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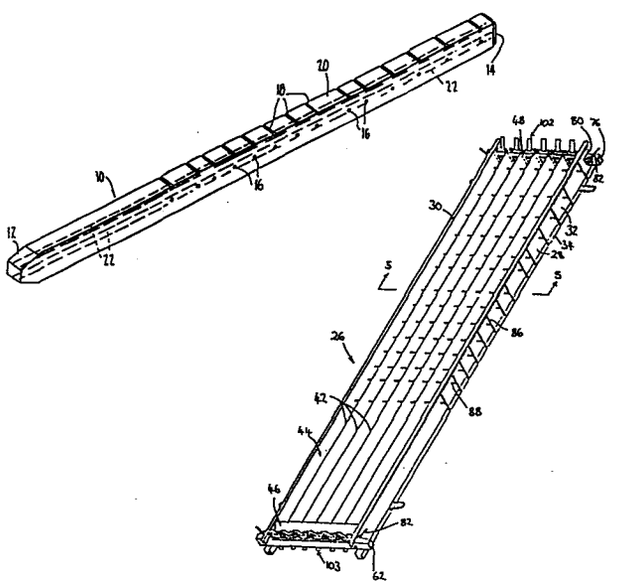
(54) Elongate article and method and apparatus for producing an elongate article.

(57) A prestressed concrete fence poste (10) has a prestressing tendon in the form of a strap (22), and has a chamfered top end (14). A mould (26) for making the post (10) has a mould body, which is flexible and/or disposable, and has moulding compartments (44) therein. Tip and top end plates (46, 48) are provided to produce a tip end and a top end for the post. The body is held within side members (28, 30), there being dogs (82) on end support members (62, 76) which act upon the side members (28, 30) to releasably hold said mould body in a moulding position by laterally compressing the side members (62, 76) and locating the end support members (62, 76) on said mould body. Upper and lower dogs are provided at the ends of each compartment for retaining strap. A tensioning device may be used to tension the strap before it is dogged off.



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This invention relates to a method of producing pre-tensioned articles using a strap as a pre-tensioned tendon. The invention is applicable to elongate articles, and also relates to a method of, and apparatus for producing such articles, examples of which are fence posts and telephone and electricity poles.

Pre-tensioned posts are known, wherein steel wire is used as a prestressing tendon, but their design is such that insofar as their use as fence posts is concerned, they cannot compete with wooden posts and are of less strength. In addition, they are constructed using heavy steel moulds or bulky wooden moulds, and accordingly the production of the posts is inefficient and costly.

It is an object of this invention to provide an improved method of pre-stressing concrete articles and to provide an improved method of and means for producing said articles.

The present invention provides a prestressed article wherein the prestressing tendon is a strap (22) having portions (24) thereof deformed to allow bonding of the tendon to the material of the article.

The invention also provides a method of producing a pre-stressed concrete article, wherein a tendon is pre-stressed characterized in that said tendon is a strap (22), said strap having a width substantially greater than its thickness.

The present invention also provides a method of moulding a generally elongate article, including the steps of arranging a generally flexible mould body (40) to provide at least one moulding chamber (44), said body (40) being provided with means to affect the appearance of portions of said article, passing at least one prestressing tendon through said moulding chamber (44), stressing said tendon (22), pouring the material from which said article is to be made into said moulding chamber (44), and subsequently removing said article from said mould.

The present invention further provides a mould (26) for producing a generally elongate article, said mould including a generally flexible mould body (40) including

at least one moulding compartment (44) frame means (28,30) for supporting said body and end plates (46,48) to close said compartment (44), and means to retain in tension tendons located within said compartment.

The present invention also provides a tensioning device for a plurality of tendons, a frame (124) capable of movement relative to an element (62) to which one end of each said tendons (22) is attached, a plurality of means for releasably attaching said tendons to said frame, and a rope (180), wire, or the like flexible member connecting each said means to said frame to distribute tendon stretching forces evenly to each said means.

Embodiments of the invention, which may be preferred, are described in detail hereinafter with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of one design of fence post according to this invention;

Fig. 2 is a plan view of portion of one type of tensioning strap used in the generally elongate articles of this invention;

Fig. 3 is a side elevation of the strap of Fig.2;

Fig. 4 is a perspective view from above of a mould for producing the fence post of Fig. 1;

Fig. 5 is a cross-section along the lines 5-5 of Fig. 4, with the pins removed;

Fig. 5A is a perspective view of part of the top end of the mould body in the assembled form;

Fig. 6 is a side elevation of the flexible mould body;

Fig. 7 is a perspective view of an end member of the mould of Fig. 3;

Fig. 8 is a top plan view of the end dogs and tip backing plates attached to the end of the mould of Fig. 3;

Fig. 9 is an end elevation of the dogs and backing plates of Fig. 8;

Fig. 10 is a perspective view of a tip end plate;

Fig. 11 is a plan view of the tip end plate of Fig. 10;

Fig. 12 is a section along the lines 12-12 of Fig 10;

Fig. 13 is a front elevation of a tip end plate;

Fig. 14 is a section along the lines 14-14 of Fig. 13;

Fig. 15 is a plan view of a strap tensioning device in place on the mould of Fig. 3;

Fig. 16 is a cross-section along the lines 16-16 of Fig. 15;

Fig. 17 is a cross-section along the lines 17-17 of Fig. 15;

Fig. 18 is a perspective view of an upper dog;

Fig. 19 is a perspective view of a lower dog;

Fig. 20 is a perspective view of a mounting block;

Fig. 21 is a side elevation of an hydraulic strap tensioning device for use on the mould of Fig. 4;

Fig. 22 is an end elevation of the device of Fig. 21;

Fig. 23 is a side elevation of the device of Fig. 21, showing additional features;

Fig. 24 is a partial side elevation of a mechanical equivalent of the hydraulic device of Fig. 21;

Fig. 25 is an end elevation of a connecting block; and

Fig. 26 is an end elevation of another connecting block.

Referring firstly to Fig. 1, there is shown a pre-tensioned elongate concrete fence post 10 of generally rectangular cross-section. The post 10 has a primary or tip end 12 in the form of a truncated right pyramid. The primary end 12 is that which is intended to be pushed into the ground or an at least partially prepared hole. The secondary or top (in use) end 14 has chamfered sides.

Apertures 16 are provided through the post 10, fourteen in the example of Fig. 1, through which apertures fencing wire may be passed, with or without the use of through-hole insulators which can be hammered into place, which would be used if the fence were to be electrified.

Grooves 18 are provided on one face 20 of the post. There are, in the example of Fig. 1, as many grooves 18 as there are apertures 16, and they are arranged in pairs. The grooves 18 may be used as an alternative means for securing fencing wire to the post.

The post 10 is pre-tensioned during manufacture (as will be described hereinafter) by the use of a prestressing tendon in the form of a strap 22, which strap is shown in broken lines in Fig. 1, in the position occupied by it in a cured post.

An example of strapping is shown in Fig. 2. The strap 22 shown there is high tensile steel strap 1 mm thick and 26 mm wide. It has been found that chemical and mechanical bonding between the strap and the concrete of the post 10 can be improved if the strap is feathered at regular intervals, has apertures provided therein at regular intervals or is otherwise processed. The strap 22 of Fig. 2 has been feathered by cutting and bending, using conventional metal working apparatus, by bending portions 24 along both sides of the strap, at regular intervals.

Figures 4 to 14 show a mould 26 capable of producing six of the concrete fence posts 10 at one time. The mould 26 includes side members 28,30 having a C configuration with a web 32, top flange 38 and bottom flange 34. The members 28,30 are preferably formed from 5 mm cold rolled steel.

The flexible moulding body 40 may be fabricated from 1.6 mm zincalume steel sheet, or from a sheet of lightweight plastic, or a sheet of cardboard. The sheet is foled, welded or bent to the concertina shape best illustrated in Fig. 4, with the vertical portions defining barriers 42 between the six moulding chambers or tubs 44. The body 40 is then inserted into a frame formed by the members 28,30. With a welding mould body 40, the body, in an unrestrained mode, assumes a generaly convex shape, opening out tubs 44.

A tip end plate 46 and a top end plate 48 are provided at each end of mould body 40. Tip end plate 46

is shown in Figs. 10 to 12. The plate 46 is steel, in this example 5 mm steel. Slots 50 are milled in the plate 46, and circular apertures 52 and notches 54, having a generally V-shaped profile, are also provided. It may then bend along broken lines 56,58 and 60 to the profile shown in Fig. 10 and 12.

Tip end plate 46 is secured to a tip end support member 62, which is a hollow-section member, preferably 51 mm square steel tube, by bolts 64 which extend into the threaded apertures 52. Slots 50 are intended to receive strap 22, and notches 54 are intended to contain portion of partitions 42 of mould body 40. The addition of tip end plate 46 to mould body 40 assists in flattening out the inbuilt curvature thereof.

Top end plate 48 (Figs. 13 and 14) is cast or otherwise fabricated from a single piece of material for example aluminium. The plate has slots 66 milled therein, and circular apertures 68 are also provided. The plate, on one side, has six top end moulds 70. Each mould 70 has (as is best shown in Fig. 16) four inclined surfaces 72 a base surface 74, and a lateral ridge 73 which serves to produce a groove (not shown) in the top surface of top end 14 of post 10.

Top end plate 48 is secured to a top end support member 76 (Fig.7) which is a hollow-section member, preferably also of 51 mm square steel tube, by bolts 78 (Fig. 16) which extend into threaded apertures 68. Apertures 77 are located as shown in Fig. 7, for the location of roll pins 94 (see Fig. 20) ,as described hereinafter.

