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SUR DES TOITS**
(54) **Title: APPARATUSES AND METHODS FOR FASTENING ROOFING STRAPS AND STRUCTURAL MEMBERS TO ROOFS**

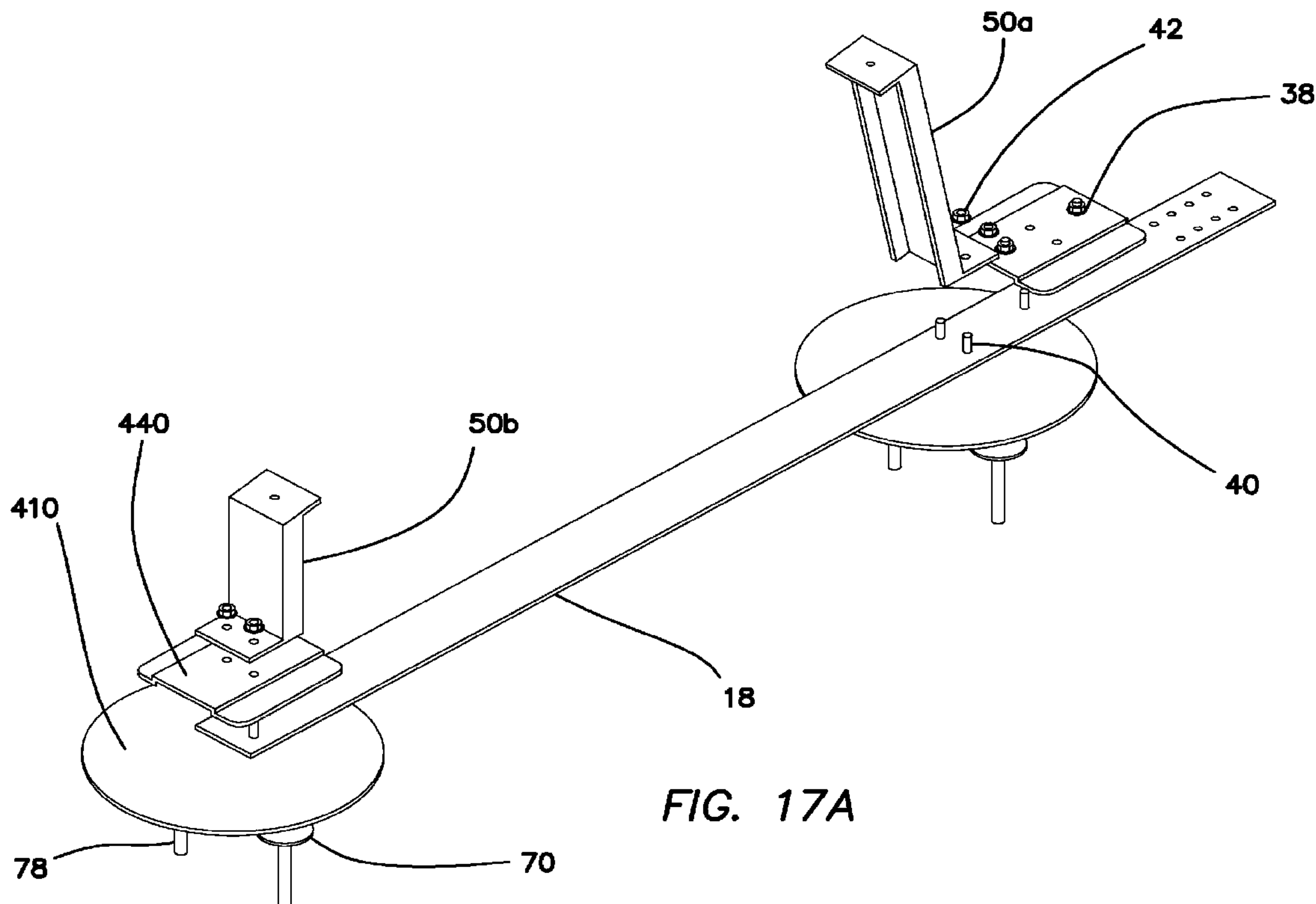


FIG. 17A

(57) **Abrégé/Abstract:**

A number of apparatuses and methods for fastening roofing straps and structural members to roofs are disclosed.



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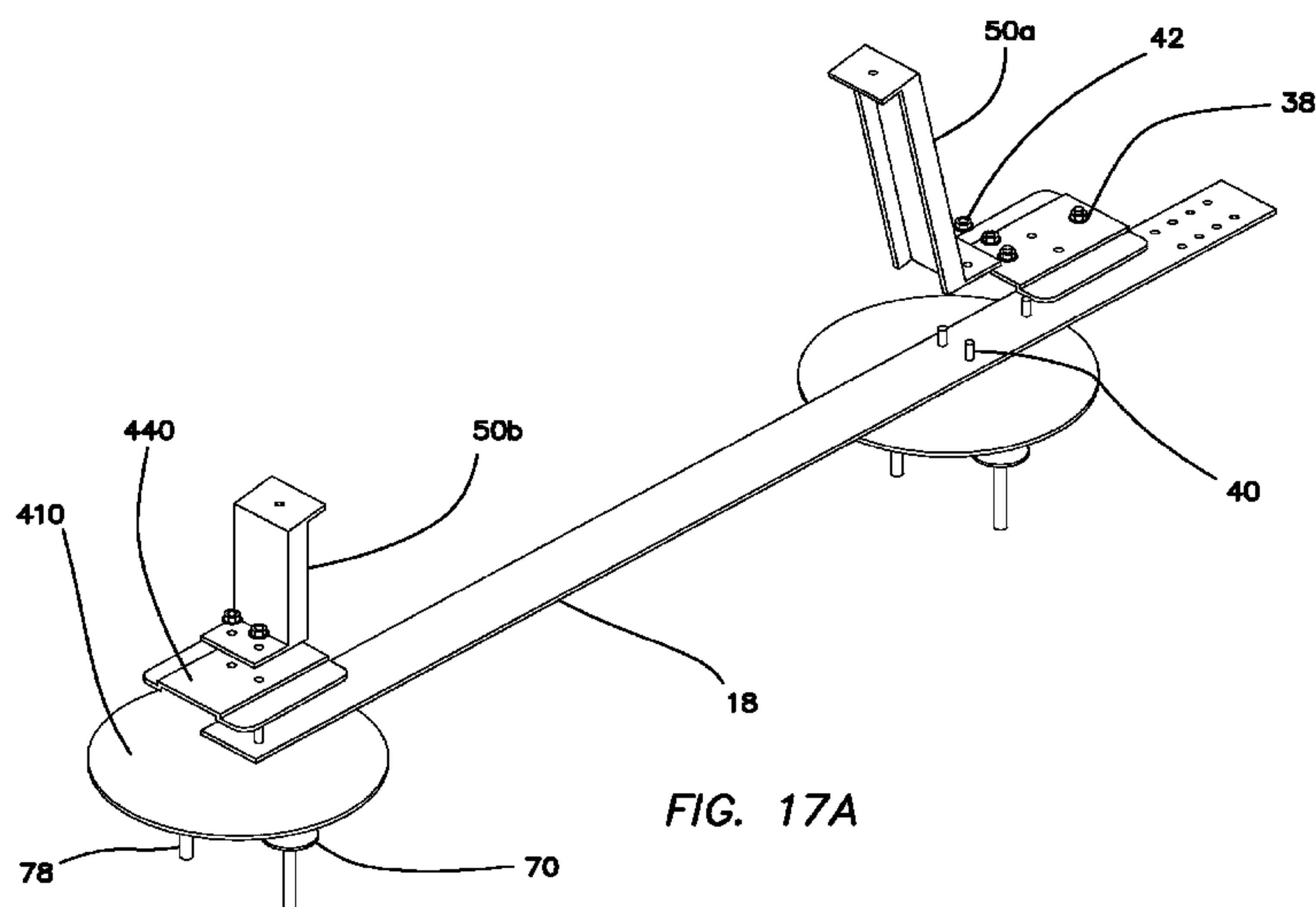


FIG. 17A

(57) Abstract: A number of apparatuses and methods for fastening roofing straps and structural members to roofs are disclosed.

WO 2015/109173 A1

Apparatuses and Methods for Fastening Roofing Strapsand Structural Members to RoofsTechnical Field

The present invention relates to the field of solar panels and more particularly to apparatuses and methods for attaching solar panel straps and structural members on surfaces, including roofs, walls and the ground. Further definition of solar panel straps and structural members may be found in US Patents Nos. 7,814,899 and 8,870,139; and PCT Patent Application No. PCT/US2013/025622 (published as WO 2014/123547); the entire specifications, claims and drawings of which are included in this document by reference.

Background Art

Solar panels can be of the photovoltaic type, of the thermal type or combinations. They can be installed as is or contained within a frame. Solar panels must be mounted correctly in order to maximize power production and to prevent movement of the panels from the force of wind and, in earthquake prone area, earthquake. The proper solar panel mounting provides stability and the proper directional and latitudinal orientation for the solar array.

Different mounting systems are available depending on whether the modules will be mounted on a roof, a wall, the ground, or a pole. For mounting on a roof or the ground there are ballast mounts, flush mounts (such as Modular IronRidge XRS available from IronRidge in Willits, CA) standing seams mounts, and adjustable mounts (such as those available from Unirac in Albuquerque, NM). These usually include a tilted rack, firmly attached to the substrate surface, on which the modules are firmly mounted; or brackets of at least two different heights, firmly attached to the substrate surface, to which the ends of the modules are firmly attached.

Such systems are heavy and expensive to fabricate and time consuming to install. They also involve penetration of the roof membrane, which has the potential to cause leakage of water. What is needed is a mounting system which is cheaper to fabricate and less time consuming to install. Preferably the improved system can be easily fabricated on site or provided as a kit. The inventor has developed three improvements on the state of the art:

US Patents Nos. 7,814,899 and 8,870,139, and PCT Patent Application No. PCT/US2013/025622.

This inventor has now developed another improvement on the state of the art. This improvement provides a positive mechanical connection of the solar panel mounting system to the roof, without penetrating the membrane. This improvement meets all requirements for structural strength, wind resistance and earthquake resistance. See attached report entitled “STRUCTURAL CALCULATIONS for Forever 21 Project”, which is incorporated in this application by reference.

Roof Mounted Solar PV Design. Development of a solar panel mounting system which is cheaper to fabricate and less time consuming to install represents a great improvement in the field of solar panel mounting and satisfies a long felt need of the solar panel installer and owner.

Disclosure of Invention

The objects of this invention are to:

- provide a positive seal which prevents moisture from penetrating the roof;
- provide strength sufficient to provide wind resistant to the solar panels; and
- provide a positive mechanical connection between the solar panels and the roof.

This invention encompasses a number of different embodiments.

First Embodiment

The first embodiment is intended to be used on roofs that are made of material that cannot be welded. The first embodiment comprises:

a first strip of weldable roofing material below a solar panel mounting strap perpendicularly crossing the strap, the bottom of the first strip being adhesively bonded to the roof;

a metal plate, smaller than the first strip, on top of the first strip and below or adjacent the strap, nailed or screwed through the first strip and the roof and into the roof

substrate (which is typically made from plywood, concrete, or metal) or into a roof rafter;

a second strip of weldable roofing material, perpendicular to the strap, lined up end to end with one end of the first strip and welded to the first strip thus encapsulating the metal plate; and

a third strip of weldable roofing material laid over the strap, perpendicular to the strap, crossing the strap, perpendicular to the strap, lined up end to end with the other end of the first strip and welded to the first strip .

The strips can be square, rectangular, hexagonal, octagonal, or any other shape and can be any convenient size.

Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment. One suitable waterproof sealant is RTV silicone rubber available from a number of manufacturers, such as GE, of Wilton, CT; and Dow Corning of Midland, MI. Another is Henry's roofing compound, available from Henry Company, El Segundo, CA.

Second Embodiment

The second embodiment is intended to be used on roofs that are made of material that can be welded. The second embodiment comprises:

a metal plate, treated to weld to weldable roof material, nailed or screwed through the roof and into the roof substrate (which can be made of plywood, concrete, or metal) or into a roof rafter, adjacent or below a solar panel mounting strap;

a first strip of weldable roofing material, larger than the metal plate , welded to the top of the metal plate and the roof, perpendicular to and adjacent the mounting strap thus encapsulating the metal plate; and

a second strip of weldable roofing material of width similar to the first strip, perpendicular to and crossing the strap, in line with the first strip and bonded to the roof.

The second strip may also overlap and be welded to the first strip. Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment.

Third Embodiment

- 5 The third embodiment is intended to be used on roofs that are made of material that can be welded. The third embodiment comprises:
 - a first strip of weldable roofing material adjacent and perpendicular to a solar panel mounting strap, the bottom of the first strip being welded to the roof;
 - 10 a metal plate, smaller than the first strip, on top of the first strip and under or adjacent the strap, nailed or screwed through the first strip and the roof and into the roof substrate such as plywood, concrete, or metal, or into a roof rafter with mechanical fasteners such as screws or nails;
 - a second strip of weldable roofing material, perpendicular to the strap, lined up in vertical registration with the first strip and welded to the first strip, thus encapsulating
 - 15 the metal plate; and
 - a third strip of weldable roofing material of the same size as the first strip perpendicular to and crossing the strap, and welded to the roof.

The strips can be square, rectangular, hexagonal, octagonal, or any other shape and of any convenient size. The second and third strips may overlap each other.

- 20 The metal plate may be treated to be weldable to weldable roofing material and then welded to the first and second strips. Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment.

Fourth Embodiment

- 25 The fourth embodiment comprises two strips of weldable roofing material that can be square, rectangular, hexagonal, octagonal, or any other shape of any convenient size. They are perpendicular to and cross the strap, one above and the other below the strap. If the roof is made of weldable material the lower strap is welded to the roof. Otherwise the

lower strap is bonded to the roof. The upper strip is bonded to the lower thus trapping the strap between them. Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment.

Fifth Embodiment

- 5 The fifth embodiment comprises one strip, of weldable roofing material. It is perpendicular to across and above the strap. If the roof is made of weldable material the strip is welded to the roof. Otherwise the strip is bonded to the roof. A plate may be fastened to the roof with mechanical fasteners such as roofing nails, screws, lag bolts, etc. This traps the strap between the strip and the roof and allows for a mechanical connection. Finally, the edges
10 may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment.

Alternative for First Through Fifth Embodiments

- Any of the first through the fifth embodiments of this invention may be reinforced with a top metal plate. If the top metal plate is treated to be weldable to weldable roofing material and
15 the strips are made of weldable roofing material, it can be welded onto the other embodiments. Otherwise, it can be adhesively bonded to the other embodiments. Alternatively, it may be fastened with the same mechanical fasteners used in the assembly.

Sixth Embodiment

- The sixth embodiment of this invention is intended to fasten rails or other structural
20 members to a roof. Such devices have much more depth than a strap. The sixth embodiment comprises a strip of roofing material with a raised section in the middle. The raised section is intended to cross a structural member perpendicularly. The raised section has a top which is larger than the width of the top of the structural member. Above and below the top of the raised section are metal strips. The lower strip is sized and shaped to fit
25 snugly over the top of the structural member. The upper strip is sized and shaped to fit the top.

The metal strips are preferably also coated with a weldable material. Then all the components of this embodiment can be welded to each other. Otherwise they can be adhesively bonded to each other. Alternatively, they can be fastened to each other and the

structural member with fasteners. If the roofing is made of weldable material then the strip of roofing material can be welded to the roof. If not, the strip can be adhesively bonded to the roof or attached with fasteners.

Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance
5 of water into this embodiment

Seventh Embodiment

The seventh embodiment of this invention is intended to fasten straps to a roof. The seventh embodiment comprises a strip of roofing material with a raised section in the middle. The raised section is intended to cross a strap perpendicularly. The raised section
10 has a top which is larger than the width of the strap. Above and below the top are metal strips. The lower strip is sized and shaped to fit snugly over the top of the strap. The upper strip is sized and shaped to fit the top.

The metal strips are preferably coated with a weldable material. Then all the components of this embodiment can be welded to each other. Otherwise they can be adhesively bonded to
15 each other. Alternatively, they can be fastened to each other and the strap with fasteners. If the roof is made of weldable material then the strip of roofing material can be welded to the roof. If not, the strip can be adhesively bonded to the roof or attached with fasteners.

Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment.

20 Usage Examples

The sixth or seventh embodiments can be attached to a roof with a seismic anchor. A seismic anchor is a washer of minimum 2" diameter with a self-tapping 1/4" screw, with length sufficient to adequately penetrate the roof, through its central hole. The washer is made of metal and may be weldable to weldable roofing material.

25 The sixth or seventh embodiments are placed over a structural member or strap on the roof. One flap is raised and a seismic anchor fully installed in the roof near the middle of the flap. Raising parts of the embodiments is possible because they are made out of roofing material which is flexible. Next the roofing material is bonded or welded to the top of the washer and the roof. If additional support is needed a second seismic anchor may be installed under the

other side. Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into the sixth and seventh embodiments.

The eighth embodiment comprises a seismic plate including a stud pointing upwards, below the strap, which is modified with a hole for allowing the stud to pass through. Screws
5 through the plate fasten the plate to the roof substrate or a roof rafter. Between the roof and the plate and between the plate and the strap is placed a layer of elastomeric roof coating. After assembly in the proper order, tightening the nut on the stud causes the elastomeric layers to compress, which provides an effective seal, and prevents moisture from entering the interfaces and percolating down the screws.

10 Roofing is sometimes referred to as a membrane. Weldable roofing material is thermoplastic polyolefin (TPO), available from a number of companies including: Firestone Building Products of Indianapolis, IN; Carlisle Syntec Systems of Carlisle, PA; and Johns Manville of Denver, CO. TPO can be made of polyvinyl chloride (PVC) or ethylene-propylene-diene-monomer (EPDM).

15 Brief Description of Drawings

Figure 1 is an exploded, isometric view of a first embodiment of this invention as used to fasten a mounting strap. For clarity, some mechanical fasteners are not shown. See US Patents Nos. 7,814,899 and 8,870,139; and PCT Patent Application No. PCT/US2013/025622 for examples of the usage of straps in mounting of solar panels.

20 Figure 2 is a top view of the first embodiment of this invention. For clarity, mechanical fasteners are not shown.

Figure 2A is a side elevational view of this first embodiment.

Figure 2B is an end elevational view of this first embodiment.

Figure 3 is an exploded, isometric view of a second embodiment of this invention as used to
25 fasten a mounting strap. For clarity, some mechanical fasteners are not shown.

Figure 4 is a top view of the second embodiment of this invention. For clarity the mechanical fasteners are not shown.

Figure 4A is a side elevational view of this second embodiment.

Figure 4B is an end elevational view of this second embodiment.

Figure 4C is a cross section showing the preferred mechanical fastening system used in all embodiments of this invention

- 5 Figure 5 is an exploded, isometric view of a third embodiment of this invention as used to fasten a mounting strap. For clarity some mechanical fasteners are not shown.

Figure 6 is a top view of the third embodiment of this invention. For clarity the mechanical fasteners are not shown.

Figure 6A is a side elevational view of this third embodiment.

- 10 Figure 6B is an end elevational view of this third embodiment.

Figure 7 is an isometric view of a fourth embodiment of this invention as used to fasten a mounting strap with angled solar panels.

Figure 7A is an enlarged view of the area annotated A on Figure 7.

- 15 Figure 8 is an isometric view of a fifth embodiment of this invention as used to fasten a mounting strap with angled solar panels.

Figure 8A is an enlarged view of the area annotated A on Figure 8.

Figure 9 is an isometric view of any of the first through the fifth embodiments of this invention reinforced with a top metal plate. For clarity the mechanical fasteners are not shown.

- 20 Figure 10 is a close up, isometric view of the alternative shown in Figure 9 as installed on a mounting strap. For clarity some mechanical fasteners are not shown.

Figure 11 is an isometric view of a sixth embodiment of this invention, which is intended to fasten rails or other structural members to a roof. For clarity the mechanical fasteners are not shown.

Figure 11A is an enlarged view of the area annotated A on Figure 11. For clarity the mechanical fasteners are not shown.

Figure 11B is a side elevational view of the sixth embodiment. For clarity the mechanical fasteners are not shown.

5 Figure 11C is a top view of the sixth embodiment. For clarity the mechanical fasteners are not shown.

Figure 11D is an end view of the sixth embodiment. For clarity the mechanical fasteners are not shown.

10 Figure 11F is an exploded, end view of the sixth embodiment. For clarity the mechanical fasteners are not shown.

Figure 12 shows the sixth embodiment used to fasten a structural member to a roof. It also shows a variation of this sixth embodiment incorporating ballast trays.

Figure 13 is an isometric view of a seventh embodiment of this invention. For clarity the mechanical fasteners are not shown.

15 Figure 13A is a top view of the seventh embodiment. For clarity the mechanical fasteners are not shown.

Figure 13B is an enlarged view of the area annotated B on Figure 13. For clarity the mechanical fasteners are not shown.

20 Figure 13C is an end view of the seventh embodiment. For clarity the mechanical fasteners are not shown.

Figure 13D is a side elevational view of the seventh embodiment. For clarity the mechanical fasteners are not shown.

Figure 13E is an exploded, end view of the seventh embodiment. For clarity the mechanical fasteners are not shown.

25 Figure 14 is an isometric view of the seventh embodiment in use to fasten a strap to a roof. For clarity the panel support brackets are not shown. See US Patents Nos. 7,814,899 and

8,870,139, and PCT Patent Application No. PCT/US2013/025622 for examples of the usage of straps in mounting of solar panels.

Figure 15 is an isometric view of a seismic anchor.

Figure 15A is a top isometric view of the sixth embodiment used with a seismic anchor. For
5 clarity the mechanical fasteners are not shown.

Figure 15B is a bottom isometric view of the sixth embodiment used with a seismic anchor. For clarity the mechanical fasteners are not shown.

Figure 15C is a top isometric view of the seventh embodiment used with a seismic anchor. For clarity the mechanical fasteners are not shown.

10 Figure 15D is a bottom isometric view of the seventh embodiment used with a seismic anchor. For clarity the mechanical fasteners are not shown.

Figure 16 illustrates that the strips in this invention may be circular instead of rectangular.

Figure 17 is a three dimensional exploded view of the fourth embodiment used with circular seismic anchors.

15 Figure 17A is a closer view of Figure 17.

Figure 17B is a cross section along the lines 17B-17B on Figure 17 with parts assembled.

Figure 18 is a three dimensional exploded view of the fourth embodiment used with rectangular seismic anchors.

Figure 18A is a closer view of Figure 18.

20 Figure 18B is a cross section along the lines 18B-18B on Figure 18 showing with parts assembled.

Figure 19 is a three dimensional exploded view of an eighth embodiment used with rectangular seismic anchors and latex roof coating.

Figure 19A is a closer view of Figure 19.

Figure 19B is a cross section along the lines 19B-19B on Figure 19 with the parts assembled.

Best Mode for Carrying Out Invention

First Embodiment

- 5 The first embodiment 100 is intended to be used on roofs 22 that are made of material that cannot be welded. Referring to Figures 1, 2, 2A and 2B, it can be seen that the first embodiment 100 of this invention comprises:
 - 10 a first strip 110 of weldable roofing material below a solar panel mounting strap 18 perpendicularly crossing the strap 18, the bottom 116 of the first strip 110 being adhesively bonded to the roof 22;
 - a metal plate 120, smaller than the first strip 110, on top of the first strip 110 and adjacent the strap 18, screwed through the first strip 110 and the roof 22, and into a roof substrate (which is typically made of plywood, concrete, or metal) or into roof rafter using appropriate fasteners, such as screws or nails;
 - 15 a second strip 130 of weldable roofing material of width similar to the first strip 110 but of length about half that of the first strip 110, perpendicular to the strap 18, lined up end 134 to end 114 with one end 114 of the first strip 110 and welded to the first strip 110; and
 - 20 a third strip 140 of weldable roofing material of width similar to the first strip 110 but of length about half that of the first strip 110, perpendicular to the strap 18, crossing the strap 18, lined up end 148 to end 112 with the other end 118 of the first strip 110 and welded to the first strip 110, thus encapsulating the metal plate 120.

In addition there are fastening systems 26 fastening the strap 18 to the second strip 130. The fastening systems 26 comprise a flush head, self-clinching threaded stud 40 clinched pointing upwards through a hole 32 (not visible) in the strap 18. The stud 40 is long enough to pass through a hole 34 in the second strip 130 where a washer 38 and nut 42 are screwed onto it thus securely fastening the second strip 130 to the strap 22. The nut 42 may be castellated and secured through a hole in the end of the stud 40 by a cotter pin, as is well known, to prevent rotation of the nut 42. An example of the fastening system is

shown in Figure 4C. The ends of the straps 18 also have holes 52 for insertion of studs 40 so that the straps 18 can be easily fastened together end to end with nuts 42 and washers.

As a consequence of this construction the metal plate 120 is in the same plane as the strap 18 and, depending on the thickness of the strap 18, the second 130 and third 140 strips
5 may be co-planar. The roofing material used for the first 110, second 130 and third 140 strips is the kind that can be welded, typically with heat.

The metal plate 120 clamps the first strip 110 in place and is satisfactory for seismic installations. Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment 100. One suitable waterproof sealant is RTV
10 silicone rubber available from a number of manufacturers, such as GE, of Wilton, CT; and Dow Corning of Midland, MI. Another is Henry's roofing compound, available from Henry Company, El Segundo, CA.

Second Embodiment

The second embodiment 200 is intended to be used on roofs 22 that are made of material
15 that can be welded. Referring to Figures 3, 4, 4A, 4B and 4C, it can be seen that the second embodiment 200 of this invention comprises:

a metal plate 220, treated to weld to weldable roof material, welded to the roof 22 and nailed or screwed through the roof 22 into a the roof substrate (which is typically made of plywood, concrete, or metal) or into a roof rafter with appropriate fasteners such as
20 nails or screws, adjacent a solar panel mounting strap 18;

a first strip 230 of weldable roofing material, larger than the metal plate 220, welded to the top 224 of the metal plate 220 and the roof 22, perpendicular to and adjacent the mounting strap 18; and

a second strip 240 of weldable roofing material of width similar to the first strip 230,
25 perpendicular to and crossing the strap 18 overlapping the first strip 230, in line with the first strip 230 and welded to the roof 22 and the first strip.

The roofing material used for the first 110, second 130 and third 140 strips is the kind that can be welded, typically with heat. The metal plate 120 is in the same plane as the strap 18 and, depending on the thickness of the strap.

In addition there are fastening systems 26 fastening the strap 18 to the second strip 130. The fastening systems 26 comprise a flush head, self-clinching threaded stud 40 clinched pointing upwards through a hole 32 (not visible) in the strap 18. The stud 30 is long enough to pass through a hole 34 in the second strip 240 where a washer 38 and nut 42 are
 5 screwed onto it thus securely fastening the second strip 240 to the strap 22. The nut 42 may be castellated and secured through a hole in the end of the stud 40 by a cotter pin, as is well known, to prevent rotation of the nut 42. An example of the fastening system is shown in Figure 4C.

Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance
 10 of water into this embodiment 200.

Third Embodiment

The third embodiment 300 is intended to be used on roofs 22 that are made of material that can be welded. Referring to Figures 5, 6, 6A and 6B, it can be seen that the third embodiment 300 of this invention comprises:

15 a first strip 310 of weldable roofing material adjacent and perpendicular to a solar panel mounting strap 18, the bottom 316 of the first strip 310 being welded to the roof 22;

a metal plate 320, smaller than the first strip 310, on top of the first strip 310 and adjacent the strap 18, screwed through the first strip 310 and the roof 22 and into a roof
 20 rafter with wood screws;

a second strip 330 of weldable roofing material of the same size as the first strip 310, perpendicular to the strap 18, lined up in vertical registration with the first strip 310 and welded to the first strip 310, thus encapsulating the metal plate 320; and

25 a third strip 340 of weldable roofing material of the same size as the first strip 310 perpendicular to and crossing the strap 18 overlapping the first 310 or second strip 330, and welded to the roof 22 and the first 310 or second 330 strip.

The roofing material used for the first 310, second 330 and third 340 strips is the kind that can be welded, typically with heat. The second 330 and third 340 strips may overlap each other.

The metal plate 320 may be treated to be weldable to weldable roofing material and then welded to the first 310 and second 330 strips. The plate 320 clamps the first strip 310 in place and is satisfactory for seismic installations.

In addition there are fastening systems 26 fastening the strap 18 to the second strip 130.

- 5 The fastening systems 26 comprise a flush head, self-clinching threaded stud 40 clinched pointing upwards through a hole 32 (not visible) in the strap 18. The stud 30 is long enough to pass through a hole 34 in the third strip 340 where a washer 38 and nut 42 are screwed onto it thus securely fastening the second strip 340 to the strap 22. The nut 42 may be castellated and secured through a hole in the end of the stud 40 by a cotter pin, as is well
10 known, to prevent rotation of the nut 42. An example of the fastening system is shown in Figure 4C.

Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment 300.

