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(54) Improved steel soldier for concrete formwork.

(57) A steel soldier (10), for use with concrete formwork, comprises two side-by-side beams (12), spaced apart but connected together by end plates (13) and diaphragms (15). Each beam (12) comprises two chords (22) separated by a web (16). The web (16) is formed with circular or elliptical openings (46) and with flanges (48) around the openings, for engagement by connector assemblies (51). Each such flange (48) has a U-shaped profile in cross-section, wherein the open end of the flanges (48) of the respective beams may face each other or opposite directions. Because of this configuration of the flange, there is very little local bending moment at the flange when the connector assembly (51) transmits shear force to the web (16) through the flange (48).

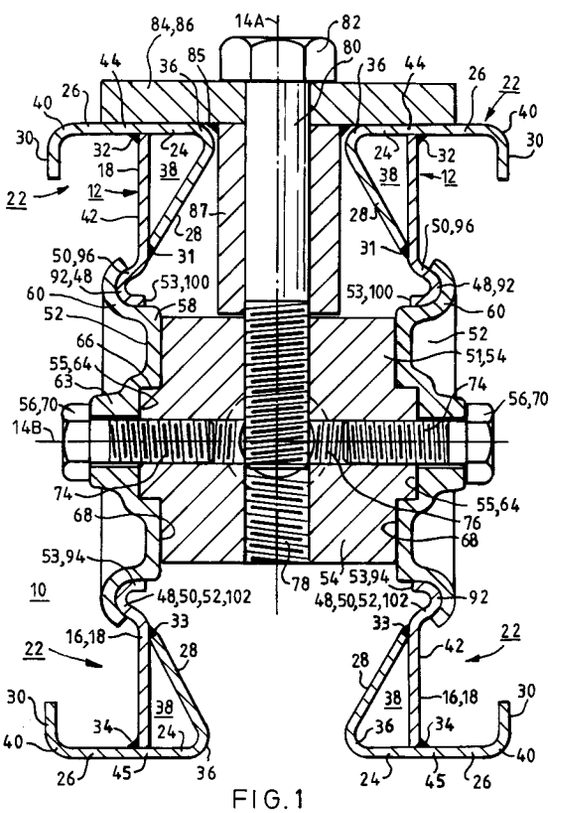

FIG. 1

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BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to structural members, particularly steel structural members known as "soldiers" and used for supporting concrete formwork.

Description of the prior art

British patent specifications nos. 1 551 154 and 2 145 145 disclose structural members called soldiers for concrete formwork. These disclosed soldiers are of a kind which comprise a pair of elongate steel beams, which may be of channel section, connected back to back and parallel with one another. Each beam has a web which, in order to minimise weight, has openings spaced at regular intervals along its length. To increase the stability of these webs the openings have peripheral lips otherwise known, and hereinafter referred to, as flanges. Further, the flanges of the respective webs may be flared as appropriate in mutually opposite directions.

SUMMARY OF THE INVENTION

The present invention has for one object the provision of a structural member which is a modification of the soldier described and illustrated in British patent specification no. 2 145 145, enabling use of a connector assembly which, in combination with the structural member, provides excellent mechanical properties.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an enlarged transverse section through a steel soldier in combination with a connector assembly in accordance with the invention;
Fig. 2 is a side elevational view at a right angle to Fig. 1, with the soldier broken away;
Fig. 3 is an elevation of a clamping disc of a connector assembly for use with a soldier in accordance with the invention;
Fig. 4 is a section on line 4-4 of Fig. 3;
Figs. 5, 6 and 7 are views in three mutually perpendicular directions of a spacer unit of a connector assembly for use with a soldier in accordance with the invention;
Fig. 8 is a diagrammatic view of a short length of a soldier embodying the invention but without a connector assembly, showing the effect of a load;
Fig. 9 is a section on line 9-9 of Fig. 8;
Fig. 10 corresponds to Fig. 8, but with the connector assembly fitted;
Fig. 11 is a section on line 11-11 of Fig. 10;
Fig. 12 is an enlarged view of part of an opening and associated flange of a soldier embodying the invention, showing the effect of a load;
Fig. 13 is a view (for comparison with Fig. 12) of part of an opening and associated flange of a soldier in accordance with British patent specification no. 2 145 145, showing the effect of the same load as in Fig. 12;
Fig. 14 illustrates a soldier and double central connector in accordance with the invention, connected to a sloping structural member;
Fig. 15 is a section on line 15-15 of Fig. 14; and
Figs. 16, 17 and 18 illustrate different combinations of one or more steel soldiers and one or more tie rods, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, there is illustrated a structural member in the form of a steel soldier 10 adapted for supporting concrete formwork (not shown).

The steel soldier 10 comprises two mutually spaced apart and mutually parallel beams 12, 12 which are symmetrically disposed relative to first and second mutually perpendicular planes of symmetry 14A, 14B. These planes of symmetry 14A, 14B both extend along the length of the structural member 10, which is symmetrical about both planes 14A, 14B.

The two beams 12, 12 are of the same length and are co-extensive, being connected to each other at their ends by two rectangular rigid tie plates 13, 13 (see Fig. 8) and, intermediate their ends, by one or more rigid diaphragms 15, welded to the two beams 12, 12.

Two beams 12, 12 have two respective webs 16, 16 in respective planes parallel to the first plane of symmetry 14A, which is disposed equidistantly between the two webs 16, 16.

Each beam 12 also has a respective top and bottom chord portions 22, 22. Each chord 22 is formed respectively by inner and outer flange portions 24, 26, an oblique portion 28 and an edge-reinforcing portion 30. The inner and outer flange elements 24, 26 are perpendicular to the web 16 and extend from the outer edge 32 of web 16 respectively towards and away from the first plane of symmetry 14A. The oblique element 28 adjoins the web 16 at 31 and the inner flange portion 24 at 36 to form a closed hollow section 38, which extends continuously along the steel soldier 10 for providing torsional stability. The edge-reinforcing portion 30 is connected to an edge 40, remote from web 16, of the outer flange element 26 for stabilising the outer flange portion 26.

Each beam 12 is made from three pieces of steel 42, 44, 45, welded together. Piece 42 forms the web 16, and piece 44 and 45 form the top and bottom chord portions, respectively. Piece 42 is welded to piece 44 at 31 and 32, and welded to piece 45 at 33 and 34. Pieces 44 and 45 are curved at 36 (where the oblique portion 28 adjoins the inner flange portion 24) and at edge 40 (where the edge-reinforcing portion 30 is connected to the outer flange portion 26).

It will be appreciated from the above that the top and bottom chords portions 22, 22 are spaced apart by, and connected to, the web 16.

