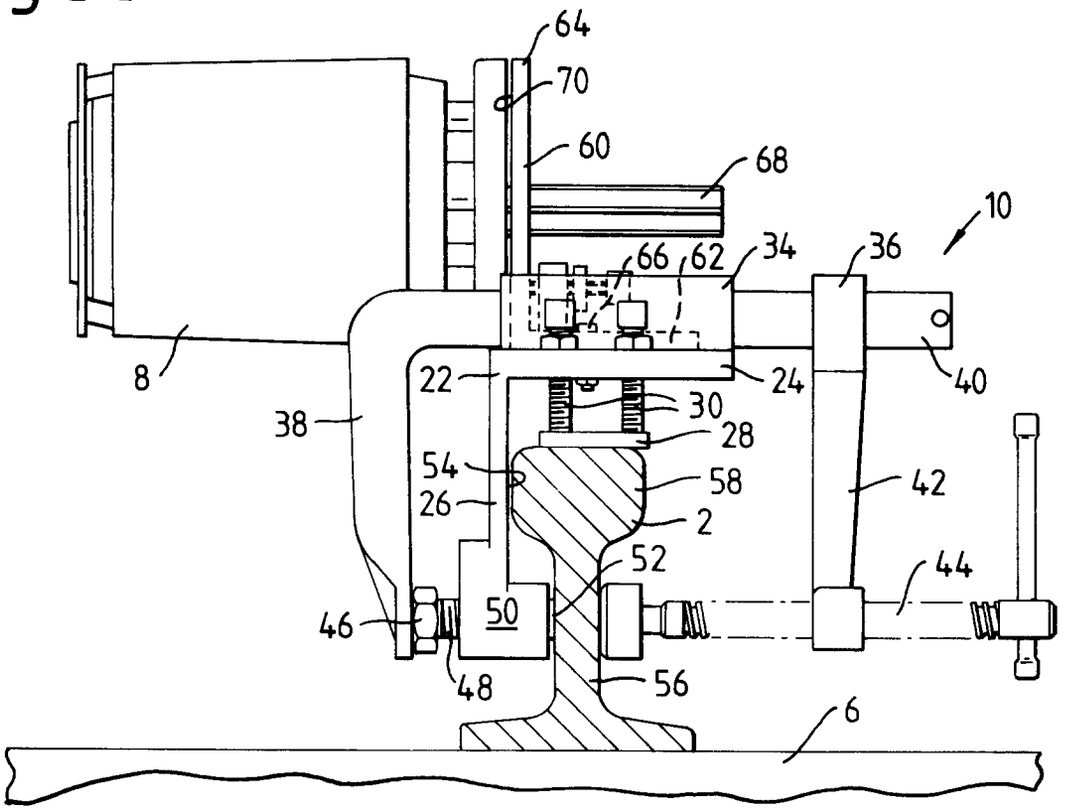

64
70
60
68
10
66
62
34
36
8
22
24
40
30
38
28
54
58
42
26
2
52
44
46
50
48
56
6

Fig.3b.

