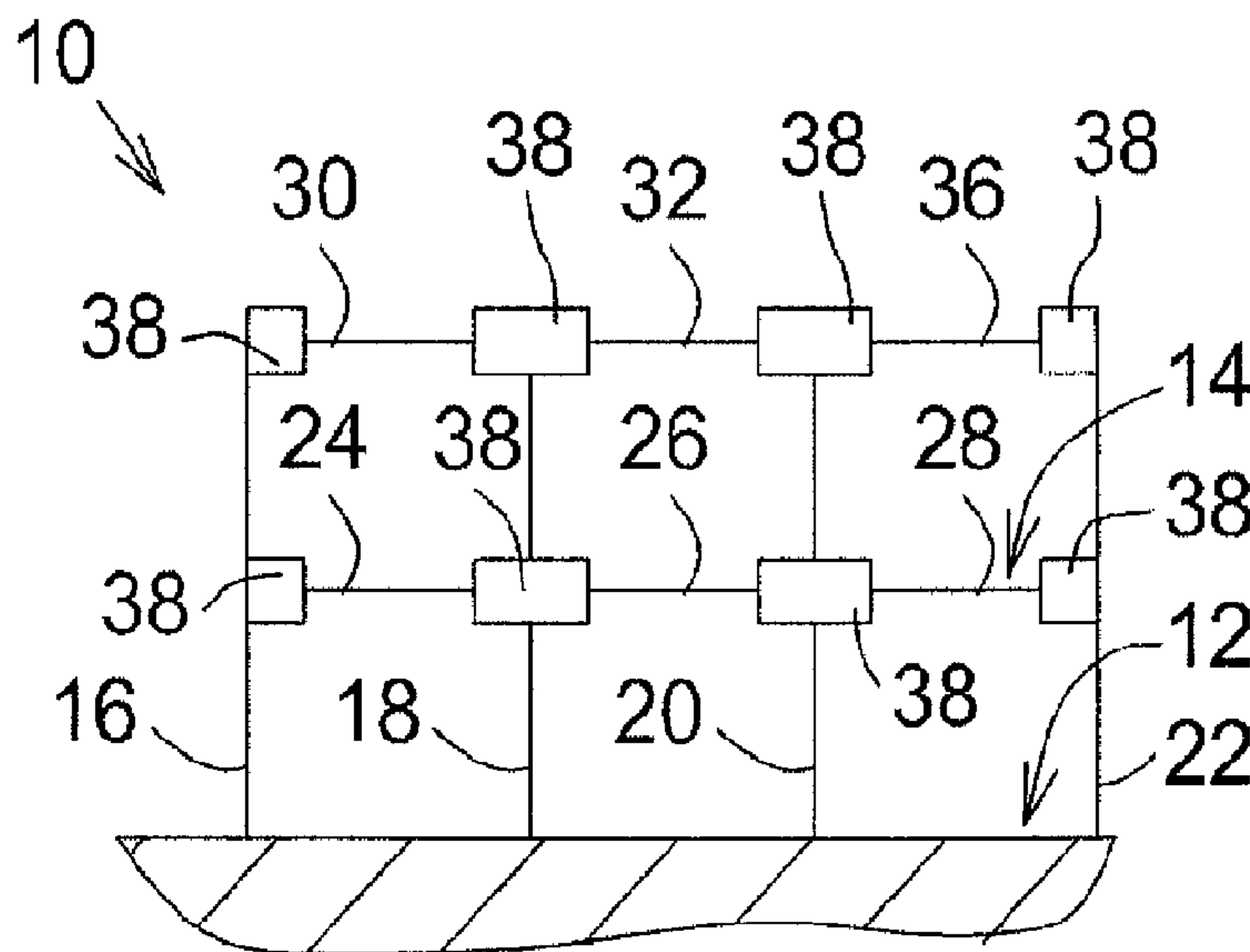




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(54) Titre : STRUCTURE METALLIQUE D'IMMEUBLE, SON PROCEDE DE FABRICATION ET SES COMPOSANTS, NOTAMMENT DES ENSEMBLES DE COLONNES ET DES ENSEMBLES DE POUTRES DE PLEINE LONGUEUR
 (54) Title: BUILDING METAL FRAME, AND METHOD OF MAKING, AND COMPONENTS THEREFOR INCLUDING COLUMN ASSEMBLIES AND FULL-LENGTH BEAM ASSEMBLIES



(57) **Abrégé/Abstract:**

A building framework includes plural column assemblies interconnected by plural full-length beam assemblies, with the union of the column assemblies and beam assemblies forming beam-to-column joint assemblies according to this invention. The column assemblies include pairs of side plates spanning the column members of the column assemblies and projecting toward another column assembly of the plurality of such column assemblies. The full-length beam assemblies include beam members for being received between column assemblies to be interconnected and defining an end gap with respect to each column member. Additionally, the full-length beam assemblies include at each opposite end portion thereof a pair of cover plates, including an upper cover plate and a lower cover plate, which cover plates are sized and configured to be united with the side plates of a column assembly, as by welding applied at a construction site. The full-length beam assemblies may also include provisions for drawing together the side plates of a column assembly preparatory to welding, which side plates are sufficiently spaced apart to provide a "rattle" space allowing entry of an end portion of a full-length beam assembly between the side plates as a step in the erection process for the framework



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(54) Title: BUILDING METAL FRAME, AND METHOD OF MAKING, AND COMPONENTS THEREFOR INCLUDING COLUMN ASSEMBLIES AND FULL-LENGTH BEAM ASSEMBLIES

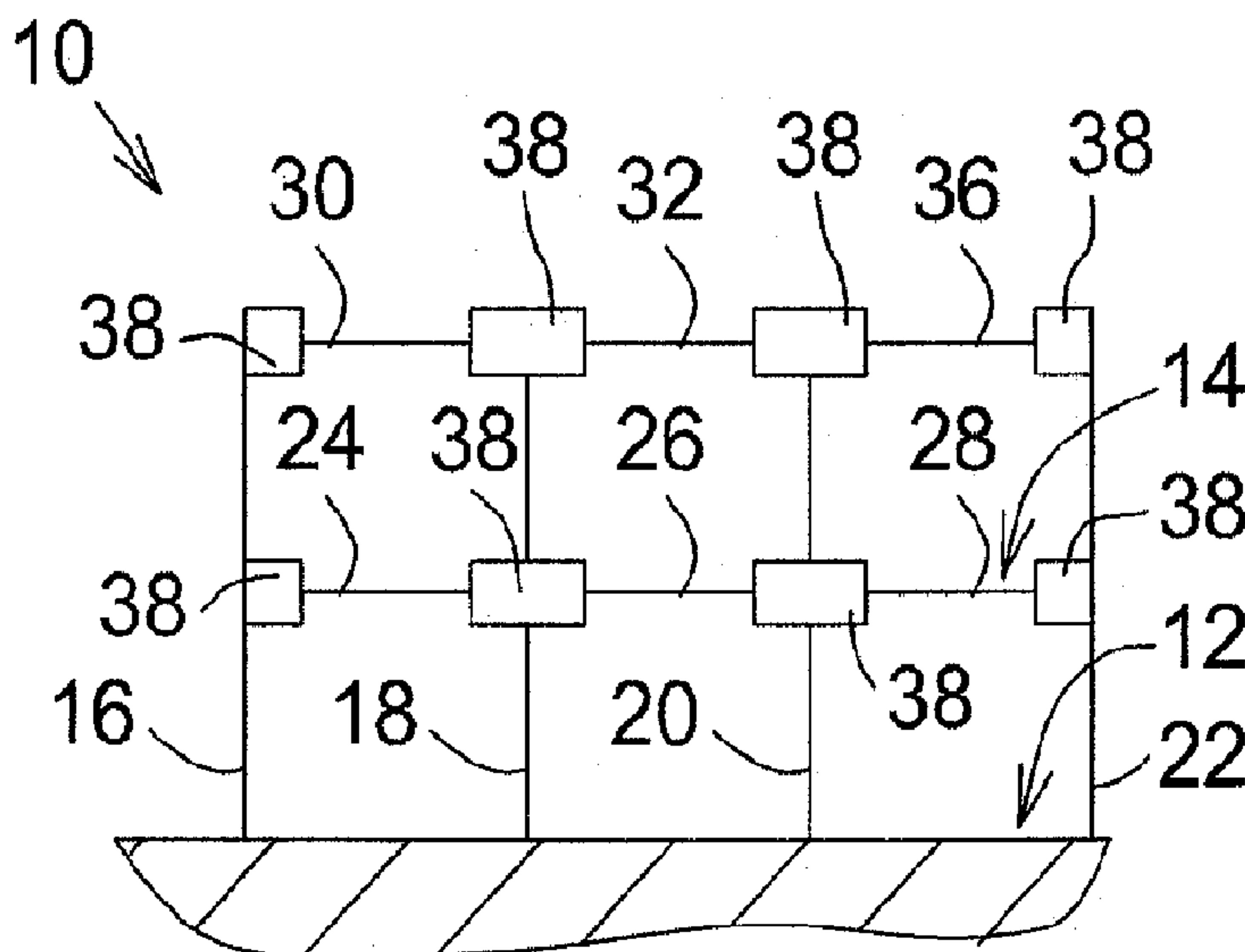


FIG. 1

(57) Abstract: A building framework includes plural column assemblies interconnected by plural full-length beam assemblies, with the union of the column assemblies and beam assemblies forming beam-to-column joint assemblies according to this invention. The column assemblies include pairs of side plates spanning the column members of the column assemblies and projecting toward another column assembly of the plurality of such column assemblies. The full-length beam assemblies include beam members for being received between column assemblies to be interconnected and defining an end gap with respect to each column member. Additionally, the full-length beam assemblies include at each opposite end portion thereof a pair of cover plates, including an upper cover plate and a lower cover plate, which cover plates are sized and configured to be united with the side plates of a column assembly, as by welding applied at a construction site. The full-length beam assemblies may also include provisions for drawing together the side plates of a column assembly preparatory to welding, which side plates are sufficiently spaced apart to provide a "rattle" space allowing entry of an end portion of a full-length beam assembly between the side plates as a step in the erection process for the framework

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BUILDING METAL FRAME, AND METHOD OF MAKING,
AND COMPONENTS THEREFOR INCLUDING COLUMN
ASSEMBLIES AND FULL-LENGTH BEAM ASSEMBLIES

BACKGROUND OF THE INVENTION

[0001] Buildings, towers and similarly heavy structures commonly are built on and around a steel framework. A primary element of the steel framework is the joint connections of the beams to the columns. An improved structural joint connection is disclosed in US patent No. 5,660,017. However, advanced stress analysis techniques and a study of building collapse mechanisms following seismic and blast events (i.e., terrorist bombings) have resulted in the present improvements.