Fourth Embodiment

- 15 Figure 7 is an isometric view of a fourth embodiment 400 of this invention as used to fasten a mounting strap 18 with angled solar panels 26 via support brackets 50. Figure 7A is an enlarged view of the area annotated A on Figure 7. As can be seen from these figures, the fourth embodiment comprises two strips 410, 440 of weldable roofing material of the same size. They are perpendicular to and cross the strap 18, one 440 above and the other 410
20 below the strap 18. If the roof 22 is made of weldable material the lower strap 410 is welded to the roof 22. Otherwise the lower strap 410 is bonded to the roof 22 or fastened to the roof 22 with mechanical fasteners such as roofing nails, screws, lag bolts, etc. The upper strip 440 is bonded to the lower strip 410 thus trapping the strap 18 between them.

- In addition there are fastening systems 26 (not illustrated) fastening the strap 18 to the
25 second strip 440. The fastening systems 26 comprise a flush head, self-clinching threaded stud 40 clinched pointing upwards through a hole 32 (not visible) in the strap 18. The stud 30 is long enough to pass through a hole 34 in the second strip 440 where a washer 38 and nut 42 are screwed onto it thus securely fastening the second strip 440 to the strap 22. The nut 42 may be castellated and secured through a hole in the end of the stud 40 by a

cotter pin, as is well known, to prevent rotation of the nut 42. An example of the fastening system is shown in Figure 4C.

Figures 17, 17A and 17B illustrate the fourth embodiment 400 used with circular seismic anchors 70.

- 5 Figures 18, 18A and 18B illustrate the fourth embodiment 400 used with rectangular seismic anchors 70.

Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment 400.

Fifth Embodiment

- 10 Figure 8 is an isometric view of a fifth embodiment 500 of this invention as used to fasten a mounting strap 18 with angled solar panels 26 via support brackets 50. Figure 8A is an enlarged view of the area annotated A on Figure 8. As can be seen from these figures, the fifth embodiment comprises one strip 510, of weldable roofing material. It is perpendicular to across and above the strap 18. If the roof 22 is made of weldable material the strip 510 is
15 welded to the roof 22. Otherwise the strip 510 is bonded to the roof 22 or fastened to the roof 22 with mechanical fasteners such as roofing nails, screws, lag bolts, etc. This traps the strap 18 between the strip 510 and the roof 22.

- In addition there are fastening systems 26 fastening the strap 18 to the strip 510. The fastening systems 26 comprise a flush head, self-clinching threaded stud 40 clinched
20 pointing upwards through a hole 32 (not visible) in the strap 18. The stud is a Pem Stud, available from Penn Engineering of Danboro, PA, or equivalent. The stud 40 is long enough to pass through a hole 34 in the strip 510 where a washer 38 and nut 42 are screwed onto it thus securely fastening the second strip 130 to the strap 22. The nut 42 may be castellated and secured through a hole in the end of the stud 40 by a cotter pin, as is well known, to
25 prevent rotation of the nut 42. An example of the fastening system is shown in Figure 4C.

Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment 500.

Alternative for First Through Fifth Embodiments

Figure 9 is an isometric view of any of the first through the fifth embodiments of this invention 100, 200, 300, 400, 500 reinforced with a top metal plate 30. Figure 10 is a close up, isometric view of the alternative shown in Figure 9 as installed on a mounting strap. If the top metal plate is treated to be weldable to weldable roofing material it can be welded onto the other embodiments 100, 200, 300, 400, 500. Otherwise, it can be adhesively bonded to the other embodiments 100, 200, 300, 400, 500. Alternatively, it may be fastened with the same fastening systems 26 used in the assembly.

Sixth Embodiment

10 The sixth embodiment 600 of this invention is intended to fasten rails or other structural members 34 to a roof. Such devices have much more depth than a strap 18. The sixth embodiment 600 can be seen in Figures 11, 11A-F and 12. The sixth embodiment 600 comprises a strip of roofing material 610 with a raised section 612 in the middle, surrounded by a lower section 611. The raised section 612 is intended to cross a structural member 64
15 perpendicularly. The raised section 612 has a top 614 which is larger than the width of the structural member 34. Above and below the top 614 are metal strips 620, 630. The lower strip 620 is sized and shaped to fit snugly over the top of the structural member. The upper strip 630 is sized and shaped to fit over the top 614.

The roofing material 610 is preferably weldable. If the roof 22 is made of weldable material
20 then strip of roofing material 610 can be welded to the roof 22. The metal strips are preferably also coated with a weldable material. Then all the components of this embodiment 600 can be welded to each other. Otherwise they can be adhesively bonded to each other. Alternatively, they can be fastened to each other and the structural member with fasteners 26 as previously described and illustrated. If not, the strip 610 can be
25 adhesively bonded to the roof 22 or attached with fasteners 26 or weighted down with ballast 46.

Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment 600.

Seventh Embodiment

The seventh embodiment 700 of this invention is intended to fasten straps 18 to a roof 22. The seventh embodiment 700 can be seen in the Figures. The seventh embodiment 700 comprises a strip of roofing material 710 with a raised section 712 in the middle. The raised section 712 is intended to cross a strap 18 perpendicularly. The raised section 712 has a top 714 which is larger than the width of the strap 18. Above and below the top 714 are metal strips 720, 730. The lower strip 720 is sized and shaped to fit snugly over the top of the strap 18. The upper strip 730 is sized and shaped to fit the top 714.

The roofing material 710 is preferably weldable. The metal strips are preferably also coated with a weldable material. Then all the components of this embodiment 700 can be welded to each other. Otherwise they can be adhesively bonded to each other. Alternatively, they can be fastened to each other and the structural member with fasteners 26 as previously described and illustrated. If the roof 22 is made of weldable material then strip of roofing material 710 can be welded to the roof 22. If not, the strip 710 can be adhesively bonded to the roof 22 or attached with fasteners 26 as previously described and illustrated.

Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into this embodiment 700.

Usage Examples

Figure 12 shows the sixth embodiment 600 used to fasten a structural member 34 to a roof 22. In this case the embodiment 600 is attached to the member with fasteners 26. Figure 12 also illustrates the alternative way of holding down this embodiment: ballast trays 42. The trays 42 are shaped to hold the member 34 down to a roof 22. In this case hold down is achieved with ballast 46.

Figure 14 is an isometric view of the seventh embodiment 700 in use to fasten a strap 18 to a roof 22.

Figure 15 is an isometric view of a seismic anchor 70. A seismic anchor 70 is a metal washer, of minimum 2" diameter 54 and a self-tapping 1/4" screw 78, with length sufficient to adequately penetrate the roof 22. The screw 78 is inserted through the hole in the center of the washer 54. The metal may be treated to be weldable to weldable roofing material. An

alternate embodiment for a seismic anchor 70 is illustrated in Figures 18, 18A, 19, and 19A. This embodiment comprises a seismic plate 76, with, preferably, two screws 78 through it which screw through the roof 22 and into the substrate or a roof rafter. The plate 76 is made of metal, which may be treated to be weldable to weldable roofing material.

- 5 The sixth 600 or seventh 700 embodiments are placed over a structural member 34 or strap 18 on the roof 22. One side of the embodiment is raised and a seismic anchor 70 fully installed in the roof 22 near middle of the flap. Raising parts of the embodiments is possible because they are made out of roofing material which is flexible. Next the roofing material is welded to the top of the washer 54 and welded to the roof 22. If additional support is needed
- 10 a second seismic anchor 70 can be installed under the other side. Finally, the edges may be sealed with a waterproofing sealant in order to prevent entrance of water into the sixth 600 and seventh 700 embodiments.

Figure 15A is a top isometric view of the sixth embodiment 600 fastened down with a seismic anchor 70.

- 15 Figure 15B is a bottom isometric view of the sixth embodiment 600 fastened down with a seismic anchor 70.

Figure 15C is a top isometric view of the seventh embodiment 700 fastened down with a seismic anchor 70.

- Figure 15D is a bottom isometric view of the seventh embodiment 700 fastened down with a
- 20 seismic anchor 70.

Eighth Embodiment

- The eighth embodiment 800 is shown in Figures 19, 19A and 19B. The eighth embodiment 800 comprises a seismic plate 76 including a stud 40 pointing upwards, below the strap 18, which is modified with a hole 90 for allowing the stud 40 to pass through. Screws 86 through
- 25 the plate 76 fasten the plate 76 to the roof substrate or a roof rafter. Between the roof 22 and the plate 76 and between the plate 76 and the strap is placed a layer of elastomeric roof coating 86. Such coatings are energy efficient, high quality coating systems that consists of a layered, watertight blanket of elastomeric roof coatings, encapsulating a fabric. The elastomeric coatings can be acrylic or silicone polymers. Metacrylics® Energy Efficient

Coatings for Commercial Properties, available from Metacrylics of Gilroy, CA, or equivalent can be used. After assembly in the proper order as shown in Figures 19 and 19A, tightening the nut 42 on the stud 40 causes the elastomeric layers to compress, which provides a positive seal, and which prevents moisture from entering the interfaces and percolating
5 down the screws.

Preferably the strips and plates of this invention are rectangular. Most of the drawings show square and rectangular strips and plates. However, they can be any convenient shape such as rectangular, square, circular, hexagonal, octagonal, oval, etc. Figure 16 shows a circular shape for the strip 410 of the fourth embodiment 400 of this invention. This is applicable to
10 all embodiments of this invention.

Roofing is sometimes referred to as a membrane. Weldable roofing material is thermoplastic polyolefin (TPO), available from a number of companies including: Firestone Building Products of Indianapolis, IN; Carlisle Syntec Systems of Carlisle, PA; and Johns Manville of Denver, CO. TPO can be made of polyvinyl chloride (PVC) or ethylene-propylene-diene-monomer (EPDM).
15

The structural adhesive 82 used in this invention to bond strips to roofs, strips to strips etc. is preferably two-component polyurethane or silicone. Such adhesives are manufactured by a number of companies. Suitable adhesives are Dash DC polyurethane, available from Versico Roofing Systems of Carlisle, PA and SCM3505 series high solids silicone available
20 from Everest Systems of Houston, TX.

For further information about installing solar panels using this invention see attached Permacity/Orion Solar Strap installation manual, which is incorporated into this application by reference.

The following reference numbers are shown on the Figures:

25 All embodiments

18 strap

22 roof membrane

24 roof substrate

- 26 fastening system
- 28 solar panel
- 30 reinforcing metal plate
- 32 hole through strap for attachment to strip with a stud, washer and nut
- 5 34 hole through roofing material for insertion of stud
- 36 width of structural member
- 38 washer
- 40 stud
- 42 nut
- 10 50 solar panel support bracket
 - 50a higher bracket
 - 50b lower bracket
- 56 hole through metal plate for insertion of screw
- 60 hole through end of strap to allow fastening of strips end to end via studs
- 15 64 structural member
- 70 seismic anchor
- 74 seismic washer – circular
- 76 seismic plate - rectangular
- 78 screw
- 20 82 adhesive
- 86 latex roof coating

90 hole

First embodiment

110 first strip

112 one end of first strip

5 114 other end of first strip

116 underside of first strip

120 metal plate

130 second strip

134 one end of second strip

10 138 other end of second strip

140 third strip

144 one end of third strip

148 other end of third strip

Second embodiment

15 220 metal plate

230 first strip

240 second strip

Third embodiment

310 first strip

20 320 metal plate

340 second strip

Fourth embodiment

410 lower strip

420 upper strip

Fifth embodiment

5 510 strip

Sixth embodiment

610 shaped strip

611 lower section of strip

612 raised section

10 614 top of shaped portion

618 ballast tray

620 bottom metal plate

622 top of bottom metal plate

630 top metal plate

15 632 bottom of top metal plate

Seventh embodiment

710 strip

712 raised section

714 top of raised section

20 720 bottom metal plate

730 top metal plate

Several embodiments 100, 200, 300, 400, 500, 600, 700 and 800 have been described. However, it should be obvious to those skilled in the art to which this invention pertains that other modifications and enhancements can be made without departing from the spirit and scope of this invention.

Claims

1. A fastening system 100 for fastening a solar panel mounting strap 18 to a roof 22 comprising:
 - a. a first strip 110 of roofing material of any convenient shape, having two ends 114, 112, two sides, a length and a width, under said solar panel mounting strap 18, perpendicularly crossing said solar panel mounting strap 18, and fastened to said roof 22 by a first fastening method;
 - b. a metal plate 120, smaller than said first strip 110, on top of said first strip 110 and adjacent said solar panel mounting strap 18, screwed or nailed through said first strip 110 and said roof 22, and into a roof substrate or a roof rafter;
 - c. a second strip 130 of roofing material, having two ends 134, 138, two sides, a width similar to the width of said first strip 110, and a second length about half the length of said first strip 110, perpendicularly crossing said solar panel mounting strap 18, above said solar panel mounting strap, lined up end 134 to end 114 with one end 114 of said first strip 110 and fastened to said first strip 110 by a second fastening method; and
 - d. a third strip 140 of roofing material, having a width similar to said first strip 110, two ends 144, 148 and two sides, but of length about half that of said first strip 110, perpendicular to said solar panel mounting strap 18, lined up end 148 to end 112 with the other end 112 of said first strip 110 and fastened to said first strip 110 and metal plate 120 by a third fastening method;
 - e. whereby said metal plate 120 is encapsulated; and
 - f. whereby said metal plate 120 is in the same plane as said solar panel mounting strap 18 and said second 130 and third 140 strips may be coplanar.
2. The fastening system as claimed in claim 1 wherein said ends and sides are straight lines or curves.

3. The fastening system as claimed in claim 1 in which said first fastening method is adhesive bonding; fastening with a fastener; or, if said first strip 110 and roof 22 are made of weldable material, welding;
4. The fastening system as claimed in claim 1 in which said second fastening method is adhesive bonding; or, if said first strip 110 and second strip 130 are made of weldable material, welding.
5. The fastening system as claimed in claim 1 in which said third fastening method is adhesive bonding; or if said first strip 110 and second strip 130 are made of weldable material and said metal plate 120 is treated to be weldable to weldable roofing material, welding
6. The fastening system as claimed in claim 1 in which said second 130 and third 140 strips overlap.
7. The fastening system as claimed in claim 1 further comprising a top metal plate 30 fastened to and above said first 130 and/or third 140 strips by a fourth fastening method.
8. The fastening system as claimed in claim 7 in which said fourth fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said first 130 and third 140 strips are made from weldable roofing material, welding.
9. A fastening system 200 for fastening a solar panel mounting strap 18 to a roof 22 comprising:
- a. a metal plate 220 having a top 224 and a bottom 226, fastened to said roof 22 by a first fastening method and screwed through said roof 22 into a roof rafter, adjacent said solar panel mounting strap 18;
 - b. a first strip 230 of roofing material, larger than said metal plate 220, having a width and four edges fastened to said top 224 and said roof by a second fastening method, perpendicular to and under or adjacent said solar panel mounting strap 18; and
 - c. a second strip 240 of roofing material having said first strip 230 and four edges, perpendicular to and crossing said solar panel mounting strap 18,

in line with and overlapping said first strip 230, fastened to said roof 22 and said first strip 230 by a third fastening method;

d. whereby said metal plate 220 is in the same plane as the solar panel mounting strap.

5 10. The fastening system as claimed in claim 9 wherein said edges are straight lines or curves.

11. The fastening system as claimed in claim 9 in which said first fastening method is adhesive bonding; or, if said bottom 226 is treated to be weldable to weldable roofing material and said roof 22 is made of weldable roofing material, welding.

10 12. The fastening system as claimed in claim 9 in which said second fastening method is adhesive bonding; or, if said top 224 is treated to be welded to weldable roofing material, and said first strip 230 and said roof are made of weldable roofing material, welding.

15 13. The fastening system as claimed in claim 9 in which said third fastening method is adhesive bonding; or, if said roof 22, first strip 230 and second strip 240 are made of weldable roofing material, welding.

14. The fastening system as claimed in claim 9 further comprising a top metal plate 30 fastened to and above said first 230 and/or second 240 strips by a fourth fastening method.

20 15. The fastening system as claimed in claim 14 in which said fourth fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said first 230 and third 240 strips are made from weldable roofing material, welding.

25 16. A fastening system 300 for fastening a solar panel mounting strap 18 to a roof 22 comprising:

a. a first strip 310 of roofing material, adjacent and perpendicular to said solar panel mounting solar panel mounting strap 18, fastened to said roof 22 by a first fastening method;

30 b. a metal plate 320, smaller than said first strip 310, on top of said first strip 310 and adjacent said solar panel mounting strap 18, nailed or screwed

through said first strip 310 and said roof 22, and into a roof substrate or a roof rafter;

5 c. a second strip 340 of roofing material of the same size as said first strip 310, perpendicular to and adjacent said solar panel mounting strap 18, lined up in vertical registration with said first strip 310 and fastened to said first strip 310 by a second fastening method; whereby said metal plate 320 is encapsulated; and

10 d. a third strip 340 of roofing material of the same size as said first strip 310 perpendicular to and crossing said solar panel mounting strap 18, interleaved between said first 310 and second 330 strips or overlapping said second strip 330 and fastened to said roof 22 and said first 310 and second 330 strips or said second strip 330 by a third fastening method.

15 17. The fastening system as claimed in claim 16 in which said first fastening method is adhesive bonding; or, if said roofing 22 and strip 310 are made of weldable roofing material; welding.

18. The fastening system as claimed in claim 16 in which said second fastening method is adhesive bonding; or, if said first strip 310 and said second strip 330 are made of weldable roofing material, adhesive bonding.

20 19. The fastening system as claimed in claim 16 in which said third fastening method is adhesive bonding; or, if said roof 22, said first strip 310, said second strip 330 and said third strip 340 are made of weldable roofing material, welding.

20. The fastening system as claimed in claim 16 further comprising a top metal plate 30 fastened to and above said second 330 and/or third 340 strips by a fourth fastening method.

25 21. The fastening system as claimed in claim 20 in which said fourth fastening method is adhesive bonding, fastening with a fastener, or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said first 310 and third 340 strips are made from weldable roofing material, welding.

30 22. A fastening system 400 for fastening a solar panel mounting strap 18 to a roof 22 comprising:

- a. a first strip 410 of roofing material having edges, perpendicular to and crossing said solar panel mounting strap 18, below said solar panel mounting strap 18 fastened to said roof 22 by a first fastening method; and
- b. a second strip 440 of roofing material having edges perpendicular to and crossing said solar panel mounting strap 18, above said solar panel mounting strap 18; said second strip 440 being the same size as said first strip 410; said first 410 and second 440 strips being fastened to each other by a second fastening method; whereby said solar panel mounting strap 18 is encapsulated between said first 410 and second 440 strips.

23. The fastening system as claimed in claim 22 wherein said ends and sides are straight lines or curves.

24. The fastening system as claimed in claim 22 in which said first fastening method is adhesive bonding, fastening with a fastener; or, if said first strip 410 and said roof 22 are made of weldable roofing material, welding

25. The fastening system as claimed in claim 22 in which said second fastening method is adhesive bonding; or, if said first 410 and second 440 strips are made of weldable roofing material, welding.

26. The fastening system as claimed in claim 22 further comprising a top metal plate 30 fastened to and above said second strip 440 by a third fastening method.

27. The fastening system as claimed in claim 26 in which said third fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said second strip 440 is made from weldable roofing material, welding.

28. A fastening system 500 for fastening a solar panel mounting strap 18 to a roof 22 comprising; a strip 510 of roofing material having edges, perpendicular to and crossing said solar panel mounting strap 18, above said solar panel mounting strap 18 and fastened to said roof 22 by a fastening method; and a top metal plate 30 fastened to and above said strip 510 by a second fastening method; whereby said solar panel mounting strap 18 is encapsulated between said strip 510 and said roof.

29. The fastening system as claimed in claim 28 in which said second fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated

to be weldable to weldable roofing material and said strip 510 is made from weldable roofing material, welding.

5 30. A fastening system 500 for fastening a solar panel mounting strap 18 to a roof 22 comprising: a strip 510 of roofing material having edges, perpendicular to and crossing said solar panel mounting strap 18, above said solar panel mounting strap 18 and fastened to said roof 22 by a fastening method; and a top metal plate 30 fastened to and above said strip 510 by a second fastening method; wherein said edges are straight lines or curves; whereby said solar panel mounting strap 18 is encapsulated between said strip 510 and said roof.

10 31. The fastening system as claimed in claim 30 in which said second fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said strip 510 is made from weldable roofing material, welding.

15 32. A fastening system 500 for fastening a solar panel mounting strap 18 to a roof 22 comprising: a strip 510 of roofing material having edges, perpendicular to and crossing said solar panel mounting strap 18, above said solar panel mounting strap 18 and fastened to said roof 22 by a fastening method; and a top metal plate 30 fastened to and above said strip 510 by a second fastening method; wherein said edges are straight lines or curves; wherein said fastening method is adhesive bonding, fastening with a fastener, or welding, if said strip 510 and said roof are made of weldable roofing material; whereby said solar panel mounting strap 18 is encapsulated between said strip 510 and said roof.

20 33. The fastening system as claimed in claim 32 in which said second fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said strip 510 is made from weldable roofing material, welding.

25 34. A method 100 for fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

- 30 a. providing a first strip 110 of roofing material, having two ends 114, 112, two sides, a length and a width;

30

- b. placing said first strip 110 under said solar panel mounting solar panel mounting strap 18, perpendicularly crossing said solar panel mounting strap 18;
- c. fastening said first strip 110 to said roof 22 by a first fastening method;
- d. providing a metal plate 120, smaller than said first strip 110,
- e. placing said metal plate 120 on top of said first strip 110 and adjacent said solar panel mounting strap 18;
- f. screwing said metal plate 120 through said first strip 110 and said roof 22, and through said roof and into a roof substrate or into a roof rafter;
- g. providing a second strip 130 of roofing material, having two ends 134, 138, two sides, a width similar to the width of said first strip 110, and a length about half the length of said first strip 110
- h. placing said second strip 130 perpendicularly crossing said solar panel mounting strap 18, above said solar panel mounting strap, lined up end 134 to end 114 with one end 114 of said first strip 110;
- i. fastening said second strip 130 to said first strip 110 by a second fastening method;
- j. providing a third strip 140 of roofing material, having a width similar to said first strip 110, two ends 144, 148 and two sides, but of length about half that of said first strip 110,
- k. placing said third strip 140 perpendicular to said solar panel mounting strap 18, lined up end 148 to end 112 with the other end 112 of said first strip 110; and
- l. fastening said third strip 140 to said first strip 110 and metal plate 120 by a third fastening method; whereby said metal plate 120 is encapsulated;
- m. whereby said metal plate 120 is in the same plane as said solar panel mounting strap 18 and said second 130 and third 140 strips may be coplanar.
35. The method as claimed in claim 34 wherein said ends and sides are straight lines or curves.

36. The method as claimed in claim 34 in which said first fastening method is adhesive bonding; fastening with a fastener; or, if said first strip 110 and roof 22 are made of weldable material, welding.

5 37. The method as claimed in claim 34 in which said second fastening method is adhesive bonding; or, if said first strip 110 and second strip 130 are made of weldable material, welding.

10 38. The method as claimed in claim 34 in which said third fastening method is adhesive bonding; or if said first strip 110 and second strip 130 are made of weldable material and said metal plate 120 is treated to be weldable to weldable roofing material, welding.

39. The method as claimed in claim 34 further comprising the step of overlapping said second 130 and third 140 strips.

40. The method as claimed in claim 34 further comprising the steps of:

15 a. providing a top metal plate 30; and

b. fastening said top metal plate 30 to and above said first 130 and/or third 140 strips by a fourth fastening method.

20 41. The method as claimed in claim 40 in which said fourth fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said first 130 and third 140 strips are made from weldable roofing material, welding.

42. A method 200 for fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

25 a. providing a metal plate 220 having a top 224 and a bottom 226;

b. placing said metal plate 220 adjacent a solar panel mounting solar panel mounting strap 18;

c. fastening said metal plate 220 to said roof 22 by a first fastening method;

d. screwing said metal plate through said roof 22 into a roof rafter;

e. providing a first strip 230 of roofing material, larger than said metal plate 220, having a width and four edges;

- f. fastening said first strip 230 to said top 224 and said roof by a second fastening method, perpendicular to and adjacent said solar panel mounting strap 18;
- g. providing a second strip 240 of roofing material having a width similar to said width of said first strip 230 and four edges;
- h. placing said second strip 240 perpendicular to and crossing said solar panel mounting strap 18, in line with and overlapping said first strip 230; and
- i. fastening said second strip 240 to said roof 22 and said first strip 230 by a third fastening method;
- j. whereby said metal plate 220 is in the same plane as said solar panel mounting strap.

43. The method as claimed in claim 42 wherein said ends and sides are straight lines or curves.

44. The method as claimed in claim 42 in which said first fastening method is adhesive bonding; or, if said bottom 226 is treated to be weldable to weldable roofing material and said roof 22 is made of weldable roofing material, welding.

45. The method as claimed in claim 42 in which said second fastening method is adhesive bonding; or, if said top 224 is treated to be welded to weldable roofing material, and said first strip 230 and said roof are made of weldable roofing material, welding.

46. The method as claimed in claim 42 in which said third fastening method is adhesive bonding; or, if said roof 22, first strip 230 and second strip 240 are made of weldable roofing material, welding.

47. The method as claimed in claim 42 further comprising the steps of:

- a. providing a top metal plate 30; and
- b. fastening said top plate 30 to and above said first 230 and/or second 240 strips by a fourth fastening method.

48. The method as claimed in claim 47 in which said fourth fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said first 230 and third 240 strips are made from weldable roofing material, welding.

49. A method 300 for fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

- a. providing a first strip 310 of roofing material;
- b. placing said first strip 310 adjacent and perpendicular to said solar panel mounting strap 18;
- c. fastening said first strip 310 to said roof 22 by a first fastening method;
- d. providing a metal plate 320, smaller than said first strip 310;
- e. placing said metal plate 320 on top of said first strip 310 and adjacent said solar panel mounting strap 18;
- f. fastening said metal plate 320 through said first strip 310 and said roof 22, and into a roof rafter;
- g. providing a second strip 330 of roofing material of the same size as said first strip 310;
- h. placing said second strip 330 perpendicular to and adjacent said solar panel mounting strap 18, lined up in vertical registration with said first strip 310;
- i. fastening said second strip to said first strip 310 by a second fastening method; whereby said metal plate 320 is encapsulated;
- j. providing a third strip 340 of roofing material of the same size as said first strip 310;
- k. placing said third strip 340 perpendicular to and crossing said solar panel mounting strap 18, interleaved between said first 310 and second 330 strips or overlapping said second strip 330; and
- l. fastening said third strip 340 to said roof 22 and said first 310 and second 330 strips or said second strip 330 by a third fastening method.

50. The method as claimed in claim 49 wherein said ends and sides are straight lines or curves.

51. The method as claimed in claim 49 in which said first fastening method is adhesive bonding; or, if said roofing 22 and strip 310 are made of weldable roofing material; welding.

52. The method as claimed in claim 49 in which said second fastening method is adhesive bonding; or, if said first strip 310 and said second strip 330 are made of weldable roofing material, adhesive bonding.

53. The method as claimed in claim 49 in which said third fastening method is adhesive bonding; or, if said roof 22, said first strip 310, said second strip 330 and said third strip 340 are made of weldable roofing material, welding.

54. The method as claimed in claim 49 further comprising the steps of:

- a. providing a top metal plate 30;
- b. fastening said top plate 30 to and above said second 330 and/or third 340 strips by a fourth fastening method.

55. The method as claimed in claim 54 in which said fourth fastening method is adhesive bonding, fastening with a fastener, or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said first 310 and third 340 strips are made from weldable roofing material, welding.

56. A method 400 for fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

- a. providing a first strip 410 of roofing material having edges;
- b. placing said first strip 410 perpendicular to and crossing said solar panel mounting strap 18, below said solar panel mounting strap 18;
- c. fastening said first strip 410 to said roof 22 by a first fastening method;
- d. providing a second strip 440 of roofing material having edges; said second strip 440 being the same size as said first strip 410;
- e. placing said second strip perpendicular to and crossing said solar panel mounting strap 18, above said solar panel mounting strap 18; and
- f. fastening said first 410 and second 440 strips to each other by a second fastening method; whereby said solar panel mounting strap 18 is encapsulated between said first 410 and second 440 strips.

57. The method as claimed in claim 56 wherein said ends and sides are straight lines or curves.

58. The method as claimed in claim 56 in which said first fastening method is adhesive bonding, fastening with a fastener; or, if said first strip 410 and said roof 22 are made of weldable roofing material, welding.

59. The method as claimed in claim 56 in which said second fastening method is adhesive bonding; or, if said first 410 and second 440 strips are made of weldable roofing material, welding.

60. The method as claimed in claim 56 further comprising the steps of:

- a. providing a top metal plate 30; and
- b. fastening said top plate 30 to and above said second strip 440 by a third fastening method.

61. The method as claimed in claim 60 in which said third fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said second strip 440 is made from weldable roofing material, welding.