Notches 80, which are formed in webs 32 of members 28,30 at the ends thereof, are adapted to receive members 62,76. Dogs 82 (Figs. 4,8 and 9) are secured to members 62,76 by bolts 82 which allow them to be rotated about the bolts. The dogs 82 include a handle 85 and a cam portion 87, the cam portion 87 acting on curved portion 33 of web 32 when the dogs 82 are operated, to compress the sides of mould 40, which in an unrestrained state is designed to spring apart, which

in use aids in the removal of the posts 10 moulded in the tubes44. The dogs 82 also draw in end members 62,76 to the mould body 40.

Once the mould is assembled as shown in Fig. 4, pins 86, preferably steel pins, are placed through registering apertures 88 in side members 28,30 and in mould body 40. The additional detail shown only in Fig. 5A shows inverted V-shaped notches 90 at the lowest part of the partitions 42 of mould body 40, in which are seated half-round members 92 which extend the entire width of the body 40. In the finished post of Fig. 1 , the apertures 16 are formed by pins 86, and the grooves 18 are formed by members 92. (Fig.s 5,5A). The top end of mould body 40 has a shoe 93 which co-operates with top end plate 48 for easier location and removal thereof.

Details of the strap dogging mechanism shown in Figs. 7 to 9 and 12 will now be described. Mounting blocks 94 (one of which is shown in Fig. 20) are located in apertures 77 (Fig. 7) in end members 62,76, two per pair of dogs. Each block 94 has a pair of roll pins 96, which serve to limit the downward movement of a block 94 when it is dropped into an aperture 77 (Fig. 16). Each block also has apertures 98, which are adapted to carry a shaft 100, each of which shafts is adapted to locate in an aperture 108 of a dog 102 or 103 (Figs. 18,19).

The dogs 102 are preferably milled from 25 mm steel stock, and are preferably case hardened. Each dog 102 has a handle 104, and a head 106 having an off-centre aperture 108 therein for insertion of roll pin 100 therein. Part of the outer surface of head 106 is knurled as indicated at 110.

In the dog 103 of Fig. 19, it can be seen that relative to handle 104, aperture 108 is off-centre more towards it than in the embodiment of Fig. 18. This is because in the 'free' position of each dog, the lower dogs 103 (Figs. 16,19) have their handles 104 hanging vertically downwards, whereas dogs 102 have their handles 104 at an angle of approximately 45^{o}.

Concrete posts are manufactured as follows. With

the mould 26 in the assembled position of Fig. 4 strap 22 is locked off by a lower dog 103 of one end of a moulding compartment 44, is passed through the appropriate lower aperture 50 or 68 of a tip end plate 46 or a top end plate 48. The strap 22 is then drawn the length of compartment 44 and is passed through the lower aperture of the plate at the other end. The strap is then tensioned, for example using apparatus to be described hereinafter, and dogged off by the lower dog 103 at the other end. Pins 86 are then inserted into apertures 88. A similar procedure is followed with the 'upper'strap 22 in the compartment 44, except that the strap 22 is inserted through upper apertures 50,68 and over pins 86, and is dogged off at each end by upper dogs 102.

With the dog 102,103/mounting block arrangement 94 best shown in Fig. 16, the lower dogs 103 can be partially operated automatically by operation of the upper dogs 102. When the upper dogs 102 are rotated to bring knurled surface 110 into frictional contact with strap 22, trapping it between surface 110 and the top surface of element 62, mounting block 94 will be raised, causing surface 110 of dog 103 to contact lower strap 22 and trap it between surface 110 and the lower surface of member 62. Lower dogs 103 may be manually brought to a contact position first, then upper dogs 102 may also be operated. Upper dogs may then be forcibly tightened, using a hammer or the like; this automatically tightens lower dogs by further raising block 94. Conversely, when top dogs 102 are released, lower dogs 103 are also automatically released.

The compartments 44 of mould body 40 are then filled with concrete, which may then be vibrated. After the initial set the pins 86 may be removed. When the concrete has cured, the posts 10 are released by unclamping the dogs 102,103 and releasing the dogs 82. Top and tip end plates 46,48 may be knocked away from the posts, and in the case of a metal mould body 40, it should spring apart sufficiently for the posts 10 to be released. Alternatively, may be turned upside down and

the posts 10 removed, the ability to open up the flexible body 40, which is possible because of its fan-like or 'concertina-like' configuration, enabling easy removal of the posts. If a disposable flexible or rigid plastic or cardboard mould body 40 or insert or part thereof is used, the side members 28,30 are lifted off, and the set of six posts is ready to be packaged, with the mould body 40 only being discarded when the posts are ready for sale or use. Of course, the mould body 40 may be generally planar in its unassembled state. Any loose ends of strap 22 may be cut off at any appropriate time.

Figs. 15,16 and 17 show a strap-tensioning device 122 for use on the mould of Fig. 4. The device includes a box-like frame 124 which is connected to member 62 (in this case; it could be connected to member 76) by means of shafts 126,128, which have crank handles, partly shown at 130,132, at one end thereof. The shafts 126,128 are mounted for rotation with respect to member 62, but are threadedly engaged with blocks 133,135 on frame 124 so that rotation of shafts 126,128 will advance from 124 towards member 62 or away from it depending on the direction of rotation.

Frame 124 has six sliding plates 134 located therein, which plates are able to move relative, in each case, to a slot 136 in front member 138 of frame 124, and pins 140,142 located between upper and lower frame members 144,146.

Each plate 134 carries dog housings 148,149, which carry, respectively dogs 150,152 , identical to dogs 102 ,103 respectively, on axles or roll pins 154,156. The axles also pass through housing plates 155,157. The dogs 150,152 act on surfaces 158,160 of housing 148. Plates 155,157 are pivotally attached to plate 134 by shaft 162, and the aperture 164 in plates 155,157 through which shaft 162 passes is enlarged to allow vertical movement. The dogging arrangements operates in the same manner as described in relation to dogs 102,103 of mould 26.

Each plate 134 also has an aperture 166 at the

rear thereof. Frame 124 also has a plurality of capstans 168, provided with rollers 169 located at the rear of the frame, between top member 144 and bottom member 146. Secured to front member 138 are two spring members 170, 172, which have apertures 174,176 therein. A cable 178 (which could be a rope, wire or the like)is run-through aperture 174 in spring member 170, to the rear of the roller 169 left-hand (in Fig. 15) capstan 168, through aperture 166 in left-hand (Fig. 15) plate 134, and so on until it is passed through aperture 176 in spring member 172 and assumes the position shown in Fig. 15. Ferrules 180, 182 (which would be knots on a rope) prevent the cable ends from pulling through apertures 174, 176.

To tension straps 22 (not shown) the procedure outlined in relation to Figs. 4 to 14 is followed, except that the straps at the 'secondary' end are not dogged in the dogs 102, 103 associated with mould 26, but are dogged by the dogs 150, 152 of tensioning device 122.

Handles 130,132 are used to rotate shafts 126, 128 to move frame 124 away from member 62. As the frame 124 moves away, plates 134 tend to remain in place until the movement of the frame 124, transmitted through spring members 170,172 and cable 178 starts to also pull them away from member 62, and thereby commences tensioning the strap. The cable 178 acts somewhat like a liquid with tensile strength in distributing the force evenly to each plate 134. For each plate 134, there is the even distribution of the force between the upper and lower straps, due to the ability of the housing 148 to rotate about shaft 162.

The degree of tension may be calibrated by reference to the deflection in spring members 170,172. These may be connected to a pointer which has an associated scale, such that when the required deflection is shown as the pointer reaches a particular point on the scale the withdrawal of frame 124 can be stopped. The upper and lower straps 22 in each tub 44 can then be dogged off by dogs 102,103, and the dogs 150,152

operated to release the straps from the tensioning device 122. The frame 124 can then be returned to the start position adjacent member 62.

Figs. 21 to 26 show another strap-tensioning device 222 for use on the mould of Fig. 4. Dealing first with Fig. 23, part of a support member 62 is shown, to which member is secured a rail 212, which extends along member 62, transversely with respect to the mould 26.

A block 214 (Fig. 25) is adapted to slide along rail 212, with legs 216 of the block 214 being retained in recesses 218 in the rail 212. Block 214 is attached to one end of main member 220 of the device 122. The other end of main frame 220 is attached via a block 224 (Fig. 26) to an hydraulic ram 226.

Main frame consists of rails 226,228,230,232 which are connected to blocks 214,224 by screws or bolts 234. Slideably mounted on rails 226,228 is a dogging mechanism consisting of upper and lower mounting blocks 236,238 secured by side plates 240 bolted together by bolt 242. Each block 236,238 has dogs 202,203 substantially identical in construction and operation to those described in relation to the mould 26 of Fig. 4.

The inner surfaces of each mounting block 236, 238 if formed with teeth in the nature of a rack 244. Racks 244 mesh with central gear wheel 246 which can rotate about bolt 248 which is secured to plates 240. Springs 250 connect mounting blocks 236, 238 to side plates 240.

Actuating rod 252 of hydraulic cylinder 226 is connected to plates 240 by a bolt 254. Fig. 24 shows a manually operable equivalent arrangement, wherein a crank handle 256 has a threaded rod 258 (which, like rod 252, is attached to plates 240) which is engaged in threaded aperture 160 in handle 256. Turning the handle advances or returns rod 258, and as a consequence moves device 222 along rails 226, 228, 230,232, as does the operation of cylinder 226.