The web 16 of each beam have a series of mutually opposite openings 46 along their lengths (see Fig. 8), the openings 46 each being elliptical (possibly circular, considered as a special form of elliptical). Around a portion of each opening 46, the web 16 has a flange 48 (not shown in Fig. 14). Each flange 48 must cover enough of the periphery of corresponding opening 46 so as to be capable of supporting clamping disc 52. Referring to Fig. 1, flange 48 has a U-shaped profile in cross-section, wherein the open end of the flanges 48 of the respective webs 16 may face each other or opposite directions.

If the elliptical holes 46 are non-circular, the minor axis or alternatively the major axis of the ellipse should be central of the web 16, extending in the longitudinal direction of the beam 12. The dimensions of the openings are chosen empirically, according to the required strength and lightness of the steel soldier 10 and the function required of the steel soldier 10 in use.

The openings 46 might not even be truly elliptical, depending on other requirements.

One or more connector assemblies 51 may be connected to the steel soldier 10 at a respective pair of the mutually opposite openings 46. Each connector assembly 51 comprises a pair of clamping discs 52, 52 (Figs. 2-4), a spacer unit 54 (Figs. 5-7) and two bolts 56, 56 (Fig. 1).

Each clamping disc 52 (Figs. 1-4) is a metal casting and comprises a spigot 58 which fits within the respective hole 46 and a dished contour flange 60 which embraces the flange 48 as shown in Fig. 1, engaging both the radially inner flange portion 53 and the radially outer flange portion 50. Indeed, the spigot 58 and contour flange 60 in combination engage the whole of the radially inner flange portion 53 (Fig. 1) and a substantial part of the radially outer flange portion 50.

The spacer unit 54 (Figs. 5-7) is a metal casting which fits between the two clamping disc 52, 52. The spacer unit 54 is formed with two projections 62, 62 which engage in correspondingly shaped recesses 55 in the clamping discs 52, 52. Whilst faces 64, 64, of the projections 62, 62 are spaced apart from corresponding faces of the clamping disc recesses 55, the sides 66, 66 of projections 62, 62 are in close contact with the corresponding surfaces of the clamping disc recesses 55. Faces 68, 68 of the spacer unit 54, around the projections 62, 62 are in close contact with corresponding faces 57, 57 of the clamping discs 52, 52 around the recesses 55.

The bolts 56, 56 (see Fig. 1) extend through the clamping discs 52, 52 and part way into the spacer unit 54. More particularly, heads 70,70 of the bolts 56, 56 engage the outsides (remote from the first plane of symmetry 14A) of central bosses 63, 63 of the clamping discs 52, 52, whilst screw-threaded shanks 74, 74 of bolts 56, 56 are threaded into a threaded through-hole 76 in spacer unit 54. The bolts 56, 56 are tightened so that the clamping discs 52, 52 are clamped tightly against the spacer unit 54 (via faces 68, 68) and against the flanges 48, 48 of the webs 16, 16.

The spacer unit 54 has a further threaded through-hole 78 (see Figs. 5-7), the axis of which is perpendicular to the longitudinal direction of the soldier 10 and lies in the first plane of symmetry 14A. The through-hole 78 is threadedly engaged by a bolt 80 which extends into it . A head 82 on one end of the bolt 80 abuts a flange 84 of a fixed end unit 86. The fixed end unit 86 also comprises a sleeve 87, to which the flange 84 is welded at 85, the bolt 80 extending through both the flange 84 and the sleeve 87. The flange 84 abuts the two adjacent top chord portions 22, 22 of soldier 10.

If loading of the bolt 80 is downwards in Fig. 1, part of this loading is transmitted by the bolt head 82 to the flange 84 and thence to the two top chord portions 22, tending to pivot the top chord portions 22, 22 about fulcrums at 92, where the flanges 48 engage the contour flanges 60 of the clamping discs 52, which exert reactions on the flanges 48 inwardly towards the first plane of symmetry 14A.

Because of the screw-threaded engagement of bolt 80 with the hole 78 in spacer unit 54, part of the axial loading of bolt 80 is transmitted to spacer unit 54 and thence to the clamping discs 52, due to engagement of the sides 66 of the projections 62 with the corresponding sides of the recesses 55 in the clamping discs 52. The clamping discs 52 transmit the loading as a bearing force to the flanges 48 of the webs 16. The clamping disc spigot 58 at each side of the soldier 10 bears upon the radially inner flange portion 53 at 94 (Figs. 1 and 12), the center-line of this bearing force being very close to the plane of the web 16, due to the radially inner flange portion 53 curving towards the first plane of symmetry 14A from where portion 53 adjoins the radially outer flange portion 50. There is thus only a relatively small amount of local bending moment at the flange 48 (see Fig. 12).

Additionally, the contour flanges 60 of clamping discs 52 bear on radially outer flange portions 50 at 96, sharing load distribution with the clamping disc spigots 58.

If the loading on bolt 80 is upwards in Fig. 1, then all the load is transmitted to the spacer unit 54 (since the fixed end unit 86 is not effective in this direction) and the clamping discs 52 bear upon the flange 48 at 100 and 102 (diametrically opposite the corresponding points 94, 96 for the loading in the direction of arrow 88).

Figs 8 and 9 on the one hand and Figs 10 and 11 on the other hand show the effect on the steel soldier 10 of a load respectively without, and with, the connector assembly 51. A rod 80A is loaded in the direction of arrow 88 and reaction is applied laterally to steel soldier 10 along its length. In the absence of the central connector 51, the opening 46A deforms as shown in Fig. 8, with excessive stress in regions 108 of web 16, between opening 46A and adjacent openings 46. With the central connector 51 fitted, as in Figs. 10 and 11, deformation of opening 46A is prevented, reducing the secondary bending stress in web 16. Figs. 8 to 11 show a different fixed end unit 110 on rod 80 from fixed end unit 86 of Fig. 1.

Figs. 12 and 13 illustrate the different effects of an applied load on the flange around the opening in the web of a soldier of the present invention (Fig. 12), on the one hand, and British patent specification no. 2 145 145 (Fig. 13), on the other hand ("UKPS 2 145 145").

According to UKPS 2 145 145 (Fig. 13) the openings OP in the web portions have been formed at their peripheries with lips of flanges FL which have a simple arcuate profile, whereas in accordance with the invention (Fig. 12) the peripheral portions of the openings 46 are formed with flanges 48 (as described above) which may be conveniently described as of U-shaped profile.

In each of Figs. 12 and 13 the dashed lines indicate the mode of elastic settlement of the newly devised flanges 48 and the previous flanges FL under the same applied load P_2. In Fig. 12, e_1 represents the lateral distance between the planes of the points of application of the load P_2 whilst in Fig. 13, e_2 represents the equivalent distance for the previously used arcuate flange configuration.