62. A method 500 for fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

- a. providing a strip 510 of roofing material having edges;
- b. placing said strip 510 perpendicular to and crossing said solar panel mounting strap 18, above said solar panel mounting strap 18; and
- c. fastening said strip 510 to said roof 22 by a fastening method; whereby said solar panel mounting strap 18 is encapsulated between said strip 510 and said roof
- d. providing a top metal plate 30; and
- e. fastening said top plate 30 to and above said strip 510 by a second fastening method.

63. The method as claimed in claim 62 in which said second fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said strip 510 is made from weldable roofing material, welding.

64. A method 500 for fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

- 5
- a. providing a strip 510 of roofing material having edges; said ends and sides being straight lines or curves;
 - b. placing said strip 510 perpendicular to and crossing said solar panel mounting strap 18, above said solar panel mounting strap 18; and
 - c. fastening said strip 510 to said roof 22 by a fastening method; whereby said solar panel mounting strap 18 is encapsulated between said strip 510 and said roof
 - d. providing a top metal plate 30; and
 - e. fastening said top plate 30 to and above said strip 510 by a second fastening method.
- 10

65. The method as claimed in claim 64 in which said second fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to be weldable to weldable roofing material and said strip 510 is made from weldable roofing material, welding.

15 66. A method 500 for fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

- 20
- a. providing a strip 510 of roofing material having edges; said ends and sides being straight lines or curves;
 - b. placing said strip 510 perpendicular to and crossing said solar panel mounting strap 18, above said solar panel mounting strap 18; and
 - c. fastening said strip 510 to said roof 22 by a fastening method;
 - d. said fastening method being adhesive bonding; fastening with a fastener; or, if said strip 510 and said roof are made of weldable roofing material, welding;
 - e. whereby said solar panel mounting strap 18 is encapsulated between said strip 510 and said roof;
 - f. providing a top metal plate 30; and
 - g. fastening said top plate 30 to and above said strip 510 by a second fastening method.
- 25

30 67. The method as claimed in claim 66 in which said second fastening method is adhesive bonding; fastening with a fastener; or, if said top metal plate 30 is treated to

be weldable to weldable roofing material and said strip 510 is made from weldable roofing material, welding.

68. A fastening system 800 for fastening a solar panel mounting strap 18, which is modified with a through hole 90 to a roof 22 comprising:

- 5 a. a first layer of elastomeric roof coating 86 placed on said roof 22 below said solar panel mounting strap 18;
- b. a seismic plate 76, having a medial hole and a peripheral hole, positioned on said first layer;
- 10 c. a stud 40 inserted pointing upwards through said medial hole; said stud passing through said hole 90 so that a threaded portion protrudes above said solar panel mounting strap;
- d. a screw 78 through said peripheral hole fastening said plate 76 to the roof substrate or a roof rafter;
- 15 e. a second layer of elastomeric roof coating 86 positioned between said mounting solar panel mounting strap 18 and said seismic plate 76;
- f. a nut 42 screwed down on said protruding portion so that said layers are compressed;
- g. whereby a positive seal is provided, which prevents moisture from entering the interfaces and percolating down said screw.

20 69. A method 800 of fastening a solar panel mounting strap 18, which is modified with a through hole 90 to a roof 22 comprising the steps of:

- a. providing a seismic plate 76 made by the steps of:
- b. providing a metal plate 76, having a medial hole and a peripheral hole;
- c. providing a stud 40;
- 25 d. inserting said stud 40 through said medial hole;
- e. placing a first layer of elastomeric roof coating 86 on said roof 22 below said solar panel mounting strap 18;
- f. placing said seismic plate on said first layer with said stud facing upwards;
- g. providing a screw 78;
- 30 h. screwing screw 78 through said peripheral hole, through said first layer and into to the roof substrate or a roof rafter;

- 5
- i. placing a second layer of elastomeric roof coating 86 on top of said seismic plate 76;
 - j. placing said solar panel mounting strap on said second layer so that:
 - i. said stud 40 passes through said second layer and said through hole 90; and
 - ii. a threaded portion protrudes above said solar panel mounting strap;
 - k. providing a nut 42;
 - l. screwing said nut 42 down on said protruding portion so that said layers are compressed;
 - 10 m. whereby a positive seal is provided, which prevents moisture from entering the interfaces and percolating down said screw.
70. A fastening system for fastening a solar panel mounting strap 18 to a roof 22 comprising:
- 15
- a. a first strip of roof material longer than said solar panel mounting strap 18 is wide placed perpendicularly across said solar panel mounting strap;
 - b. a second strip of roof material longer than said solar panel mounting strap 18 is wide placed perpendicularly under said solar panel mounting strap 18 and adhered to said roof 22 and said first strip by adhesive bonding or welding.
- 20
71. The fastening system as claimed in claim 70 further comprising:
- a. first hole through said solar panel mounting strap 18;
 - b. a second hole through said first strip;
 - c. a stud inserted pointing upwards through said holes so that a threaded portion thereof protrudes above said solar panel mounting strap; and
 - 25 d. a nut 42 on said protruding portion, fastening said solar panel mounting strap and first strip together.
72. A system for fastening a solar panel mounting strap 18 to a roof 22 comprising:
- 30
- a. a strip of roof material longer than said solar panel mounting strap 18 is wide placed perpendicularly across said solar panel mounting strap; said strip having a bottom surface;

- b. one of a seismic anchor 70 and seismic plate 76 screwed by a screw 78 into the roof substrate or a roof joist; each of said seismic anchor 70 and said seismic plate 76 having a top metal plate having a top surface; said top surface adhered to said bottom surface by welding or adhesive bonding.

5 73. The fastening system as claimed in claim 72 further comprising:

- a. first hole through said solar panel mounting strap 18;
- b. a second hole through said first strip;
- c. a stud inserted pointing upwards through said holes so that a threaded portion thereof protrudes above said solar panel mounting strap; and
- 10 d. a nut 42 on said protruding portion, fastening said solar panel mounting strap and first strip together.

74. A system for fastening a solar panel mounting solar panel mounting strap 18 to a roof 22 comprising:

- 15 a. a first strip of roof material longer than said solar panel mounting strap 18 is wide placed perpendicularly across said solar panel mounting strap; said first strip having a first bottom surface;
- b. a second strip of roof material longer than said solar panel mounting strap 18 is wide placed perpendicularly under said solar panel mounting strap; said second strip having a second bottom surface a second top surface; and
- 20 c. one of a seismic anchor 70 and seismic plate 76 screwed by a screw 78 into the roof substrate or a roof joist; each of said seismic anchor 70 and said seismic plate 76 having a top metal plate having a top surface;
- d. said top surface adhered to said second bottom surface by welding or adhesive bonding;
- 25 e. said first bottom surface adhered to said second top surface by welding or adhesive bonding.

75. The fastening system as claimed in claim 74 further comprising:

- a. first hole through said solar panel mounting strap 18;
- b. a second hole through said first strip;
- 30 c. a stud inserted pointing upwards through said holes so that a threaded portion thereof protrudes above said solar panel mounting strap; and

- d. a nut 42 on said protruding portion, fastening said solar panel mounting strap and first strip together.

76. A method of fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

- 5 a. providing a first strip of roof material longer than said solar panel mounting strap 18 is wide;
- b. placing said first strip perpendicularly across said solar panel mounting strap;
- c. providing a second strip of roof material longer than said solar panel mounting strap 18 is wide;
- 10 d. placing said second strip perpendicularly under said solar panel mounting strap 18;
- e. adhering said second strip to said roof 22 and said first strip by adhesive bonding or welding.

77. The method as claimed in claim 76 further comprising the steps of:

- 15 a. drilling a first hole through said solar panel mounting strap 18;
- b. drilling a second hole through said first strip;
- c. providing a threaded stud;
- d. inserting said threaded stud pointing upwards through said holes so that a portion thereof protrudes above said solar panel mounting strap;
- 20 e. screwing a nut 42 on said protruding portion, thereby fastening said solar panel mounting strap and first strip together.

78. A method of fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

- 25 a. providing a strip of roof material longer than said solar panel mounting strap 18 is wide;
- b. placing said strip perpendicularly across said solar panel mounting strap; said strip having a bottom surface;
- 30 c. providing a seismic anchor 70 or seismic plate 76; each of said seismic anchor 70 and said seismic plate 76 having a top metal plate having a top surface;

- d. fastening said seismic anchor 70 or seismic plate into the roof substrate or a roof joist; and
- e. adhering said top surface to said bottom surface by welding or adhesive bonding.

5 79. The method as claimed in claim 78 further comprising the steps of:

- a. drilling a first hole through said solar panel mounting strap 18;
- b. drilling a second hole through said first strip;
- c. inserting a threaded stud pointing upwards through said holes so that a portion thereof protrudes above said solar panel mounting strap;
- 10 d. providing a nut 42;
- e. screwing said nut on said protruding portion, thereby fastening said solar panel mounting strap and first strip together.

80. A method of fastening a solar panel mounting strap 18 to a roof 22 comprising the steps of:

- 15 a. providing a first strip of roof material longer than said solar panel mounting strap 18 is wide; said first strip having a first bottom surface;
- b. placing said first strip perpendicularly across said solar panel mounting strap;
- c. providing a second strip of roof material longer than said solar panel mounting strap 18 is wide; said second strip having a second bottom surface and a second top surface;
- 20 d. placing said second strip perpendicularly under said solar panel mounting strap;
- e. providing a seismic anchor 70 or a seismic plate 76; each of said seismic anchor 70 and said seismic plate 76 having a top metal plate having a top surface;
- 25 f. providing a screw 78;
- g. screwing said seismic anchor 70 or seismic plate with said screw 78 into the roof substrate or a roof joist;
- 30 h. adhering said top surface to said second bottom surface by welding or adhesive bonding; and

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- i. adhering said first bottom surface to said second top surface by welding or adhesive bonding.

81. The method as claimed in claim 80 further comprising the steps of:

- a. drilling a first hole through said solar panel mounting strap 18;
- b. drilling a second hole through said first strip;
- c. providing a threaded stud;
- d. inserting said stud pointing upwards through said holes so that a portion thereof protrudes above said solar panel mounting strap;
- e. providing a nut 42;

82. screwing said nut 42 onto said protruding portion, thereby fastening said solar panel mounting strap and first strip together

83. A fastening system 600 for fastening a solar panel mounting structure 34 to a roof 22 comprising:

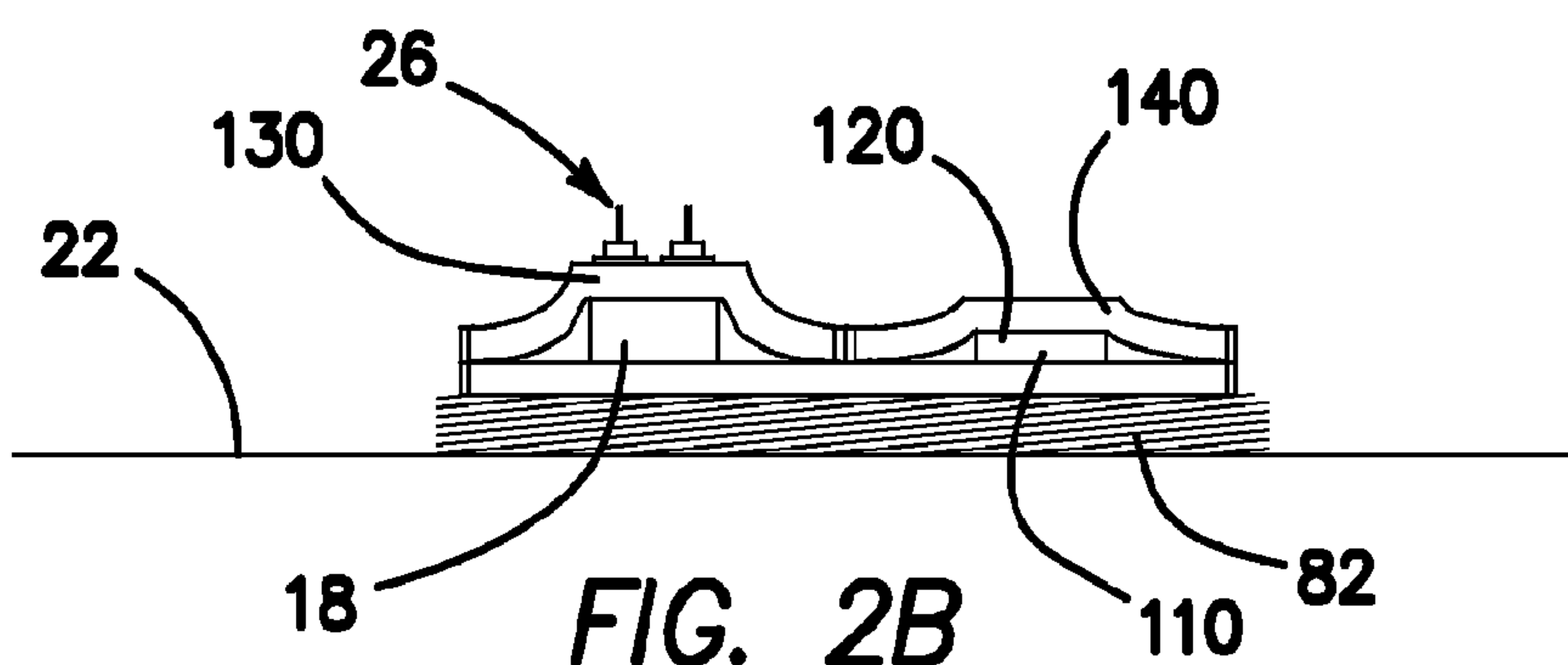
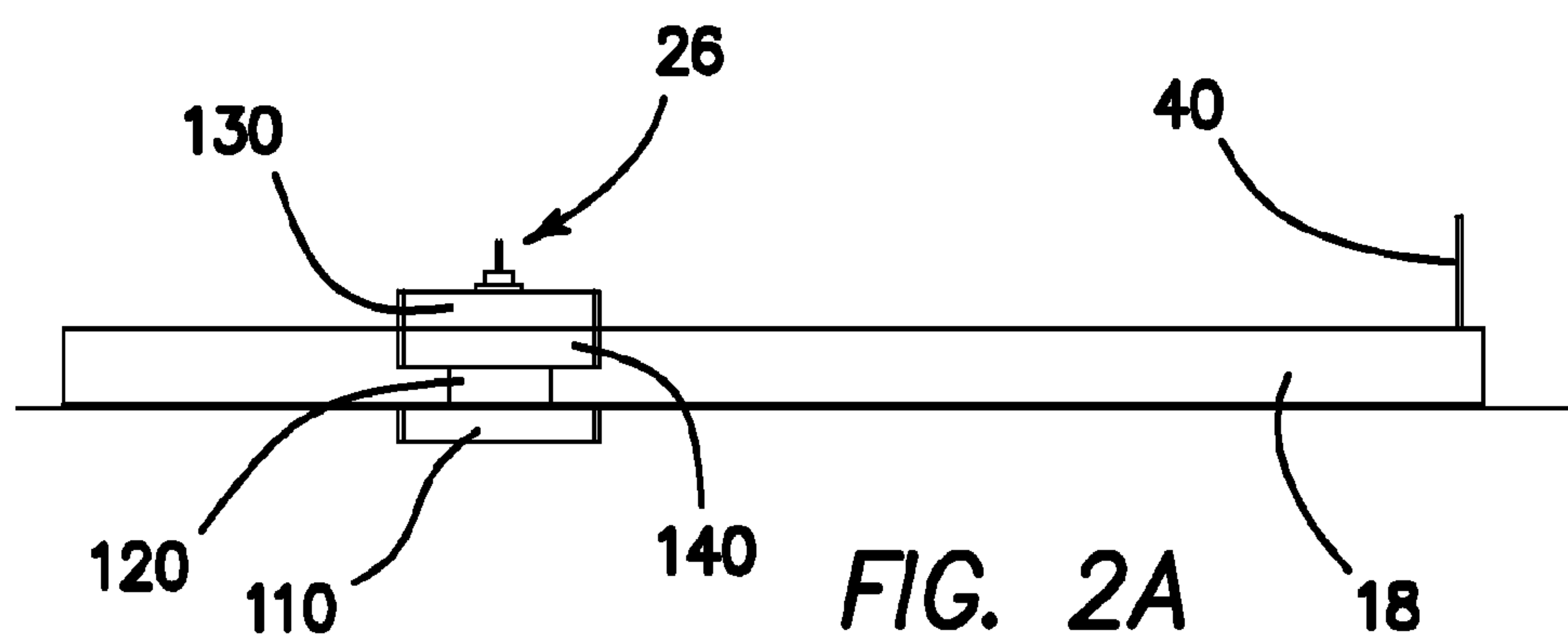
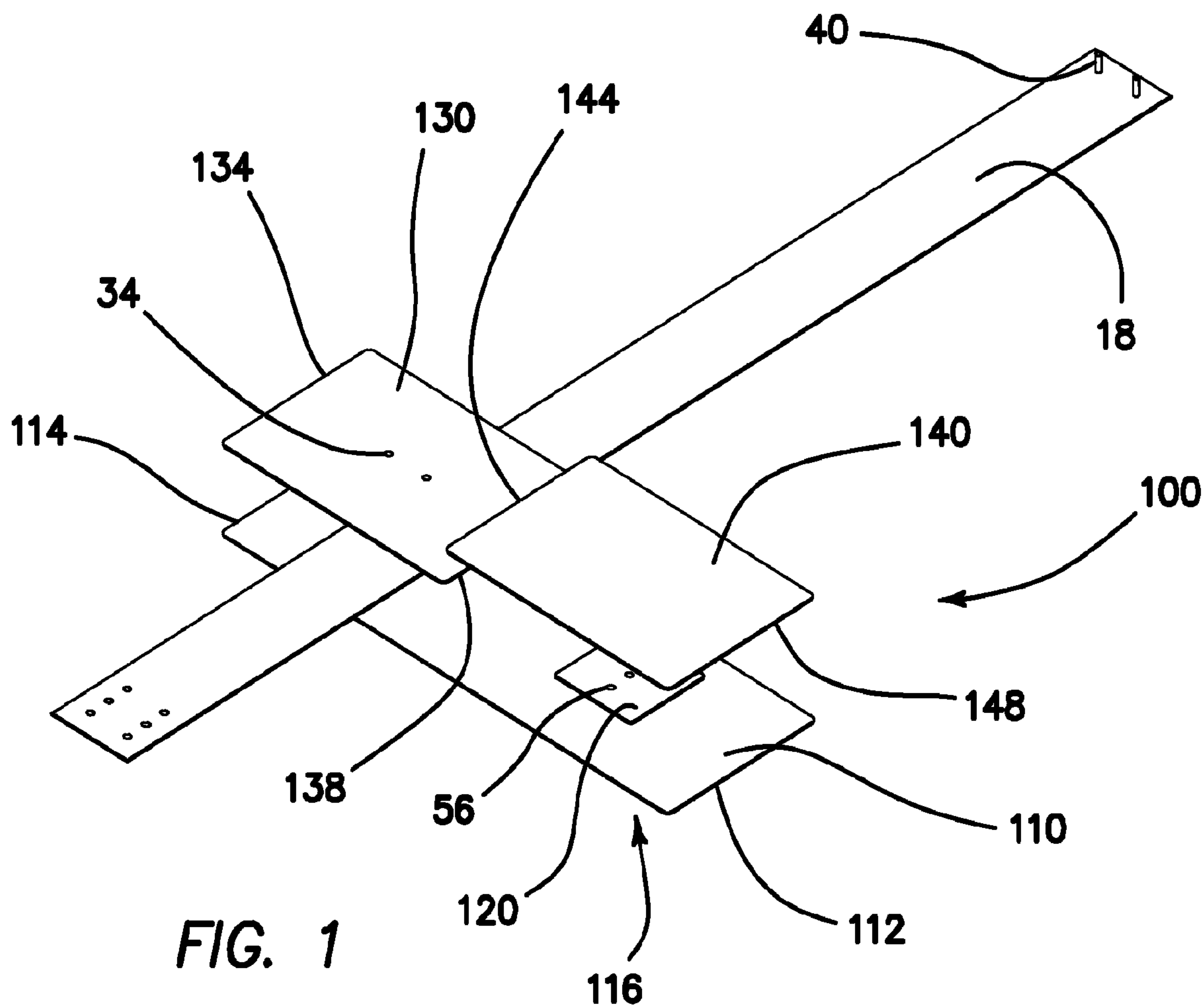
- a. a strip of roofing material 610 having edges, a raised section 612 in the middle and a lowered section 611 at each end; said raised section 612 having a top 614 which is larger than the width of said structural member 34; said raised section 612 above and crossing said member 34 perpendicularly; said lowered section 611 being fastened to said roof 22 by a first fastening method;
- b. a lower metal strip 620 fastened to and below said top 614 by a second fastening method; said lower strip 620 being sized and shaped to fit snugly over the top 36 of said structural member 34; said lower metal strip extending part of a distance between said raised section and said lowered section; and
- c. an upper metal strip 630 fastened to and above said top 614 by a third fastening method; said upper metal strip 630 being sized and shaped to fit said top 6

84. The fastening system as claimed in claim 82 wherein said edges are straight lines or curves.

85. The fastening system as claimed in claim 82 in which said first fastening method is a fastener; adhesive bonding; ballast; a seismic anchor 70; or, if said strip 610 and said roof 22 are made of weldable roofing material, welding.
86. The fastening system as claimed in claim 84 in which said seismic anchor 70 is fastened to said lowered section 611 by adhesive bonding; or, if said lowered section 611 and said seismic anchor 70 are made of weldable roofing material, by welding.
87. The fastening system as claimed in claim 82 in which said second fastening method is adhesive bonding; or, if said strip 610 is made of weldable roofing material and said lower strip 620 is treated to be weldable to weldable roofing material, welding.
88. The fastening system as claimed in claim 82 in which said third fastening method is adhesive bonding; or, if said strip 610 is made of weldable roofing material and said lower strip 630 is treated to be weldable to weldable roofing material, welding.
89. A method 600 for fastening a solar panel mounting structure 34, having a mounting structure top 36, to a roof 22 comprising the steps of:
- providing a strip of roofing material 610 having edges, a raised section 612 in the middle and a lowered section 611 at each end; said raised section 612 having a top 614 which is larger than said mounting structure top 36;
 - placing said strip 610 perpendicularly crossing said mounting structure 34 with said top 614 over said mounting structure top 36;
 - fastening said lowered section 611 to said roof 22 by a first fastening method;
 - providing a lower metal strip 620 sized and shaped to fit snugly over said mounting structure top 36; said lower metal strip extending part of a distance between said raised section and said lowered section;
 - fastening said lower strip to and below said top 614 by a second fastening method;
 - providing an upper metal strip 630; said upper metal strip 630 being sized and shaped to fit said top 614; and
 - fastening said upper metal strip to and above said top 614 by a third fastening method.

90. The method as claimed in claim 87 wherein said ends and sides are straight lines or curves.
91. The method as claimed in claim 87 in which said first fastening method is a fastener; adhesive bonding; ballast; a seismic anchor 70; or, if said strip 610 and said roof 22 are made of weldable roofing material, welding.
92. The method as claimed in claim 90 further comprising the step of fastening said seismic anchor 70 to said lowered section 611 by adhesive bonding; or, if said lowered section 611 and said seismic anchor 70 are made of weldable roofing material, by welding.
93. The method as claimed in claim 87 in which said second fastening method is adhesive bonding; or, if said strip 610 is made of weldable roofing material and said lower strip 620 is treated to be weldable to weldable roofing material, welding.
94. The method as claimed in claim 87 in which said third fastening method is adhesive bonding; or, if said strip 610 is made of weldable roofing material and said lower strip 630 is treated to be weldable to weldable roofing material, welding.
95. The fastening system as claimed in claim 32 in which said seismic anchor 70 comprises:
- a flat metal circle with central hole 54; and
 - a self-tapping screw 78 long enough to penetrate said roof 22 and securely fasten to a roof joist inserted through said hole 54; said hole 54 being smaller than the head of said screw.
96. The method as claimed in claim 49 further comprising fabricating said seismic anchor 70 by the steps of:
- providing a flat circle of roofing material with central hole 54; and
 - providing a self-tapping screw 78 long enough to penetrate said roof 22 and securely fasten to a roof joist,
 - inserting said screw through said hole 54; said hole 54 being smaller than the head of said screw.

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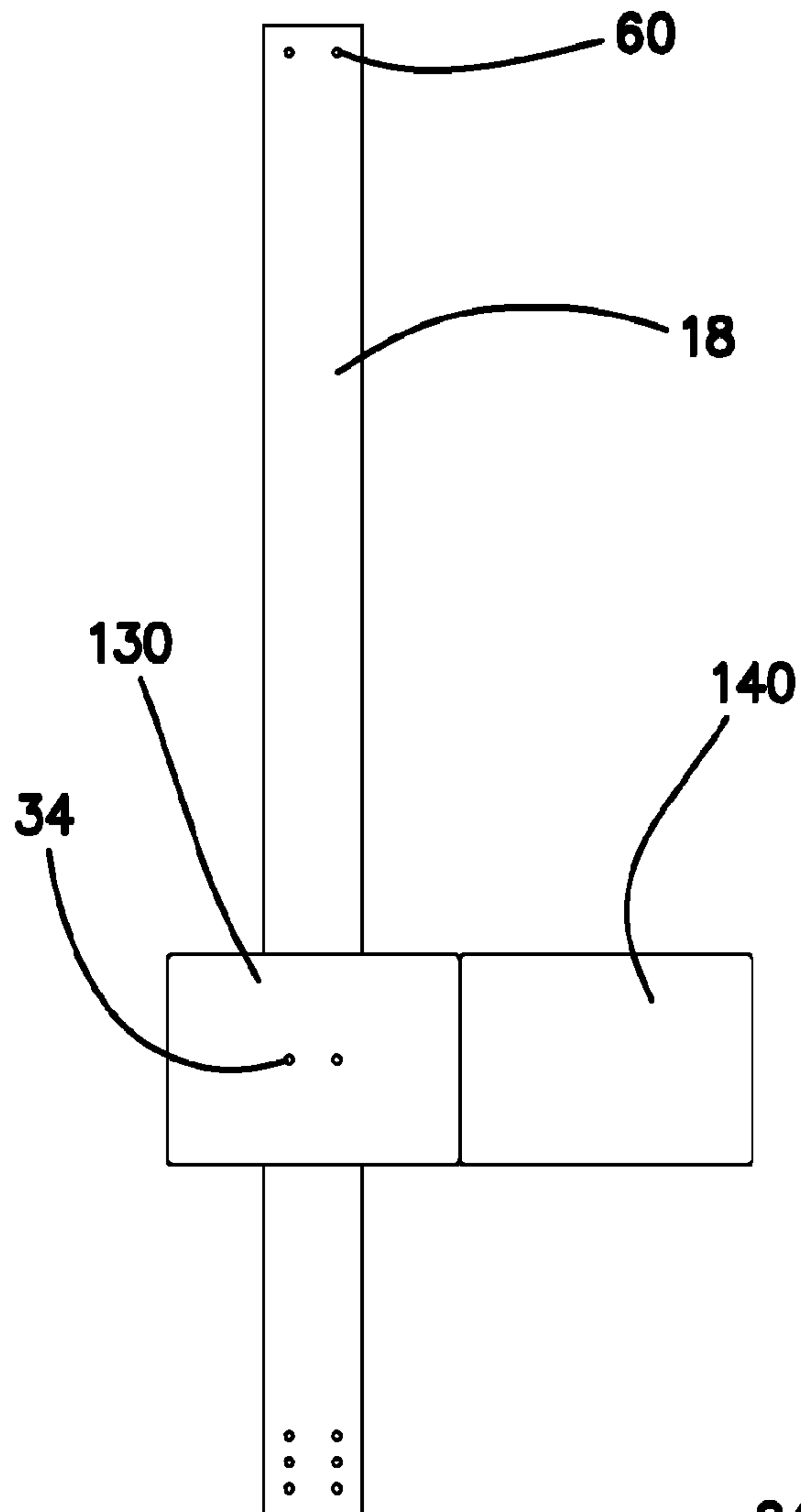