[0002] Further, consideration of the conventional building erection tasks and methodologies employed when erecting a building or constructing components for such a steel frame building (as well as the on-site erection of the buildings themselves), with joint connections including gusset plates (or side plates) spanning a column and receiving an end portion of a beam therebetween, has also resulted in the recognition of several inefficiencies or problem areas. Hereinafter, the gusset plates (or side plates) are referred to with either term (or with both terms) as one term has to do with the function of the plates as reinforcement or strengthening to a beam-to-column joint, and the other term has to do with the location of the plates on the sides of the columns and beams. Moreover, as a result of the deficiencies of the conventional technologies, construction costs and material costs for a steel frame building structure of conventional construction are significantly higher than necessary. That is, the current technology teaches a beam (or beams)-to-column joint structure for joining one or more beams in a supporting relationship to a column, with each joint structure including a pair of gusset plates (or side plates) spaced apart and spanning the column, and sandwiching between them the column and an end portion of a connecting beam or beams. The gusset plates or side plates extend outwardly from the column along the sides of the beam(s). Of course, as taught in U.S. Pat. No. 5,660,017, the gusset plates may extend in both directions from a column so that they extend across the column, and connect two beams together, in a supporting relationship to the interposed column.

[0003] Conventionally, in preparation for erection of such a steel frame building, column structures are shop fabricated, adding the gusset plates or side plates to column sections for one or more floors of the building to be erected at a building site. Between the gusset plates or side plates, an end portion (or stub) of connecting beam is secured into each joint assembly, as

by welding. Additional components of the joint assembly are generally added to the columns at this time also, such as welded in vertical shear plates and welded in horizontal continuity plates or shear plates, which improve the strength and stiffness of the joint assemblies. These additional components also facilitate load transfer between the principal components of the joint assembly.

[0004] Such column structures or assemblies are then shipped to a construction site where the column assemblies for one or more of the lower floors of the building are properly aligned to one another, and are set in the building foundation. With the column assemblies so set and aligned, the conventional practice is then to connect each two aligning stub beams of adjacent column assemblies with a so-called link beam. This link beam is simply an elongate steel beam section generally matching the two stub beams to be connected, and of the proper length to fit between these stub beams with a proper welding root gap. The link beam is then welded in the field (i.e., at the construction site) at each of its ends to one of the aligned stub beams of the connected joint assemblies. Understandably, fitting such link beams into place, and making the field welds at each end of such link beams, which are necessary to structurally join the beam stubs and link beam, is a labor intensive and expensive process. The field welding necessary for this joining of beam stubs to link beams will require multiple passes, and it is to be understood that the beam stubs and link beam may be 30 inches to 42 inches, or more in the vertical dimension and 10 inches to 14 inches or more in the horizontal dimension, so each field weld (required to connect the web of a beam stub to the web of a link beam, and to connect the flanges of a beam stub to the flanges of a link beam) is a big and labor intensive job to be done in the field. Further, these welding jobs must be performed at heights above the ground that make working and welding a somewhat risky operation. Depending on the design height of the building, construction of successive floors or groups of floors proceeds upwardly atop of the framework for the lower floors. Consequently, as the building grows upwardly, the heights at which such link-beam-to-beam-stub welds must be done grows progressively also.

[0005] Moreover, during the last several years, there has been considerable additional concern as to how to improve the beam-to-column, and beam-to-beam joint connections of a steel frame building so they will better withstand explosions, blasts and the like as well as other related extraordinary load phenomena. Of particular concern is the prevention of progressive collapse of a building if there are one or more column failures due to terrorist bomb blast, vehicular and/or debris impact, structural fire, or any other impact and/or heat-induced damaging condition.

[0006] Column failures due to explosions, severe impact and/or sustained fire, have led to progressive collapse of entire buildings. An example of such progressive collapse occurred in the bombing of the A. P. Murrah Federal Building in Oklahoma City in 1995 and in the aerial attack on the World Trade Center towers in 2001.

[0007] Following the 1994, Northridge, California earthquake, in addition to the invention set forth in U.S. Pat. No. 5,660,017, a number of other alternatives to resist joint connection failure, were suggested or adopted for use in steel construction design for improved seismic performance. For example, the reduced beam section (RBS), or "dog bone" joint connection has been proposed, in which the beam flanges are narrowed near the joint connection. This alternative design reduces the plastic moment capacity of the beam allowing inelastic hinge formation in the beam to occur at the reduced section of the beam. This inelastic hinge connection is thought to relieve some of the stress in the joint connection between the beam and the column. An example is seen in U.S. Pat. No. 5,595,040, for Beam-to-Column Connection, which illustrates such "dog bone" connections. But, because the plastic moment capacity of the beam is reduced due to the narrowing of the beam flanges, the moment load which can be sustained by the beam is also substantially reduced.

[0008] [009] Another alternative is illustrated by U.S. Pat. No. 6,237,303, in which slots and holes are provided in the web of one or both of the column and the beam, in the vicinity of the joint connection, in order to provide improved stress and strain distribution in the vicinity of the joint connection. Other post-Northridge joint connections are also identified in FEMA 350-Recommended Seismic Design Criteria for New Steel Moment Frame Building, published by the Federal Emergency Management Agency in 2000. All such post-Northridge joint connections have reportedly demonstrated their ability to achieve the required inelastic rotational capacity to survive a severe earthquake.

[0009] [010] However, one important consideration to be noted in contrast to the present invention is that none of these alternative joint connections provide independent beam-to-beam structural continuity across a column; such continuity being capable of independently carrying gravity loads under a "double-span" condition resulting from a column being suddenly or violently removed by, for example, explosion, blast, impact or other means, regardless of the damaged condition of the column. Additionally none of these alternatives, except the gusset plates used as taught in U.S. Pat. No. 5,660,017, provide any significant torsion capacity or significant resistance to lateral bending to resist direct explosive air blast impingement and severe impact loads. Torsion demands for the joint are created because while the top flanges of

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the beams are typically rigidly attached to the floor system of a building against relative lateral movement, the bottom flange of the beam is free to twist when subjected to, for example, direct lateral blast impingement loads caused by a terrorist attack. A structure according to this invention will sustain such "double-span" conditions as well as demands from severe torsion loads; while also providing advantages in savings of material, weight, and labor. Indeed, there are no additional and discrete load paths across the column in the event of column failure or joint connection failure or both.

SUMMARY OF INVENTION

[0010] In view of the deficiencies of the prior joint connection technologies, and the elimination of these deficiencies in the improved current joint connection technology taught in U.S. Pat. No. 5,660,017, an object for an embodiment of this invention is to provide a structure and method for eliminating the need for stub beams and later addition of link beams in order to interconnect adjacent joint connections.

[0011] An embodiment of the present invention provides a metal frame building with multiple column assemblies each having gusset plates or side plates, with the joint connections including and being interconnected by beam assemblies which are substantially full-length between interconnected column assemblies. That is, no field-welded splices in these full length beam assemblies are required in order to interconnect adjacent joint connections with horizontal beam material. Instead, the joint connections are interconnected by a substantially full-length beam assembly which is welded into each joint connection, forming a unitary structure.

[0012] In view of the above, an embodiment of the present invention provides an improved building framework comprising: at least a pair of vertical column assemblies; each column assembly of the pair of column assemblies having a vertically elongate column member defining a horizontal dimension and a pair of horizontally spaced vertically and horizontally extending side plate members spanning the horizontal dimension of the column member and projecting generally horizontally toward the other column assembly of the pair; a full-length beam assembly disposed between the pairs of projecting side plates of the pair of column assemblies and including a beam member defining an end gap with each column member, and the full-length beam assembly including a pair of opposite cover plates each extending along an end portion of the beam member at each opposite end of the full-length beam assembly; and each of the pair of cover plates being received between a respective pair of projecting side plates of a respective column assembly.

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[0013] Further, an embodiment of the present invention provides a steel frame building structure utilizing a plurality of such beam-to-column joint structures in a unified or holistic structure mutually supporting one another in the event of structural damage or obliteration of a part of the building structure, so that progressive building collapse is mitigated.

[0014] An embodiment of this invention provides component parts for making a building structure including a beam-to-column, and beam-to-beam structural joint connection, the component parts comprising: a full-length beam assembly for construction of a building framework, the building framework including a pair of spaced apart column assemblies each including a column member and a pair of laterally spaced apart side plates spanning the column member and projecting toward the other column assembly of the pair of column assemblies, the full-length beam assembly comprising: a beam member for extending between the column members of the pair of spaced apart column assemblies and for defining an end gap with each column member; the full-length beam assembly including an end portion at each opposite end thereof, and each end portion of the full-length beam assembly including a pair of opposite cover plates each extending along the end portion of the beam member, each pair of opposite cover plates including an upper cover plate and a lower cover plate, and at least one of the upper cover plates and the lower cover plates being configured and sized for receipt between a respective pair of projecting side plates of a respective column assembly of the pair of column assemblies. And further including a column assembly module for a building framework, the column assembly comprising: a vertically elongate column member defining a horizontal dimension; and a pair of horizontally spaced vertically and horizontally extending side plate members spanning the horizontal dimension of the column member and projecting together and generally in parallel horizontally therefrom; whereby a full-length beam assembly may be disposed between pairs of projecting side plates of a spaced apart pair of such column assembly modules to be welded thereto providing a beam-to-column joint assembly.

[0015] Among the advantages of some embodiments of this present invention are a recognition that when a seismic catastrophe occurs, or upon blast or explosion or other disastrous events, support from one or more of the columns of a building steel frame structure may be partially or totally lost. This may be due to loss of the column and/or partial or total failure of the beams-to-column joint connections. In either event, the prior conventional beam-to-column joint connections are then insufficient and unreliable. This is because extreme axial tension and moment demands result from the creation of, and gravity loading of, a "double-span" condition of the two joined beams located on either side of a failed or explosively removed or damaged column, which exerts

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tremendous tensile pull and vertical moment demand on the beam-to-beam joint connection across the failed or removed column, and adjacent beams-to-column joint connections located a beam span distance away. The joint connections of the present invention are best able to resist this condition.

5 **[0016]** Further, in an embodiment of the present invention the beams-to-column joint connections advantageously includes two improved or optimized gusset plates disposed on opposite sides of the beam and column and providing major elements of the improved joint connection, and connected to both of the beams and thus connect them together. The beam-to-beam connection provided by the improved or optimized gusset plates is sufficiently strong
10 to greatly mitigate the damage from blasts, explosions, earthquakes, tornadoes and other violent disasters. The beams may be co-linear, somewhat angled with respect to each other, or even curved, as in the practice in constructing a curved facade for buildings.

[0017] In an embodiment of the present invention, as stated above, the gusset plates cover and protect the beams-to-column joint connections which attach one, or two, or
15 more beams to a column. In broad view, the joint connections typically utilize an improved version of the gusset plates connection taught in U.S. Pat. No. 5,660,017, in which the gusset plates are not only welded to the beams (or cover plates on the beams, as the case may be), but, the gusset plates are also, welded directly, in a vertical direction, to the flange tips of the column by fillet welds, thus, creating through the gusset plates substantial moment-resisting
20 connections. However, an embodiment of the present invention offers improvements in labor savings, in material costs, and in erection time requirements in comparison to the prior art.