To tension straps 22 (not shown) the procedure outlined in relation to Figs. 4 to 14 is followed,

except that the straps at the 'secondary' end are not dogged in the dogs 102 associated with mould 26, but are dogged by the dogs 202,203 of tensioning device 222. Rod 252 (or 258) is then caused to move away from mould 26, drawing device 222 with it along rails 226 to 232. The blocks 236,238 have limited movement against springs 250 as the straps 22 are tensioned on the arrangement provides a way in which the desired tension is equalised in the upper and lower straps. When this tension value is achieved, the straps are dogged off by dogs 102,103 on mould 26, and the tensioning device may move along rail 212 to a position to tension the straps 22 in the adjacent compartment 44.

It can be seen that the present invention provides a new and improved post or other generally elongate article, and a process and apparatus for manufacturing such objects. Although the embodiments relate to a concrete fence post, other articles may easily be manufactured. Example of such articles are telephone and electricity poles, tubs, troughs, tanks, pipes, cattle grid elements, railway sleepers, building panels and bridge sections. The concrete fence post 10 of Fig. 1 has the following characteristics:

1. It has a compressive shear and tensile strength sufficient to allow its emplacement using a post driver.
2. Its design allows it to be compatible with existing fencing arrangements.
3. Its apertures 16 can be used for the installation of through-hole insulators.
4. As well as apertures 16 , it has grooves 18 along one face, for holding wire.
5. It has a feathered strap 22 as a pre-stressing tendon which provides greater chemical and mechanical bonds , between the concrete and the tendon.
6. It is lightweight, and is easy packaged and handled, particularly when the disposable mould body 40 is used to produce it.
7. It has a chamfered top end which reduces spalling when it is being driven into the ground.

Of course, the strap 22 may be feathered in other ways, or may have apertures punched therein to achieve the desired level of bonding.

The mould 26 has the advantage of a flexible mould body 40, which, when it is intended to be re-used, allows for easy removal of the cured articles therefrom.

CLAIMS:

1. A prestressed article wherein the prestressing tendon is a strap (22) having portions (24) thereof deformed to allow bonding of the tendon to the material of the article.

2. A prestressed article according to claim 1, wherein the strap (22) has at least one portion (24) thereof turned away from the plane of the strap.

3. A prestressed article according to claim 2, wherein the strap (22) has a number of alternate portions (24) deformed in a staggered pattern on each edge of said strap.

4. A prestressed article according to any preceding claim wherein said article has one chamfered end (14).

5. A prestressed article according to any preceding claim, wherein said material is concrete.

6. A prestressed article according to claim 5, wherein said article is a fence post (10).

7. A prestressed article according to claim 6, wherein said post (10) is provided with a truncated right pyramidal tip end (12) has apertures (16) located therethrough , and has grooves (18) on one face corresponding with said apertures (16).

8. A method of moulding a generally elongate article, including the steps of arranging a generally flexible mould body (40) to provide at least one moulding chamber (44), said body (40) being provided with means to affect the appearance of portions of said article, passing at least one prestressing tendon through said moulding chamber (44), stressing said tendon (22), pouring the material from which said article is to be made into said moulding chamber (44) and subsequently removing said article from said mould.

9. A method according to claim 8, wherein said prestressing tendon is in the form of a strap (22) with at least one portion (24) deformed to improve the bond between the tendon and said material.

10. A method according to claim 8 or claim 9, further including the step of deforming said mould body (40)

to remove said article.

11. A method according to claim 8, claim 9 or claim 10, wherein said mould body (40) has a generally concertina-like configuration, or is capable of assuming a convex fan-like shape.

12. A generally elongate article when produced by the method of any one of claims 8 to 11.

13. A mould (26) for producing a generally elongate article, said mould including a generally flexible mould body (40) including at least one moulding compartment (44) frame means (28,30) for supporting said body and end plates (46,48) to close said compartment (44), and means to retain in tension tendons located within said compartment.

14. A mould according to claim 13, wherein said mould body (40) has a generally concertina-like configuration, may be opened up like a fan, or assumes a convex configuration in an unrestrained state.

15. A mould according to claim 13 or claim 14 wherein said means is one dog (102,103) at either end of said compartment, and wherein said tendon is a strap (22).

16. A mould according to any one of claims 13 to 15, wherein pins (86) are located in said compartment (44) to provide apertures in said article.

17. A mould according to any one of claims 13 to 16, where said plates (46,48) are shaped to provide a chamfered top end and a truncated right pyramidal tip end to said article.

18. A mould according to any one of claims 13, and 15 to 17, wherein said mould body (40) is capable of being left in situ around said article until it is desired to use said article.

19. A mould according to claim 18, wherein said mould body (40) is formed from plastics material or cardboard.

20. In a tensioning device for a plurality of tendons, a frame (124) capable of movement relative to an element (62) to which one end of each said tendons (22) is attached, a plurality of means for releasably attaching said tendons to said frame, and a rope (180) or the like

flexible member connecting each said means to said frame to distribute tendon stretching forces evenly to each said means.

21. In a device according to claim 20, wherein each said means includes dogging means (150,152) supported on a housing (148) which housing (148) is supported on a plate (134) , said plate (134) being capable of limited movement relative to said frame (124).

22. A method producing a pre-stressed concrete article, wherein a tendon is pre-stressed, characterised in that said tendon is a strap (22), said strap having a width substantially greater than its thickness.

23. A method according to claim 22, characterized in that said strap is feathered in that portions of it have been deformed.

24. A dogging arrangement in which there are upper and lower dogs (102,150,103,152) supported on a housing (94,148) characterized in that said housing (94,148) capable of movement in a generally vertical direction such that when an upper dog is operated, the housing (94,148) will be raised, causing the lower dog to assume an operative position, and such that when an upper dog (102,150) is released, the housing will fall, thereby releasing the lower dog (103,152).

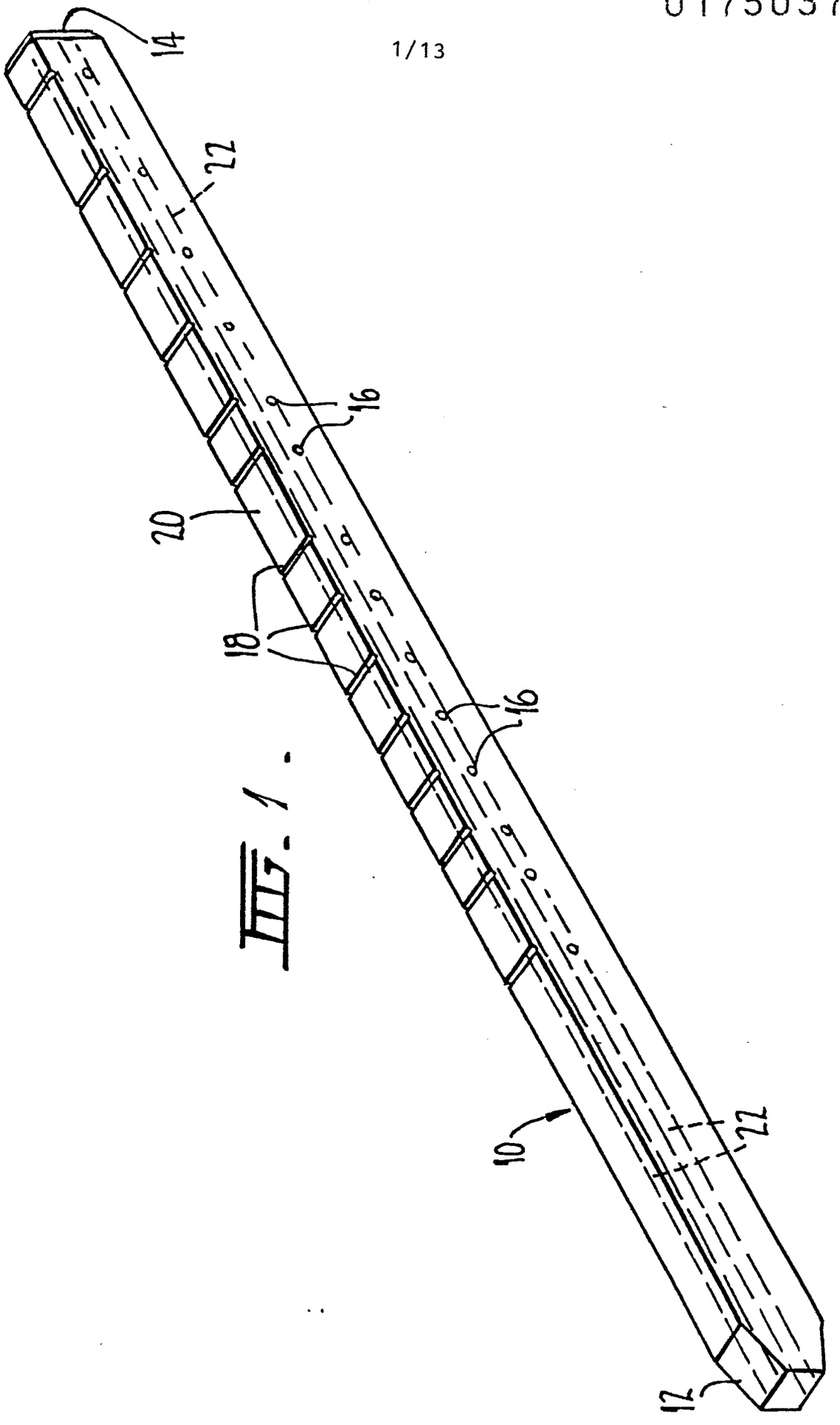

FIG. 1.