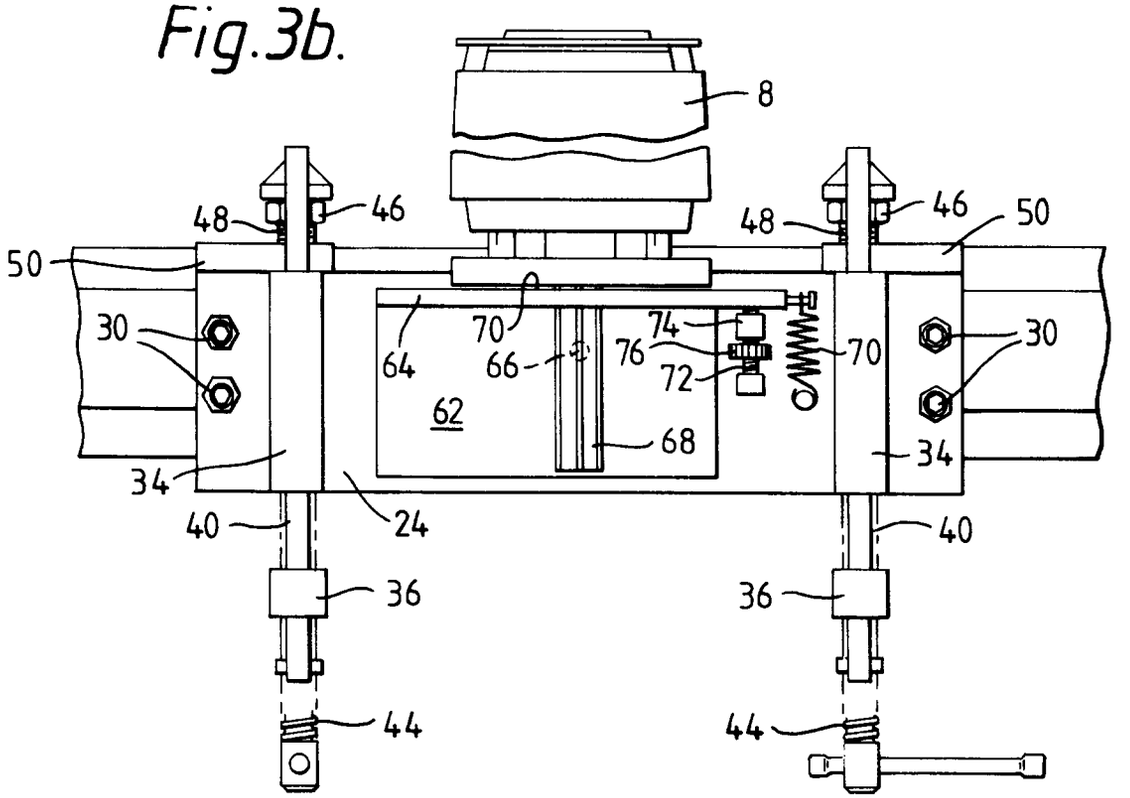

8
48
46
48
46
50
50
30
70
74
70
30
64
66
76
72
62
68
34
34
40
24
40
36
36
44
44

Fig.3c

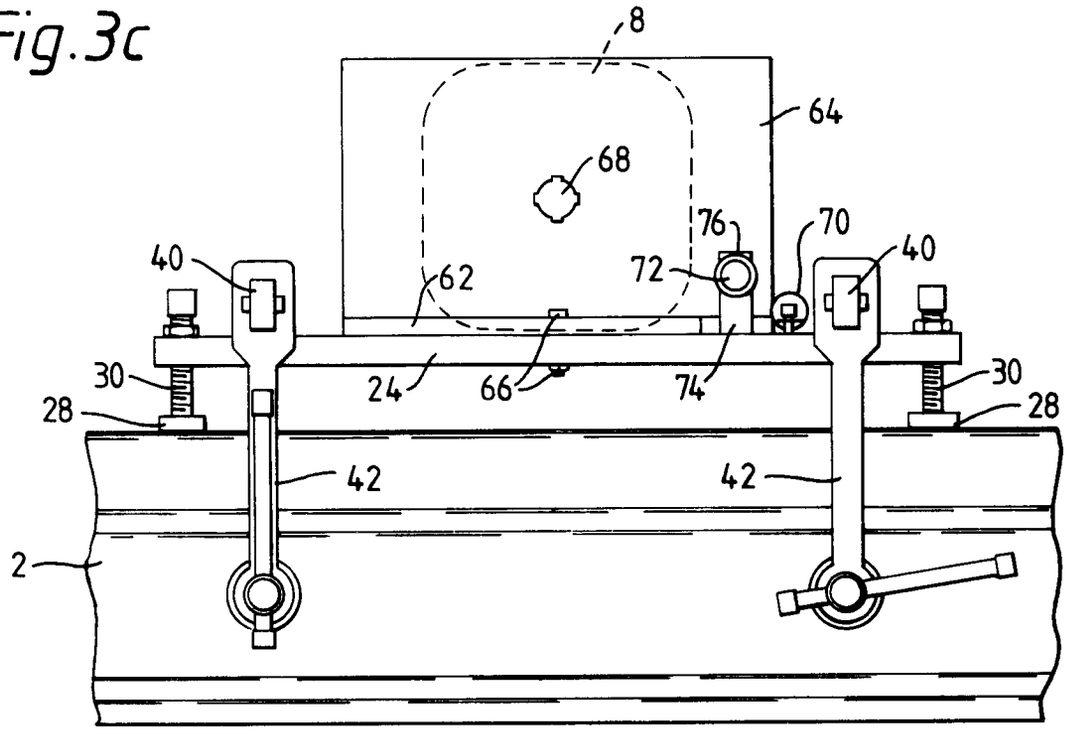

8
64
68
76
70
40
72
40
62
30
24
66
74
30
28
28
42
42
2

Fig.4a.