[0017a] A further embodiment relates to a building framework comprising: at least a pair of vertical column assemblies; each column assembly of said pair of column assemblies having a vertically elongate column member defining a horizontal dimension and a pair of
25 horizontally spaced vertically and horizontally extending side plate members plates spanning the horizontal dimension of said column member and projecting generally horizontally toward the other column assembly of said pair; a full-length beam assembly including a beam member defining an end gap with each column member, and said full-length beam assembly

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including a pair of opposite cover plates at each opposite end of said full-length beam assembly; one cover plate of said pair of opposite cover plates being configured and sized for receipt between a respective pair of projecting side plates while another cover plate of said pair of opposite cover plates is sized and configured to be wider than a spacing of the
5 respective pair of projecting side plates, and each end portion of the beam member being received between a respective pair of projecting side plates of a respective column assembly.

[0017b] A further embodiment relates to a method of making a building framework, said method comprising steps of: providing a pair of vertical column assemblies; and configuring each of said pair of vertical column assemblies to include a vertically
10 elongate column member defining a horizontal dimension, providing each of said vertical column assemblies additionally with a respective pair of horizontally spaced vertically and horizontally extending side plates spanning the horizontal dimension of the respective one of said column members and projecting generally horizontally toward the other column assembly of said pair; providing a full-length beam assembly for being disposed between said pairs of
15 projecting side plates of said pair of column assemblies, providing for said full-length beam assembly to be fillet welded to said projecting side plates, said full-length beam assembly including a beam member for defining an end gap with each column member of said pair of column assemblies; including in said full-length beam assembly a pair of opposite cover plates each extending along an end portion of said beam member at each opposite end of said
20 full-length beam assembly; and disposing one of said end portions of said beam member between a respective pair of projecting side plates of a respective one of said pair of column assemblies; whereby said cover plates at one of said opposite ends of the full-length beam assembly can be attached to said respective pair of side plates to form a beam-to-column joint assembly; and further including the step of configuring one of said pair of cover plates at one
25 of the of the opposite ends of said full-length beam assembly to be received between said pair of projecting side plates and the other of the pair of opposite cover plates at one of the opposite ends of said full-length beam assembly to be wider in horizontal lateral dimension transverse to a length dimension of said full-length beam assembly than a spacing between said pair of projecting side plates.

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[0017c] A further embodiment relates to a full-length beam assembly for construction of a building framework, said building framework including a pair of spaced apart column assemblies each including a column member and a pair of laterally spaced apart side plates spanning said column member and projecting toward the other column assembly of said pair of column assemblies, said full-length beam assembly comprising: a beam member for extending between said column members of said pair of spaced apart column assemblies and for defining an end gap with each column member; said full-length beam assembly including an end portion at each opposite end thereof, and each end portion of said full-length beam assembly including a pair of opposite cover plates each extending along said end portion of said beam member, each pair of opposite cover plates including an upper cover plate and a lower cover plate, and one of said upper cover plates and said lower cover plates being configured and sized for receipt between a respective pair of projecting side plates of a respective column assembly of said pair of column assemblies, while another of said upper and lower cover plates is sized and configured to be wider than the spacing of a respective pair of projecting side plates, and said another cover plate confronting and being engageable with said projecting pair of side plates.

[0017d] A further embodiment relates to a full-length beam assembly for construction of a building framework, said building framework including a pair of spaced apart column assemblies each including a column member and a pair of laterally spaced apart side plates spanning said column member and projecting toward the other column assembly of said pair of column assemblies, said full-length beam assembly comprising: a beam member for extending between said column members of said pair of spaced apart column assemblies and for defining an end gap with each column member; said full-length beam assembly including an end portion at each opposite end thereof, and each end portion of said full-length beam assembly including a pair of opposite cover plates each extending along said end portion of said beam member, each pair of opposite cover plates including an upper cover plate and a lower cover plate, and one of said upper cover plates and said lower cover plates being configured and sized for receipt between a respective pair of projecting side plates of a respective column assembly of said pair of column assemblies, while another of said upper

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and lower cover plates is sized and configured to be wider than the spacing of a respective pair of projecting side plates, and said another cover plate confronting and being engageable with said projecting pair of side plates.

[0017e] A further embodiment relates to a method of making a building framework
5 utilizing pairs of spaced apart vertical column assemblies interconnected by full-length beam
assemblies, the column assemblies and full-length beam assemblies being united to one
another to form beam-to-column joint assemblies, said method comprising steps of: providing
a pair of vertical column assemblies; and configuring each of said pair of vertical column
10 assemblies to include a vertically elongate column member defining a horizontal dimension,
providing each of said vertical column assemblies additionally with a respective pair of
horizontally spaced vertically and horizontally extending side plate members spanning the
horizontal dimension of the respective one of said column members and projecting generally
horizontally toward the other column assembly of said pair; disposing between said pairs of
projecting side plates of said pair of column assemblies respective end portions of a full-
15 length beam assembly, providing for said full-length beam assembly to include a beam
member defining an end gap with each column member of said pair of column assemblies;
and including in said full-length beam assembly at each respective end portion thereof a pair
of opposite cover plates each extending along the end portion of said beam member; and
including in said pair of opposite cover plates at each end portion of said full-length beam
20 assembly an upper cover plate and a lower cover plate, one of the upper and lower cover
plates being received between the projecting side plates and the other of the upper and lower
cover plates having a width greater than a transverse dimension between the side plates and
greater than a width of said one of the upper and lower cover plates; and providing for said
upper cover plate and said lower cover plate at each end portion of said full-length beam
25 assembly to be welded to said projecting side plates to form a beam-to-column joint assembly
at each of said spaced apart column assemblies.

[0018] It is therefore an object of an embodiment of this invention to provide an improved joint connection in a metal frame building in which adjacent joint connections are

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integrally connected by a substantially full-length beam assembly extending between and integrally welded into and forming a part of each of the interconnected joint connections.

[0019] It is another object of an embodiment of this invention to provide an improved joint connection structure which includes a column assembly with side plates or gusset plates so arranged and positioned that stub beams are not needed, and that once adjacent pairs of such columns are set in a foundation, then full-length beam assemblies may be fitted into the portions of the joint connections carried by the column assemblies and welded in place.

[0020] Still another object of an embodiment of this invention is to provide a beam-to-beam connection across a column which mitigates the likelihood of progressive collapse of the entire building or similarly heavy structure, upon loss of support from the column; or loss of effective beams-to-

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column joint connections constructed using conventional prior joint connection technology. [022]It is another object of an embodiment of this invention to provide a beam-to-beam connection at a joint connection of beams to a column, which beam-to-beam connection and the beams can carry the gravity and other loads on the beams upon the loss of column support; or loss of beam-to-columns joint connection constructed using conventional prior joint connection technology.

[0021] It is another object of an embodiment of this invention to provide a full-length beam assembly for assembly into a joint connection as generally described above, which full-length beam assembly provides for its fitment between an adjacent pair of column assemblies and for welding into a unitary structure.

[0022] Further objects, features, capabilities and applications of the inventions herein will be apparent to those skilled in the art, from the following drawings and description or particularly preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0023] Figures 1, 2, and 3 are each diagrammatic elevation views of respective: two, three, and four story building frameworks; and each illustrates plural column assemblies and plural interconnecting full-length beam assemblies defining the indicated numbers of levels or floors of a building. These drawing Figures also diagrammatically illustrate beam (or beams)-to-column joint connections according to this invention which are further described herein below;

[0024] Figures 2A and 3A are more developed or detailed schematic elevation views of the building frameworks seen in Figures 2 and 3, respectively, and include an illustration of an erection methodology made possible by the present invention;

[0025] Figure 4 provides a fragmentary view, partially in cross section, of a column assembly, including a column sandwiched by and welded to a pair of gusset plates (or side plates), with an intentionally introduced root gap being provided preparatory to the welds;

[0026] Figures 5 is a fragmentary side elevation view of the column and side plates (or gusset plates) of the column assembly seen in Figure 4 after completion of the welds;

[0027] Figure 6 illustrates a fragmentary view, partially in cross section, of a column welded to one of a pair of gusset plates (or side plates), and preparatory to placement and welding of the other of the pair of gusset plates (or side plates);

[0028] Figure 7 illustrates the column and gusset plates (or side plates) seen in Figure 6, but with the welding operations for each gusset plate (or side plate) completed, and illustrating resultant changes in alignment of the gusset plates (or side plates);

[0029] Figure 8 provides an illustration of another embodiment of column assembly according to this invention, along with fragmentary illustration of end portions of two full-length beam assemblies which will be united with the column assembly by welding;

[0030] Figure 8A provides an illustration of a column assembly similar to that seen in Figure 8, except that this column assembly is single-sided, and is intended for construction of a corner or outside wall of a building structure;

[0031] Figure 9 provides a side elevation view of an embodiment of a full-length beam assembly according to this invention, with part of the length of the beam broken out for clarity of illustration;

[0032] Figure 10 illustrates a plan view of the full-length beam assembly seen in Figure 9, and similarly has part of the length of the beam broken out for clarity of illustration;

[0033] Figure 11 provides a fragmentary elevation view of an embodiment of column assembly with particularly configured side plates or gusset plates according to this invention;

[0034] Figure 12 illustrates a fragmentary view of an embodiment of a column assembly similar to that of Figure 4, with an intentional root gap introduced into the welded column assembly without the use of gap spacers;

[0035] Figure 13 illustrates a fragmentary view of another embodiment of a column according to the present invention, and with a bending outwardly or flaring outwardly of the side plates or gusset plates introduced prior to and somewhat remaining after welding of the side plates to the column;

[0036] Figures 14 and 14A provide respective side elevation and longitudinal edge views of a particular gusset plate or side plate construction, which is a plate weldment construction;

[0037] Figures 15 and 15A provide respective side elevation and longitudinal edge views of an alternative construction of gusset plate or side plate, which is also a plate weldment construction according to this invention;

[0038] Figures 16 and 16A provide respective side elevation and longitudinal edge views of still another alternative construction of gusset plate or side plate, which is also a plate weldment construction according to this invention;

[0039] Figures 17 and 17A provide respective side elevation and longitudinal edge views of yet another alternative gusset plate or side plate construction, which is also a plate weldment construction according to this invention;

[0040] Figures 18 and 18A provide respective side elevation and fragmentary plan views of an alternative construction of column assembly in which a continuity plate is especially configured and placed to serve as a reinforcement of a side plate or gusset plate, along with a preferred configuration of weld bead at a gap location of the column assembly;

[0041] Figure 19 provides a perspective or isometric view of an end portion of a full-length beam assembly according to one embodiment of this invention;

[0042] Figure 20 provides a perspective or isometric view of an end portion of a full-length beam assembly like that seen in Figure 19 during the process of joining (as by field welding) of the full-length beam assembly to a column assembly to form a beam-to-column joint assembly according to this invention;

[0043] Figure 21 shows a perspective view of an end portion of yet another alternative embodiment of full-length beam assembly preparatory to uniting this beam assembly with a column assembly to form a beam-to-column joint.