FIG. 2

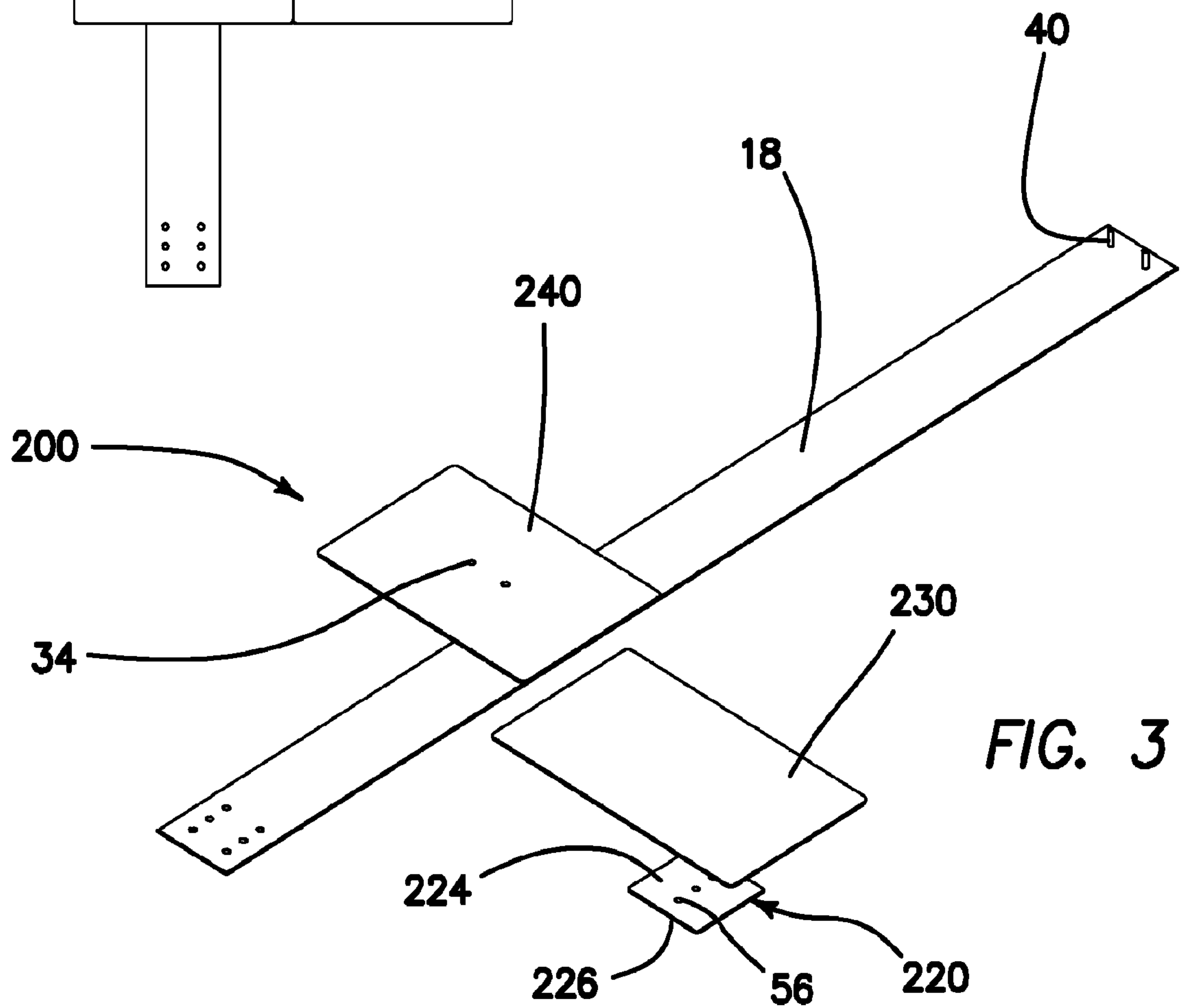
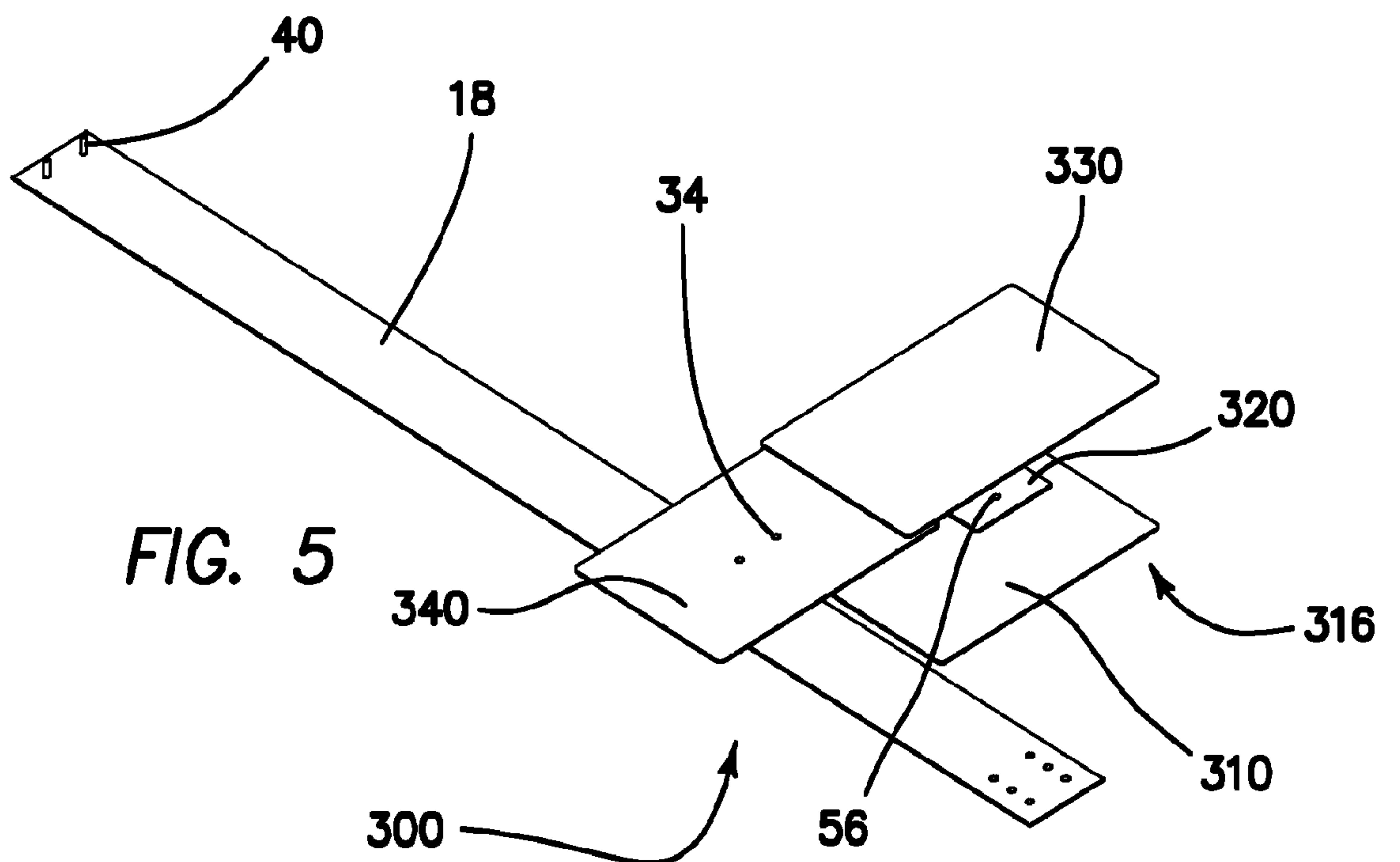
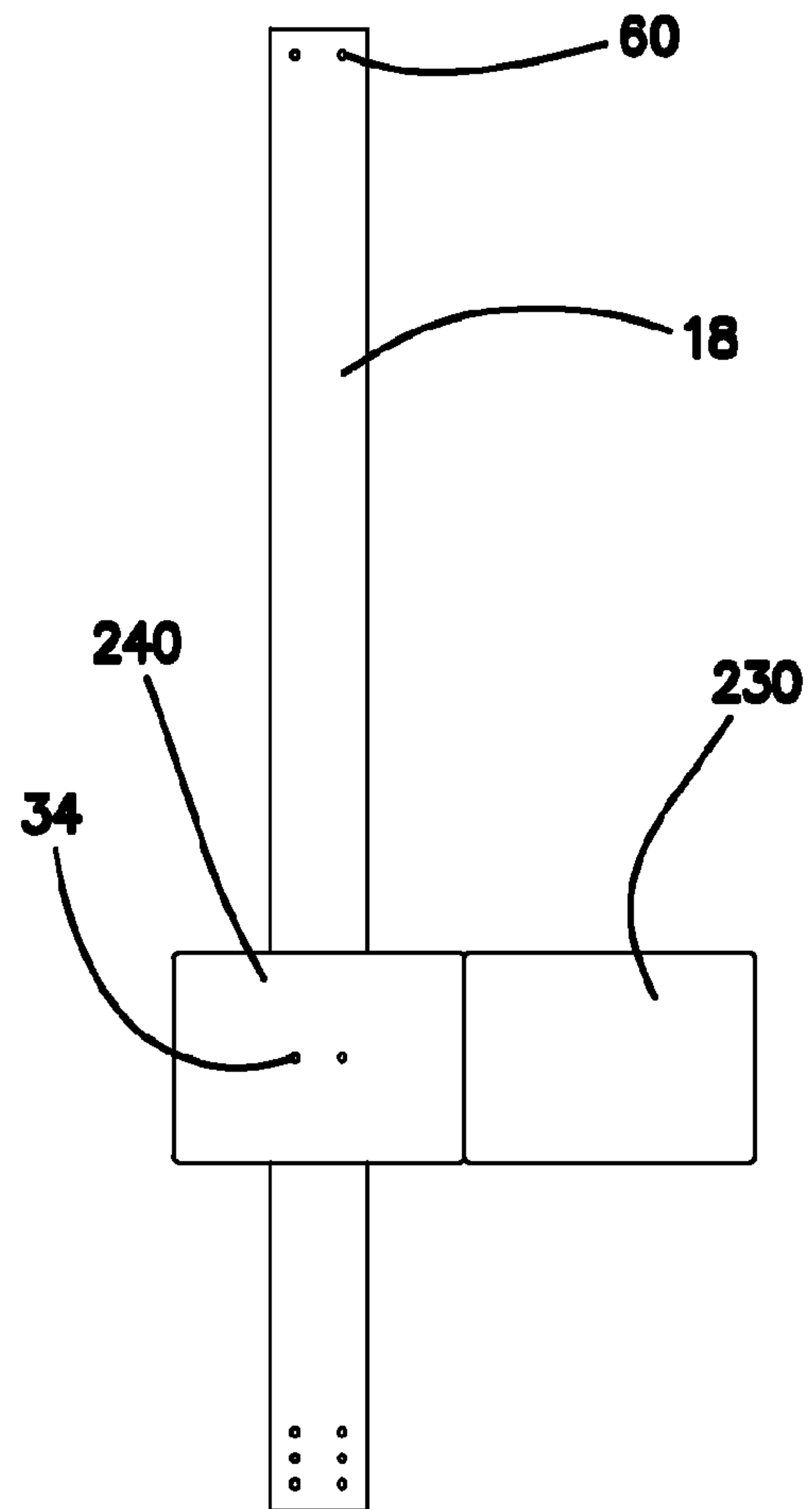
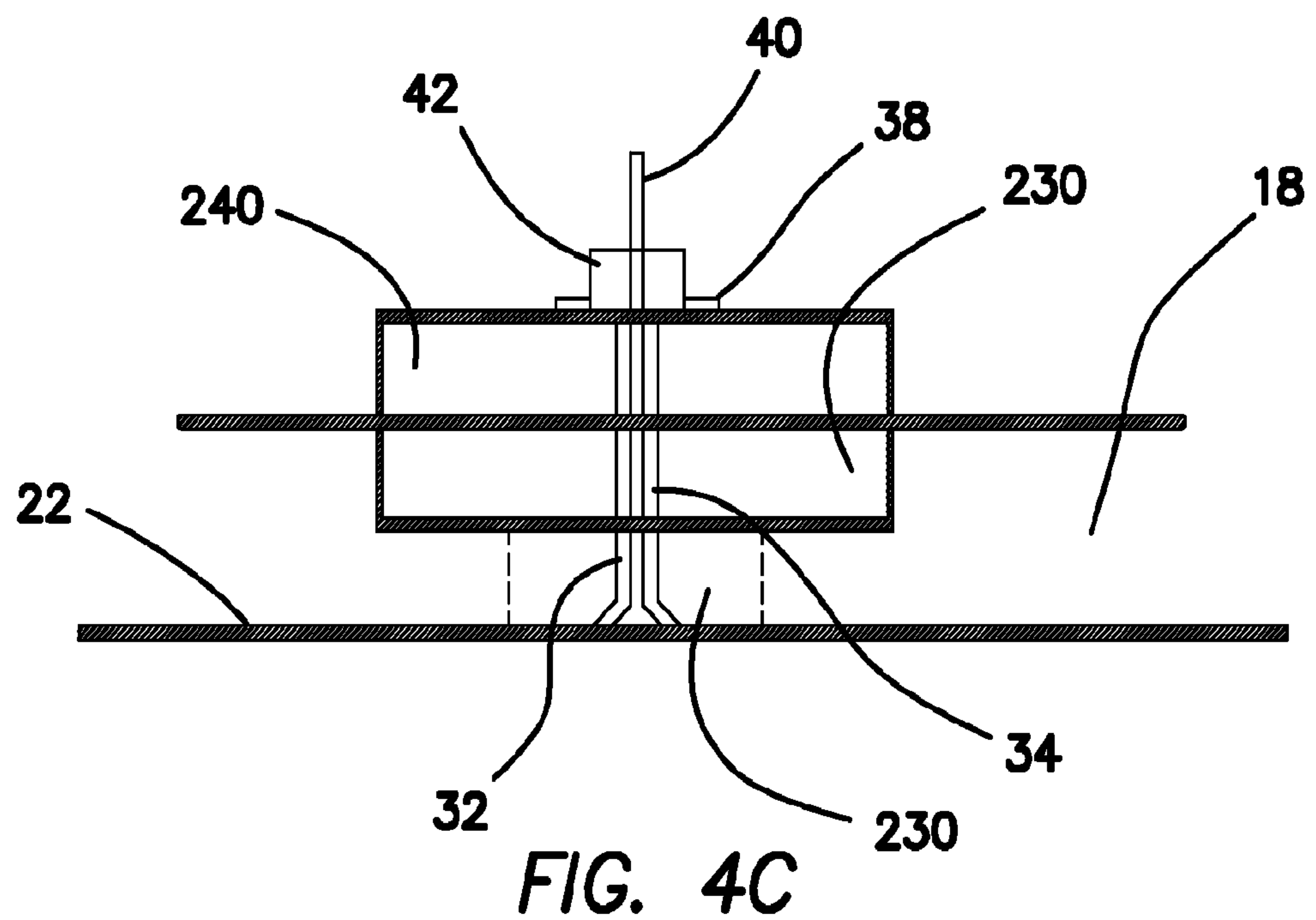
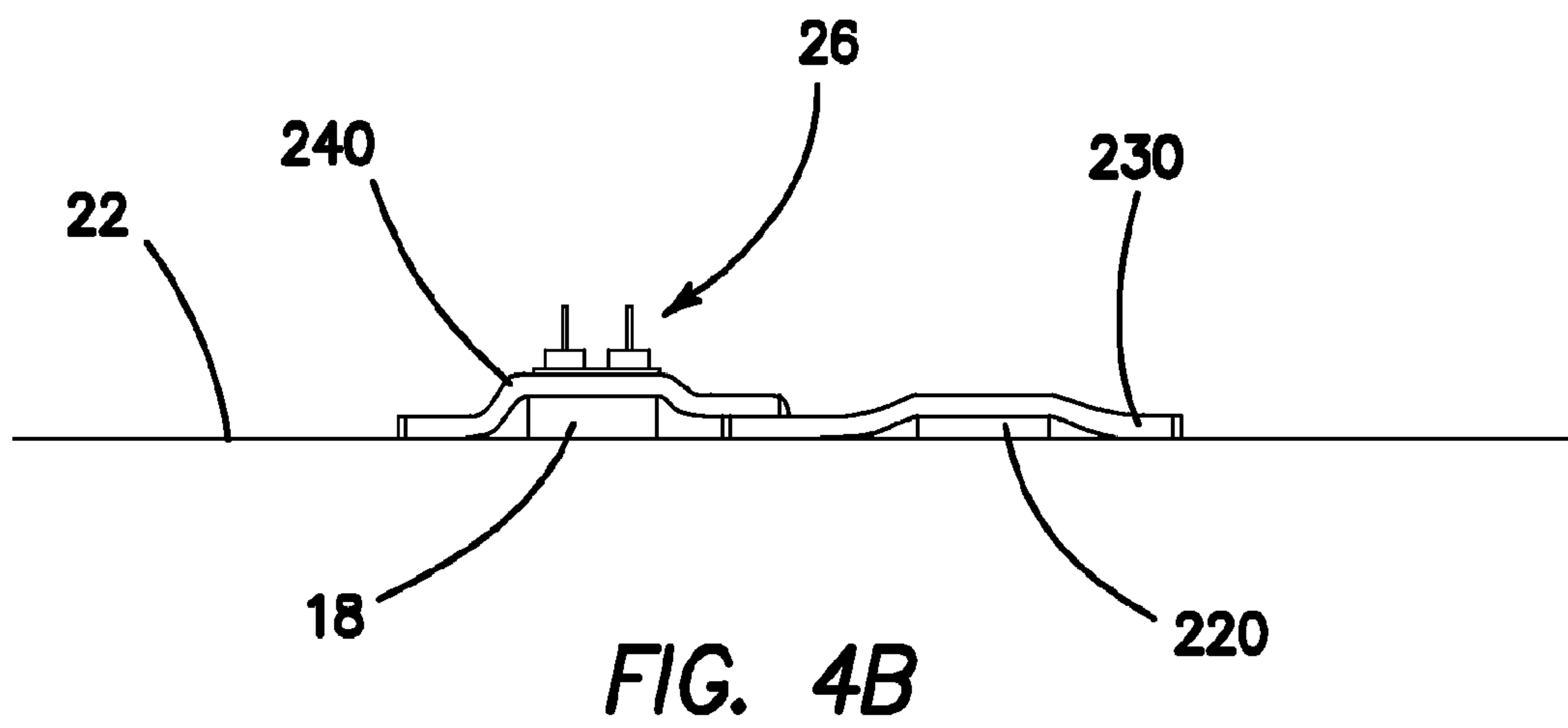
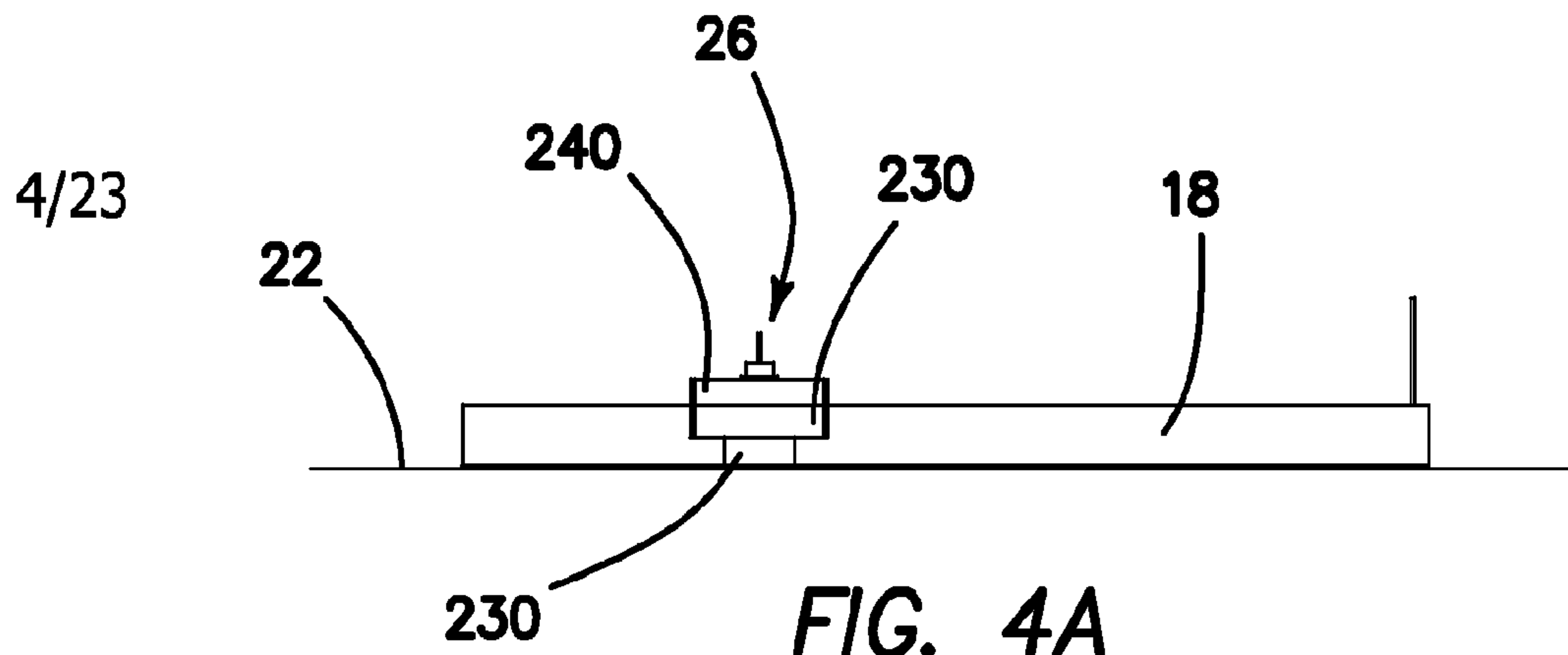


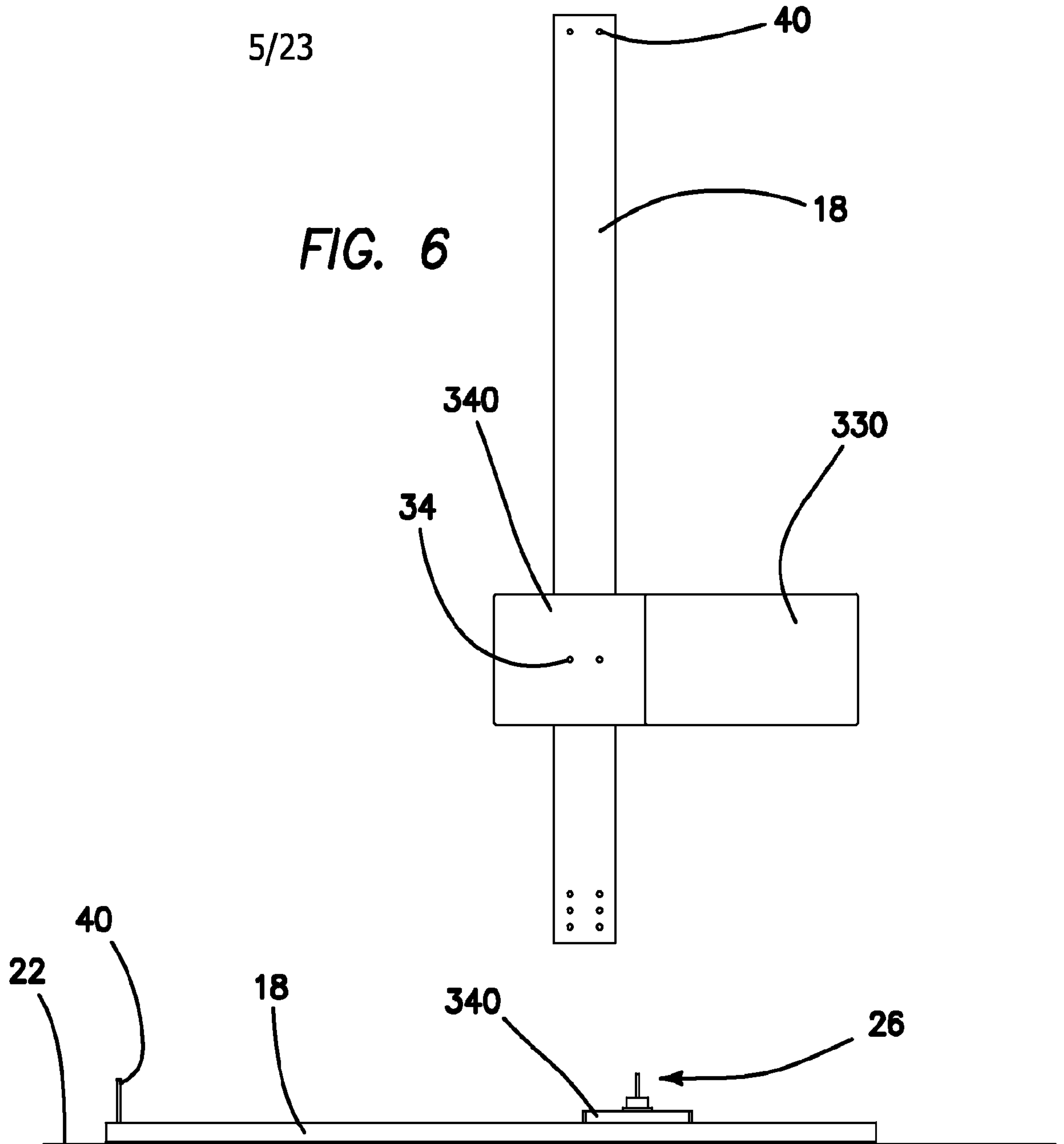
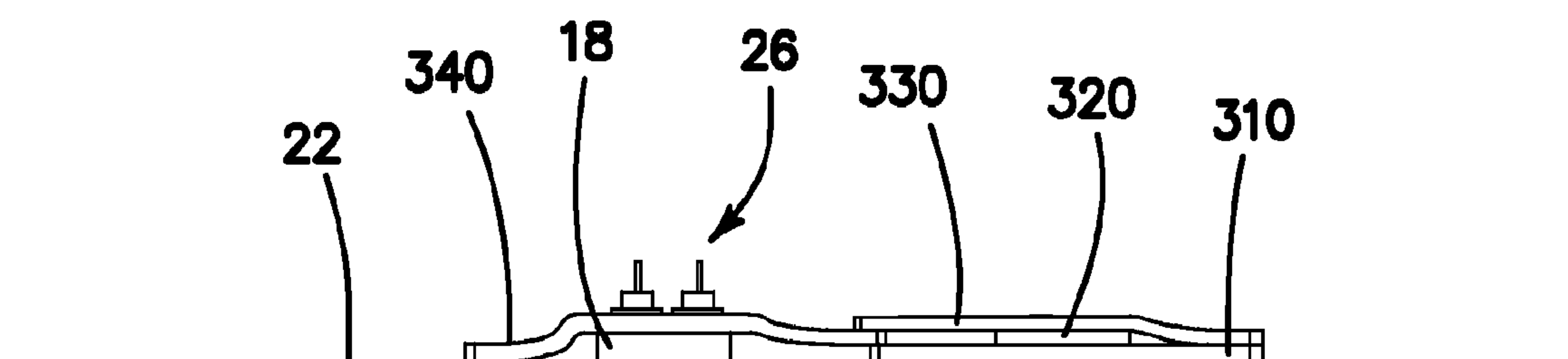
FIG. 3