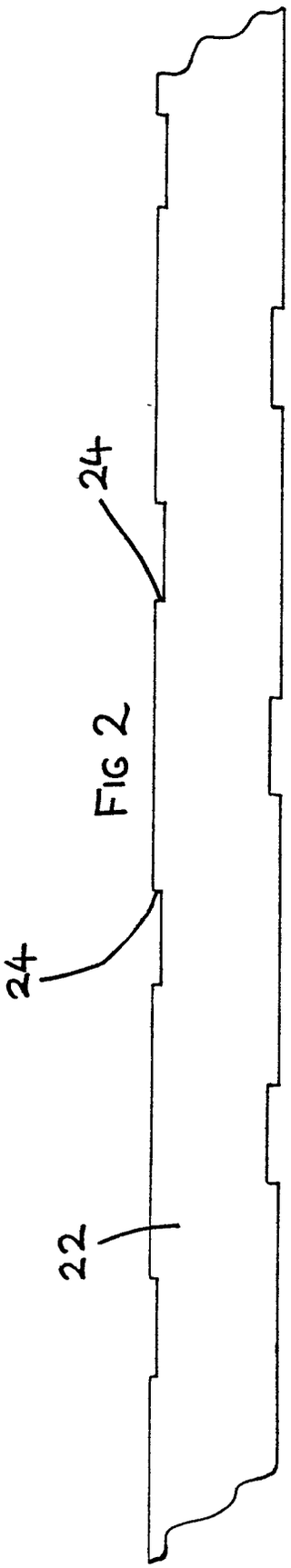

FIG 2

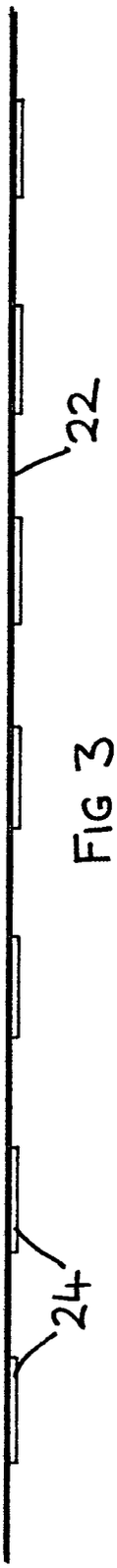

FIG 3

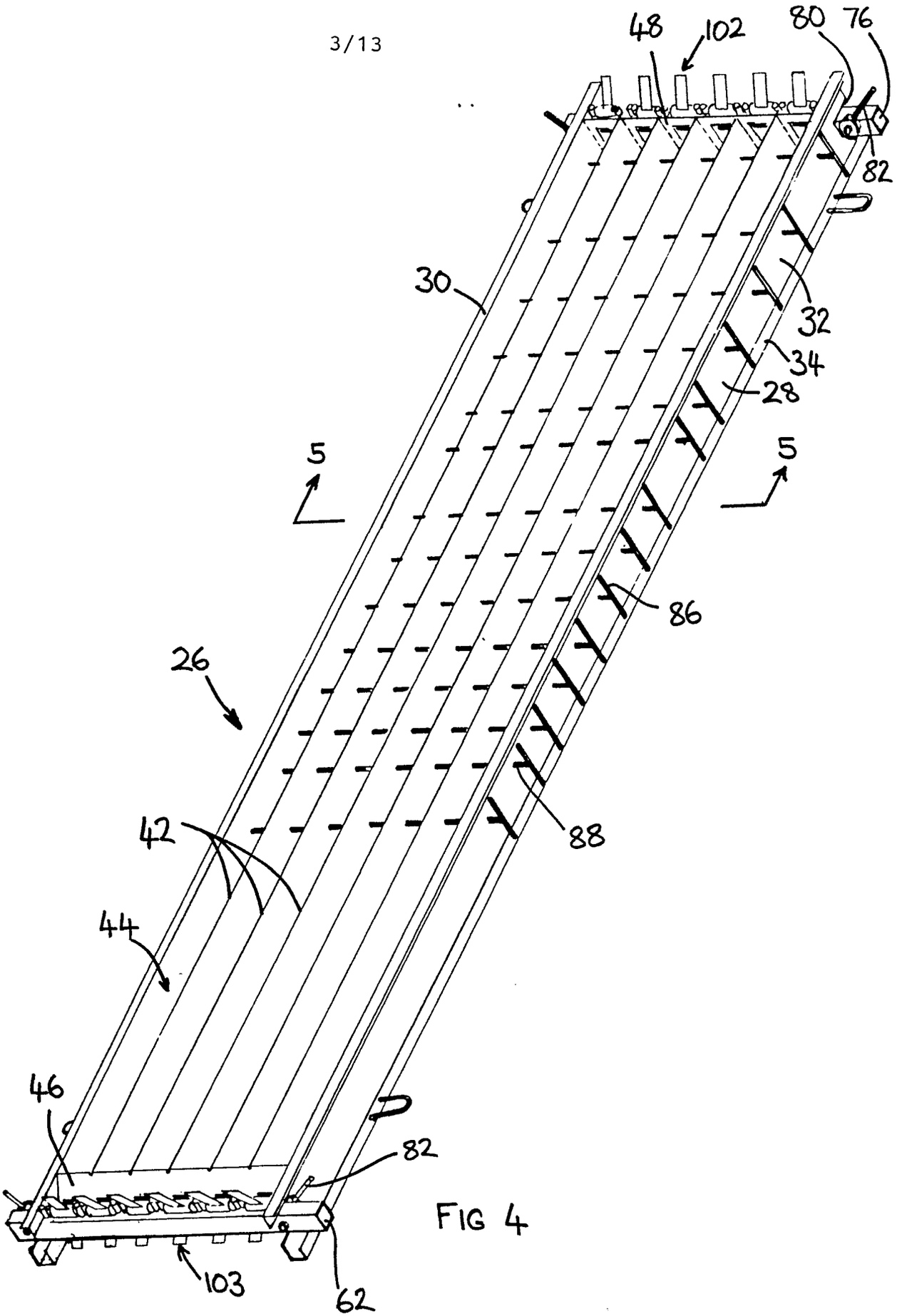

FIG 4

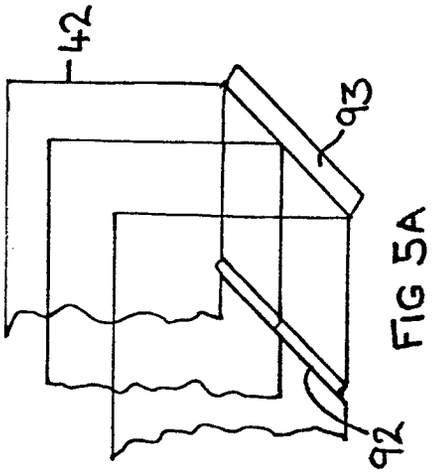

FIG 5A

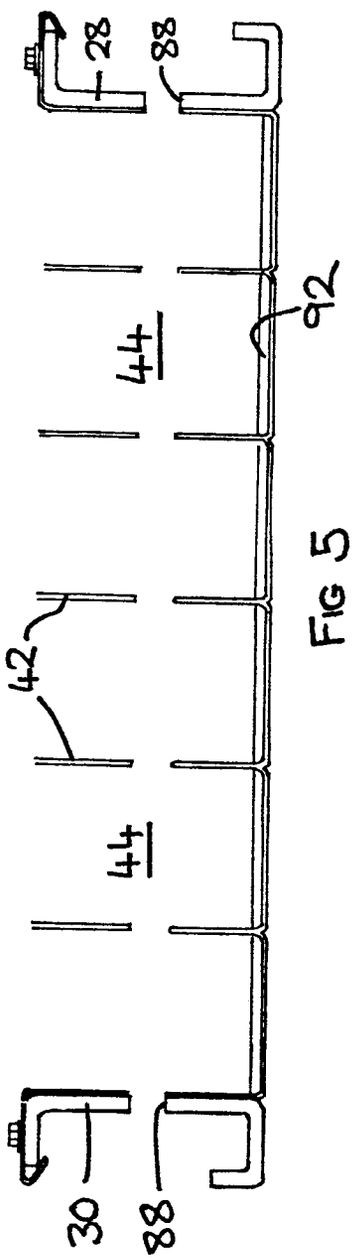