From Figs. 12 and 13 it should readily be understandable that under resilient settlement the value of e_2 increases to a greater extent than that of e_1 with the same loading. This causes lack of dispersal of load around the opening resulting in an increase in the rate of settlement with respect to load. Otherwise expressed, because fibre stresses are proportional to e_1 and e_2 it is therefore desirable to utilise a configuration which results in e_1 having a minimum value.

Figs. 14 and 15 are partly diagrammatic, showing steel soldier 10, a double connector assemblies 51, 51 and a bracket 112 which replaces the fixed end unit 86. The bracket 112 is secured to the double connectors 51, 51 by two screw-threaded bolts 114, 114, each replacing the corresponding rod 80. A sloping structural member 116, to serve as a strut, is pivoted at 118 on the bracket 112.

In Fig. 16, a tie rod 120 passes through connector assembly 51, but has a small diameter so that it does not screw-threadedly engage the connector assembly 51. A wing nut 122 on the rod 120 engages the soldier 10 via an end unit 124 as shown, load on the rod 120 in the direction of arrow 126 putting the rod 120 always in tension. The clamping discs 52 - there being one on each side, as in Figs. 1 and 2 - stabilise the web of the soldier against buckling.

In Fig. 17 (compare Fig. 14) a pair of soldiers 10, 10 are clamped together by a tie rod 120' which, like the rod 120 of Fig. 16, passes through the upper one of two connector assemblies 51 in the right-hand soldier, but does not screw-threadly engage the connector assembly 51, the rod 120' being of too small a diameter. Member 116 (compare Fig. 14) may be in either tension or compression, so that the vertical and horizontal load components at pivot 118 may each be respectively down and to the right, or up and to the left.

In Fig. 18, two tie rods 120a and 120b are respectively screwed into two respective connector assemblies 51a and 51b. Tie rod 120a extends in line with the soldier 10, whilst tie rod 120b extends laterally obliquely.

These are just a few examples of the kind of loading which may be applied to a connector assembly in a soldier, in accordance with the invention.

Claims

1. A steel soldier apparatus for use with concrete formwork, and comprising two parallel beams (12, 12), each said beam (12) having a web portion (16) with one or more openings (46), said openings (46) being spaced along said web portion (16), each said opening (46) having a periphery, a portion of said periphery comprising a flange (48) having a U-shaped profile in cross-section, characterised in that said flange (48) supports, or is supported by, a clamping disc (52), said flange (48) matingly engaging said clamp disc (52).

2. A soldier apparatus as claimed in claim 1 wherein the U-shaped flange profiles of the openings (46) in the respective beams (12) face in mutually opposite directions.

3. A soldier apparatus as claimed in claim 1 wherein the U-shaped flange profiles of the openings (46) in the respective beams (12) face each other.

4. A soldier apparatus as claimed in claim 1, 2 or 3 wherein each said U-shaped flange profile (48) extends completely around the periphery of each opening (46).

5. A soldier apparatus as claimed in any preceding claim wherein the openings (46) are circular or elliptical.

6. A soldier apparatus as claimed in any preceding claim and further comprising two rigid tie plates (13) connecting the ends of said beams (12) and one or more rigid diaphragms (15) connecting intermediate portions of said beams (12).

7. A soldier apparatus as claimed in any preceding claim, wherein each said beam (12) further comprises top and bottom chord portions (22) spaced apart by and connected to said web (16), said chord portions (22) extending longitudinally along said beam (12).

8. A soldier apparatus as claimed in any preceding claim, further comprising an end unit (86) for transmitting a load to said chord portions (22).

9. A soldier apparatus as claimed in claim 17, wherein said end unit (86) comprises a flange portion (84) abutting said top chord portions (22), and a sleeve portion (87) perpendicular to said flange portion (84) and attached thereto.

10. A steel soldier apparatus for use with concrete formwork and comprising:

first and second parallel beams (12, 12), each said beam (12) having a web portion (16) with one or more openings (46) such that each said opening (46) in said first beam (12) is positioned opposite an opening (46) in said second beam (12), each said opening (46) further having a periphery, a portion of said periphery comprising a flange (48) having a U-shaped profile in cross-section; and

a central connector assembly (51) in combination therewith, said central connector assembly (51) extending through a said opening (46) in said first beam (12) and an oppositely positioned opening (46) in said second beam (12), said connector assembly (51) matingly engaging with each said opening (46) through which said connector assembly (51) extends.

11. A soldier apparatus as claimed in claim 10 wherein said connector assembly (51) comprises:

two clamping discs (52) matingly engaging said openings (46) at said flanges (48);

a spacer unit (54) fitted between said clamping disc (52); and

means (56) securing said clamping discs (52) to said spacer unit (54) and said beams (12).

12. A soldier apparatus as claimed in claim 11 wherein said means securing said clamping disc (52) comprises screw threaded bolt means (56) engaging and extending through said discs (52) and spacer unit (54).

13. A soldier apparatus as claimed in claim 10, 11 or 12 wherein said U-shaped flange profiles (48) of the oppositely positioned openings (46) in the respective beams (12) face in opposite directions.

14. A soldier apparatus as claimed in claim 10, 11 or 12 wherein said U-shaped flange profiles (48) of the oppositely positioned openings (46) in the respective beams (12) face each other.

15. A soldier apparatus as claimed in any one of claims 10 to 14 wherein each said U-shaped flange profile (48) extends competely around the periphery of each opening (46).

16. A soldier apparatus as claimed in any one of claims 10 to 15 wherein the openings are circular or elliptical.

17. A soldier apparatus as claimed in any one of claims 10 to 16 and further comprising two rectangular rigid tie plates (13) connecting the ends of said beams (12) and one or more rigid diaphragms (15) connecting intermediate portions of said beams (12).

18. A soldier apparatus as claimed in any one of claims 10 to 17 wherein each said beam (12) further comprises top and bottom chord portions (22) spaced apart by and connected to said web (16), and extending longitudinally along said beam (12).

19. A soldier apparatus as claimed in claim 18 further comprising an end unit (86) for transmitting load to said chord portions (22).

20. A soldier apparatus as claimed in claim 19 wherein said end unit (86) comprises a flange portion (84) abutting both said top chord por-

tions (22), and a sleeve portion (87) perpendicular to said flange portion (84) and attached thereto.