[0044] Figures 22-24 show sequential steps in the fitting of a full-length beam assembly to a column assembly, showing initial fit-up, bolting, and finished welding of the full-length beam assembly to a column assembly, forming a beam-to-column joint.

[0045] Figures 25 and 26, respectively provide diagrammatic illustrations of alternative embodiments of side plates of a column assembly and end portions of full-length beam assemblies, preparatory to and during the formation by welding of beam-to-column joint assemblies according to this invention;

[0046] Figures 27, 28, and 29 respectively provide diagrammatic side elevation, cross sectional, and plan views (the latter also being partially in cross sectional view) of a column assembly and an end portion of a full-length beam assembly according to another embodiment of the present invention, preparatory to the formation by welding of a beam-to-column joint assembly according to this invention;

[0047] Figures 30, 31, and 32 provide fragmentary diagrammatic plan views taken in cross section just above projecting pairs of side plates of column assemblies according to this invention, and preparatory to the uniting with these column assemblies of end portions of full-length beam assemblies showing other alternative embodiments of a beams-to-column joint connection according to this invention;

[0048] Figures 33 and 33A illustrate yet another alternative embodiment of the present invention, in which a column assembly includes a bracket or shelf for supporting an end portion full-length beam assembly, and the full-length beam assembly includes a stud or fitting for

interlocking with this column assembly during erection and preparatory to welding of the full-length beam assembly and column assembly into a unitary whole; and

[0049] Figures 34 and 34A diagrammatically depict yet another embodiment of a side plate construction according to this invention, which is particularly efficient in its use of steel or other material for construction of the side plate.

DETAILED DESCRIPTION OF EXEMPLARY PREFERRED EMBODIMENTS OF THE INVENTION

[0050] The structural steel commonly used in the steel frameworks of buildings is generally produced in conformance with steel ASTM standards A-36, A-572 and A-992 specifications. On the other hand, high strength aluminum and other high-strength metals might be found suitable for use in this invention under some circumstances. Thus, the invention is not limited to construction of steel frame buildings, but is applicable to construction of building frameworks from metals. It is also recognized that materials other than steel might be used for component parts of a beams-to-column joint according to this invention, particularly in the gusset plates or side plates and, possibly, in other elements of the joint connections. For example, in the gusset plates or side plates, other cross sectional shapes might be used in addition to those illustrated herein. So, the invention is not limited to the precise details of the embodiments shown and described herein.

[0051] Commonly shown in the drawings herein are fillet welds. However, the mention or illustration of a particular kind of weld herein does not preclude the possibility of other kinds of welds being found suitable by a person skilled in the art, including full-penetration and partial penetration single bevel groove welds. In a particular application, it might well be found suitable to use partial-penetration groove welds, flare-bevel groove welds and even other welds and forms of welding, which will be familiar to those ordinarily skilled in the pertinent arts.

[0052] Also, this invention is not limited to a particular configuration of or shape of beams and columns. Other shapes of columns or beams may be found suitable and capable of applying the inventions herein described, such as square or rectangular structural tube and box built-up shapes.

[0053] In broad overview, Figure 1 provides a fragmentary diagrammatic front elevation view of a framework 10 for a building. The framework is three dimensional although the front elevation view does not illustrate this fact. In this instance, the framework 10 provides for a ground floor 12, and a second floor 14. This framework or building structure includes

plural column assemblies 16, 18, 20, and 22 each embedded into or supported upon a foundation (not seen in the drawing Figures but indicated as a ground plane). Extending between adjacent column assemblies are plural full-length beam assemblies 24-36 for supporting the second floor and roof of the building. Joining the column assemblies 16-22 and full-length beam assemblies 24-36 are plural beam-to-column joint assemblies according to this invention (each indicated with the numeral 38), which upon completion of field-welding operations (to be described) become integral parts of and integrally join the column assemblies and full-length beam assemblies into a unitary whole. Again, although Figure 1 is shown only in front elevation view, it is to be understood that the structure of building framework 10 is three-dimensional (i.e., extending away from the viewer into the plane of the drawing Figure) and the un-seen remainder of the building structure is similarly constructed.

[0054] In similar broad overview, Figure 2 provides a fragmentary diagrammatic front elevation view of a framework 40 for a building. In this instance, the framework 40 provides for a ground floor 42, a second floor 44, and a third floor 46. This framework or building structure 40 includes plural column assemblies 48, 50, 52, and 54 each embedded into or supported upon a foundation (not seen in the drawing Figures – but indicated by a ground plane). Extending between adjacent column assemblies are plural full-length beam assemblies 56-72 for supporting the second floor, third floor, and roof of the building. Joining the column assemblies 48-54 and full-length beam assemblies 56-72 are plural beam-to-column joint assemblies according to this invention (each indicated with the numeral 74), which upon completion of field-welding operations (to be described) become integral parts of and integrally join the full-length beam assemblies and column assemblies into an integral whole. Again, although shown only in front elevation view, it is to be understood that the structure of Figure 2 is three-dimensional and the remainder of the structure is similarly constructed.

[0055] Figure 3 similarly provides a fragmentary diagrammatic front elevation view of a framework 76 for a building. In this instance, the framework 76 provides for a ground floor 78, a second floor 80, a third floor 82, and a fourth floor 84. Upon consideration of Figure 3A it will be noted immediately that because the column assemblies of this embodiment are perhaps too long to be shipped in their full length to a construction site, or too heavy to be moved about the construction site within crane limitations if they were full length, these column assemblies are each made of two pieces, and are field-welded together as is indicated at column joints 86.

[0056] This framework or building structure 76, viewing Figure 3, includes plural column assemblies 88-94 at the lower level, and 96-102 at the upper level, with the upper level

resting upon and being joined at field-welded column joints 86 to the lower level. Further, the column assemblies 88-94 of the lower level are each embedded into or supported upon a foundation (again not seen in the drawing Figures – but indicated by a ground plane). In the diagrammatic illustration of Figure 3, the field welds to make column joints 86 have already been completed. And, extending between adjacent column assemblies 88-102 are plural full-length beam assemblies 104-126 for supporting the second, third, and fourth floors, and roof of the building to be finished on framework 76. Joining the column assemblies 88-102 and full-length beam assemblies 104-126 are plural beam-to-column joint assemblies according to this invention (each indicated with the numeral 128), which upon completion of field-welding operations to be described become integral parts of and integrally join the full-length beam assemblies and the column assemblies. Again, although shown only in front elevation view, it is to be understood that the structure of Figure 3 is three-dimensional and the remainder of the structure is similarly constructed.

[0057] Figures 2A and 3A diagrammatically illustrate a methodology for fitting full-length beam assemblies between pre-set (i.e., substantially immovable) column assemblies, preparatory to making the field welds which unite these full-length beam assemblies with the column assemblies to define and form the beam-to-column joints described above. In the case of Figure 2, it is seen that the column assemblies have been set at their design locations and alignments into a foundation for the building. Again, Figures 2A and 3A illustrate an erection or construction methodology utilized in placing full-length beam assemblies between placed or set column assemblies according to this invention. It will be noted in the following description that in each case, the full-length beam assemblies are moved into an alignment between column assemblies to be connected, and then are moved vertically relative to the column assemblies either upwardly or downwardly to engage the full-length beam assemblies with the column assemblies preparatory to field welding that will permanently unite these assemblies into unitary structures defining beam-to-column joints according to this invention. Further, it is to be noted that these column assemblies include side plates (or gusset plates) extending toward next-adjacent column assemblies. And again, the gusset plates (or side plates) are referred to with either term (or with both terms) as one term has to do with the function of the plates as reinforcement or strengthening for a beam-to-column joint, and the other term has to do with the location of the plates on the sides of the columns and beams. But, at the time the column assemblies are set on a building foundation, or on a lower level of column assemblies, the column assemblies are not yet interconnected by full-length beam assemblies. And, because the

beam assemblies are full-length (i.e., stub beams are not employed as parts of the beam-to-column joint assemblies), these full-length beam assemblies are too long to be moved horizontally between the column assemblies at the level of the extending side plates or gusset plates which will form parts of beam-to-column joints, as described above.

[0058] However, the full-length beam assemblies can be moved horizontally between the column assemblies at levels above or below the projecting gusset plates or side plates (as will be explained), and can then be lowered or raised into position with their opposite end portions received or sandwiched between the extending and spaced apart gusset plates or side plates. One way of picturing this operation is to imagine the extending side plates as jaws between which the end portions of full-length beams are moved vertically in preparation to being united by field-welding operations. Figure 3A illustrates that in that particular embodiment of the invention, the full-length beam assemblies are each positioned at a level above the projecting side plates or gusset plates, and are then lowered downwardly into place, as is to be further described, preparatory to the field welding which will complete the beam-to-column joints. Also, as will be further described, the column assemblies may include a bracket or shelf upon which the end portions of the full-length beams may set preparatory to welding of the beam-to-column joint assemblies.

[0059] Similarly, Figure 3A illustrates that the column assemblies 88-94 for the ground floor and for the second and third floors as well, have been set into place and aligned on the building foundation. Again, these column assemblies include side plates or gusset plates extending toward next-adjacent column assemblies. But, the column assemblies are not yet interconnected by full-length beam assemblies 104-114. And again, because the beam assemblies are full-length (i.e., stub beams are not employed), they are too long to be moved horizontally between the column assemblies at the level of the projecting side plates or gusset plates which will form parts of beam-to-column joints, as described above. However, as is seen in Figure 3A the full-length beam assemblies can be moved horizontally between the column assemblies at levels above or below the gusset plates or side plates, and then can be lowered or raised into position with their opposite end portions sandwiched between the extending gusset plates or side plates. Figure 3A illustrates that in the illustrated embodiment of the invention, the full-length beam assemblies 104-126 are most preferably positioned at a level below the projecting side plates or gusset plates of the column assemblies, and are then raised upwardly into place between the side plates or gusset plates of the column assemblies, as is to be further described, preparatory to the field welding which will complete the beam-to-column joints.

[0060] As Figure 3A also illustrates, the building frame 76 also includes a fourth floor and roof level of connecting full-length beams. The most preferred methodology or sequence of erection of this building frame is to erect the column assemblies and full-length beam assemblies (as was described immediately above) for the second and third floors, and then to erect on this base the column assemblies 96-102 for higher floors by making the field welds at column assembly joints 86. Next, the interconnecting (i.e., interconnecting the column assemblies) full-length beam assemblies for the higher floors are fitted into place, and the field welds for these higher floors are completed, uniting the framework 76 into a unitary whole. It will be understood that for building frameworks having a greater number of floors or levels, the methodology is simply extended upwardly for the additional floors or levels of the building framework.

[0061] That is, those ordinarily skilled in the pertinent arts will understand in view of Figures 3 and 3A, that the same methodology can be used for building frames of a greater number of levels or floors than are illustrated in the present drawing Figures. It will be noted that many of the beam-to-column joint connections provide for load transfer and connection among at least two full-length beam assemblies and a column assembly. On the other hand, joint connections at a building corner or at an outside face of the building, or at an interior location of a building 10, 40, or 76 may also be similar although they may connect together a differing disposition and number of full-length beam assemblies and a column assembly. A column assembly for such a outside wall or corner location of a building framework is described below.