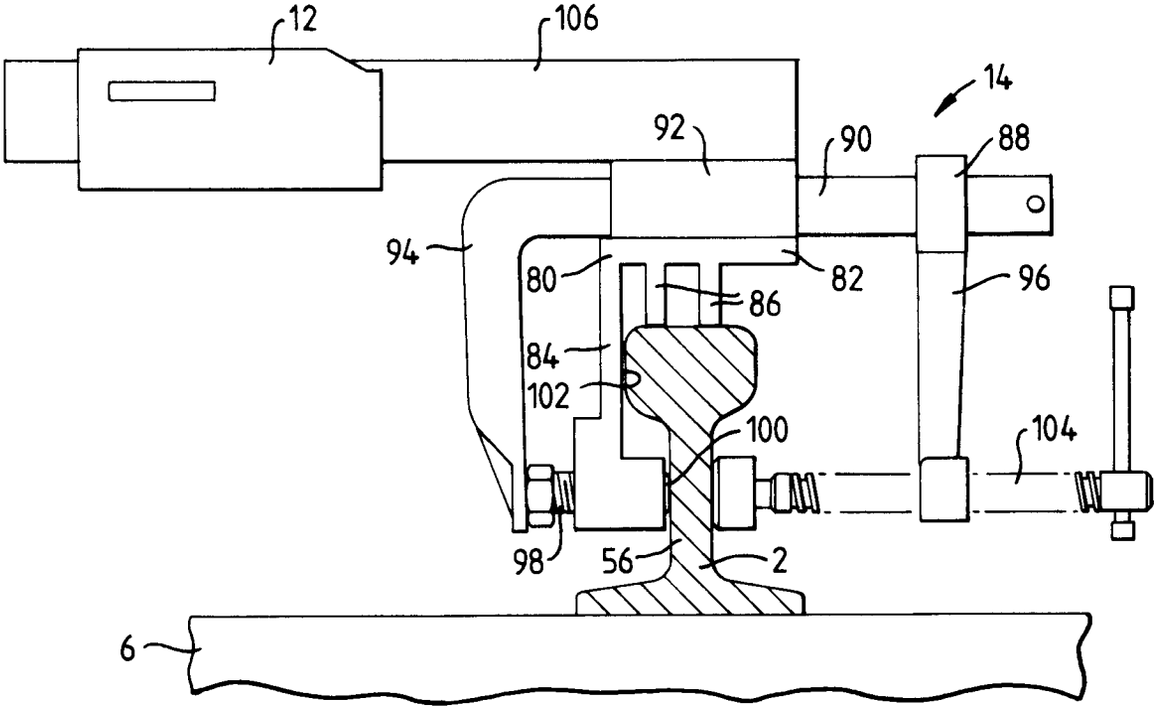

12
106
14
92
90
88
94
80
82
96
86
84
102
100
104
98
56
2
6

Fig. 4b.