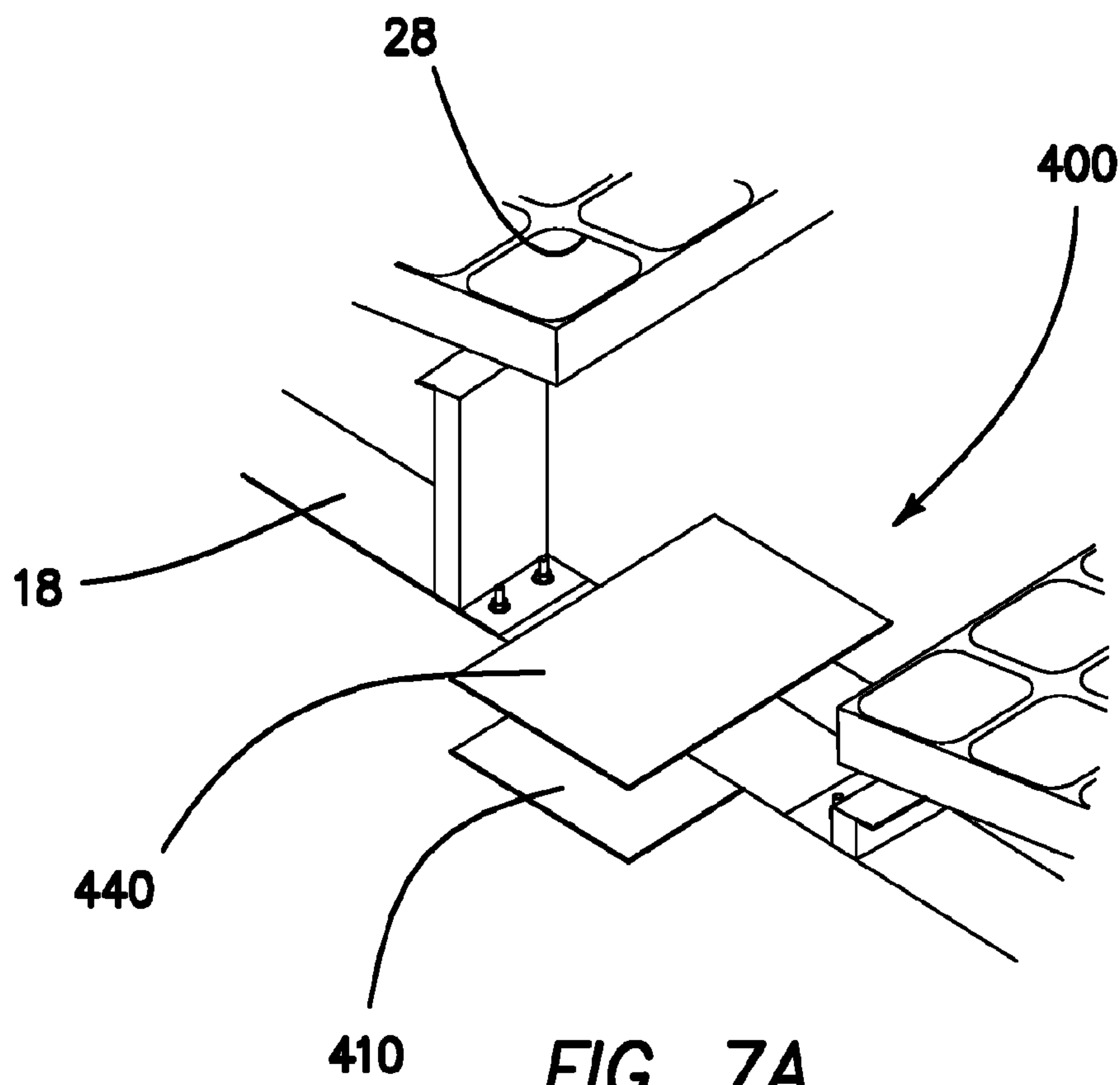
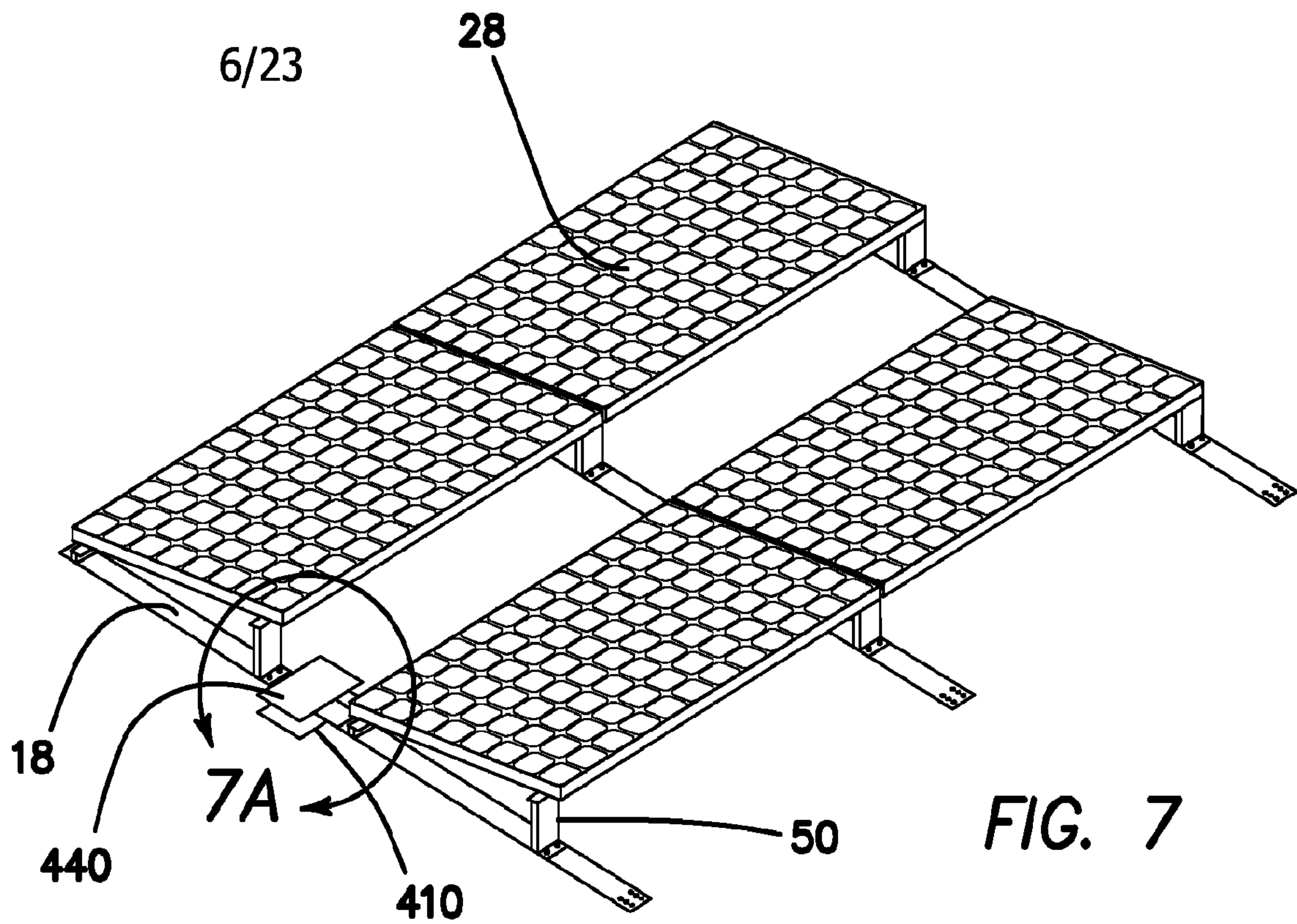
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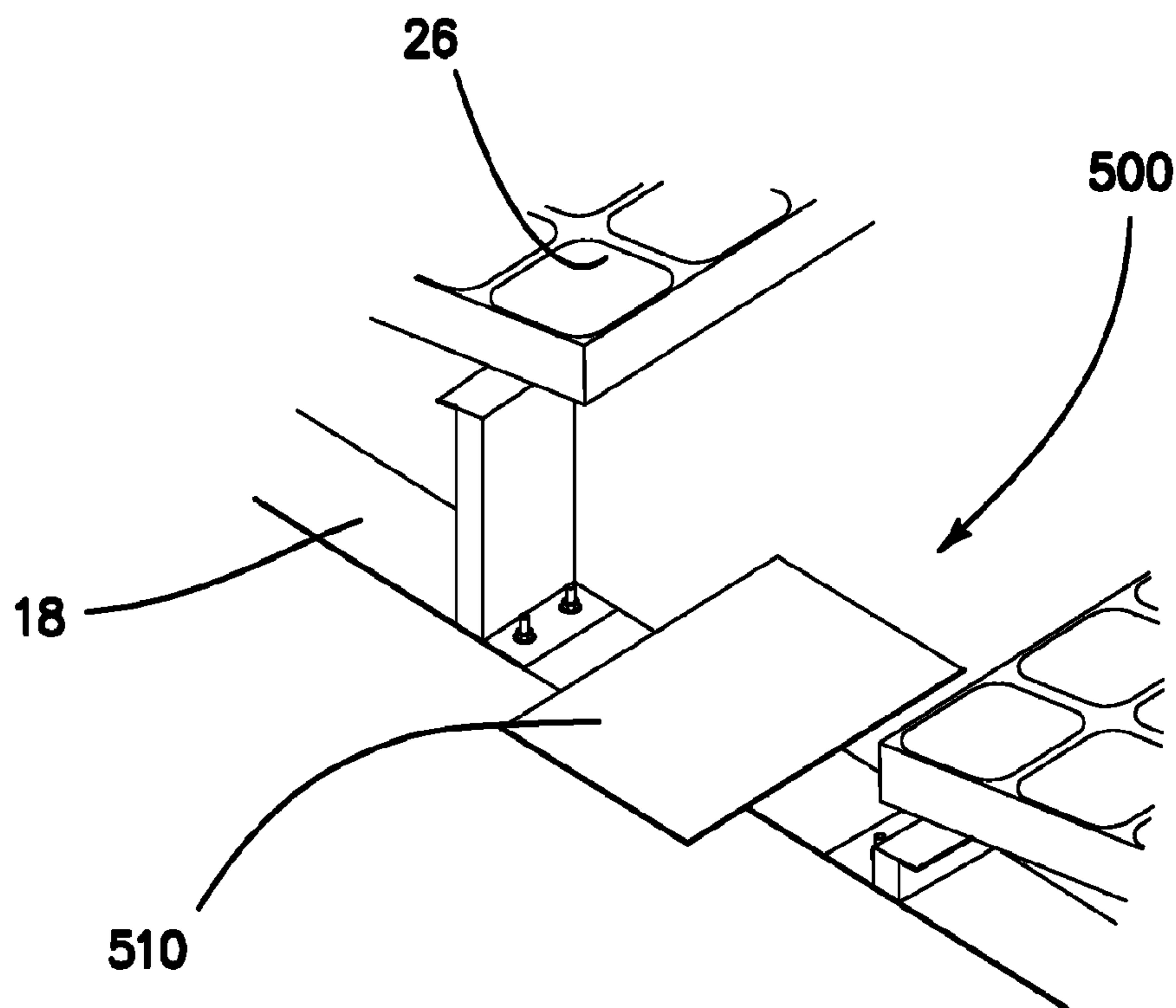
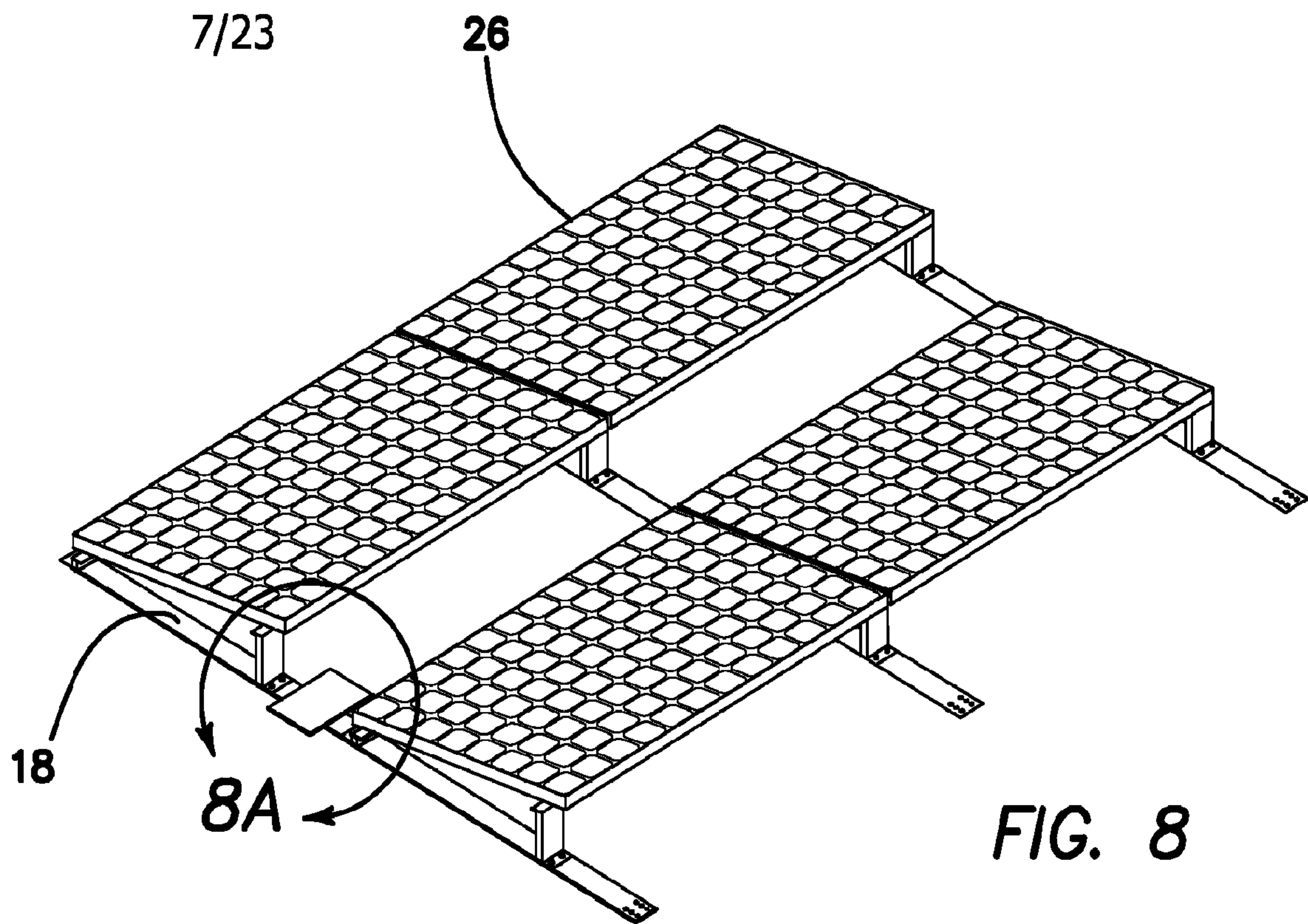
FIG. 4**FIG. 5**



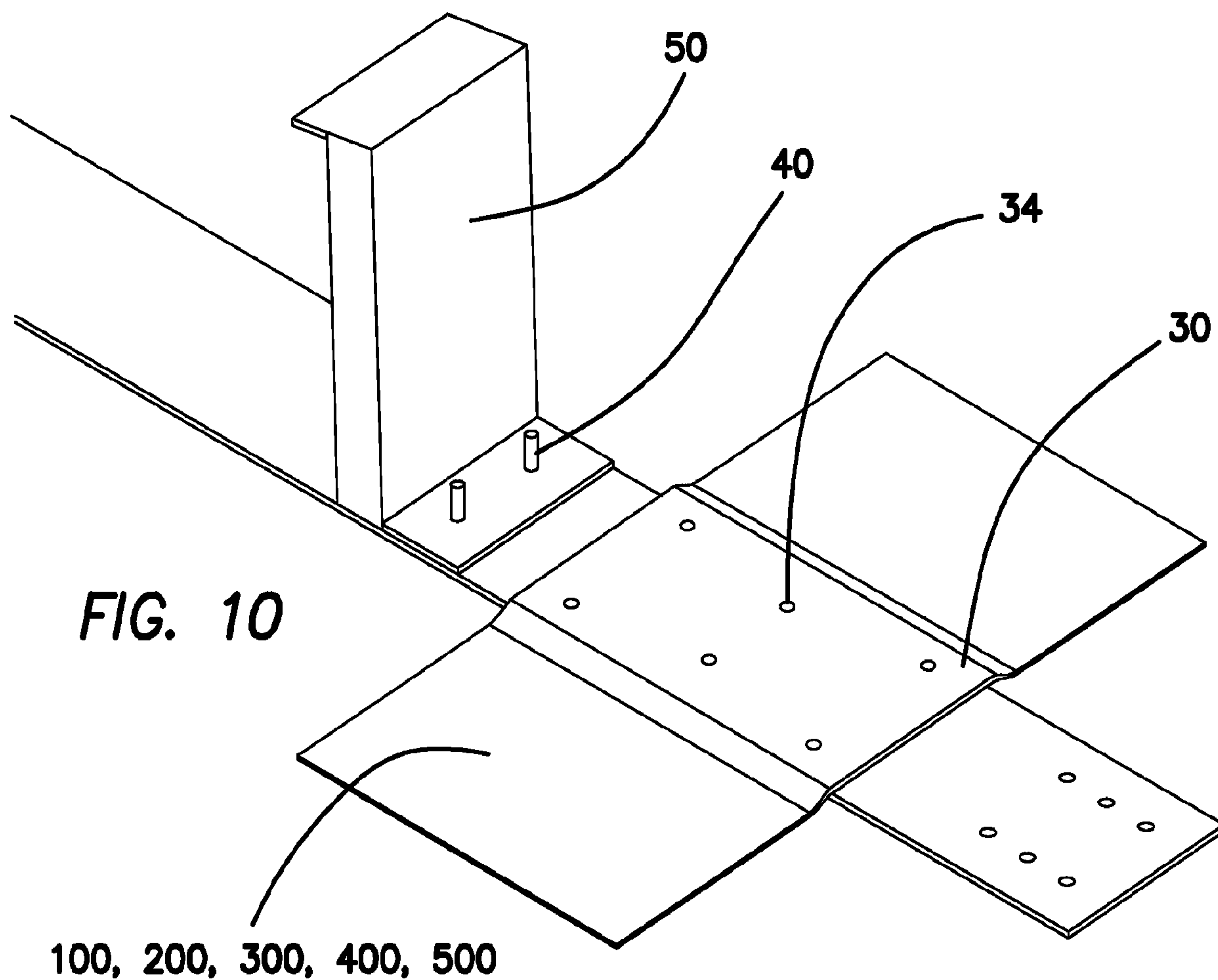
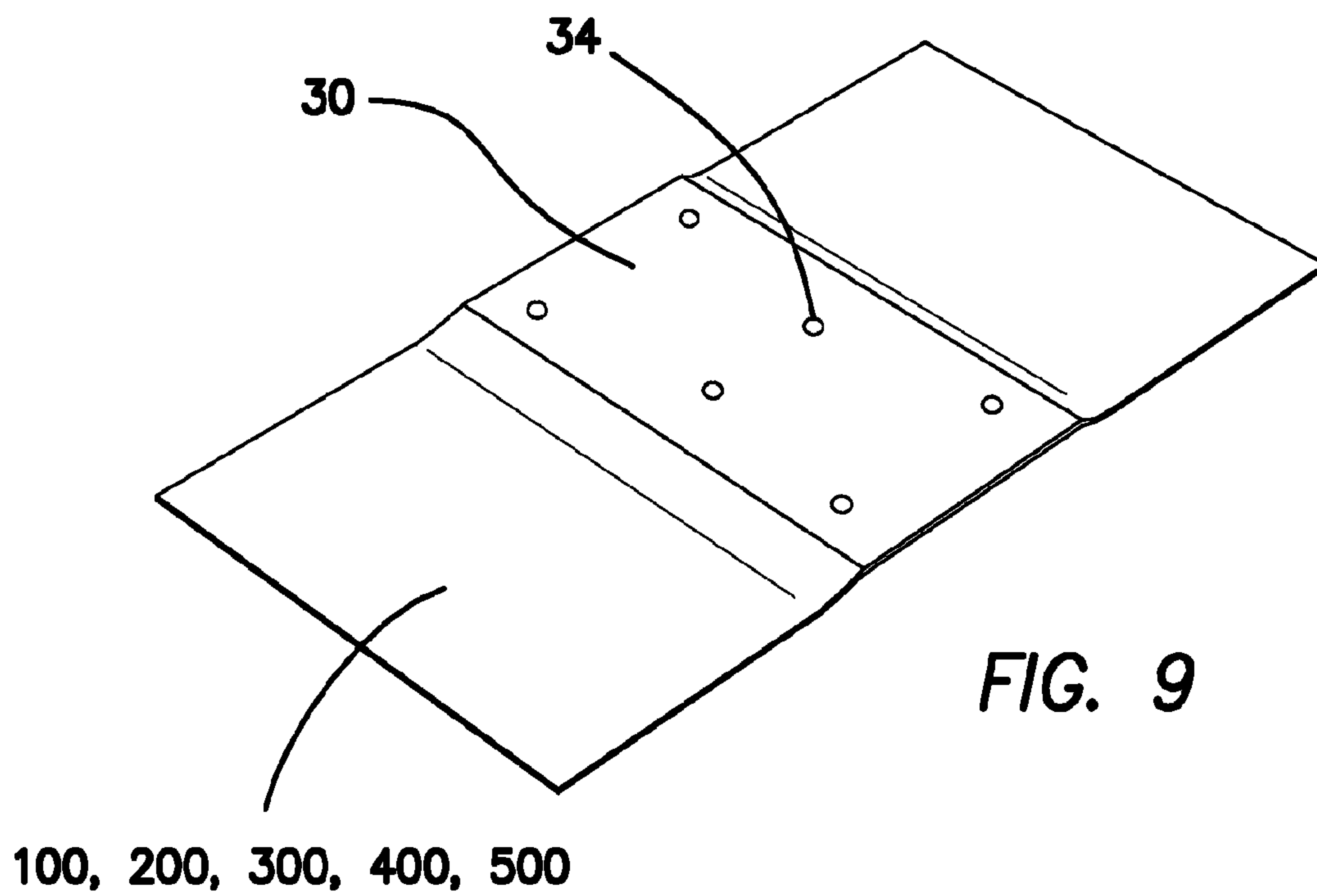
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FIG. 6**FIG. 6A****FIG. 6B**

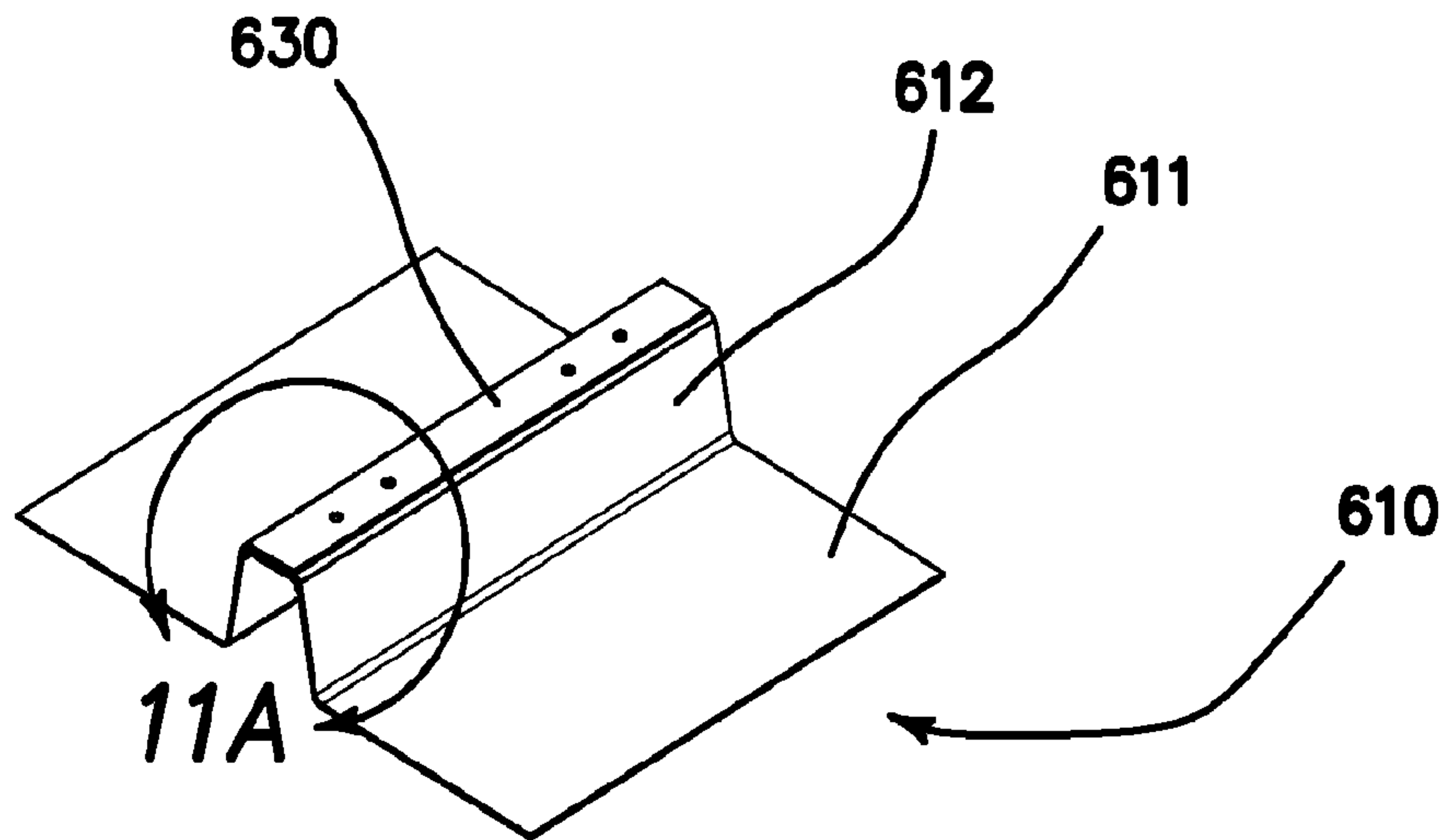
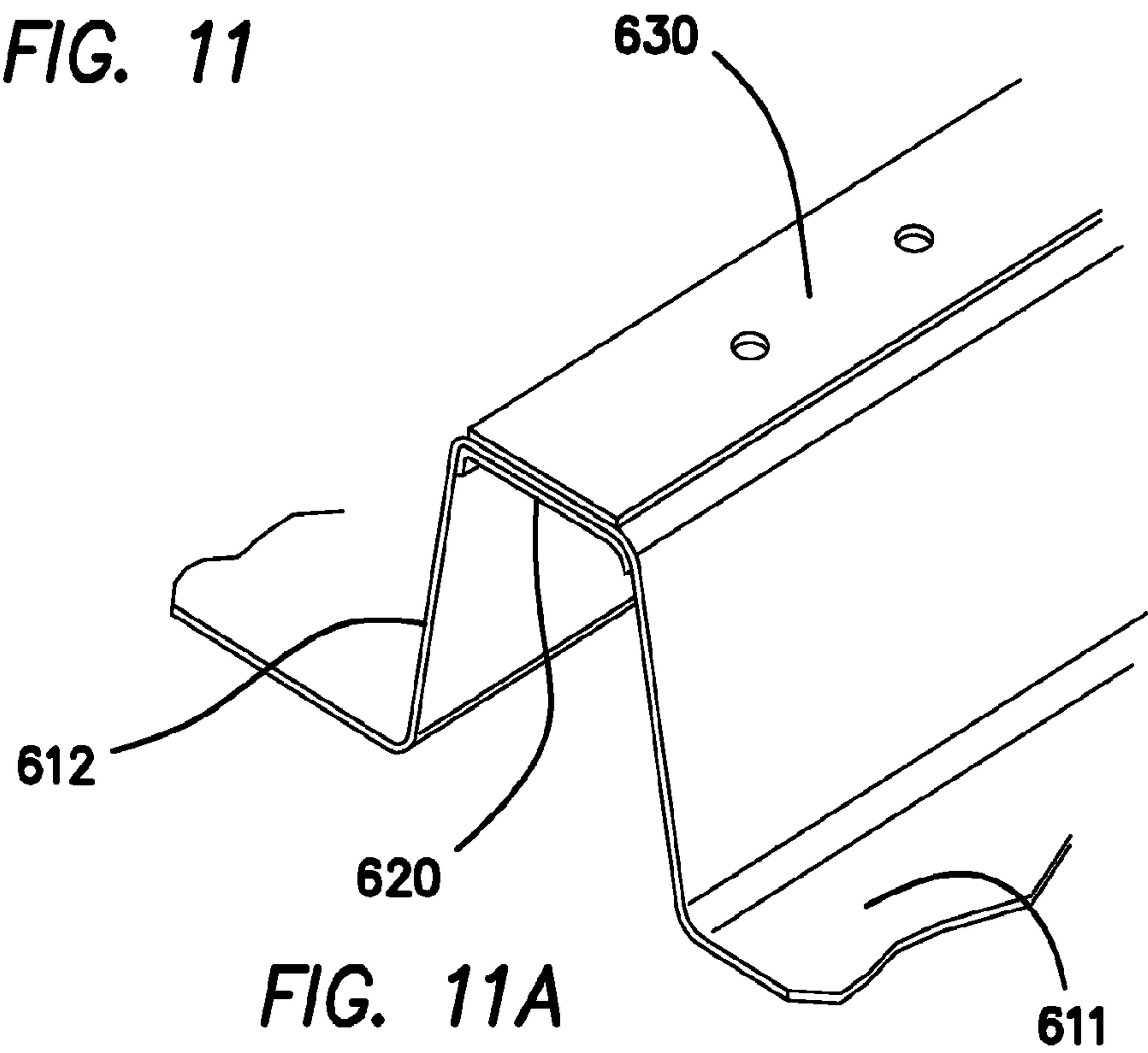
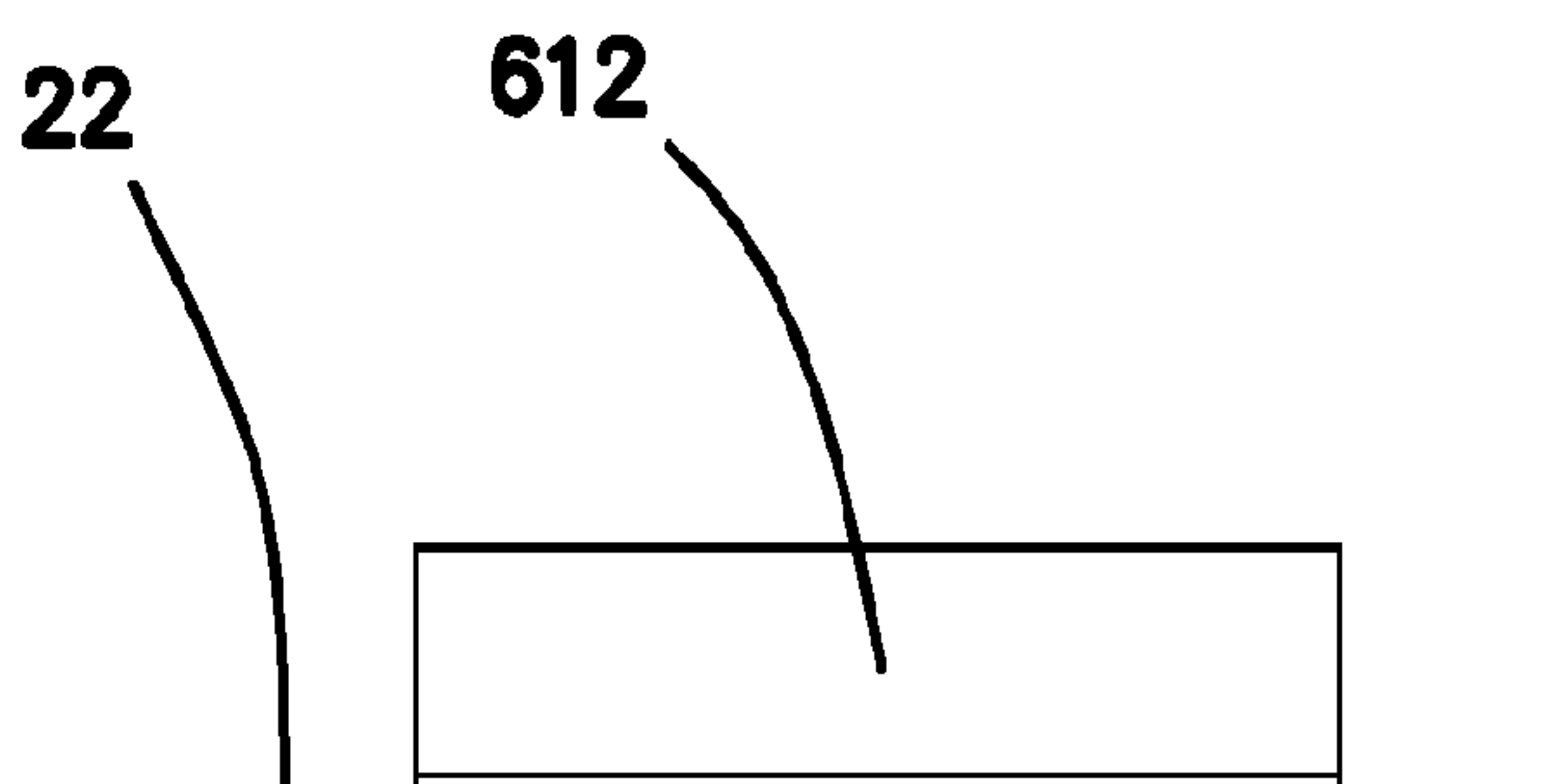