[0062] In view of the above, it will be appreciated that in order to fit a full-length beam assembly between the projecting side plates or gusset plates of a set (i.e., essentially immovable) column assembly, it is necessary to have a certain amount of clearance both between the ends of the full-length beam assembly and the column assemblies, and between the end portion of the full-length beam assembly and the spaced apart side plates or gusset plates of the column assemblies to be interconnected. In other words, some working space or “rattle” space must exist for the construction personnel to fit parts into, and this is true both with respect to the length of the full-length beam assemblies and to the fitting of their end portions between projecting gusset plates (or side plates).

[0063] Stated differently again, there must be a gap to a column assembly in the length direction of a full length beam assembly. In fact, the present invention employs such a gap for structural reasons, so the term “full-length beam assembly” means a beam assembly with welded components that extends substantially from and between two adjacent column assemblies, and

defines an end gap of only a few inches with respect to each column assembly. On the other hand, with respect to fitting the end portions of the full-length beam assemblies between the projecting side plates or gusset plates, there must be a certain amount of lateral “rattle” space into which the end portion of a full-length beam assembly can move (i.e., upwardly or downwardly as explained above) with at least some clearance in order to allow construction personnel to fit together the full-length beam assemblies to the set column assemblies preparatory to field welding of the beam-to-column joints.

[0064] Figure 4 illustrates one embodiment of a column assembly 130 (seen in cross sectional plan view taken just above a pair of side plates 132, 134 (or gusset plates) for a beam-to-column joint connection). Figure 5 illustrates a fragmentary elevation view of this same column assembly 130 looking toward the H-section column 136 and between the projecting side plates (or gusset plates) 132, 134. Viewing Figure 4, it is seen that the H-section column 136 includes a central web 138 and a pair of spaced apart opposite flanges 140, 142. The flanges each have flange tips or end surfaces, indicated with the numerals 144. At these flange tips 144, the side plates or gusset plates 132, 134 are attached by welding, with the welding operation resulting in multi-pass weld beads 146. Those ordinarily skilled in the pertinent arts will understand that when the welds 146 are placed and cool, the weld metal contracts as it cools and tends to pull the outer ends 132a, 134a of the side plates (or gusset plates) 132, 134 toward one another, as is indicated by arrows on Figure 4. Depending on the skill of the welder and variables in dimensions for the column 136, it would be possible for this “weld pulling” to influence or change the spacing between the side plates 132, 134 (i.e., moving or pulling the side plates toward one another) to result in a spacing 150 between these side plates at their out ends which is too small to accept an end portion of a full-length beam assembly during erection of a building frame at a construction site.

[0065] In order to offset this effect described above, and insure sufficient “rattle” room between the side plates 132, 134 all along their projecting length, the present invention according to one embodiment utilizes an intentionally introduced or created root gap between the tips of the column flanges 140, 142 and the side plates 132, 134 preparatory to welding. As is seen best in Figure 4, a spacer item, such as a small spacer, steel block, or length of welding rod or wire 143 is inserted between each flange tip 144 and the side plate 132 or 134, creating a gap (or root gap) 148 illustrated on Figure 4. This intentional root gap is not so large as to prevent the weld beads from spanning this gap. But, the root gap 148 does slightly space apart the side plates 132, 134 at their attachments to the column flange tips 144 by a dimension that slightly exceeds the width

of the column 136. The result is that even if the outer ends of the side plates pull together as a result of the welding operation, there is still sufficient spacing 150 between these side plates at their outer ends that an end portion of a full-length beam assembly can be moved vertically (i.e., upwardly or downwardly) between these side plates during the building frame erection process.

[0066] Those ordinarily skilled in the pertinent arts will recognize that the spacers 143 may be certified structural material (such as certified welding rod or wire) in which case they may be left in place as seen in Figure 4. On the other hand, a less expensive steel may also be used to make the spacers 143, and may be removed after the tacking of welds 146 is completed. Alternatively, the desired intentional root gap may be achieved by using a different expedient that does not use metal spacers interposed between surfaces to be welded. That is, a fixture, or holder may be used to space the column member and side plates preparatory to welding.

[0067] Figures 6 and 7 illustrate an alternative embodiment of the present invention, in which a different expedient is employed to make sure that there is sufficient “rattle” space between the outer ends of the spaced apart side plates after welding, so that an end portion of a full-length beam assembly can be fitted between these side plates.

[0068] Figure 6 illustrates a column assembly 136b (seen in cross sectional plan view taken just above a pair of side plates 132b, 134b (or gusset plates) for a beam-to-column joint connection. This column assembly 136b includes an H-section column 136a. In Figure 6 it will be noted that the upper (in this view) side plate 132b has not yet been welded into place, and that this side plate is not truly straight. That is, the end portions of the side plate have been displaced slightly out of plane, so that the side plate ends flare away from the opposite side plate 134b. However, the lower (in this view) side plate 134b has been completely welded (weld beads being illustrated at 146a) to the tips of the column flanges, recalling the description above. As a result, the previously slightly cambered or displaced side plate 134b has been pulled by cooling weld contraction forces into a position of being straight, or nearly so, as is indicated by arrows on Figure 6.

[0069] Figure 7 illustrates a cross sectional plan view like Figure 6, but showing both the side plates 132b and 134b with completed welds uniting these side plates with the H-section column 136a. In solid lines are shown the pre-welding shapes and positions of the outer ends of the side plates 132b, 134b, while the dashed lines indicate the shapes and positions of the outer ends of these side plates after completion of the welds 146a. As is seen best in Figure 7 the weld metal has contracted as it cools and pulls the outer ends of the side plates (or gusset plates) 132b, 134b toward one another. As a result, the side plates 132b, 134b are essentially parallel and

equally spaced apart along their length. The end result is a spacing between these side plates at their out ends (and along their length from these outer ends to the column 136a) which provides sufficient “rattle” space or room (i.e., extra lateral space) between the side plates 132b, 134b all along their projecting length so that an end portion of a full-length beam assembly can be moved vertically (i.e., upwardly or downwardly) between these side plates during the building frame erection process.

[0070] Figure 8 is an exploded elevation view, showing a column assembly 130d setting on and secured in place to a foundation or ground plane. Thus, the column assembly 130d should be considered to be essentially immovable. This column assembly 130d is configured for supporting the second and third floors (i.e., along with other similar column assemblies) of a building structure, and for addition on top of this column assembly of an additional column assembly (or assemblies) for still higher floors of a building framework. For this purpose, the column assembly 130d includes two vertically spaced apart pairs of side plates (or gusset plates), with only the side plate 132d and 132e closest to the viewer being visible in Figure 8. The side plates 134d and 134e spaced away from the viewer are not visible in Figure 8.

[0071] The column assembly 130d includes an H-section column 136d having a central web and opposite flanges (as described above) and to which the side plates are welded in spaced apart pairs (also as described above. However, the side plates 132d and 132e (and 134d, 134e) embody an alternative embodiment of the present invention, which is particularly efficient in its use of steel. That is, the side plates illustrated in Figure 8 have an extraordinarily low steel utilization (i.e., a considerable material saving), and yet achieve outstanding strength and stiffness for a beam-to-column (or beams-to-column) joint connection, as is further explained below. As a first consideration, it is to be noted that the side plates 132d and 132e (and 134d, 134e) are essentially fabricated of comparatively thin, flat plate construction requiring considerably less steel to make than would be taught by the conventional technology, and that only at the most highly stressed locations (as will be explained) are these rather thin flat plates reinforced by addition of (in this case) localized, welded-on reinforcing features, such as lugs, plate members, bars, or surface applied weld metal (further disclosed below).

[0072] As a predicate to understanding the advantages of the side plate constructions seen in Figure 8, it is to be noted that end portions (each indicated with the numeral 152a) of full length beam assemblies 152, are each seen in the positions these beam assemblies will occupy preparatory to their being lifted vertically upward so that the end portion 152a is received

between the projecting side plates 132d, 134d (or between plates 132e, 134e) of the column assembly. Those ordinarily skilled in the pertinent arts will recognize that the full length beam assemblies 152 (further described below with reference to Figures 9 and 10) have end portions 152a at each of their opposite ends, and also have a length just slightly less than the spacing distance between the column members of the column assemblies which these full-length beam assemblies will interconnect. As a result, the full-length beam assemblies define a slight gap "G" with each column member.

[0073] Giving further attention to Figure 8, it is seen that the side plates 132d, 134d (and 132e, 134e) each have a number of (in this case, three) through holes 133 aligned generally vertically and located near the outer or distal ends of these side plates. Also, the side plates 132d, 132e each have two vertically aligned pairs of reinforcing members 154. These reinforcing members are disposed generally near the top and bottom edges (156, 158) of the side plates 132d, 132e, and span across the gap "G." The column assembly 130d also includes vertically spaced apart pairs of continuity plates 160 (or horizontal shear plates) which are welded to the web of the H-section column member, and into the space between the flanges of this H-section column member 136d. These continuity plates are welded to the column web, and are optionally welded as well to the column flanges. The continuity plates 160 are also welded to the side plates 132d, 132e.

[0074] As is seen in Figure 8 at the right-hand side, and as is also seen in Figures 9 and 10, the full-length beam assemblies 152 have a beam portion 152', and a pair of opposite end portions 152a. The beam portion 152' generally is a hot-rolled steel structural member, most preferably of I-beam configuration (although the invention is not so limited), and may have a depth of about 18 inches to about 44 inches or more, and a width of from about 6 inches to 16 inches, or more. Accordingly, it will be appreciated that the drawing Figures are not to scale, and that in several Figures length or proportion of parts and components has been reduced or rearranged for clarity and ease of illustration. Each end portion 152a includes an elongate cover plate 162 welded to the upper flange of the beam 152', and another elongate cover plate 164 similarly welded to the lower flange of the beam 152'. In addition, on each side of the end portion 152a, the beam assembly 152 includes a pair of brackets, indicated with the numeral 166, only the one of which is on the side facing the viewer is visible in Figure 8 and 9. This bracket 166 may be L-shaped as illustrated, although the invention is not so limited.

[0075] As is indicated in Figures 8 and 9, the bracket 166 includes a leg or side 166a, which is generally coextensive in a vertical alignment at its outer face with a corresponding side

edge of one or both of the cover plates 162, 164. This bracket leg 166a also has a number of (three in this case) vertically spaced holes 168, which align with the holes 133 of the side plates 132 (d & e), 134 (d & e) when the end portion 152a is placed between these side plates. As will be explained, at that stage of the erection process, temporary support members will be placed into the holes 133, 168 so that the full-length beam assembly 152 is supported between the aligned columns by the projecting side plates.