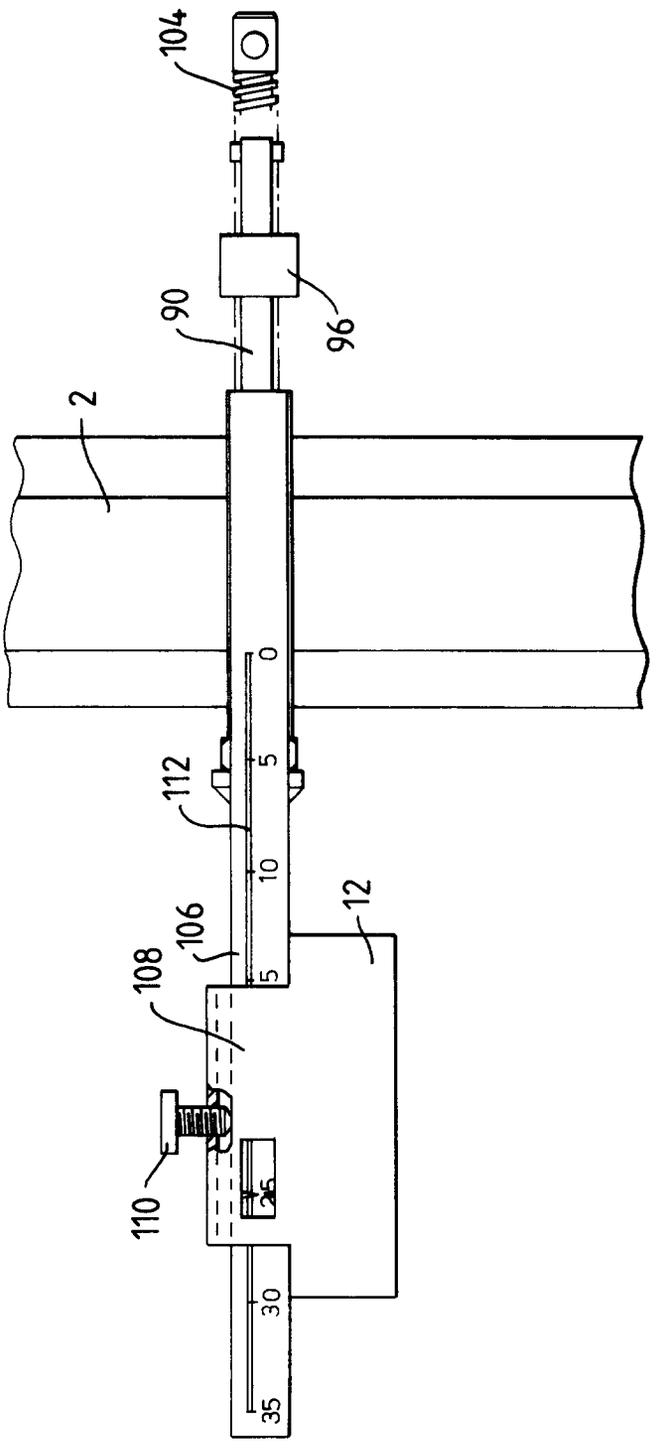


Fig.5a.