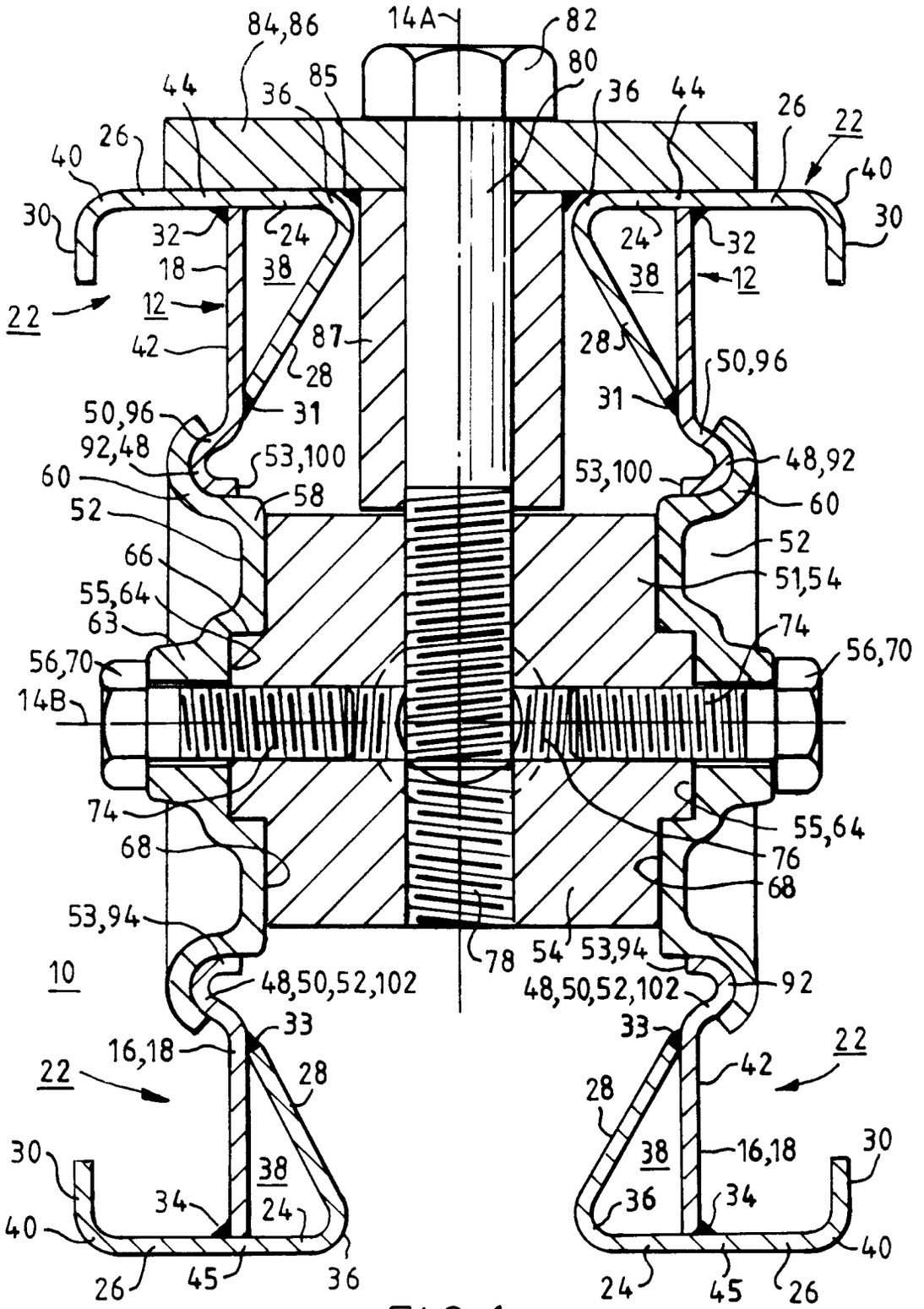
84,86
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FIG. 1