[0076] Figure 8A provides a fragmentary side elevation view of a column assembly 174 which is similar in many respects to that seen in Figure 8, except that the column assembly 174 is for installation at an outside wall (i.e., outside face) or corner of a building framework, or at the end of an exterior or interior building framework. For this reason, the side plates of the column assembly seen in Figure 8A extend only in a single direction from the column, although they span across the horizontal dimension of the column itself and sandwich this column between the welded-on side plates. Viewing Figure 8A, it is seen that this column assembly 174 is configured for supporting the second and third floors (i.e., along with other similar column assemblies) of a building structure, and for addition on top of this column assembly of an additional column assembly (or assemblies) for still higher floors of a building framework. For this purpose, the column assembly 174 includes two vertically spaced apart pairs of side plates (or gusset plates), with only the side plate 176a and 178a closest to the viewer being visible in Figure 8A. The side plates 176b and 178b spaced away from the viewer are not visible in Figure 8. This column assembly 174 (like column assembly 130d of Figure 8) includes an H-section column 180 having a central web and opposite flanges (as described above) and to which the side plates are welded in spaced apart pairs (also as described above. Also similarly to that illustrated in Figure 8, the side plates 176a and 176b (and 178a, 178b) embody the alternative embodiment of the present invention seen in Figure 8. So, it is to be understood that plural column assemblies of Figure 8 and of Figure 8A could be employed together in a building framework to mutually support full-length beam assemblies extending between and joined by welding to these column assemblies. Again, the side plates 176, 178 are essentially or can be fabricated as comparatively thin, flat plate constructions requiring considerably less steel to make than would be taught by the conventional technology.

[0077] Turning now to Figure 11, a fragmentary side elevation view is provided of an alternative embodiment of column assembly 182 and side plate 184 configuration. As seen in Figure 11, the column assembly 182 includes a column member 182a which is of the now-familiar H-section configuration. However, the side plates 184a, 184b are each of a

configuration which in section (or end elevation view) as seen in Figure 11, is of a shallow U-shape. Each side plate 184 includes a rather or comparatively thin central section 184' and an upper and lower thicker section, each indicated with the numeral 184". In the column assembly 182 of Figure 11, it is to be noted that the shallow U-shape of the side plates 184 faces the column member 182a, and that the thicker sections 184" are welded to the flange tips of the H-shaped column member 182a by weld beads 186. Also seen in Figure 11 is a support bracket 187 which is secured to the column member 182 between the side plates 184a, 184b, and provides a support ledge 187a at approximately the lower extent of these side plates. This support bracket 187 may be employed when full-length beam assemblies are to be lowered between side plates (recalling Figures 2 and 2A). In that assembly method, the end portions of the full-length beam assemblies rest upon the support brackets 187 (i.e., after placing the full-length beam assembly and removing support from a crane) preparatory to the field welding of the beam assemblies to the column assemblies, resulting in the formation of the beam-to-column joints, as described herein.

[0078] Figure 12 provides a diagrammatic illustration of an alternative method of providing a spacing (or root gap at the welds of a column member to a pair of projecting side plates. Recalling the embodiment and method disclosed with reference to Figures 4 and 5, it will be remembered that in that embodiment small spacer blocks of steel or lengths of weld wire were utilized in preparation to welding the side plates to the column member as part of the process of making a column assembly. In the embodiment of Figure 12, no such spacer blocks are employed. Instead, a spacing or root gap, indicated with an arrowed numeral 188 is created between the column member 190 and each side plate 192, 194 preparatory to welding, and is so maintained by fixing or supporting devices (not seen in the drawing Figure – but possibly including a fixture or jig, for example) during the welding process. The welding process produces weld beads 196 seen in Figure 12. The result is that the side plates 192, 194 are spaced apart adjacent to the column member 190 by a dimension "D" extending from the column member 190 to the full extent of each side plate 192, 194, which is greater than the size of the column member itself.

[0079] Turning now to Figure 13, an alternative method of providing for sufficient "rattle" space between projecting side plates of a column assembly is diagrammatically illustrated. Viewing Figure 13, it is seen that in this case, similarly to that illustrated and described above with reference to Figures 6 and 7, the side plates 198 are intentionally cambered, or displaced from being truly straight such that the projecting distal end portions 198a

of the side plates 198 angle away from one another. However, while in the embodiment of Figures 6 and 7, the contractions of weld beads were utilized to bring bowed side plates into or nearly into parallel alignment with one another, in the embodiment of Figure 13, the finished welded side plates 198 are still angulated so that they diverge away from one another as they project outwardly from a column member 200. The result is a wedge shaped, or keystone shaped gap 202 between the projecting distal end portions 198a of side plates 198, as is seen in Figure 13. A full-length beam assembly which is especially configured and constructed to be used in cooperation with column assemblies as illustrated in Figure 13 is depicted herein (i.e., Figure 30), and is described below.

[0080] Turning now to Figures 14 and 14A considered together, an alternative embodiment of construction for a side plate 204 according to this invention is illustrated. Again, this alternative embodiment is a plate weldment construction, including a relatively or comparatively thin plate portion 206 with distal end portions 206a which will project beyond and away from a column member (not seen in Figures 14 and 14A). Adjacent to the distal ends of the plate portions, the side plates define a row of vertically extending holes 208 or perforations for temporary and permanent fixing or supporting of a full-length beam assembly during erection of a building framework, as will be further described. As described above, the full-length beam assemblies to be used with these side plates will be somewhat shorter than the spacing between set and aligned column assemblies, so that a gap dimension will be defined between the end of the full-length beam and the column member of the column assembly. The side plates 204 will span across this gap dimension. For purposes of illustration, in Figures 14 and 14A, the gap dimension and location is illustrated with the character "G" and dashed lines across the side plate 204. It is to be noted in Figures 14 and 14A that adjacent their upper and lower edges, and spanning the gap "G", the side plates 204 include reinforcement features or members, indicated with the numeral 210. In the embodiment of Figures 14 and 14A, these reinforcement features or members take the form of localized, rather thin, blocks or areas of steel welded onto or deposited onto (as by welding with multiple passes leaving multiple unified weld beads) the side plate member 206. These blocks or reinforcing features are preferably rectangular in side elevation view of the side plate, and may be rectangular or trapezoidal shape in elevation view, as is best seen in Figure 14A. Although not shown in Figures 14 and 14A, it is to be noted that the reinforcing members are not limited to being located within the outline of the side plates, but may extend or project outside of the outside edges of the side plates in order to more effectively

add moment area or moment capacity about a neutral axis to the side plates. An embodiment of such a reinforcement is disclosed herein (see Figures 18, 18A).

[0081] Considering Figures 15 and 15A, another alternative embodiment of construction for a side plate 212 according to this invention is illustrated. This alternative embodiment is a plate weldment construction, including a relatively or comparatively thin plate portion 214 with distal end portions 214a which will project beyond and away from a column member (not seen in Figures 15 and 15A). Adjacent to the distal ends of the plate portions, the side plates define a row of vertically extending holes 216 or perforations for temporary and permanent fixing or supporting of a full-length beam assembly during erection of a building framework, as will be further described. Again, a gap dimension is illustrated in Figures 15 and 15A, and is located and illustrated with the character "G" and dashed lines across the side plate 214. Again, it is to be noted in Figures 15 and 15A that adjacent their upper and lower edges, and spanning the gap "G", the side plates 214 include reinforcement features or members, indicated with the numeral 218. In the embodiment of Figures 14 and 14A, these reinforcement features or members take the form of blocks of steel welded onto the side plate member 214. These blocks are rectangular in side elevation view of the side plate and include a recess (or fish mouth) 218a. The fish mouth blocks 218 may be rectangular in elevation view, as is best seen in Figure 15A.

[0082] Figures 16 and 16A illustrate still another alternative embodiment of construction for a side plate 220 according to this invention. This embodiment for a side plate is also a plate weldment construction, including a relatively or comparatively thin plate portion 222 with distal end portions 222a which will project beyond and away from a column member (not seen in Figures 16 and 16A). Adjacent to the distal ends of the plate portions, the side plates define a row of vertically extending holes 224 or perforations for temporary and permanent fixing or supporting of a full-length beam assembly during erection of a building framework, as will be further described. Again, a gap dimension is defined with respect to the side plate 220, and is illustrated with the character "G" and dashed lines across the side plate 220. Again, it will be noted in Figures 16 and 16A that adjacent their upper and lower edges, and spanning the gap "G", the side plates 220 include reinforcement features or members, indicated with the numeral 226. In the embodiment of Figures 16 and 16A, these reinforcement features or members take the form of plural beads of weld metal placed onto the side plate member 222, and built up and out (i.e., possibly in plural layers or passes of weld metal) by successive welding passes in order to provide a sufficient depth and surface area of reinforcement of the side plate member at the

location indicated. It will be noted in Figures 16 and 16A that the lines or beads of weld metal extend in a direction generally parallel with the length of the side plate member 222, while providing a body or mass of weld metal that has a vertical orientation (as viewed in side elevation view), although the invention is not so limited. In other words, the lines or beads of weld metal placed on the plate member 222 could extend transverse to the length of the plate member or in some other direction within the scope of this invention.

[0083] Turning now to Figures 17 and 17A yet another alternative embodiment of a side plate 228 according to this invention is illustrated. Again, this alternative embodiment is a plate weldment construction, including a relatively or comparatively thin plate portion 230 with distal end portions 230a which will project beyond and away from a column member (not seen in Figures 17 and 17A). Adjacent to the distal ends of the plate portions, the side plates define a row of vertically extending holes 232 or perforations for temporary and permanent fixing or supporting of a full-length beam assembly during erection of a building framework, as will be further described. A gap dimension "G" is indicated on Figure 17 with dashed lines across the side plate 228. Again, adjacent their upper and lower edges, and spanning the gap "G", the side plates 228 include reinforcement features or members, indicated with the numeral 236. In the embodiment of Figures 17 and 17A, these reinforcement features or members take the form of oval or elliptical blocks of steel welded onto the side plate member 230. These oval or elliptical blocks are rectangular in elevation view, as is best seen in Figure 17A.

[0084] Figures 18 and 18A illustrate yet another alternative construction of a reinforcement for a side plate member (and for a beam, or beams, to column joint). Viewing first Figure 18, it is seen that a column assembly 238 includes a column member 238a of H-section configuration, which will be familiar to the reader in view of the disclosure above. The column assembly 238 carries a pair of side plates 240a, 240b, only the first of these side plates (240a) being visible in Figure 18. The other side plate, 240b, is located directly behind side plate 240a as seen in the side elevation view of Figure 18 (i.e., seen in the plan view of Figure 18A) A full-length beam assembly 242 is associated with column assembly 238, and defines an end gap "G" therewith, as will also by now be familiar in view of the disclosure above. However, in this embodiment, the column assembly 238 also carries continuity plates (or horizontal shear plates) 244 (only one of which is seen in Figure 18) which are each inset into the space between the flanges of the H-section column member 238a on opposite sides of the web of this column member, and are joined to the column assembly as by welding. The continuity plates are in this embodiment generally of T-shaped configuration, as is best seen in Figure 18a, and include a leg

portion (or pair of such leg portions) 236 which are extended along the adjacent surface (i.e., the top surface as seen in Figures 18 and 18a) of the side plate 240a and across the gap "G". The continuity plate projects somewhat across the top of the side plate 240a, and is welded thereto along the length of the continuity plate 244 by a fillet weld indicated with arrowed numeral 248 which weld extends across the gap "G". Thus, the side plate 240a and continuity plate 244 are united into a unitary structure by the weld 248. However, as is also seen in Figure 18, additional weld beads (indicated at 250) are also extended across the gap "G" and adjacent to the weld 248. The additional weld beads may be seen as an expansion of the weld area deposited on the side plate 240a, 240b. Thus, the leg portion 246 and welds 248, 250 reinforce the side plate 240a in the area of gap "G".