FIG 5

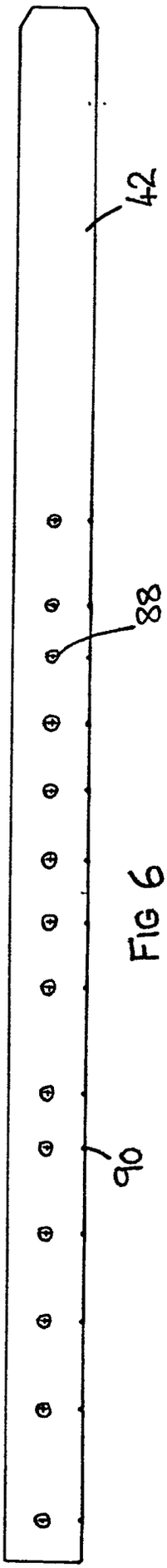

FIG 6

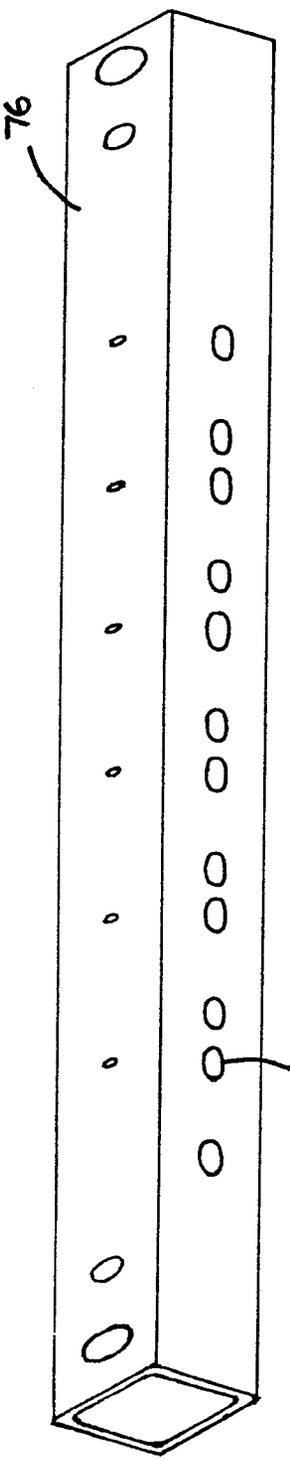

FIG 7

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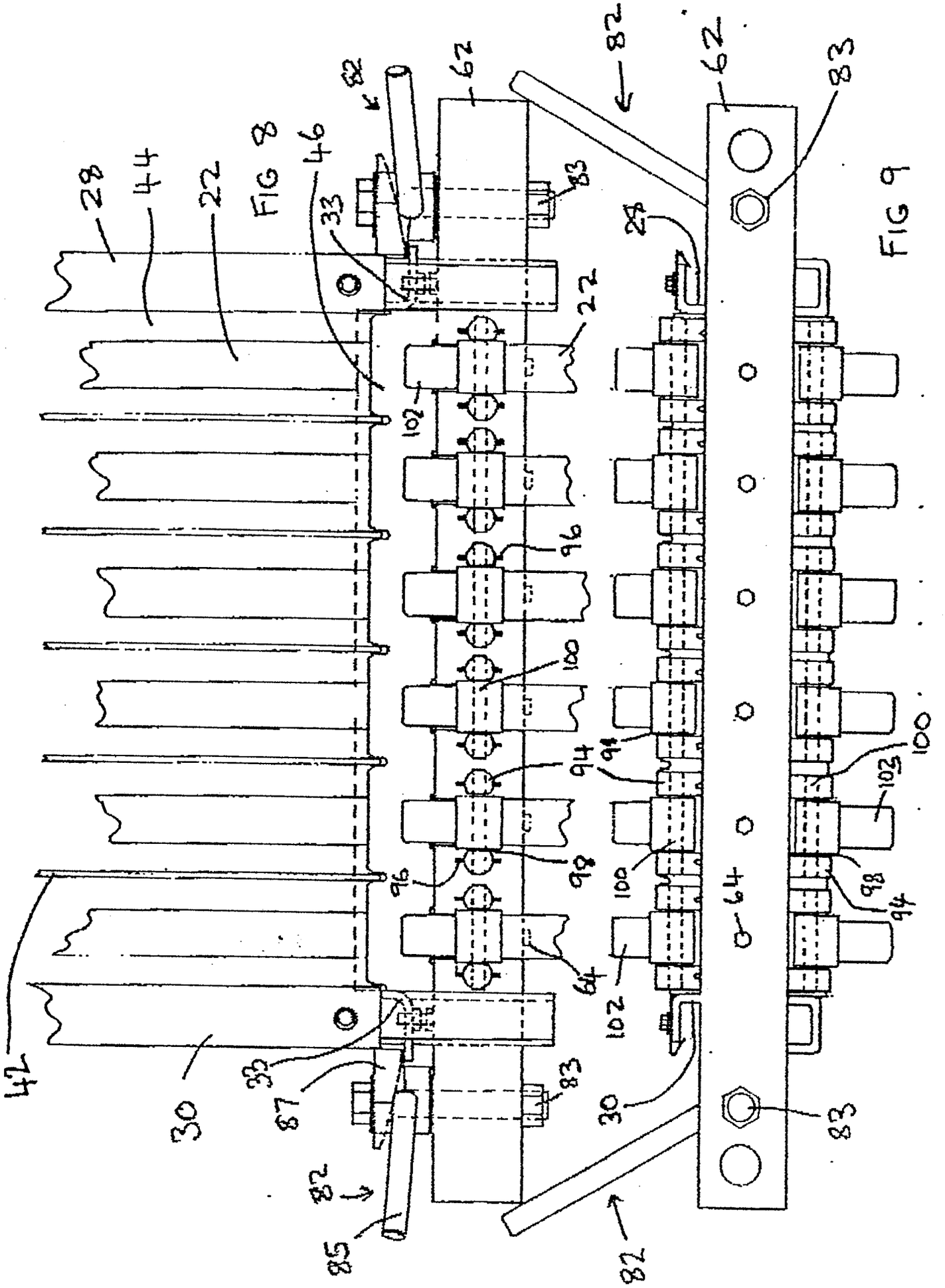