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**FIG. 11****FIG. 11A****FIG. 11B**

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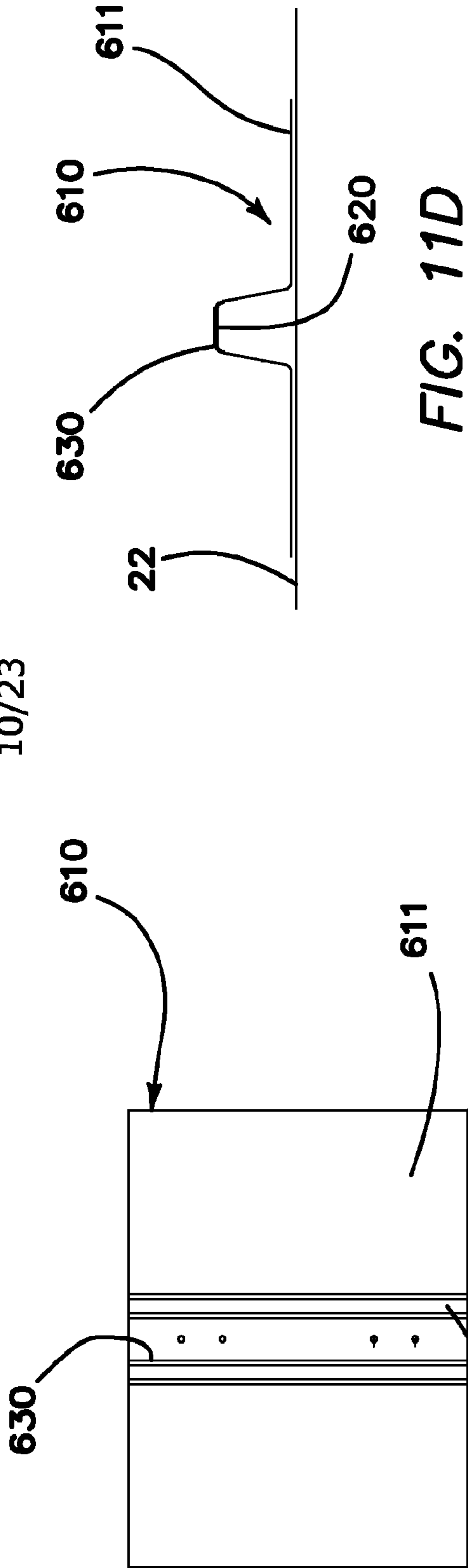


FIG. 11D

FIG. 11C

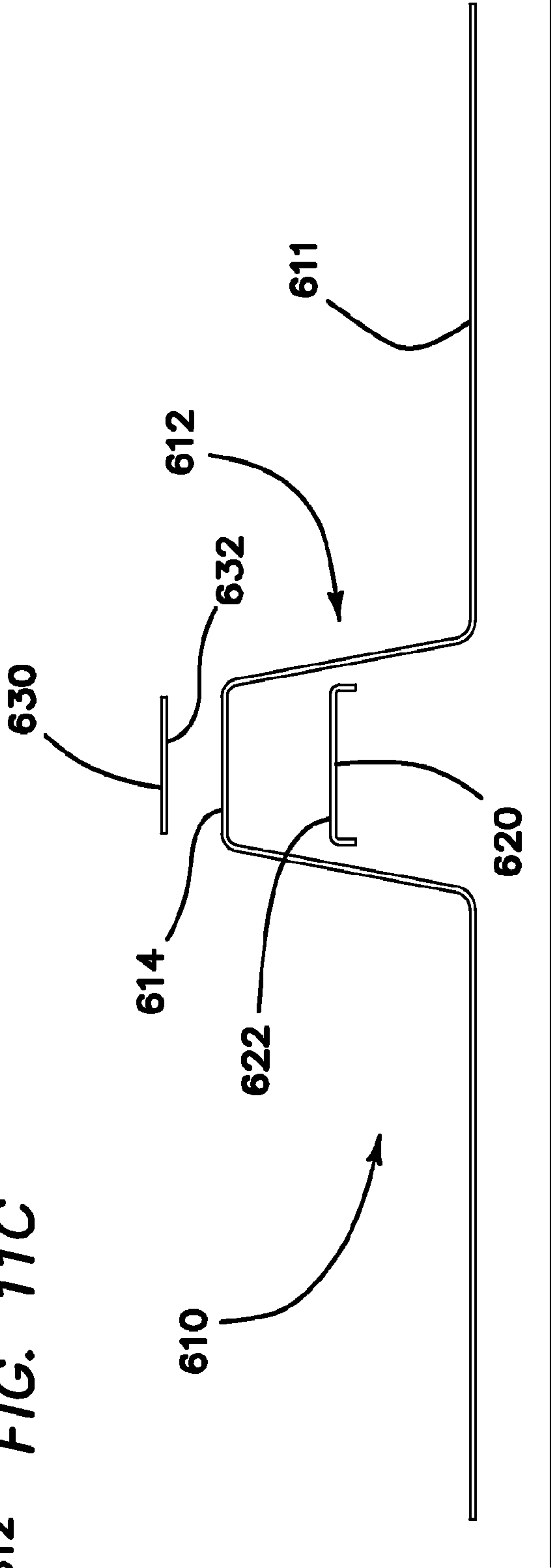
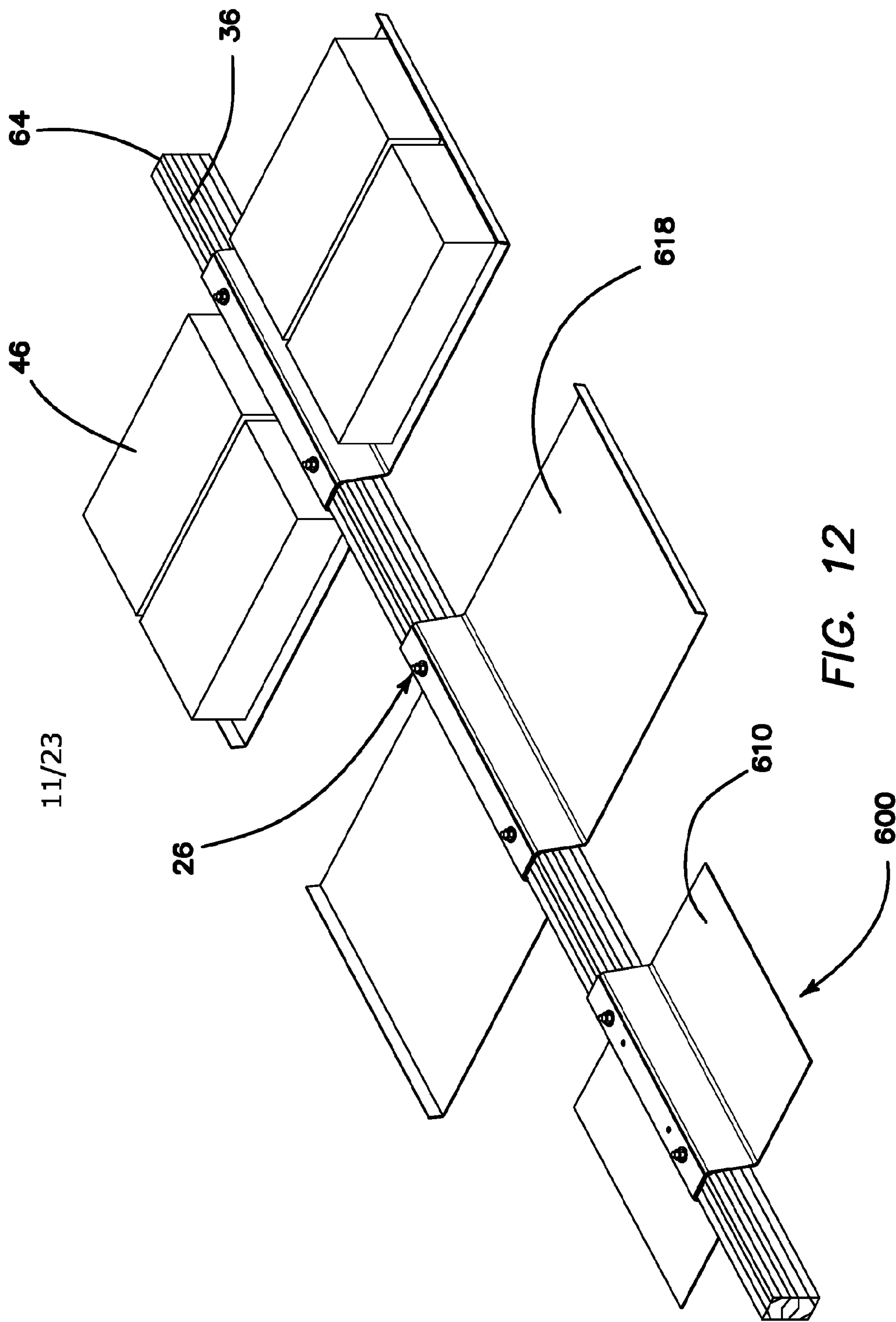
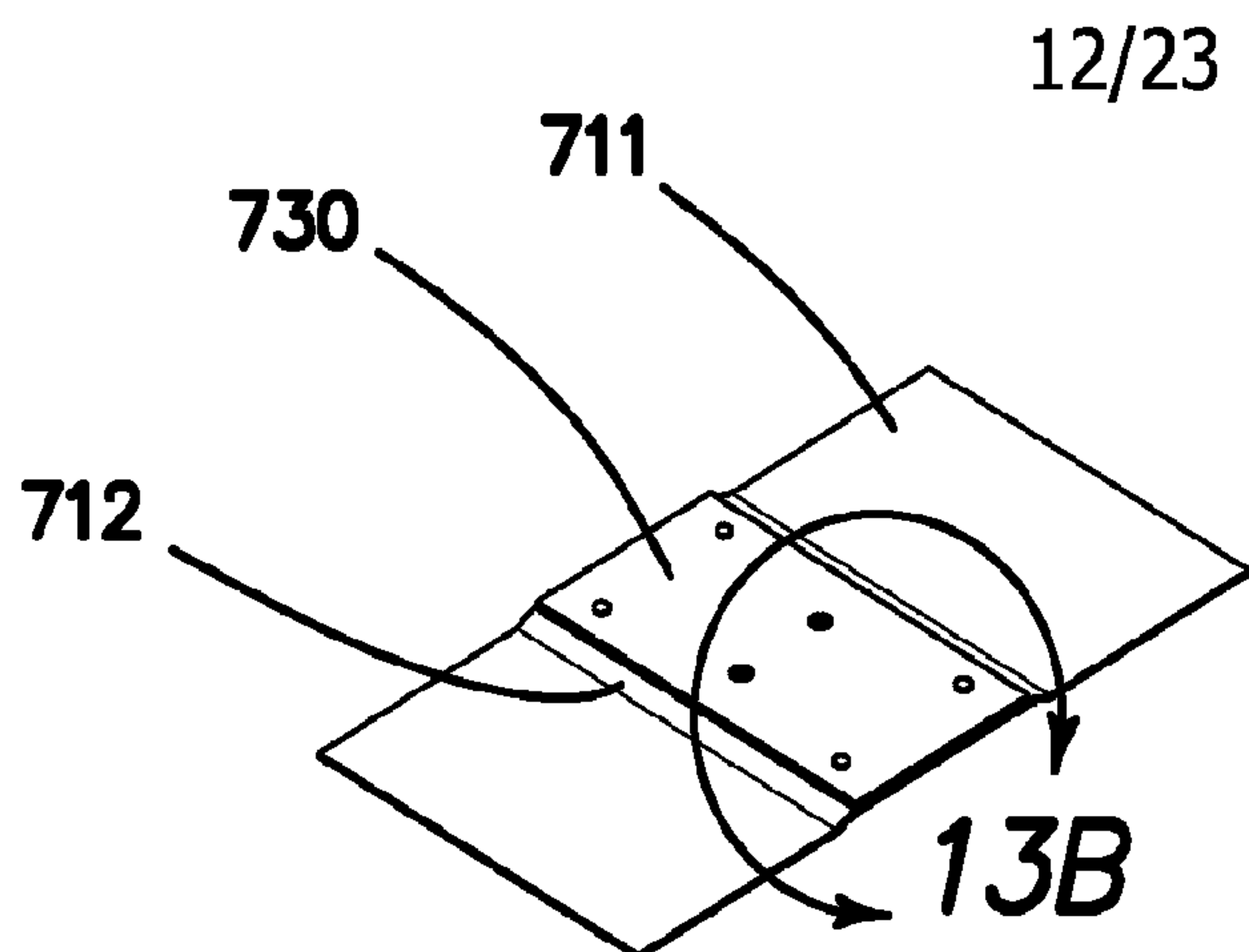
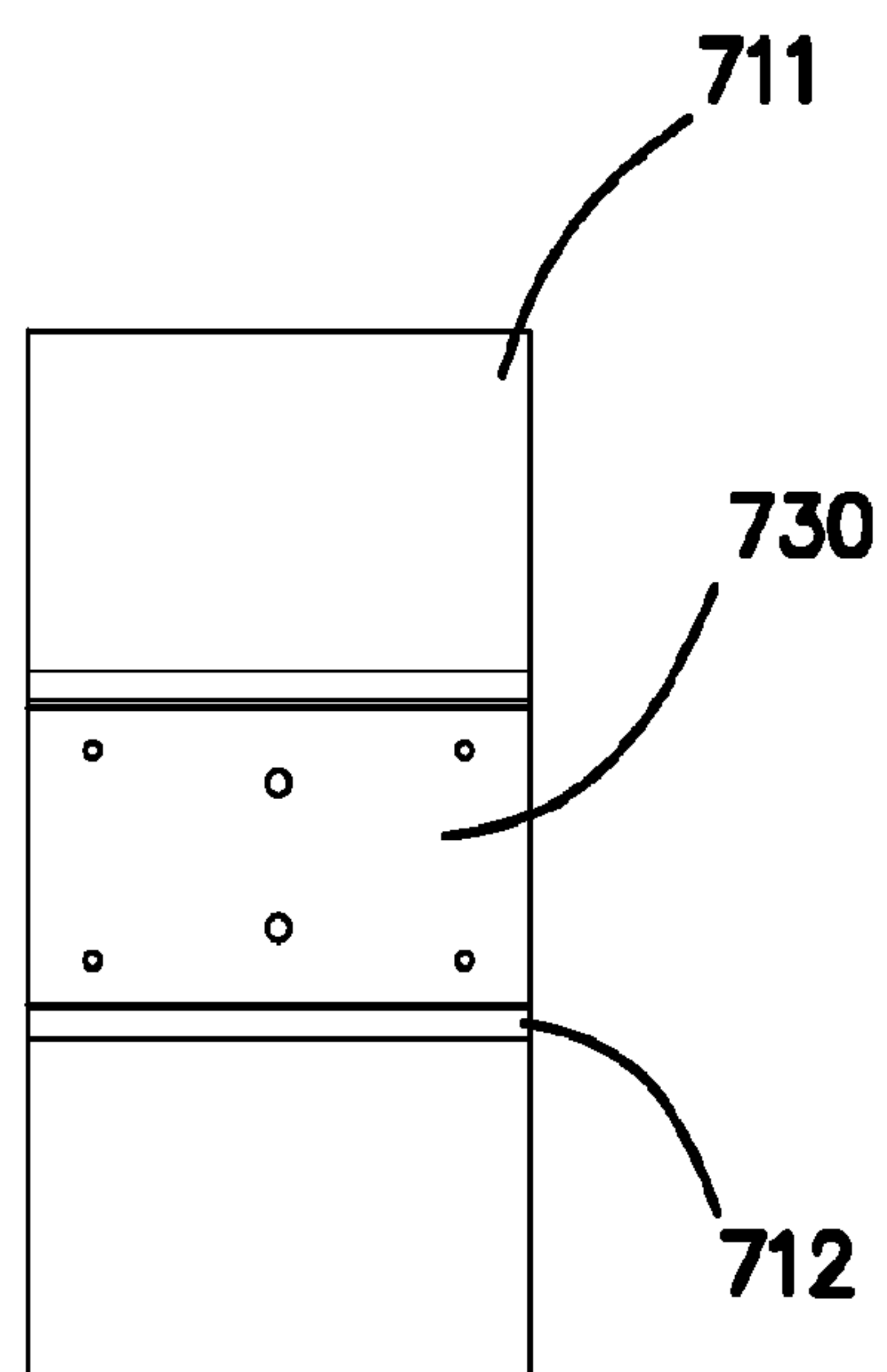
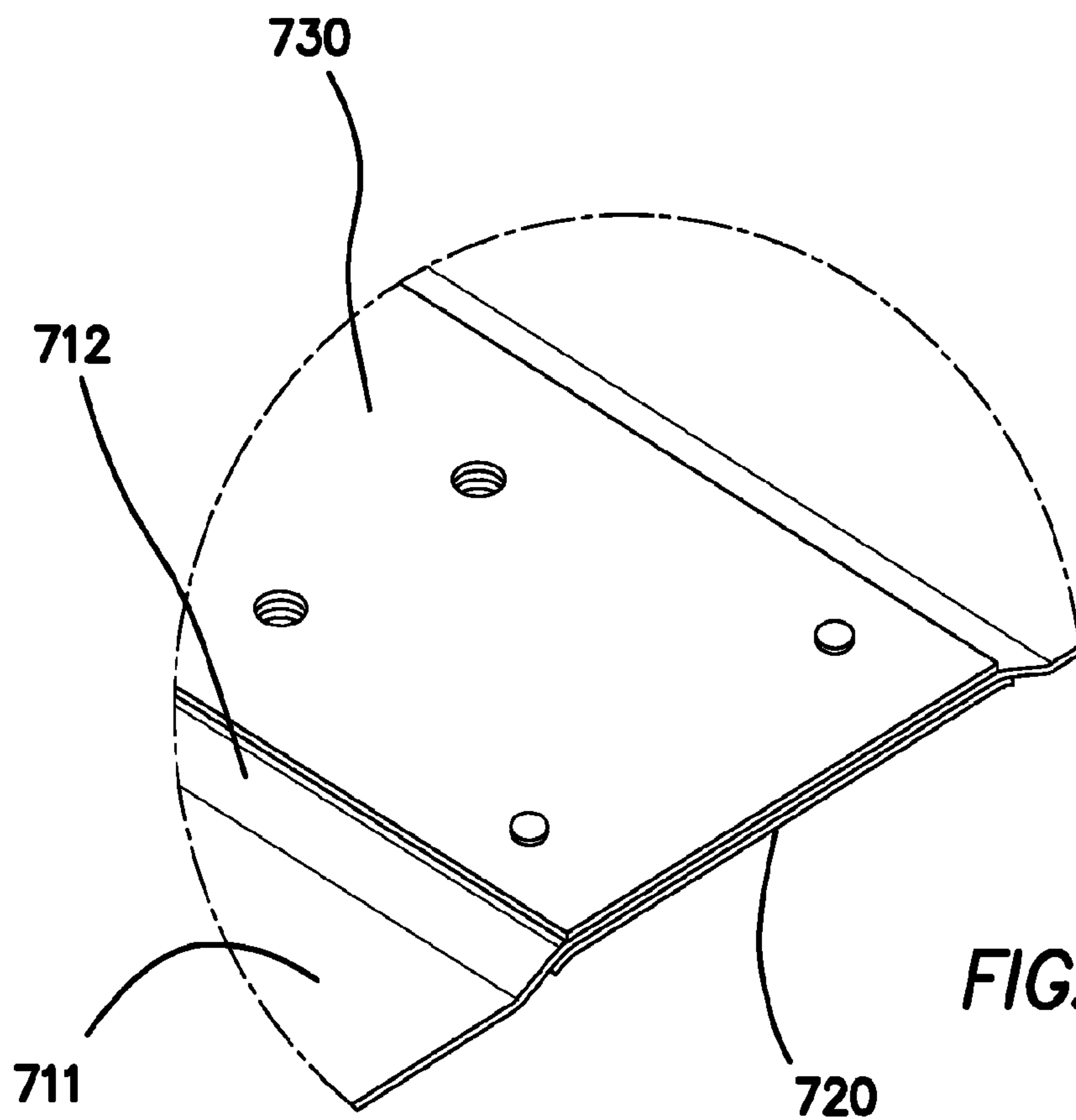