[0085] Turning now to Figure 19, a fragmentary view of a full-length beam assembly 254, and particularly of the end portion 254a of this beam assembly is illustrated. As is seen in Figure 19, this full-length beam assembly 254 includes a steel structural beam member 254b generally of I-beam sectional shape. That is, the member 254b may have a width of from about 6 inches to about 16 inches, and may have a vertical depth of from about 18 inches to as much as 44 inches or more, depending on the specifics of the building structure of which this beam assembly makes up a part. At the end portion 254a of this full-length beam assembly, a pair of cover plates 256 and 258 are joined to (i.e., welded to) the beam member 254b. As is seen in Figure 19, the upper cover plate 256 is narrower than the lower cover plate 258, although these cover plates have the same (or about the same) length along the beam member 254b, extending from its end a distance along its length. The cover plates are united with the beam 254 by welding along their length, as is seen in Figure 19.

[0086] Figure 20 now illustrates a method of joining a full-length beam assembly 254 as seen in Figure 19 to a set column assembly, indicated generally with the numeral 260. It will be recalled that the column assembly 260 includes side plates 262a, 262b, projecting therefrom toward the next-adjacent column assembly, and that the full-length beam assembly defines an end gap "G" with these column assemblies. Recalling Figure 3A, in which the full-length beam assemblies were first moved into alignment between spaced apart column assemblies, and then are moved vertically upwardly between the projecting side plates of these column assemblies, it will be seen in Figure 20, that this method has been used to position the end portion 254a of the beam assembly 254 between the side plates 262a, 262b. In this position, the beam assembly 254 is temporarily supported (as will be further explained) while fillet welds 264 are used to unite the upper cover plate 256 to the side plates 262a, 262b adjacent to the inside upper extent of these

side plates. Similarly, fillet welds 266 are employed to unite the lower cover plate 258 to the outside lower extent of the side plates 262a, 262b (only one of the welds 266 being shown in Figure 20). Viewing Figure 20 it is to be noted that these welds 264, 266 are each applied in a generally downward direction, indicated by arrow 268, which indicates generally the orientation of the welding torch used to place the welds 264, 266. Thus, it will be appreciated that the welds 264, 266 are easy to place with field welding equipment and techniques. Once the welds 264, 266 are placed at each end of the beam assembly, the full-length beam assembly 254 unites the adjacent column assemblies and the beam assembly into an integral structure, including a beam-to-column joint assembly (indicated with numeral 270) at each column assembly, and at each end portion of the full-length beam assembly. It will further be understood that for simplicity of illustration, some components of the joint assembly 270 have been omitted or are not yet installed on this joint assembly at the time of illustration in Figure 20.

[0087] Turning now to Figure 21, an embodiment of full-length beam assembly 272 which provides for simplified and expedient temporary (and permanent) support of the beam assembly during and after erection of a building framework is illustrated. It will be appreciated that Figure 21 is a fragmentary perspective view showing the beam member 272a, and only one end portion 272b of a full-length beam assembly 272, and that the beam assembly will have a similar or identically configured end portion at its other end (not seen in Figure 21). Viewing Figure 21, it is seen that the end portion 272b includes upper (274) and lower (276) cover plates, which will be familiar in view of the disclosure above. As illustrated in Figures 19 and 20, the upper cover plate 274 is narrow enough to go between a pair of projecting side plates at a column assembly, while the lower cover plate 276 is wide enough to span those side plates and be welded to those side plates at the outside lower extent of the side plates, as illustrated in Figure 20. However, the end portion 272b also includes a vertically extending shear and support bracket member, indicated with the arrowed numeral 278. This bracket member 278 includes a first leg 278a, which is welded to the web of beam member 272a as indicated at arrowed numeral 280. A second leg 278b of the bracket member 278 extends generally parallel with the length of the beam assembly 272, and is provided in this embodiment with vertically spaced apart and aligned holes 278c (three such holes 278c are shown for illustration, although the invention is not so limited). Most preferably, the second leg 278b defines an outer face or surface 278d, which aligns vertically with the tip or outer edge of the upper cover plate 274. Also, preferably, the beam assembly 272 includes such a shear and support bracket member 278 on each of its opposite sides, as will be better understood in view of the following description.

[0088] Turning now to Figures 22, 23, and 24, considered together and generally in numerical sequence, it is seen in Figure 22 that the end portion 272b of the full-length beam assembly 272 has been lifted vertically upwardly between the extending side plates of a column assembly, recalling the illustrations and descriptions of the column assemblies seen in Figures 8 and 8A. This lifting or vertical movement of the full-length beam assembly is continued until it reaches its designed location, with the top face or surface of the lower cover plate 276 in contact with the bottom edge of the side plates 132. As is seen in Figure 22, a side-to-side rattle space “R” exists between the side plates and the upper cover plate 274. Thus, the full-length beam assembly can be positioned in alignment with the column assemblies and at a level just below the bottom edges of side plates 132, and can then be lifted without interference vertically upwardly into place between the side plates 132, until the lower cover plates contact the bottoms of the side plates 132.

[0089] In Figures 22-24 for clarity and ease of illustration, the number of holes in the shear and support bracket members (and in the side plates 132 – recalling Figure 8) has been shown to be two (2), although the invention is not so limited. That is, the shear and support brackets and side plates may have any number of bolt holes according to necessity and design requirements. But, viewing Figure 22, it is seen that the full-length beam assembly is “self shoring,” and that as a first temporary support for the full-length beam assembly (while it is still supported by a crane), a pair of spud wrenches have been inserted at their tapered handle ends 282 through the holes 133 of the side plates 132 and into the holes 278c of the shear and support brackets 278. Thus, it is understood that these spud wrench handles and the brackets 278 serve as a first temporary support and stabilization for the full-length beam assembly 272 while being placed into its design position between aligned set column assemblies. Also, as is seen in Figure 22, a worker has installed a pair of bolts 284 through the other holes 278c and 133, and has attached a pair of nuts to these bolts (i.e., on the outside face of side plates 132). Subsequently, before support to the full-length beam assembly 272 from a crane is removed, another pair of bolts 284 (best seen in Figure 23) is placed as described above, in substitution for the spud wrench handles. This is done at both ends of the full-length beam assembly 272. The bolts 284 serve as a second temporary support for the full-length beam assembly 272. As thus secured, the crane support can be removed from the beam assembly 272. Further, floor decking (not seen in the drawing Figures) can now be placed upon the full length beam assembly, allowing workmen to walk on this floor decking and considerably improving the safety of the working conditions for these workmen.

[0090] In Figure 23, it is seen that the bolts securing the side plates 132 to brackets 278 have been tightened, drawing the rattle space “R” closed, and bringing the side plates into contact or close proximity with the sides of the top cover plate 274.

[0091] In Figure 24, it is seen that weld beads 286 have been placed, uniting the beam assembly 272 with a column assembly, and producing a beam-to-column joint assembly 288 in accordance with this invention. An additional option is shown also in Figure 24, in which weld bead 290 further unites brackets 278 with side plates 132. This welding of brackets 278 to the side plates 132 provides additional shear capacity in the beam-to-column joint assembly.

[0092] Figure 25 illustrates an alternative structure and method for drawing together a pair of side plates 132 of a column assembly after an end portion of a full-length beam assembly has been placed between these side plates. By way of example, it is seen that the end portion of the full length beam assembly may be configured like that seen in Figure 19. In this case, a large C-clamp type of apparatus 300 has been placed on the side plates 132, with the rattle space “R” still existing. In preparation to welding the side plates 132 to the top and bottom cover plates of the full-length beam assembly, the clamp 300 is tightened, bringing the side plates into contact or close proximity with the top cover plate. As so clamped and while still supported by a crane or other support device, at least a portion of the weld between the top cover plate and side plates is placed. Preferably, at least a portion of the weld between the lower cover plate and side plates is also placed before support from a crane or other support device is removed from the beam assembly. Once such a full-length beam assembly has been “tacked” (i.e., partially welded) in place at both ends in this way, the welds may be finished without support from a crane or other support device, resulting in a beam-to-column joint assembly in accord with this invention.

[0093] Considering now Figure 26, another alternative structure and method is depicted for drawing together a pair of side plates 302 of a column assembly after an end portion of a full-length beam assembly 304 has been placed between these side plates. Again, it is seen that the end portion of the full length beam assembly may be configured like that seen in Figure 19. But, in this case, the side plates 302 have each been provided with a sacrificial tab, ear, or bracket 306. After the full-length beam assembly 304 is placed at its end portion between the side plates (recalling the disclosure above) a tie bolt 308 is inserted through the tabs 306, as seen in Figure 26. It will be appreciated that when the tie bolt 308 is drawn tight, the side plates 302 are drawn together, eliminating the rattle space between the side plates and the top cover plate of the beam assembly. Subsequently, weld material 310 is placed at the cover plate to side plate locations, as is seen in Figure 26. Again, once such a full-length beam assembly has been

welded in place at both ends in this way a beam-to-column joint assembly in accord with this invention is formed.

[0094] Turning now to Figures 27, 28, and 29, considered together and generally in numerical sequence, it is seen in Figure 27 that the end portion 314a of a full-length beam assembly 314 has been lifted vertically upwardly between the extending side plates 316 of a column assembly 318. The column assembly 318 may be like that shown in Figures 8 or 8A, or may be of another configuration having extending side plates. Recalling the description above, it will be understood that a side-to-side “rattle” space “R” exists between the side plates 316 and the upper cover plate 320 of the full-length beam assembly. Thus, the full-length beam assembly 318 can be positioned in alignment with two spaced apart column assemblies at a level just below the bottom edges of side plates 316, and can be lifted without interference vertically upwardly into place between the side plates, until the lower cover plates 322 contact the bottoms of the side plates 316, as is seen in Figures 27 and 29.

[0095] It will be seen in Figures 27, 28, and 29, that the web 314b of the beam member end portion 314a of the full length beam assembly 314 defines a through hole 324. Similarly, the side plates 316 each define similar through holes 326, which align with the hole 324 when the end portion 314a is placed between the side plates 316 in its design position. This alignment of the holes 324 and 326 is best seen in Figure 27. As Figures 28 and 29 show, a tension rod or bolt 328 is placed through the aligned holes 324 and 326. The pair of brackets 325 (only one bracket shown in Figure 27) are omitted in the partial plan view of Figure 28 for clarity. When the tension rod 328 is tightened, the “rattle” space “R” between the side plates 316 and the edges of the top cover plate 320 is substantially eliminated, by drawing the side plates 316 toward one another. In this condition, the cover plate 320 is welded to the upper inside portion of the side plates 316, and the lower cover plate 322 is welded to the lower outer extent of the side plates 316, recalling the description of Figures 22-26 above.