FIG 8

FIG 9

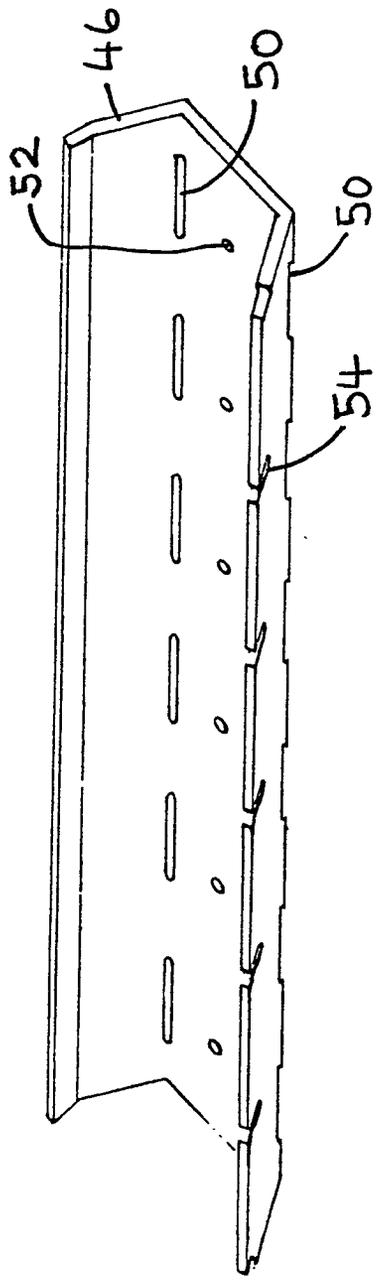

FIG 10

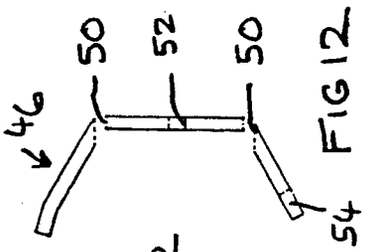

FIG 12

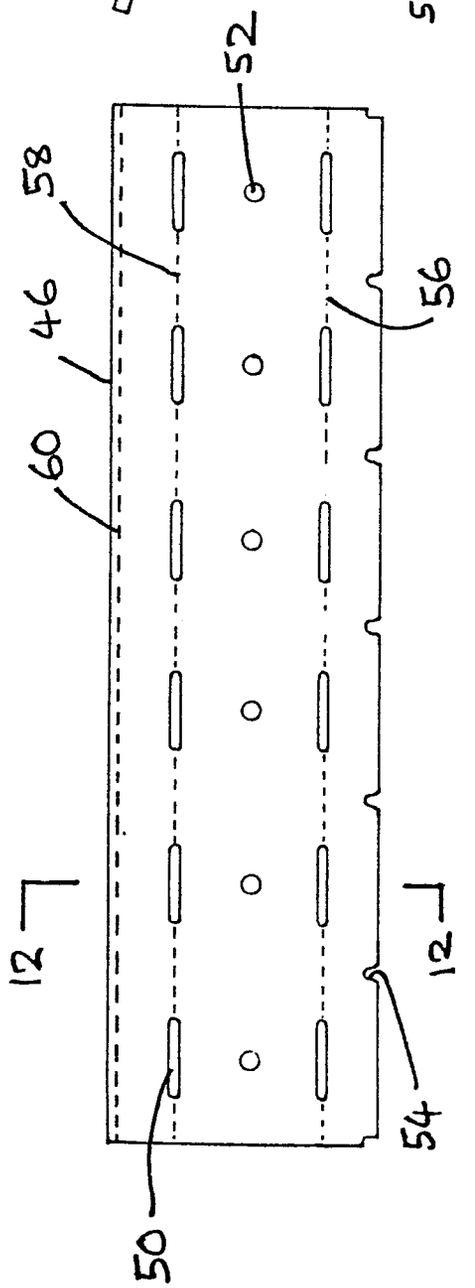

FIG 11

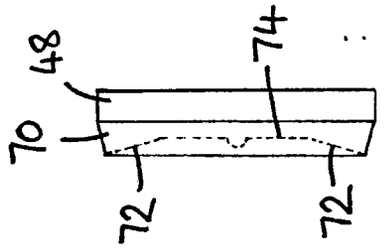

FIG 14

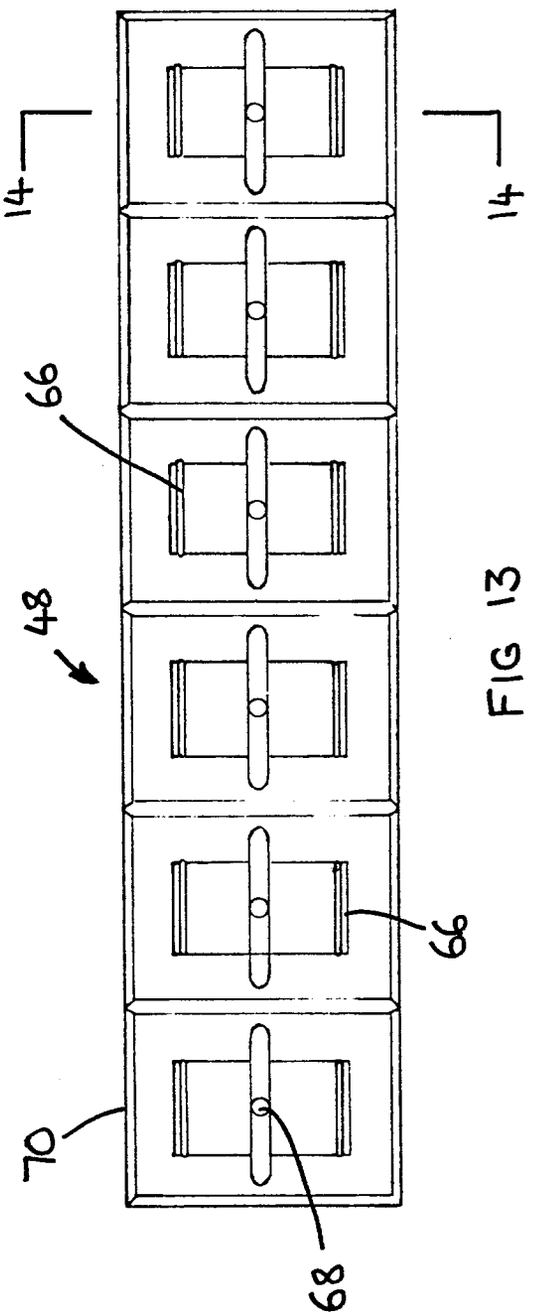

FIG 13

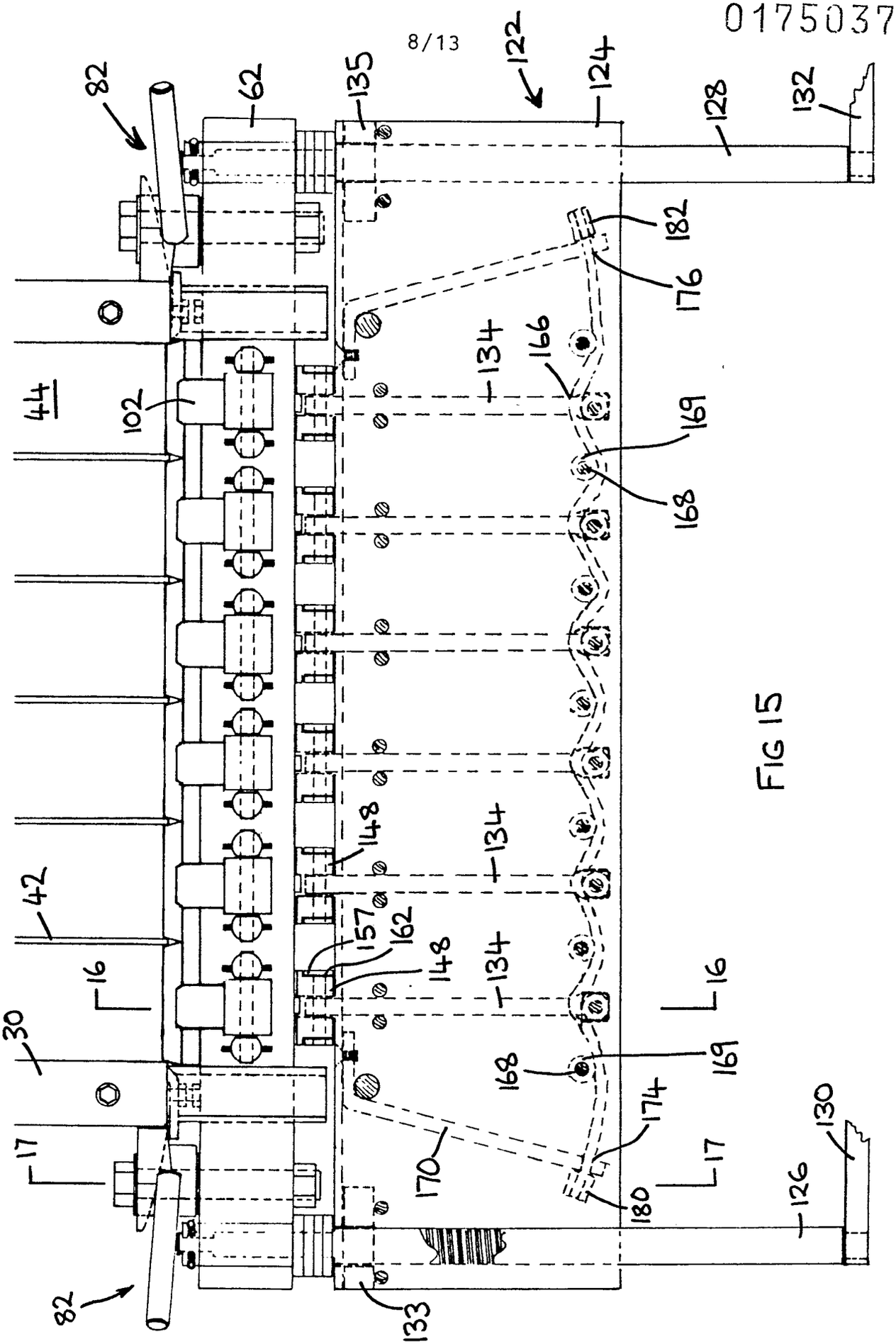
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FIG 15

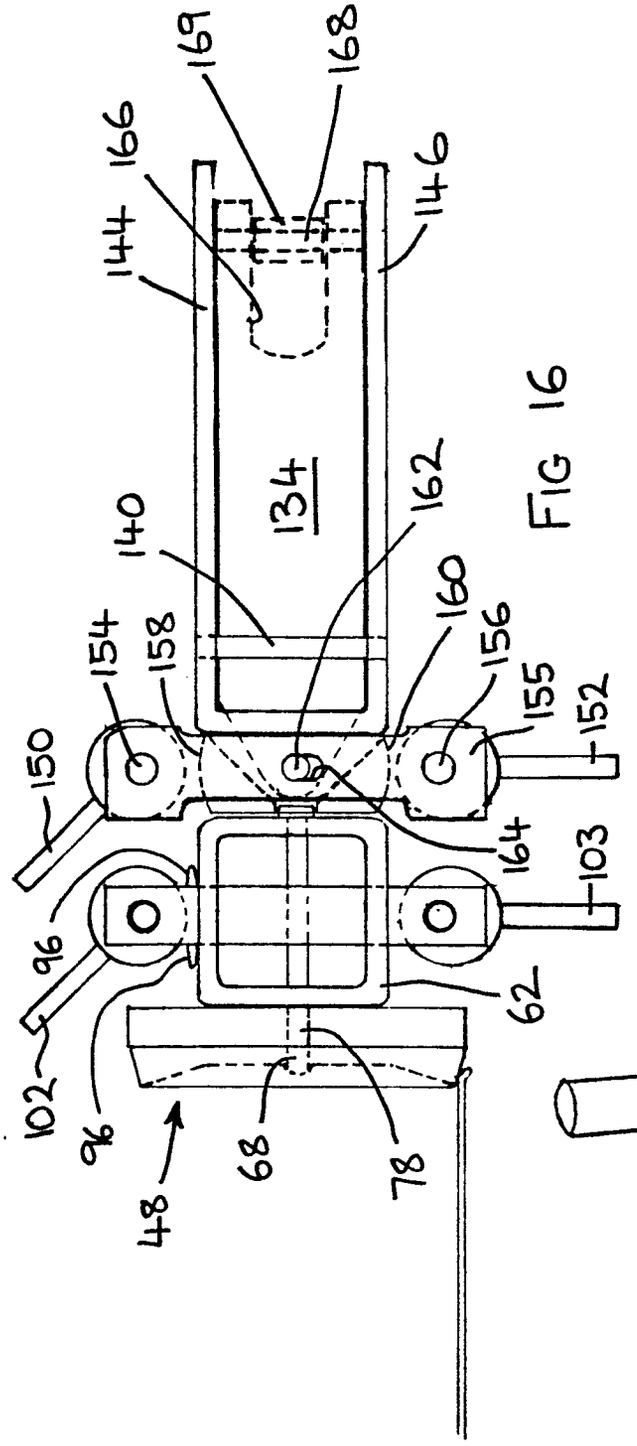
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FIG 16