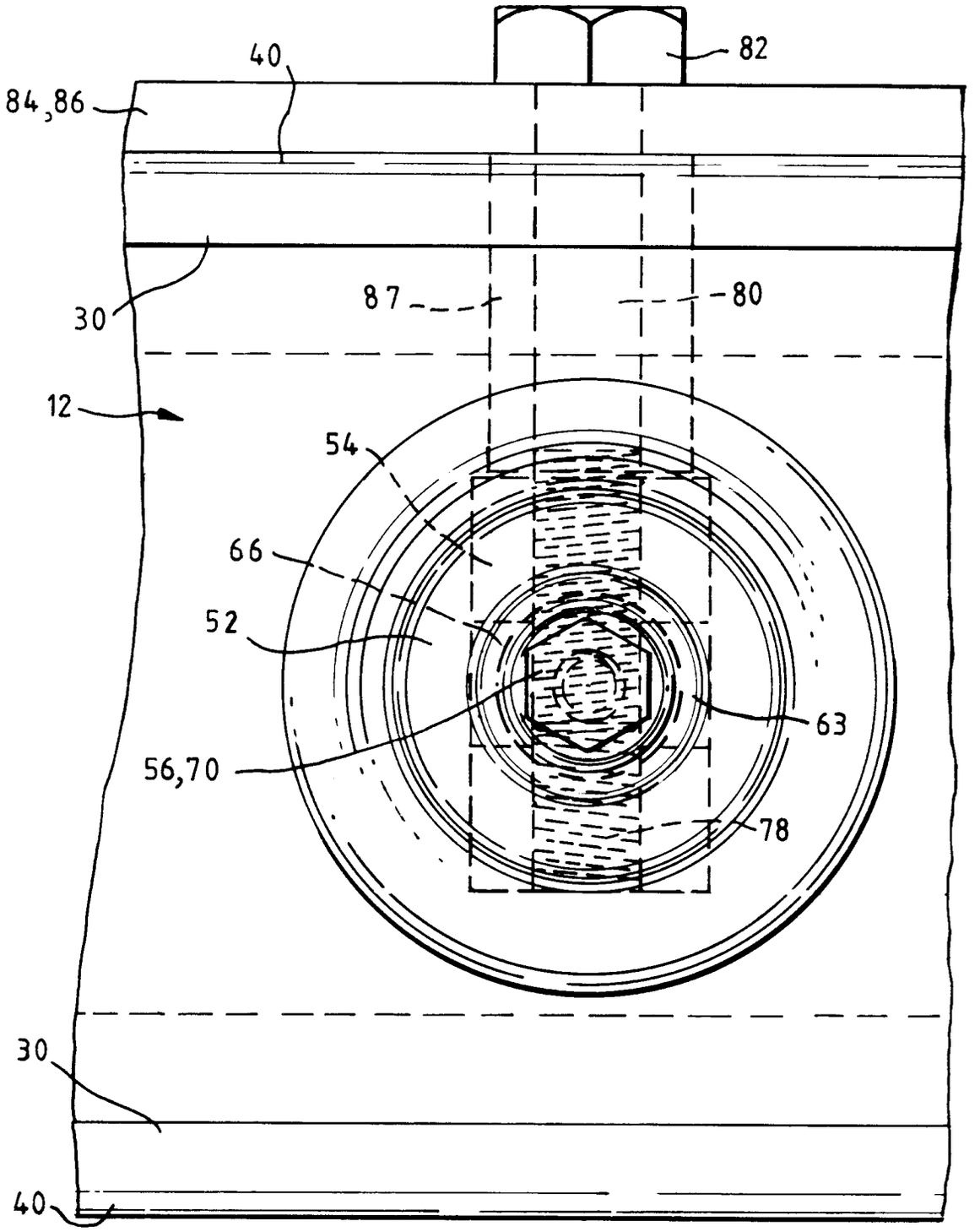


FIG.2

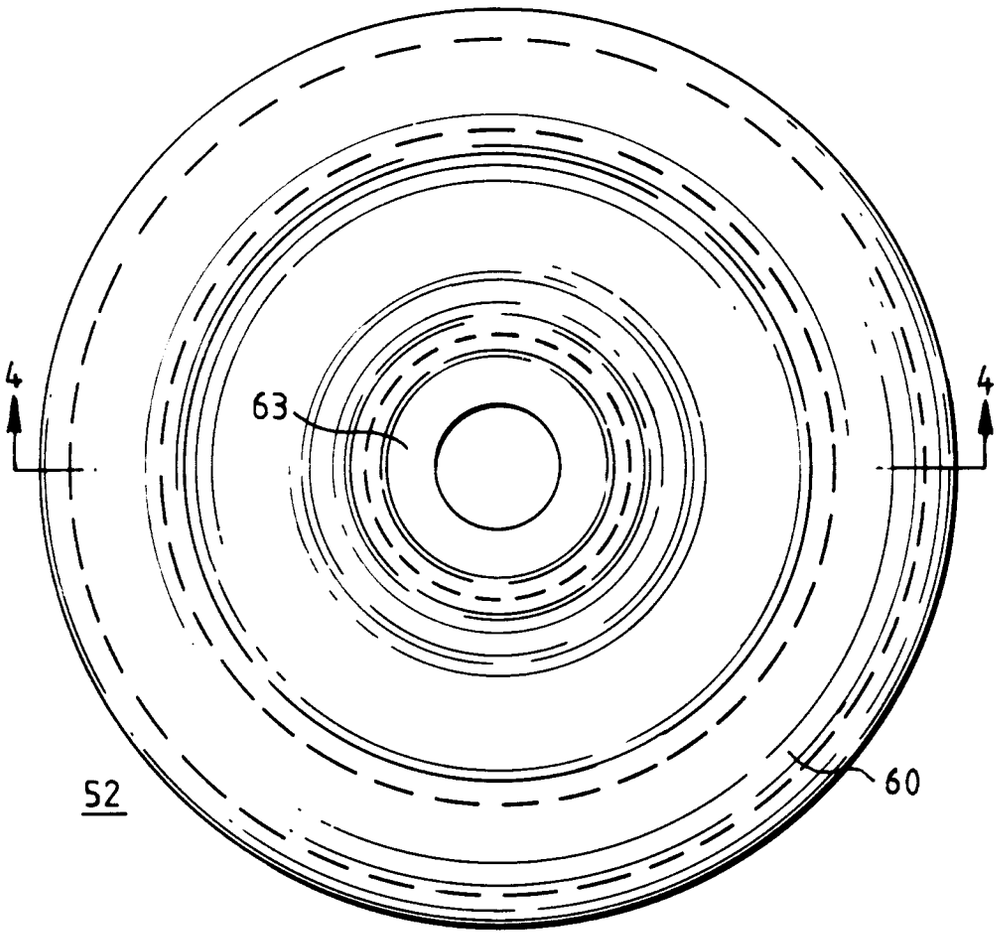


FIG. 3.

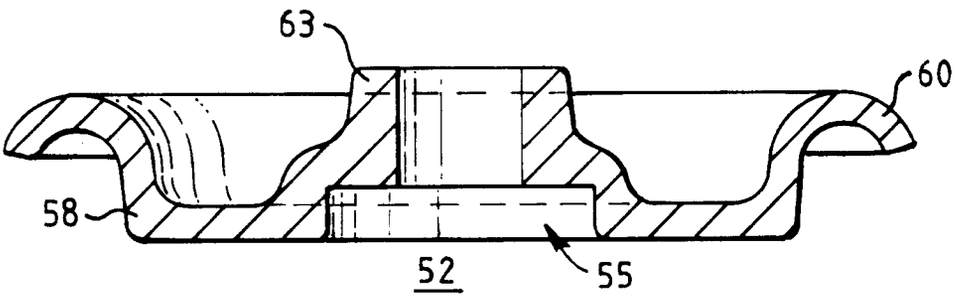


FIG. 4.

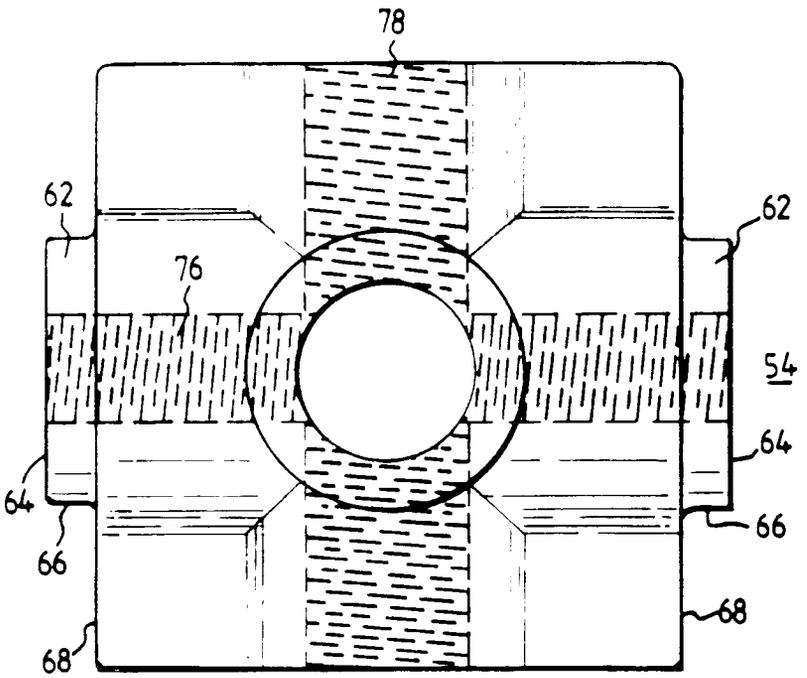


FIG.5.