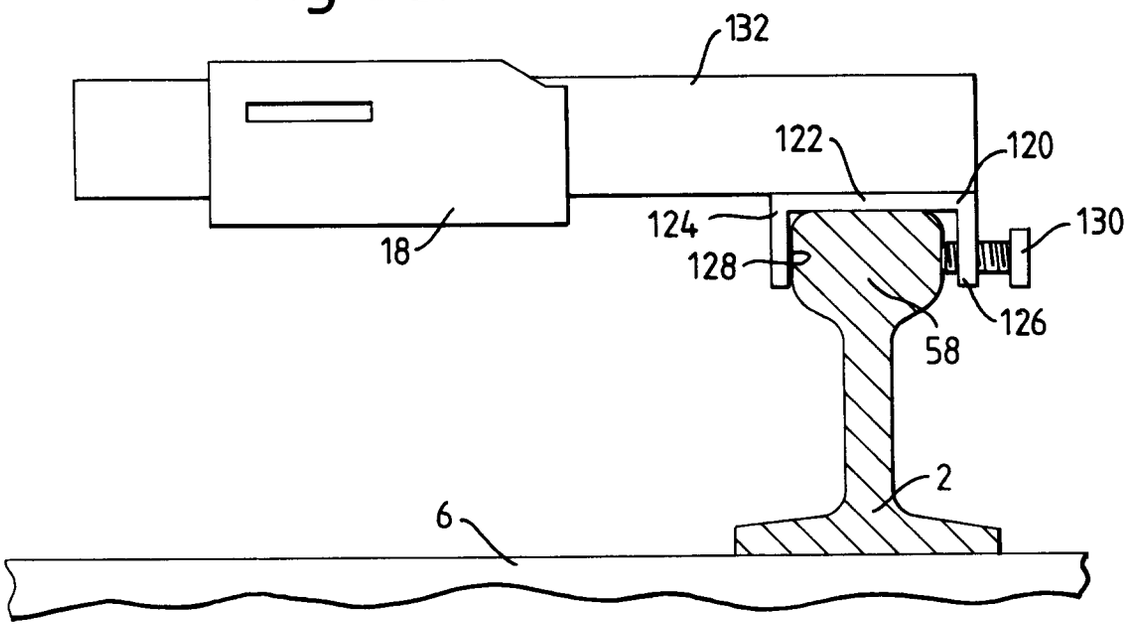
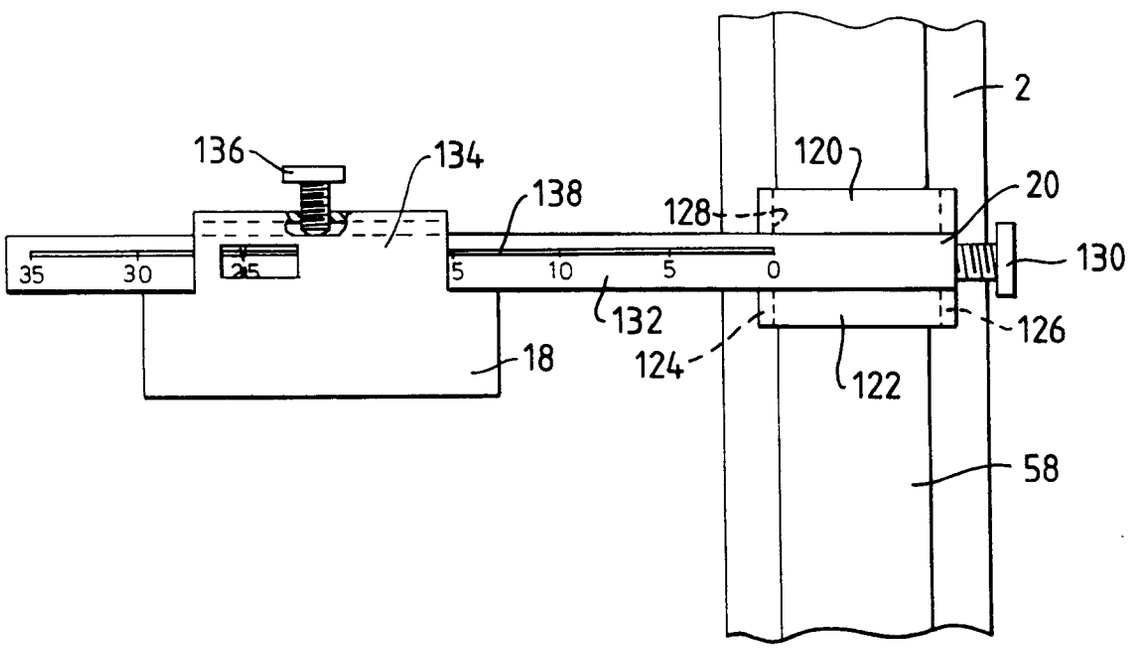

132
122
120
124
130
128
18
126
58
2
6

Fig.5b.


2
136
134
120
138
20
128
130
35
30
25
5
10
5
0
132
126
18
124
122
58

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 12 0016

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	DE-U-19 77 444 (KUHN) * the whole document *	1,2	E01B35/10
A		3,6,7	
A	DE-A-25 36 434 (GEORG ROBEL& CO) * the whole document *	1,3,4	
A	AT-B-314 579 (FRANZ PLASSER BAHNBAUMASCHINEN-INDUSTRIEGESELLSCHAFTM.B.H.) * the whole document *	1-4	
A	US-A-3 922 969 (TYLER ET AL.) * the whole document *	1-4	
A	AT-B-293 461 (ROBEL & CO) * the whole document *	1-3	
A	DE-A-22 46 142 (FRANZ PLASSER BAHNBAUMASCHINEN-INDUSTRIEGESELLSCHAFT MBH) * the whole document *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.5)
A	US-A-3 021 601 (HAYES) * figures 1-6 *	6,9	E01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	4 July 1994	Paetzel, H-J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)