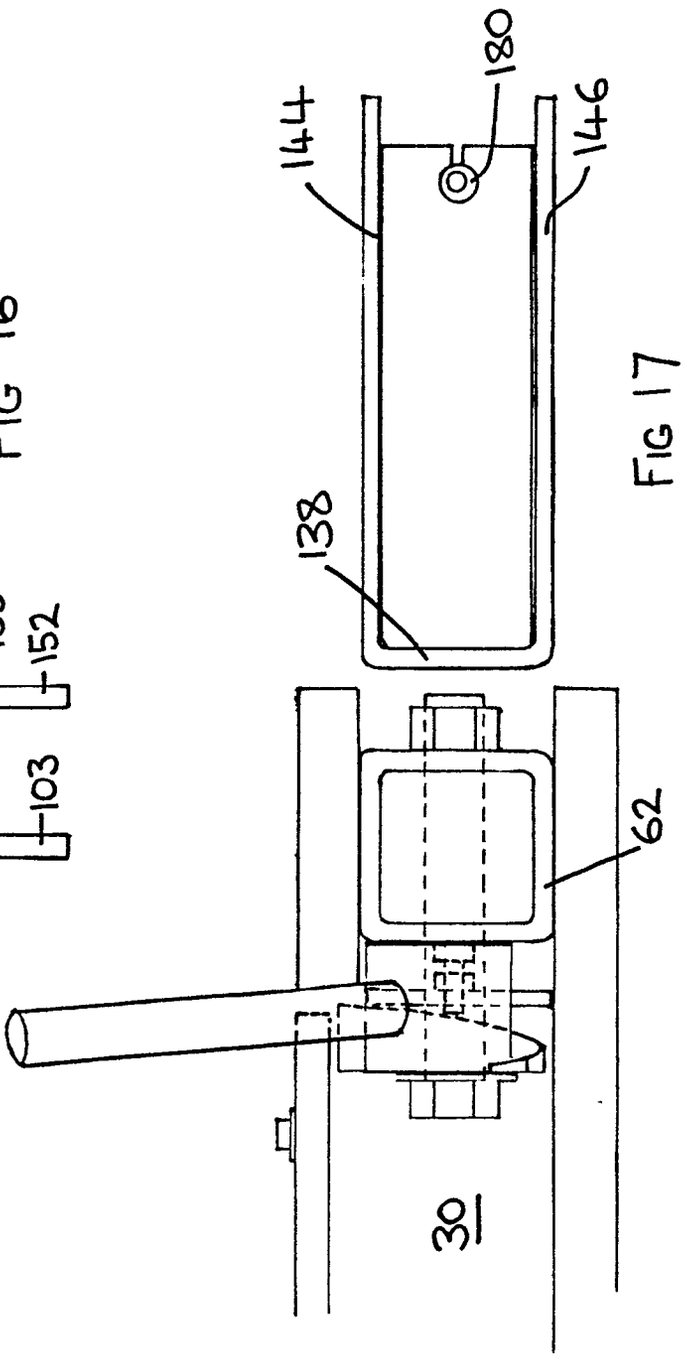
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FIG 17

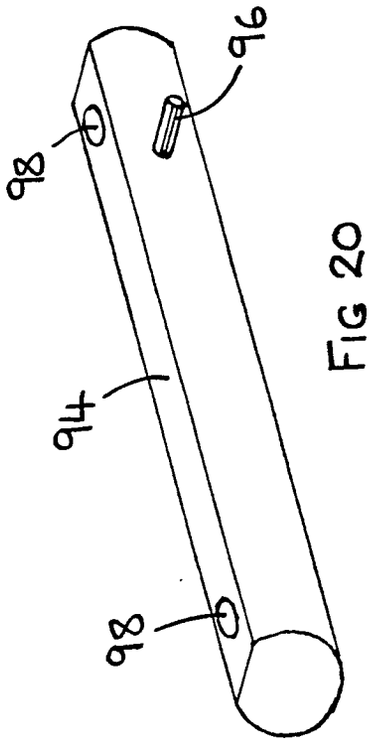

FIG 20

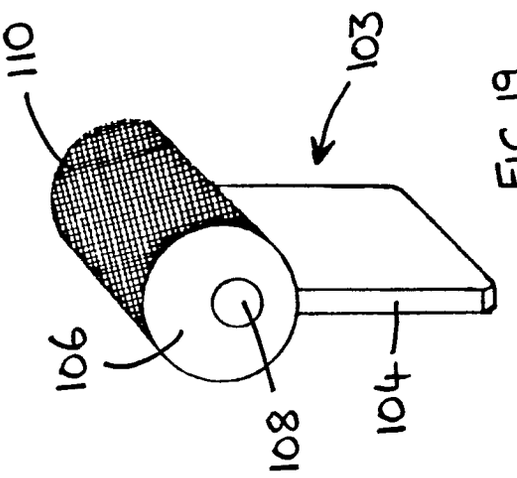

FIG 19

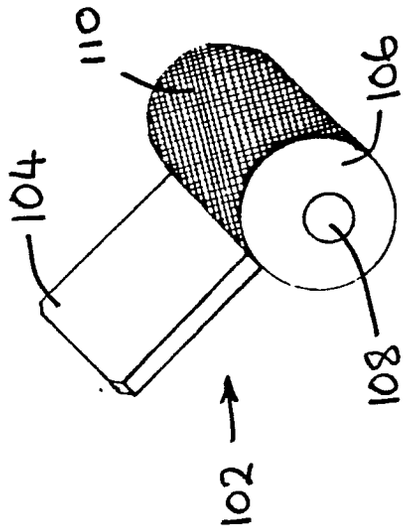

FIG 18

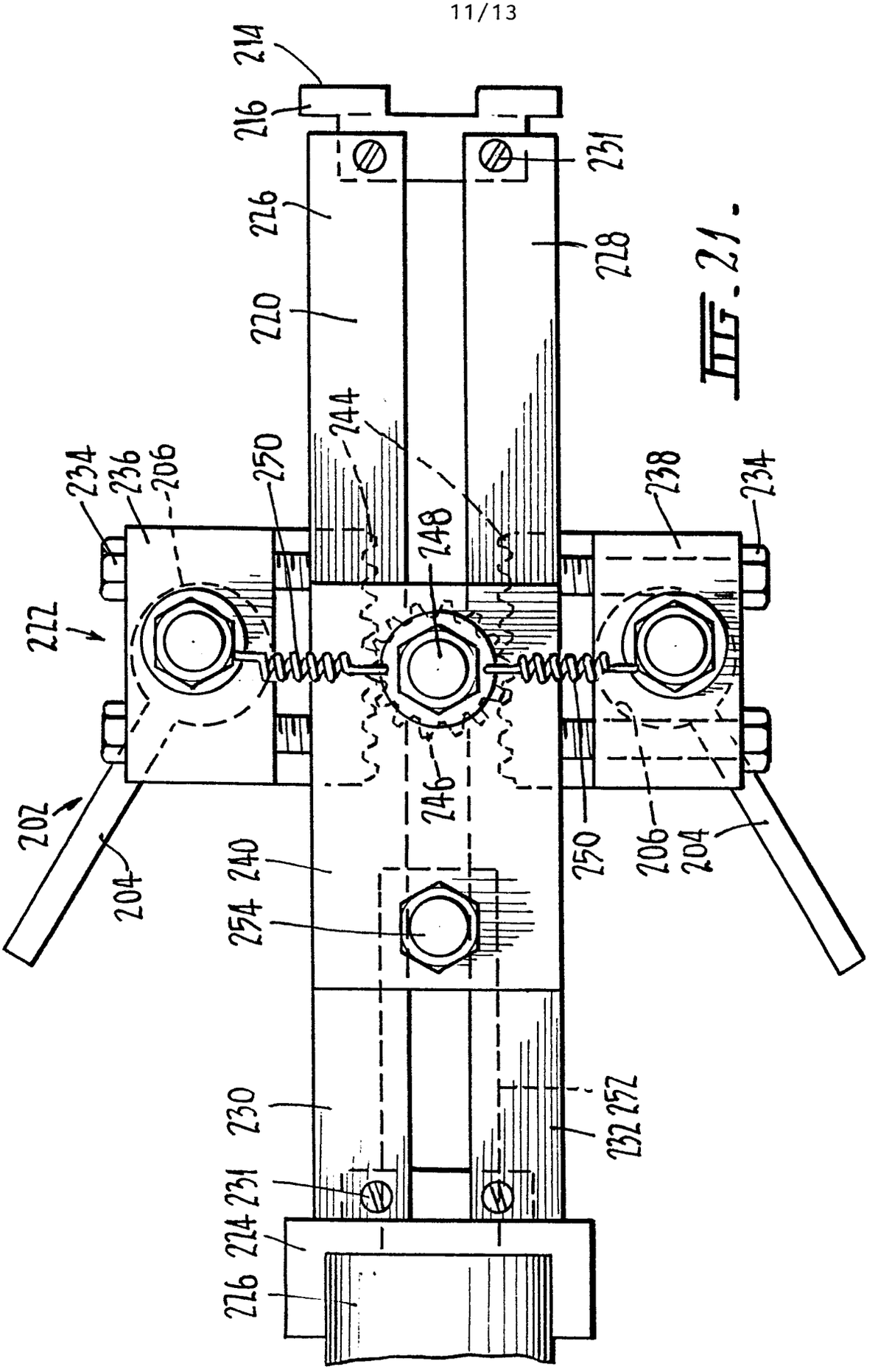
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Fig. 21.