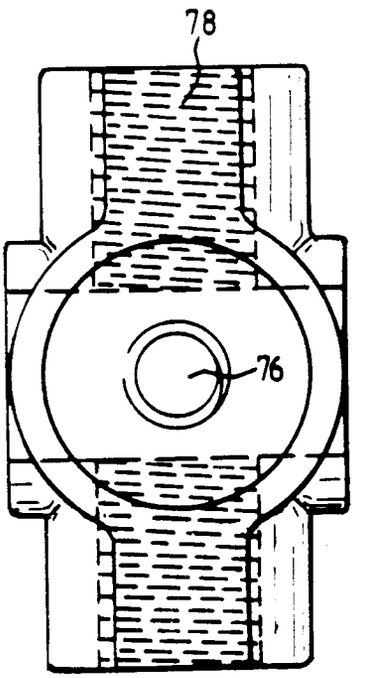
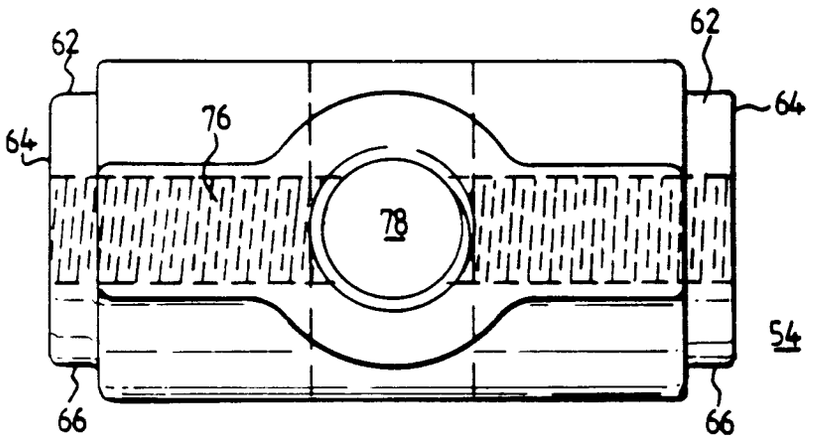


FIG.6.

FIG.7.



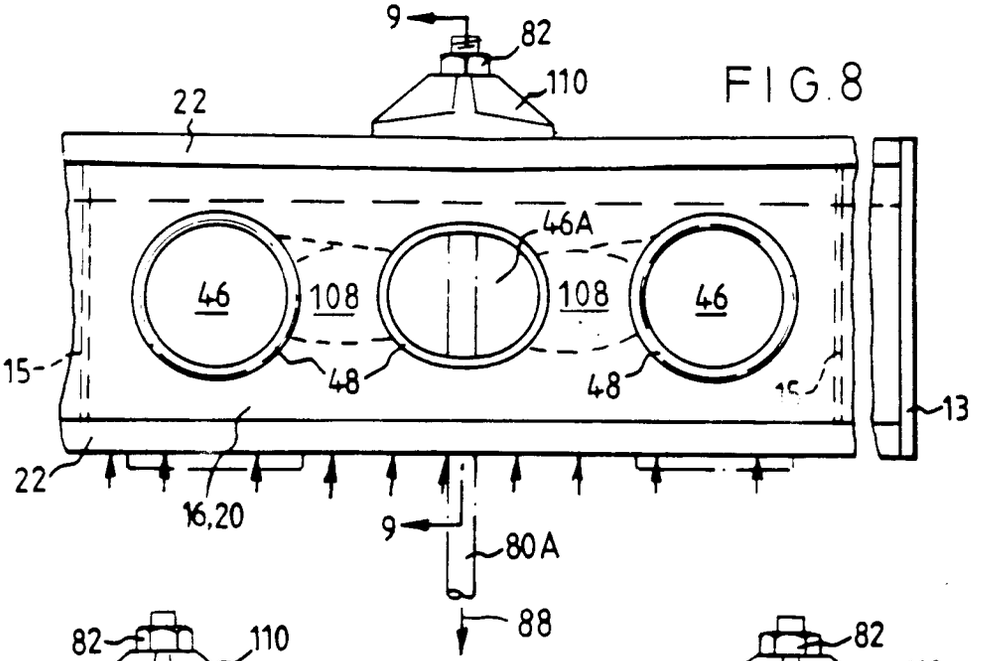


FIG.8

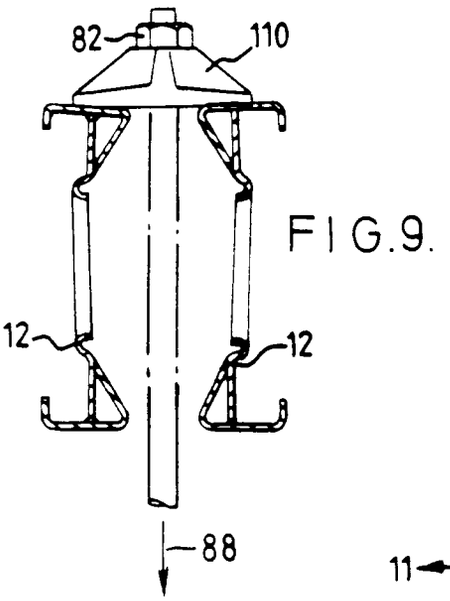


FIG.9.

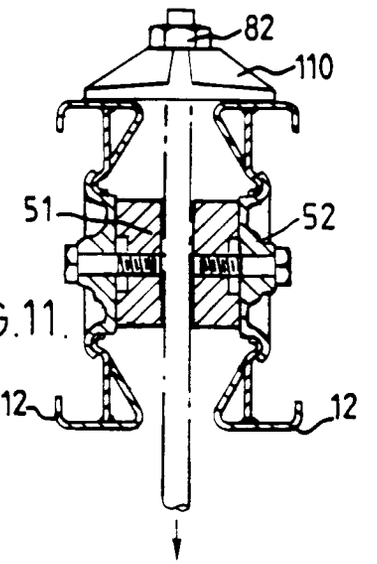


FIG.11.

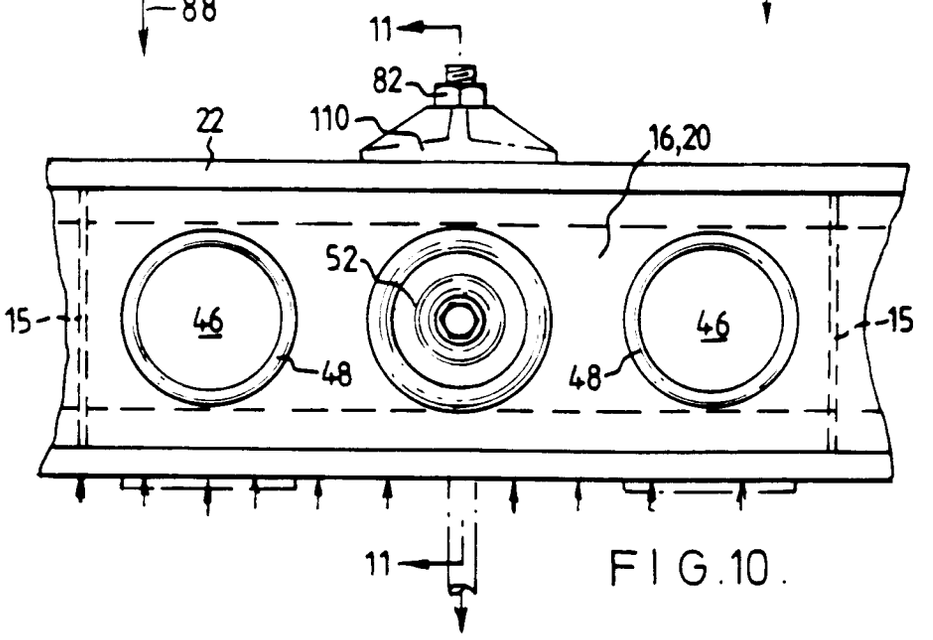


FIG.10.