FIG. 11E



**FIG. 13****FIG. 13A****FIG. 13B**

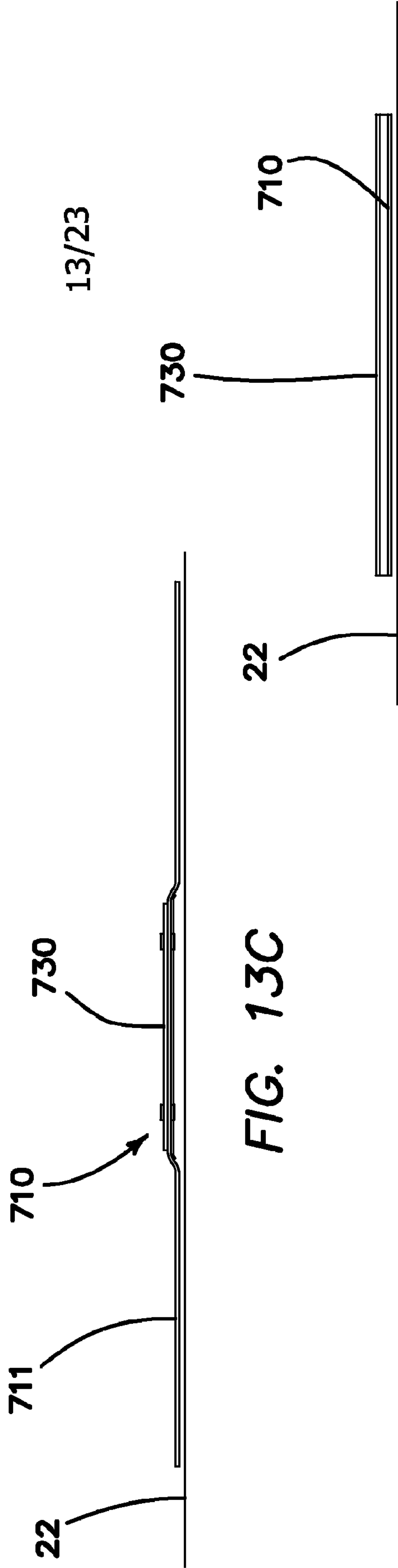


FIG. 13D

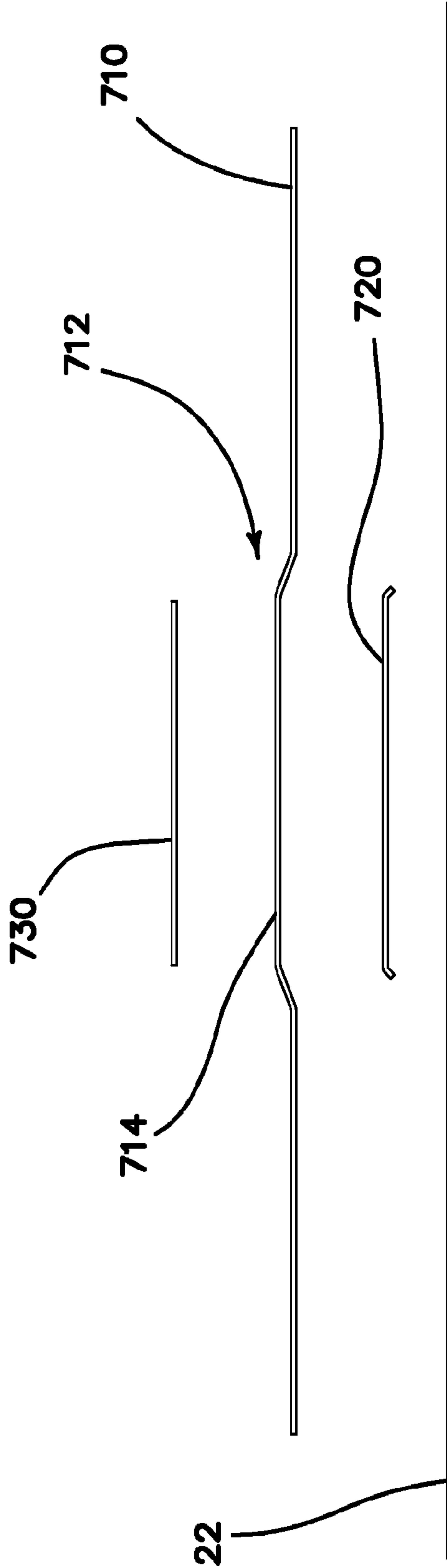
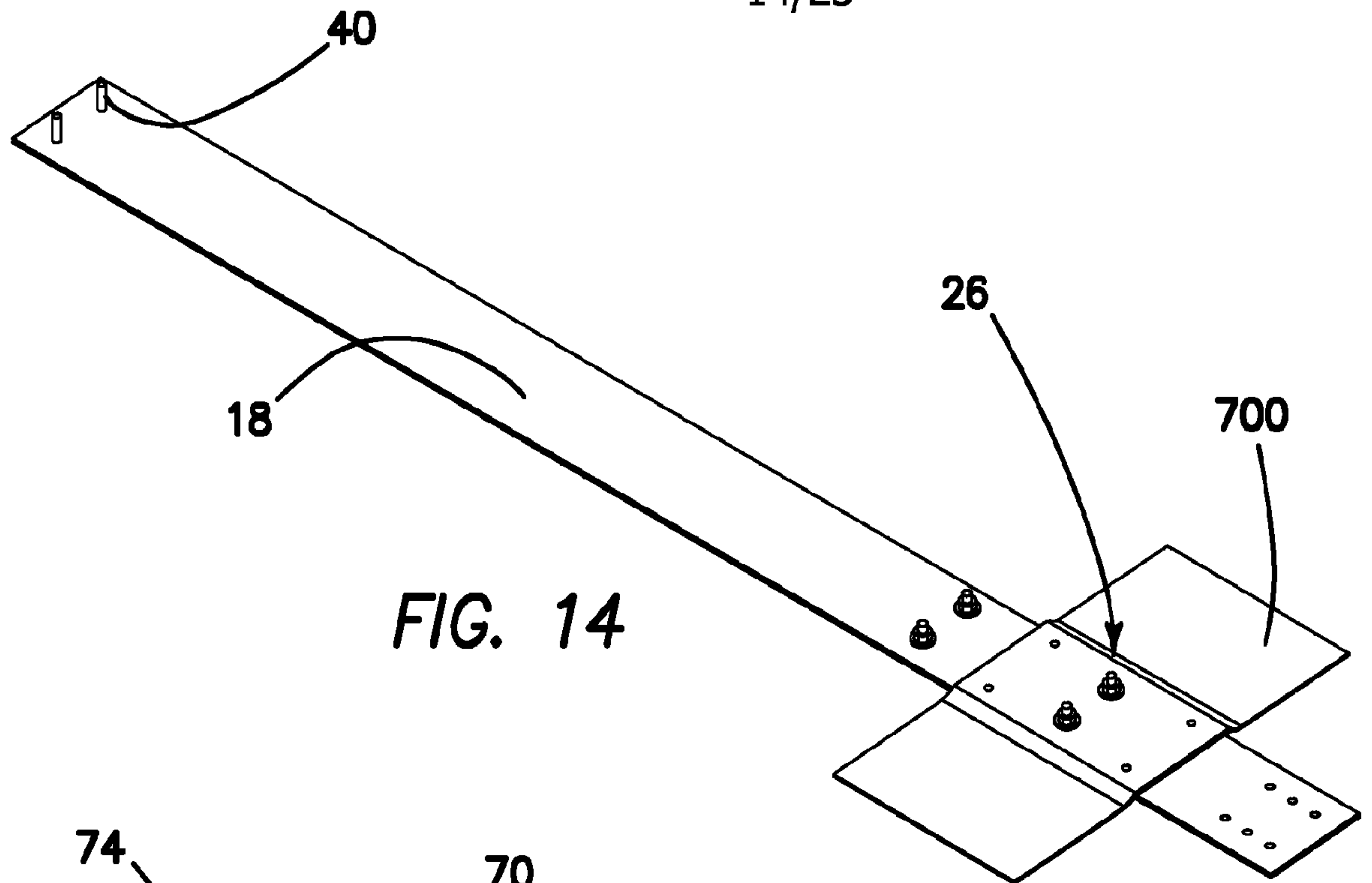
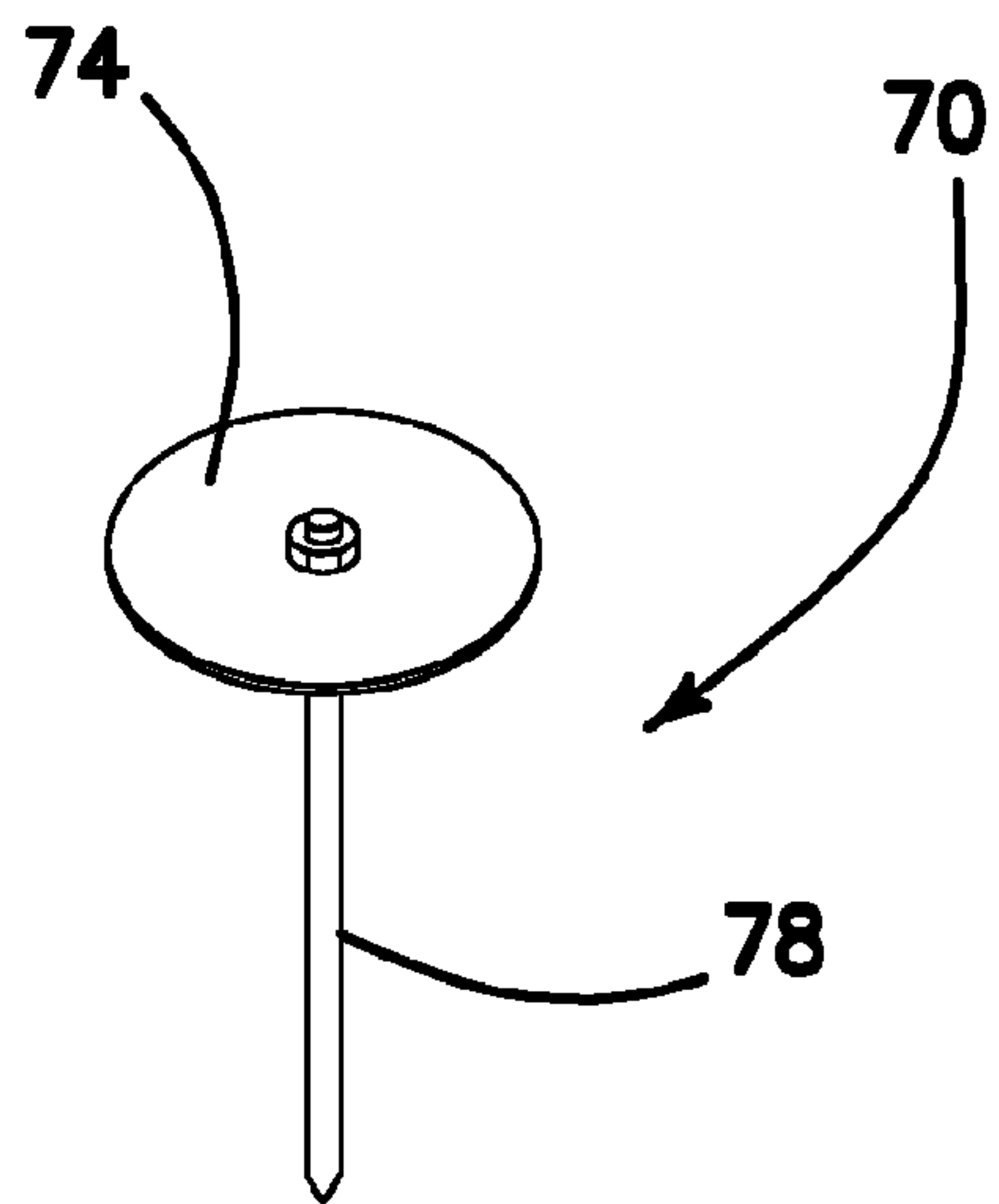
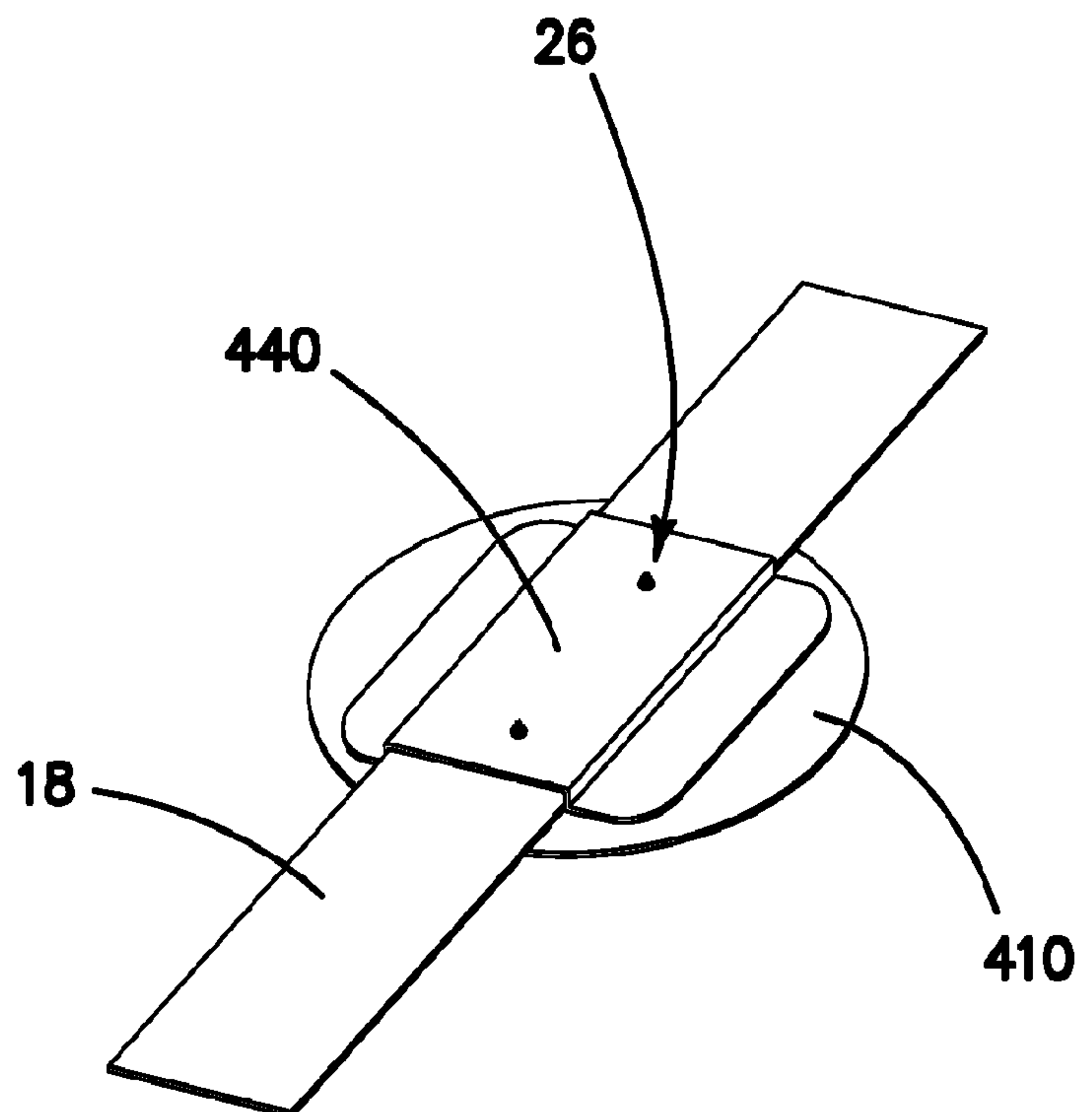


FIG. 13E

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**FIG. 14****FIG. 15****FIG. 16**

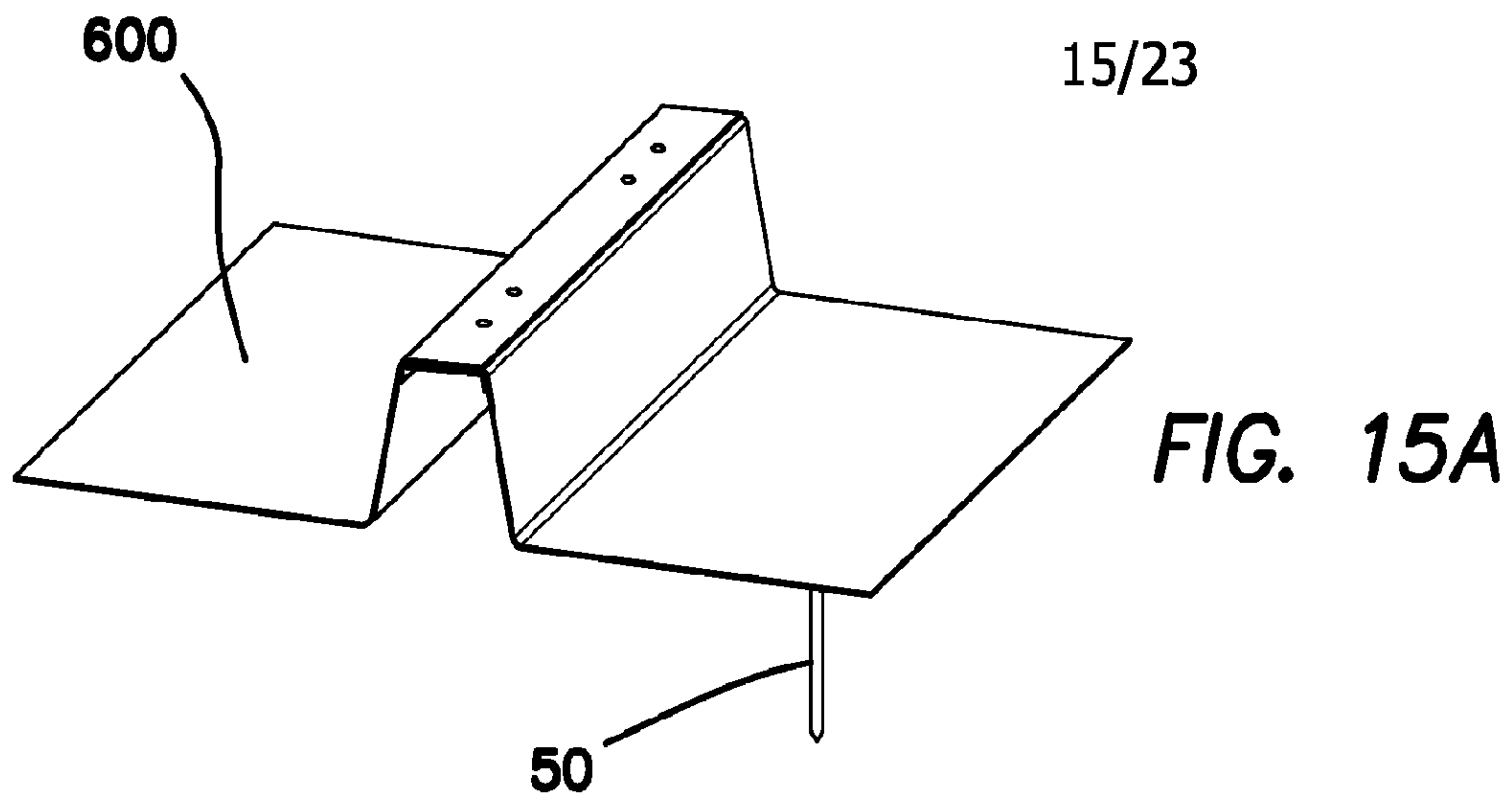


FIG. 15B

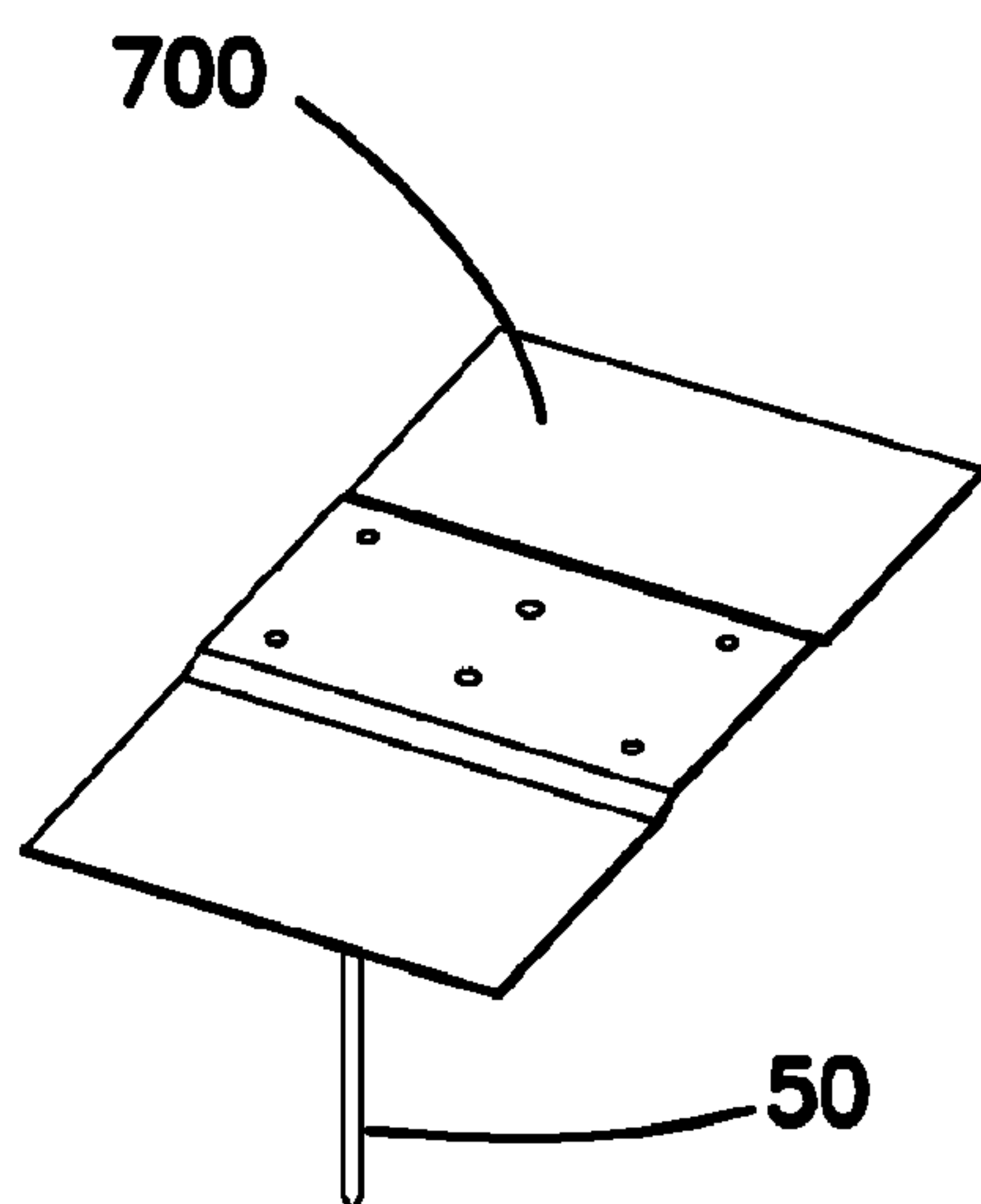
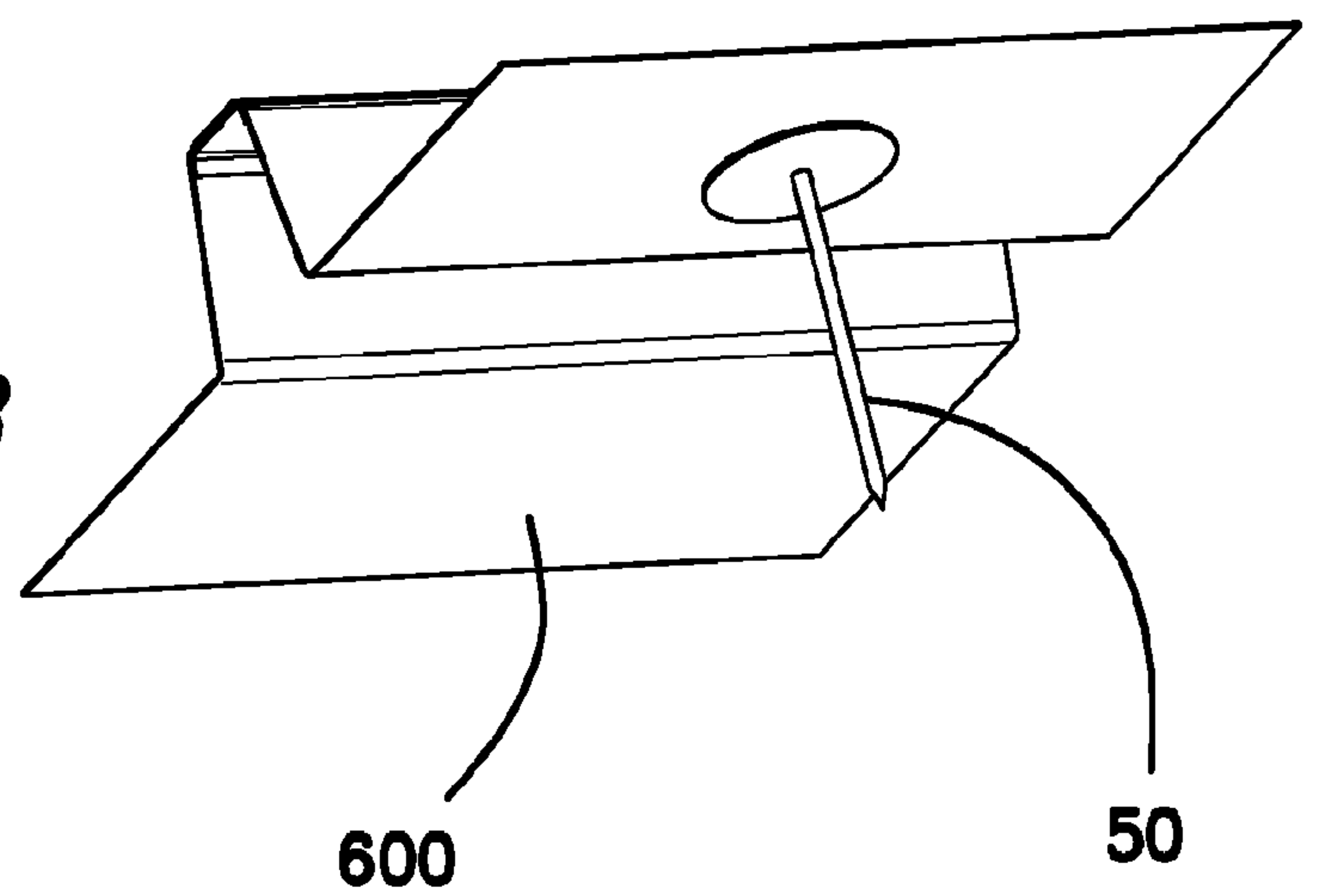


FIG. 15C

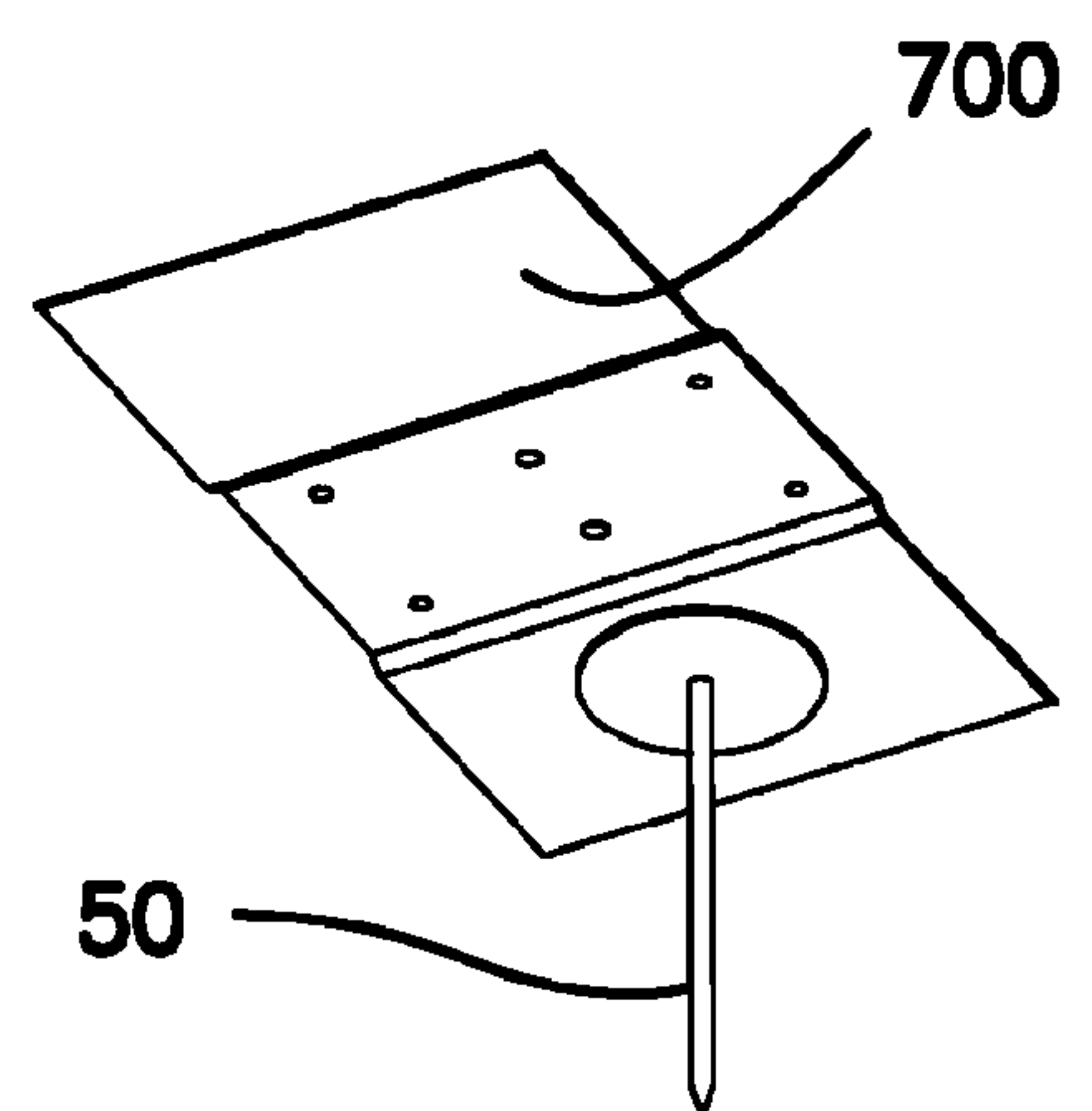
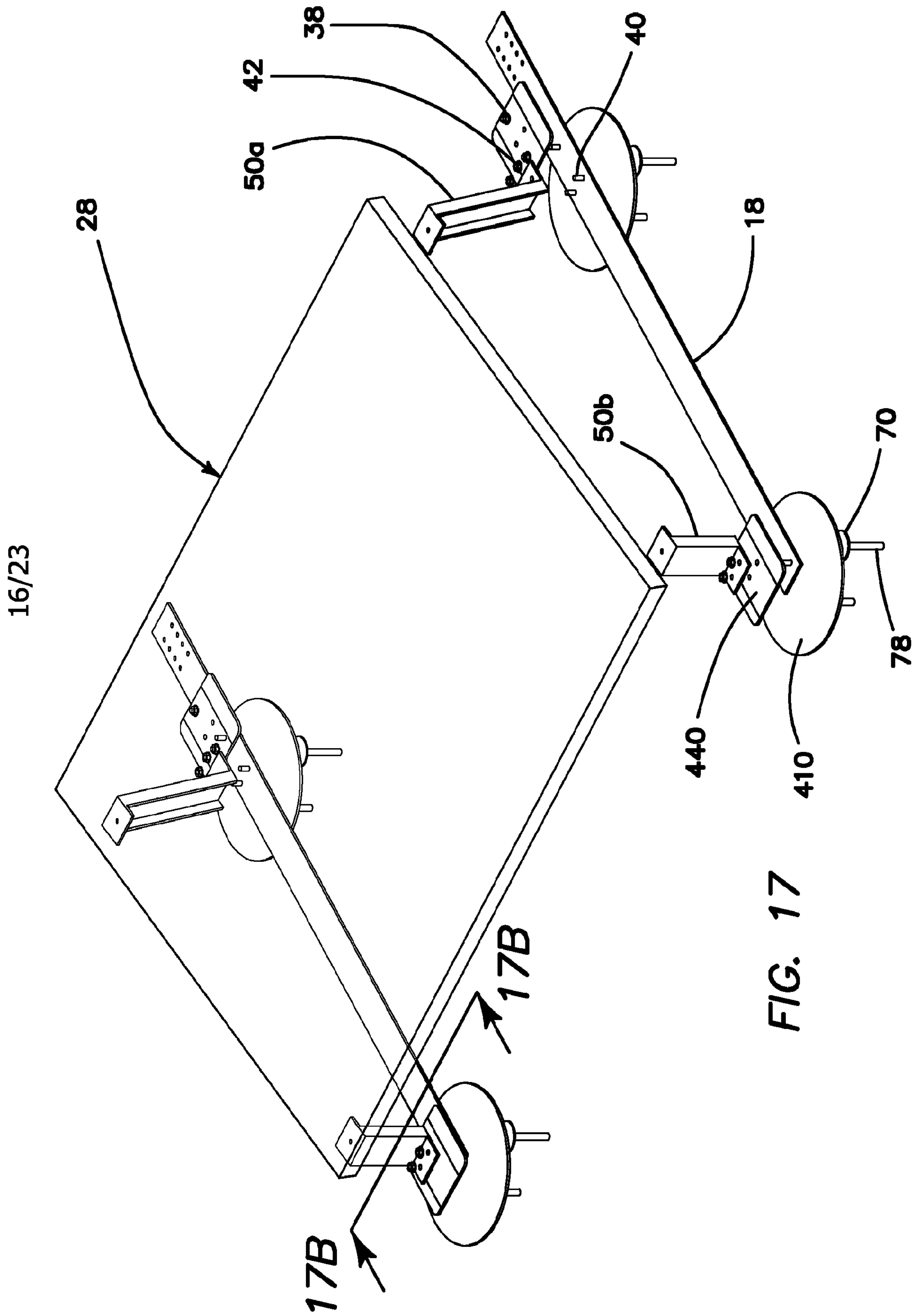
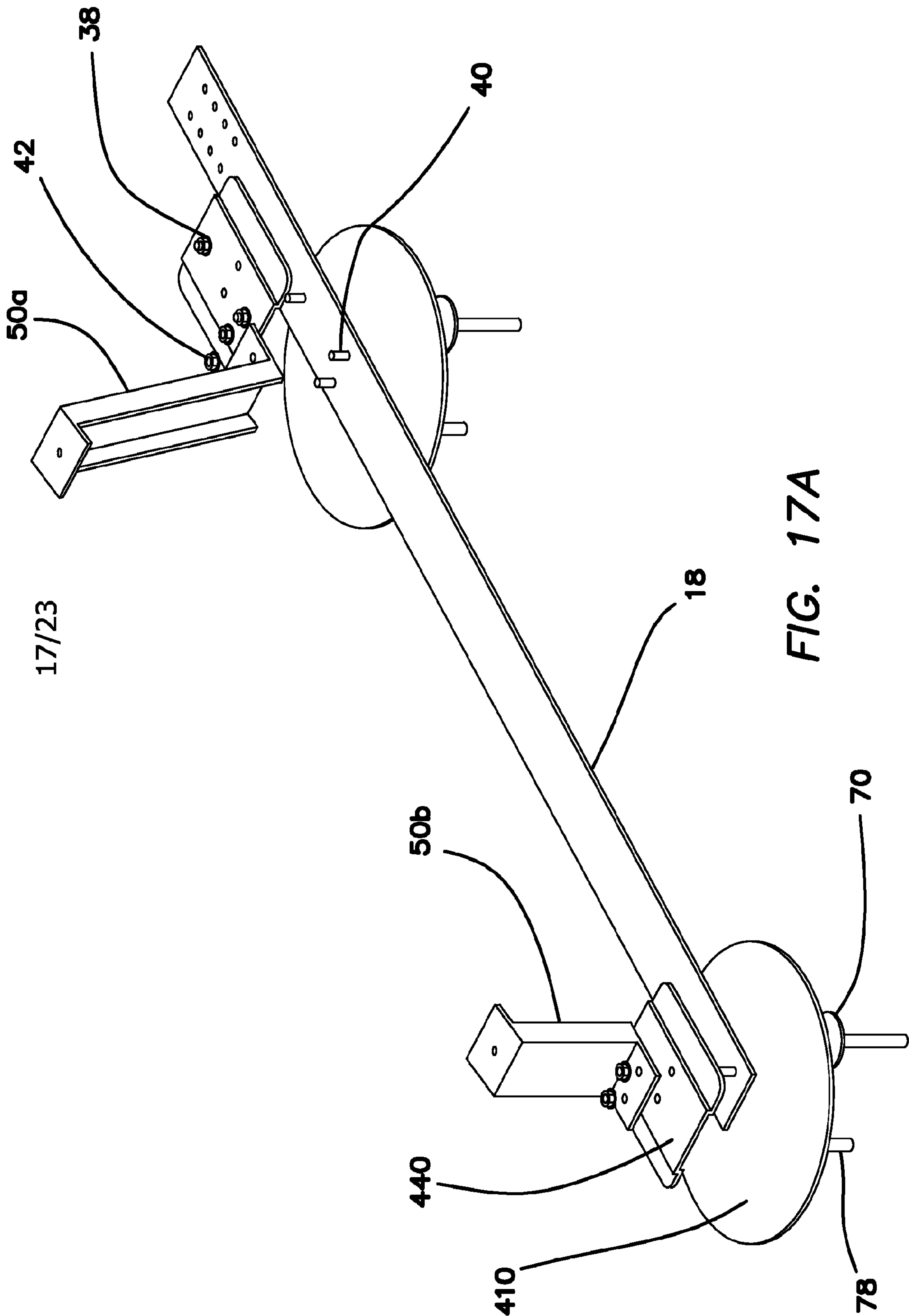