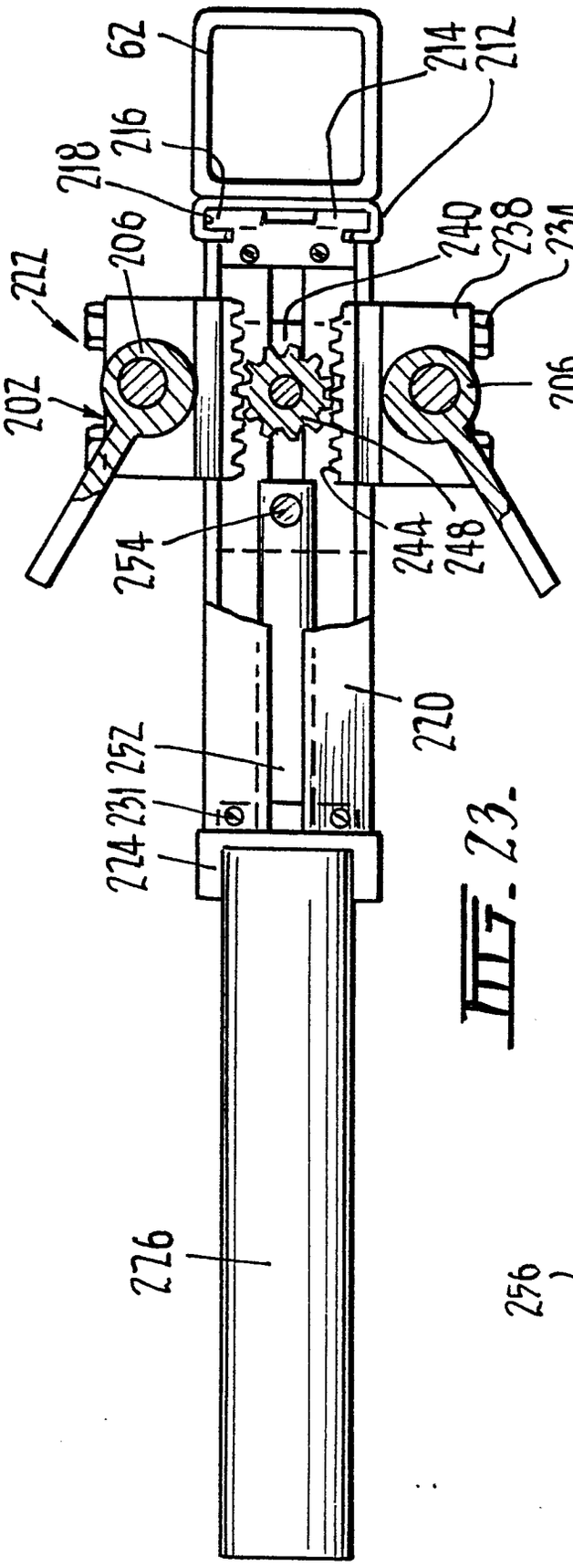
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FIG. 23.

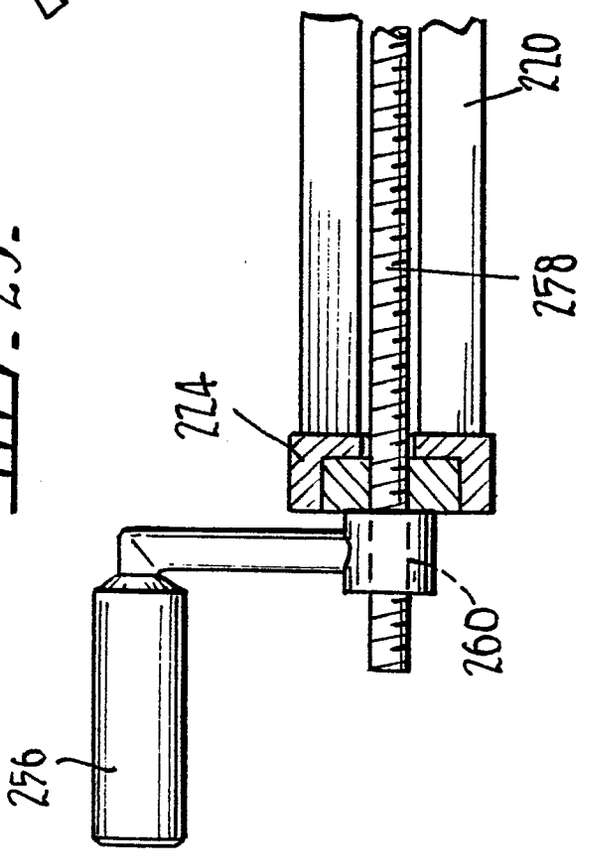
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FIG. 24.

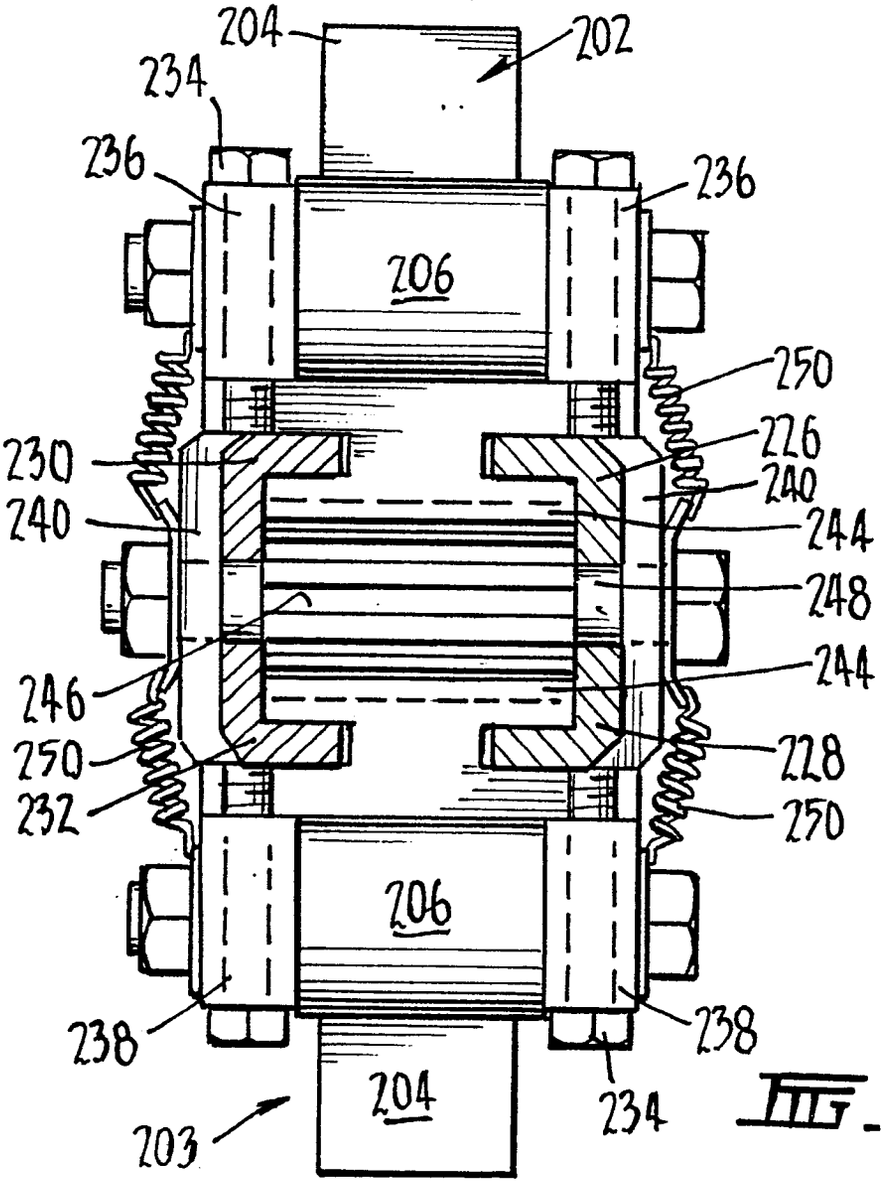

FIG. 22.

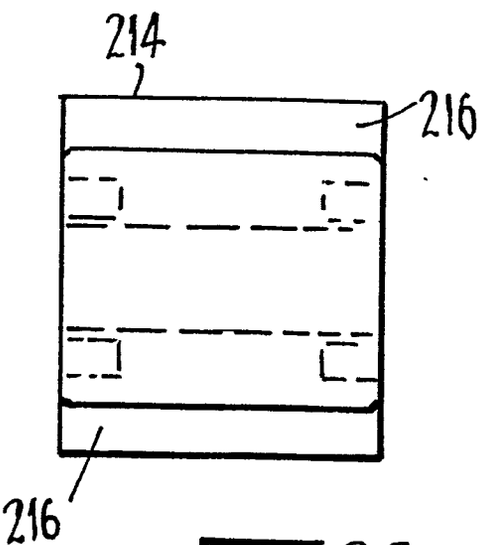

FIG. 25.

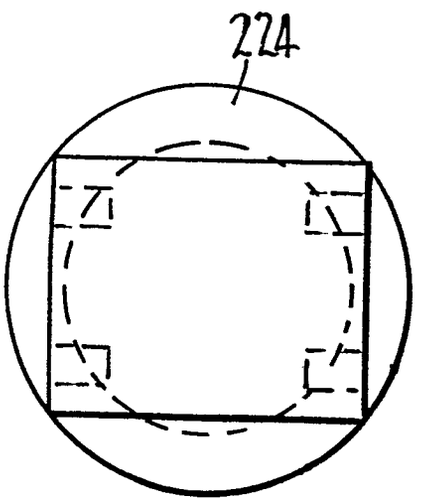

FIG. 26.