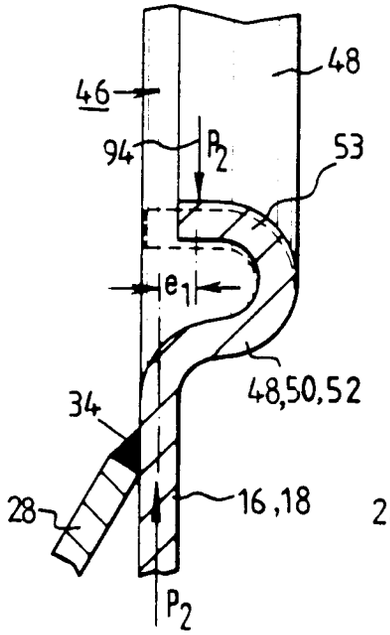


FIG.12

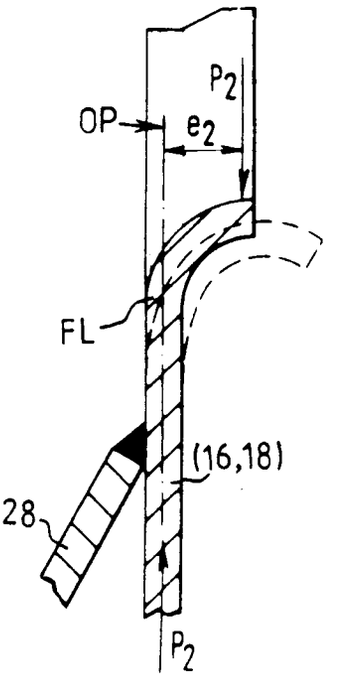


FIG.13.

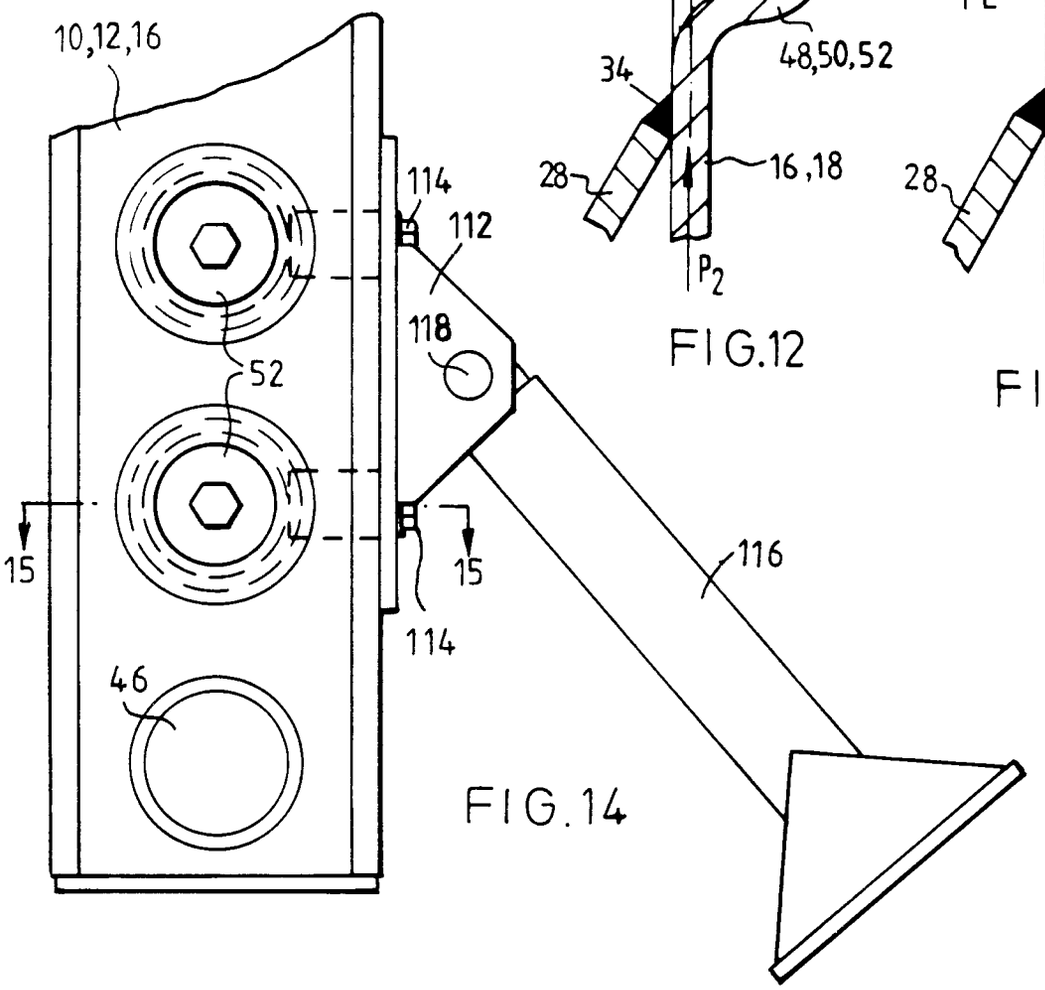


FIG.14

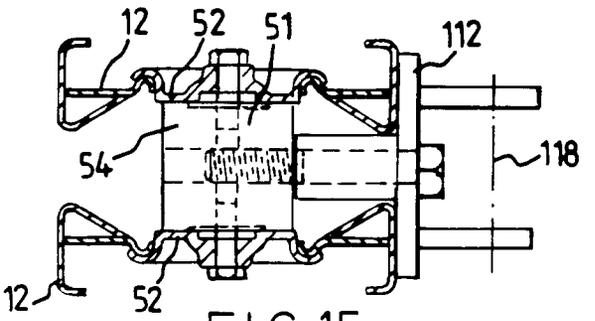


FIG.15.