FIG. 15D





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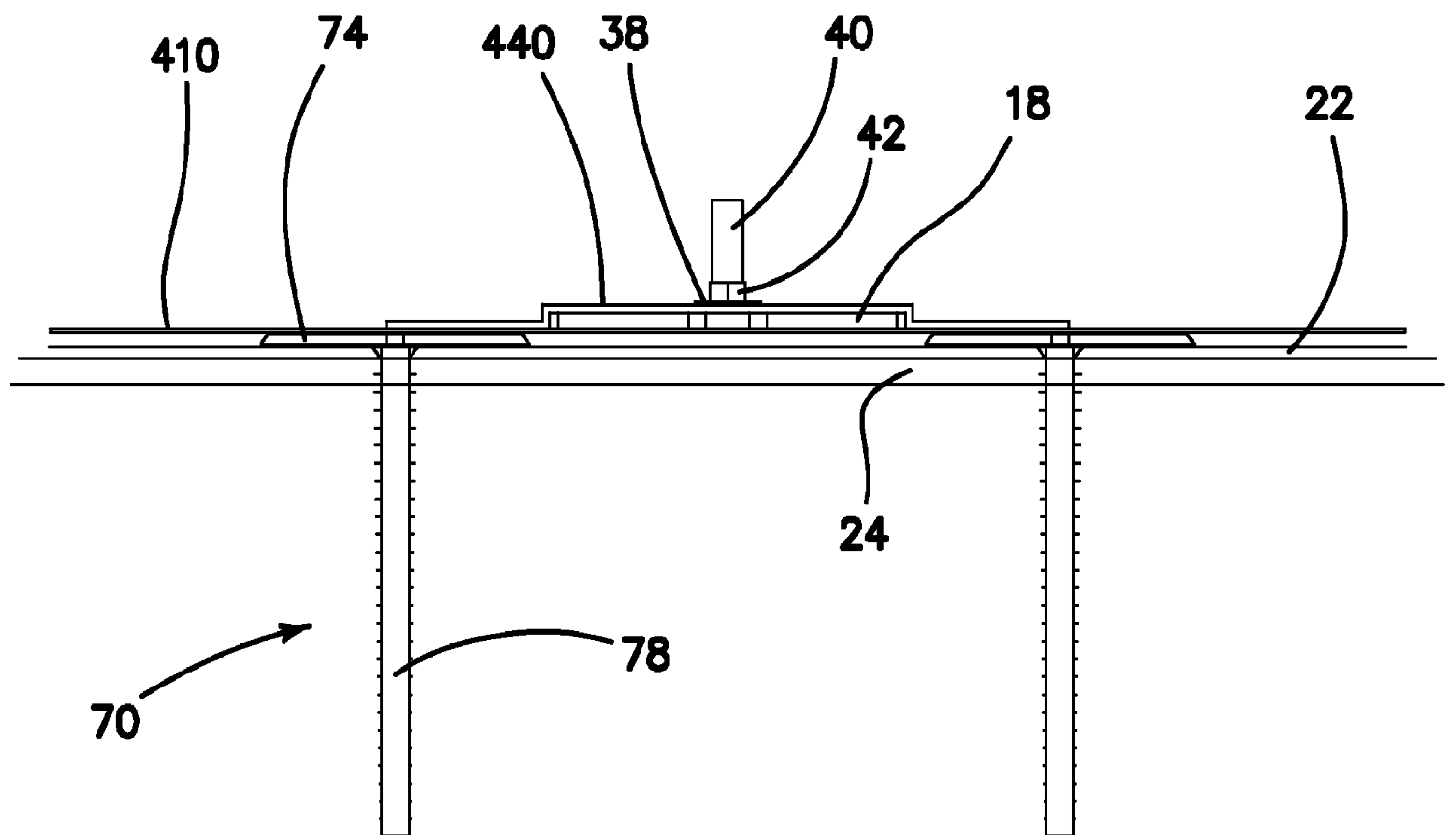


FIG. 17B

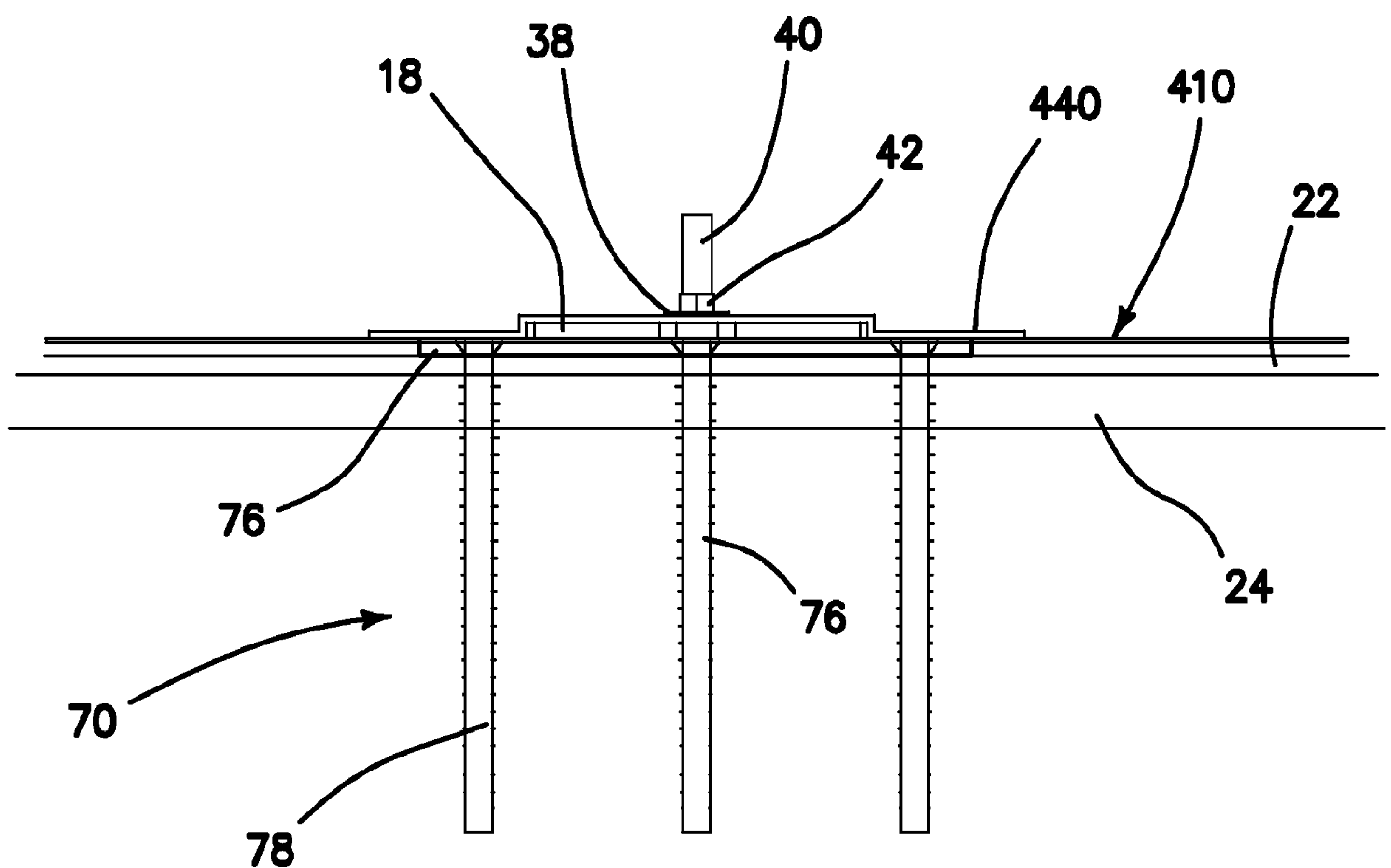


FIG. 18B

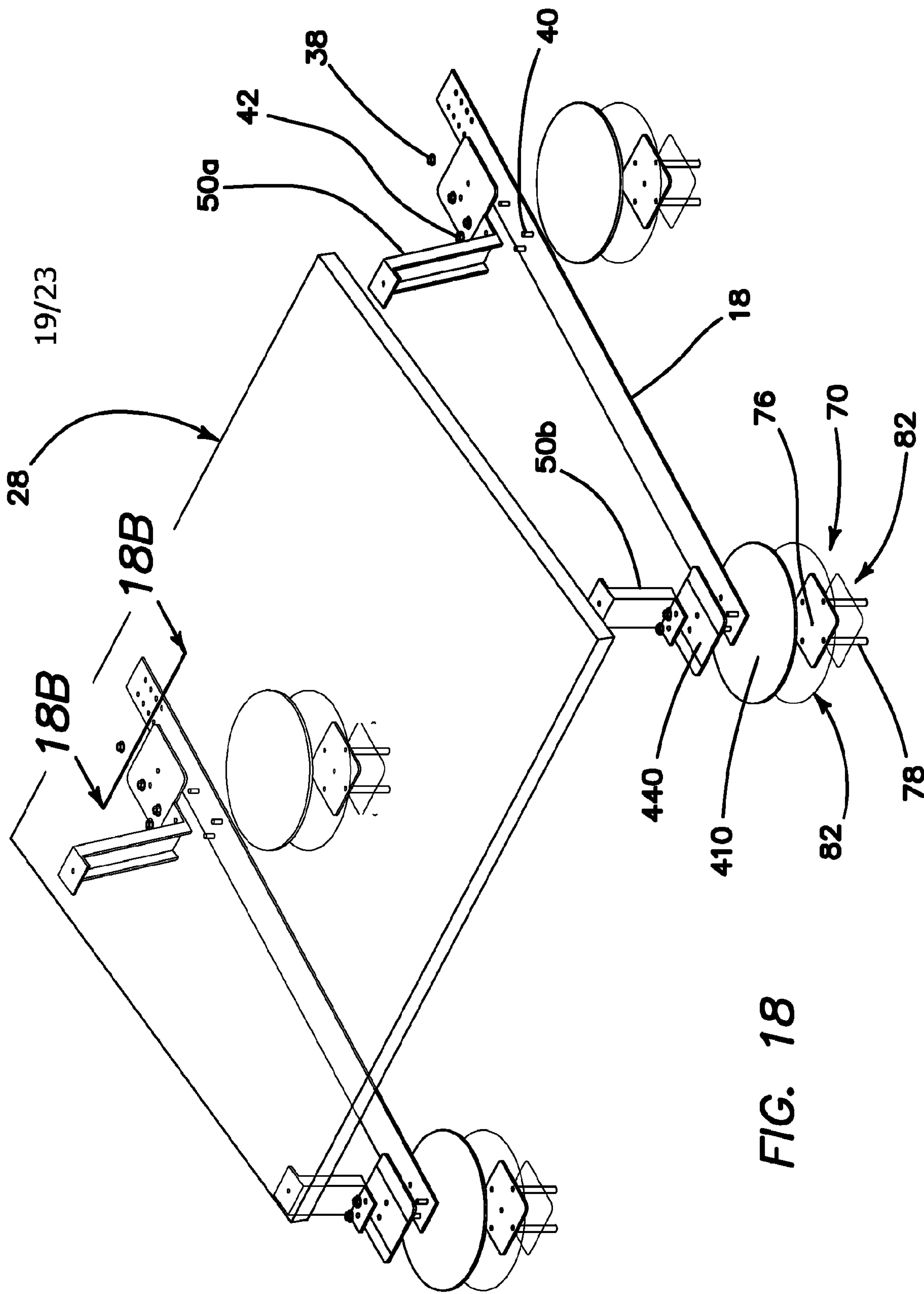
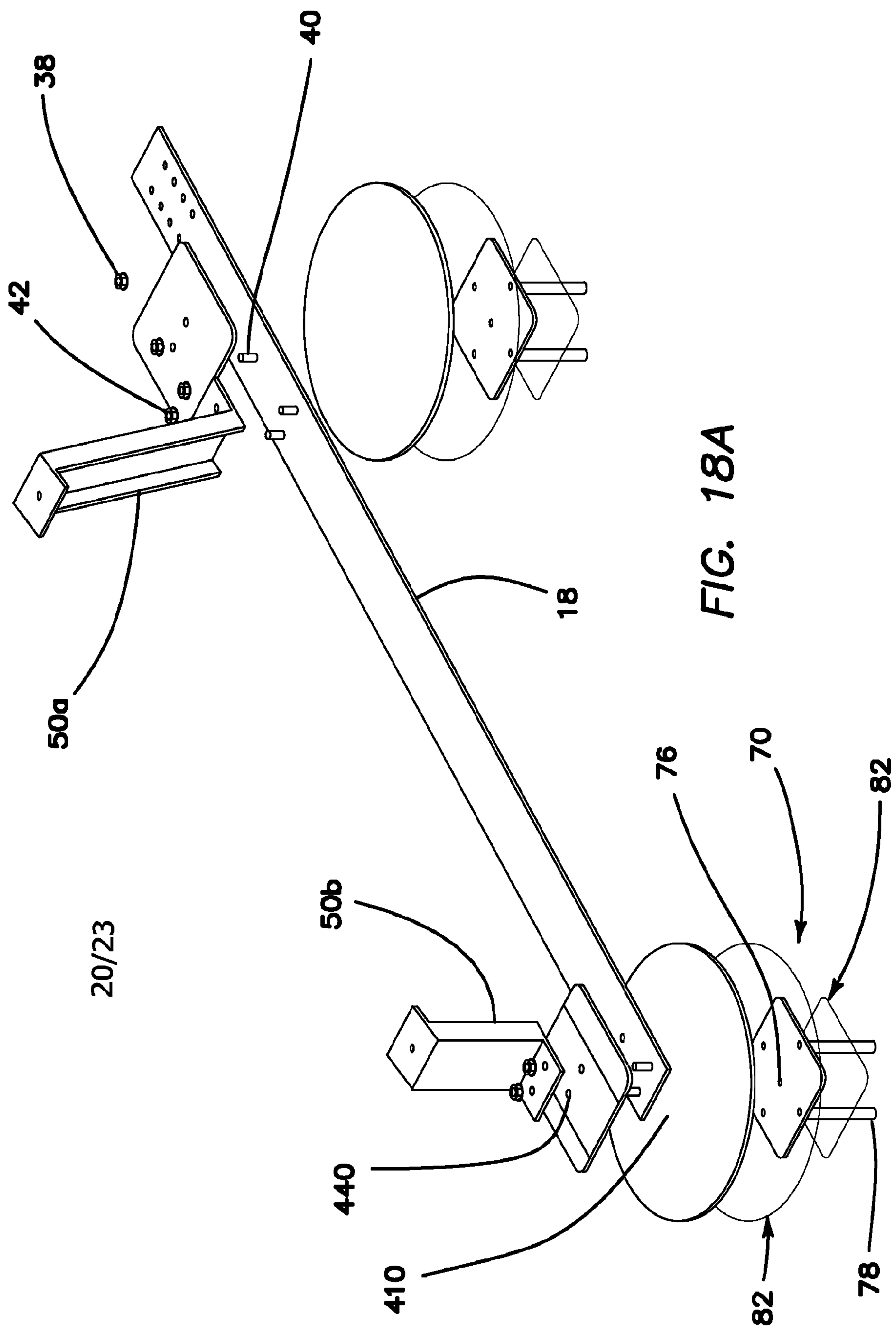
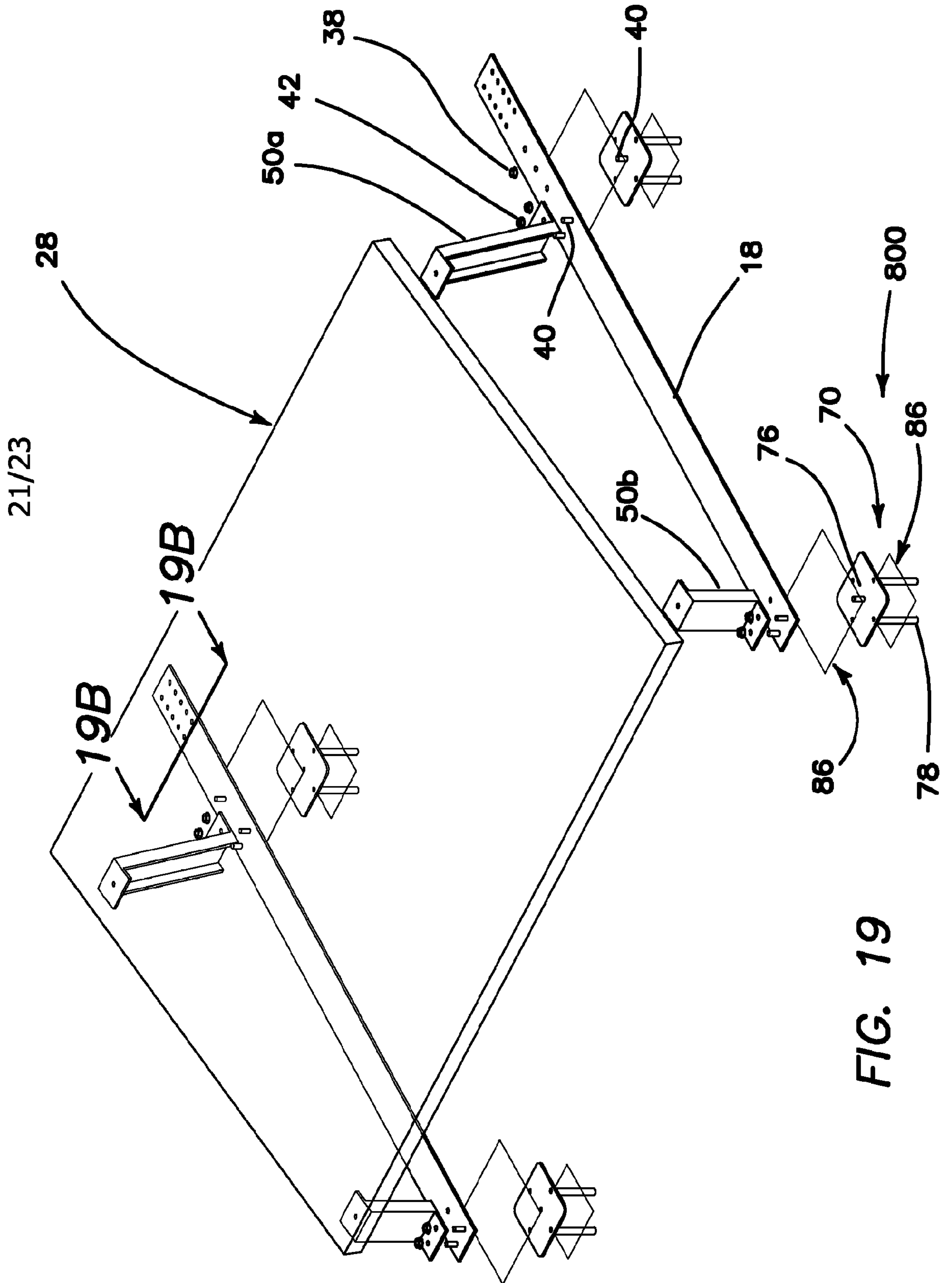
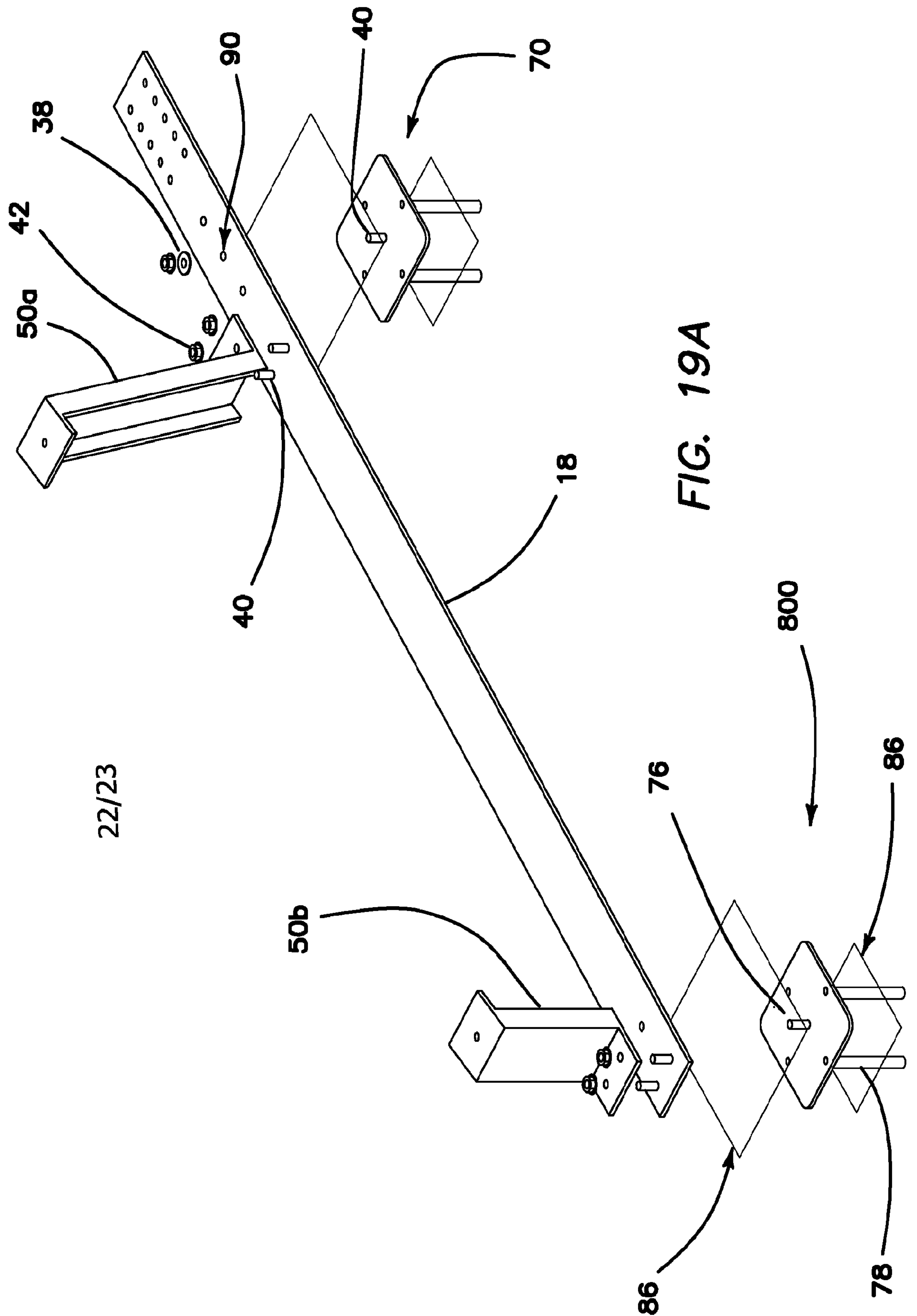


FIG. 18

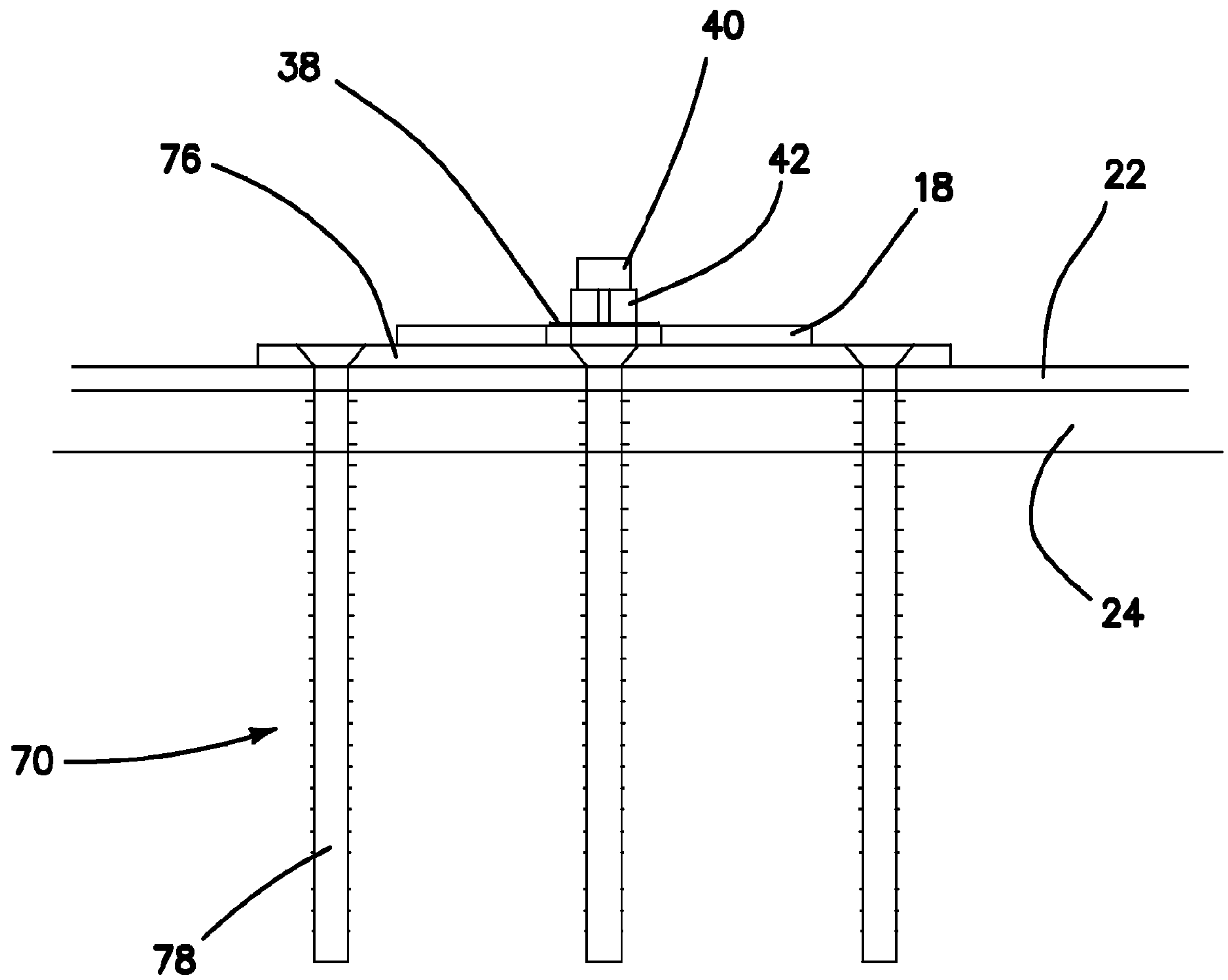






SUBSTITUTE SHEET (RULE 26)

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**FIG. 19B**