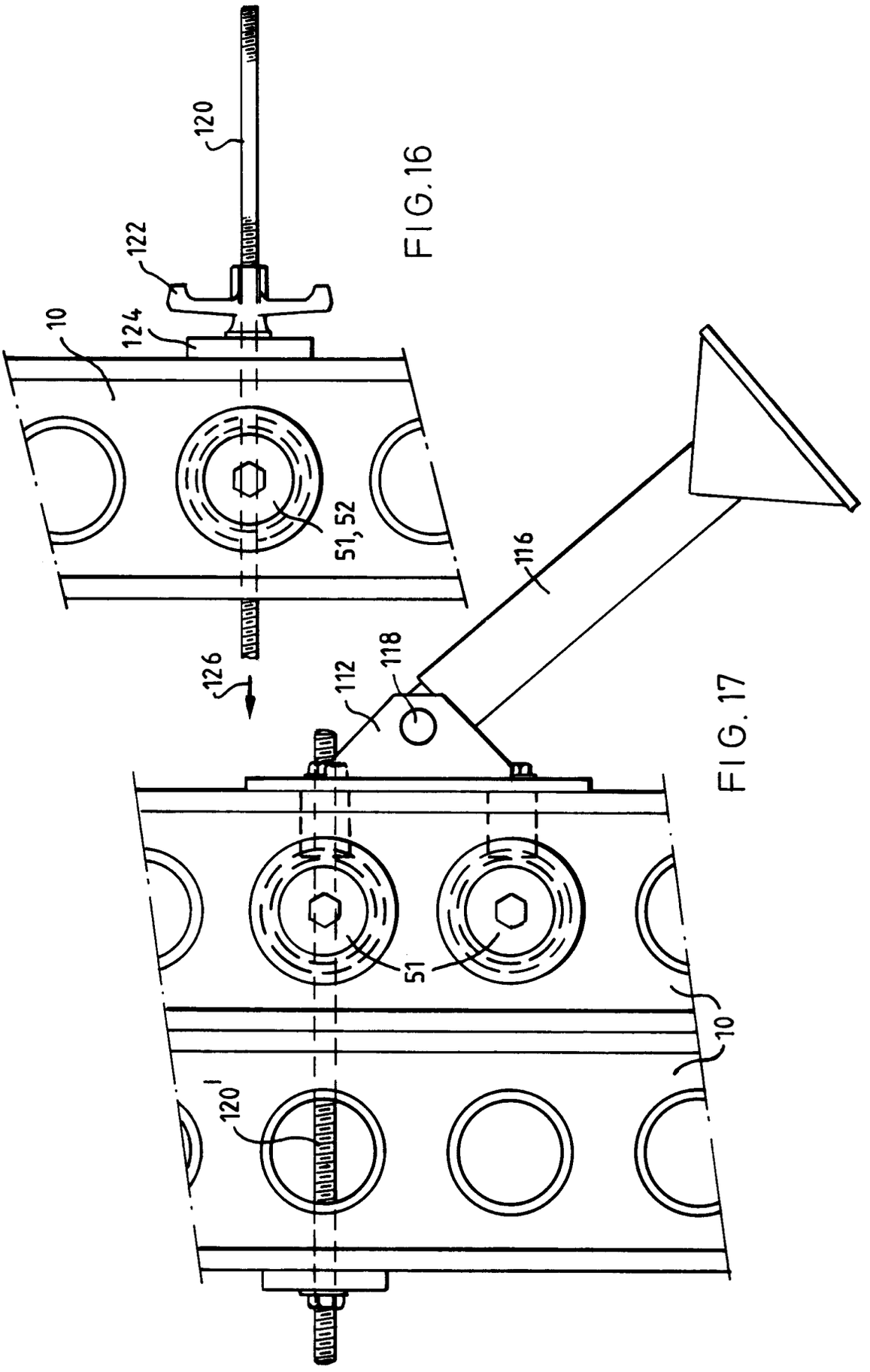


FIG. 16

FIG. 17

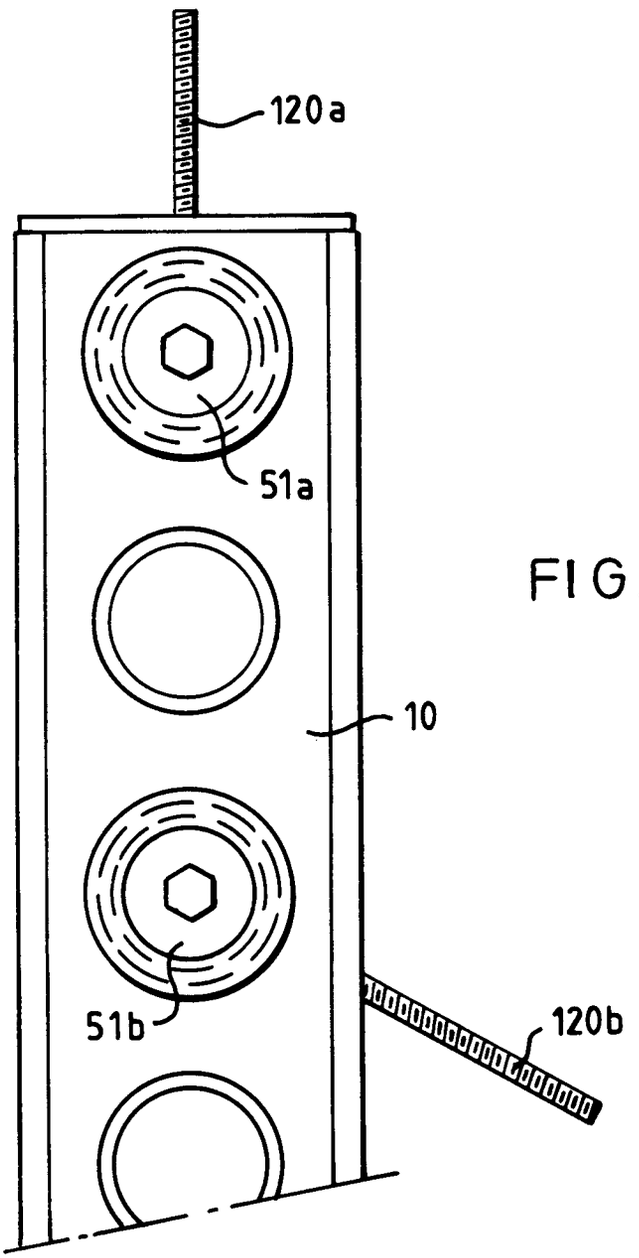


FIG. 18

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 30 8048

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)
A	EP-A-0 227 314 (MABEY HIRE COMPANY LTD.) * complete document *	1-7,10, 13-18	E 04 C 3/07 E 04 G 11/48 E 04 G 17/14
A	DE-A-3 524 346 (E.E. FIELITZ) * column 3, lines 11-24 *	10-12	
D,A	GB-A-1 551 154 (BEACHLEY MACHINERY LTD.) * figures 1-5 *	1	
D,A	GB-A-2 145 145 (MABEY HIRE COMPANY LTD.) * figures 1,2 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E 04 C
E 04 G

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
Berlin	20 March 91	PAETZEL H-J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same catagory
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