[0096] Turning now to Figures 30, 31, and 32, alternative embodiments of column assemblies 330, 332, and 334 are diagrammatically illustrated in cross sectional view taken transverse to the column assemblies and immediately above projecting pairs of side plates 336, 338, and 340, respectively. Comparing the illustrations of Figures 30, 31, and 32 to those of Figures 4, 5, and 12, it is seen that an intentional root gap (recalling Figures 4, 5, and 12) is not employed. On the other hand, flaring or displacing the side plates away from one another at their distal ends (Figures 6, 7, 13) may be employed, as is seen in Figure 30. However, the expedient employed in the embodiments of column assembly and full length beam assemblies seen in

Figures 30, 31, and 32 (i.e., an expedient allowing full-length beams to be assembled between projecting side plates with a sufficient rattle space, and preparatory to welding), is to fit at least the upper cover plate, or at least the lower cover plate, of a full-length beam assembly to the spacing actually existing between the projecting side plates such that a sufficient “rattle” space “R” is provided. In Figure 30, it is seen that the projecting side plates 336 flare away from one another so that they are spaced further apart at their distal ends than they are at the column member 330a. Consequently, the end portion 342a of the full-length beam 342 is provided with a cover plate 344 which is generally “keystone” shaped, having a narrower end 344a proximate to the column member 330a, and a wider end 344b spaced from the column member 330a. The width of the cover plate 344 is made to match the spacing between the side plates such that a sufficient “rattle” space “R” exists for fitting of the end portion 342a between the side plates 336, and such that this rattle space can be substantially eliminated by drawing the side plates slightly (i.e., sufficiently) toward one another preparatory to welding of the side plates to the end portion of the full-length beam assembly 342 to provide a beam-to-column joint according to this invention.

[0097] In Figure 31, it is seen that the projecting side plates 338 are either substantially parallel or that perhaps they even converge slightly toward one another so that they are spaced less far apart at their distal ends than they are at the column member 332a. Consequently, the end portion 346a of the full-length beam 346 is in this embodiment provided with a cover plate 348 having an end 348a proximate to the column member 332a, and an end 348b spaced from the column member 332a. The width of the cover plate 348 again is made to match the spacing between the side plates 338 such that a sufficient “rattle” space “R” exists for assembly of the end portion 346a between the side plates 338. In this case, the cover plate 348 is made with end 348a the same width (i.e., rectangular), or narrower, or even wider, than end 348b. And again, this rattle space “R” can be substantially eliminated by drawing the side plates toward one another preparatory to welding of the side plates to the end portion of the full-length beam assembly 346.

[0098] Figure 32 illustrates an embodiment of the invention in which the side plates 340 are allowed to converge significantly and visually, as is seen in this drawing Figure somewhat exaggerated for clarity of illustration. So, at their distal ends, the projecting side plates 340 converge toward one another so that they are spaced less far apart at their distal ends than they are at the column member 334a. Consequently, in this embodiment the end portion 350a of a full-length beam 350 is provided with a cover plate 352 which is noticeably “keystone”

shaped, but which is tapered in the opposite direction from the embodiment seen in Figure 30 (i.e., cover plate end 350a is wider than end 350b). However, even though the cover plate 352 of Figure 32 could not be fitted horizontally between the projecting side plates 340, it will fit with sufficient rattle space when the end portion 350a of full-length beam assembly 350 is moved vertically from below or vertically from above the projecting side plates either upwardly or downwardly between the pair of projecting side plates 340.

[0099] Figures 33 and 33A illustrate yet another alternative embodiment of the present invention, in which a column assembly includes a bracket or shelf for supporting an end portion full-length beam assembly, and the full-length beam assembly includes a stud or fitting for interlocking with this column assembly during erection and preparatory to welding of the full-length beam assembly and column assembly into a unitary whole. Viewing Figure 33, it is seen that a column assembly 354 includes a pair of projecting side plates, generally indicated with arrowed numeral 356. Adjacent to the lower extent of the projecting side plates, and positioned generally between these side plates (as is best seen in Figure 33A), the column assembly 354 includes a bracket or shelf member 358. Most preferably, this bracket or shelf member 358 may be formed of sufficiently heavy angle iron or plate that it is strong enough to support an end portion of a full-length beam assembly preparatory to welding of the full-length beam assembly to the column assembly at the side plates.

[0100] As is illustrated in Figure 33A, the bracket member 358 preferably includes a vertically extending through hole 358a. Also as is seen in Figure 33A, the end portion 360a of a full-length beam assembly 360 includes a downwardly projecting stud or stem 360b, which when the full-length beam assembly 360 is positioned adjacent to the column assembly preparatory to being lowered between the projecting side plates 356, aligns with the hole 358a. Thus, it will be understood that when the full-length beam assembly 360 is lowered between the projecting side plates 356, the stud or stem 360b is received into the hole 358a (i.e., at each end of the full-length beam assembly), as the full-length beam assembly comes to rest upon the projecting bracket 358. Those ordinarily skilled in the pertinent arts will recognize that support from a construction site crane can then be removed, and further preparations for bringing the side plates 356 sufficiently close to the cover plates of the full-length beam assembly can be carried out. Thus, welding of the full-length beam assembly to the column assembly to provide a beam-to-column joint according to this invention can be carried out without the further need for support from a construction site crane.

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[0101] Turning now to Figures 34 and 34A, it is seen that these Figures diagrammatically depict yet another embodiment of a side plate construction according to this invention, which is similar in some respects to those depicted and described above. However, the embodiment of side plate illustrated in Figures 34 and 34A is particularly efficient in its use of steel (or other material) for construction of the side plate. Viewing now Figures 34 and 34A together, it is seen that in side elevation view, the side plate 362 is generally rectangular, and may form a part of and span across the horizontal dimension of a column member 364 (indicated by dashed lines) of a column assembly (not seen in Figure 34). As mentioned and explained above, the side plate 362 may include holes 362a or perforations near the distal ends of this side plate for purposes explained above. Importantly, as is best seen in Figure 34A, the side plate is not of uniform shape considered vertically in end view or cross section. That is, the side plate 362 includes an upper and a lower portion 366, 368 which are larger in cross section (i.e., thicker) than the remainder of the side plate 362, and provide a significant increase in the stiffness of side plate 362 about its neutral axis, as well as a comparatively large moment capacity about a neutral axis of the side plate 362. Accordingly, it is seen that the side plate 362 includes a central portion 370 which is comparatively thin, and provides a comparatively smaller moment about a neutral axis of the side plate. However, where the side plate 362 is to span a gap "G" as has been discussed above, still greater area and moment capacity about a neutral axis of the side plate 362 is desired. To this end, the side plate 362 includes added on reinforcement members 372, which will be familiar to the reader by this point in the disclosure of the present invention.

[0102] While the present invention has been illustrated and described by reference to preferred exemplary embodiments of the invention, such reference does not imply a limitation on the invention, and no such limitation is to be inferred. Rather, the invention is limited only by the scope of the appended claims giving full cognizance to equivalents in all respects.

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CLAIMS:

1. A building framework comprising:

at least a pair of vertical column assemblies; each column assembly of said pair of column assemblies having a vertically elongate column member defining a horizontal dimension and a pair of horizontally spaced vertically and horizontally extending side plate members plates spanning the horizontal dimension of said column member and projecting generally horizontally toward the other column assembly of said pair;

5 a full-length beam assembly including a beam member defining an end gap with each column member, and said full-length beam assembly including a pair of opposite cover plates at each opposite end of said full-length beam assembly; one cover plate of said pair of opposite cover plates being configured and sized for receipt between a respective pair of projecting side plates while another cover plate of said pair of opposite cover plates is sized and configured to be wider than a spacing of the respective pair of projecting side plates, and each end portion of the beam member being received between a respective pair of projecting side plates of a respective column assembly.

2. The building framework of Claim 1, wherein each pair of opposite cover plates are welded in the horizontal welding position as opposed to the overhead welding position to said pair of opposite side plates at a respective one of said pair of column assemblies, so as to provide a beam-to-column joint assembly at each of said pair of column assemblies.

20 3. The building framework of Claim 1, wherein said pairs of cover plates including opposite upper cover plates and opposite lower cover plates each respectively disposed adjacent to opposite ends of said beam member.

4. The building framework of Claim 3 wherein one of said upper cover plates and lower cover plates are wider in horizontal lateral dimension transverse to a length dimension of said full-length beam assembly than a spacing between said pair of projecting side plates.

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5. The building framework of Claim 4 wherein said upper cover plates are wider than said side plate spacing, whereby said upper cover plates rest upon said projecting side plates.

6. The building framework of Claim 3 wherein said lower cover plates are wider than said side plate spacing, whereby said lower cover plates are disposed adjacent to a lower edge of said projecting side plates, and are welded thereto along a lower outer edge of said projecting side plates whereby said lower wider cover plates can be welded in the horizontal welding position as opposed to the overhead welding position.

7. The building framework of Claim 3 wherein said full-length beam assembly further includes at one of the end portions thereof a pair of opposite bracket members extending vertically between upper and lower flange portions of said beam member, and each of said pair of bracket members including a respective first leg portion attaching to a web portion of said beam member, and a second leg portion extending from said first leg away from an adjacent end of said beam member in a direction along the length of said beam member, and said second leg portion further providing an outer surface disposed in vertical alignment with an outer edge of one of said pair of cover plates.

8. The building framework of Claim 7 wherein said second leg of said bracket member defines at least one through hole, and a projecting side plate of said column assembly also defining at least one through hole aligning with said through hole of said bracket member in a design position of said full-length beam assembly relative to said projecting side plates, whereby a bolt connecting said second leg portion of said bracket member to said side plate provides support to said full-length beam assembly, and further said bolt when tightened drawing said side plate toward said full-length beam assembly preparatory to welding of said side plate and cover plates.

9. The building framework of Claim 1 wherein a vertical column assembly includes a root gap spacing introduced between at least one of said pairs of projecting side plates, and said column member of said column assembly, whereby, said root gap spacing increases a lateral spacing between said projecting pair of side plates.

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10. The building framework of Claim 1 wherein said one cover plate sized to fit between a projecting pair of side plates of a column assembly with a determined rattle space, whereby an end portion of said full-length beam assembly can be moved vertically upwardly or downwardly between said pair of projecting side plates of said column assembly
5 preparatory to welding said cover plate to said projecting side plates.
11. The building framework of Claim 1 wherein at least one side plate of said pair of projecting side plates of one of said column assemblies is composed of plate material, and said one side plate further including a reinforcing member or mass disposed at and spanning said end gap adjacent to an upper or a lower extent of said one side plate.
- 10 12. The building framework of Claim 11 wherein said at least one side plate includes both an upper and a lower reinforcing member or mass disposed at and spanning said end gap adjacent to respective upper and lower extents of said one side plate, whereby, said reinforcing members or masses increase the moment capacity with respect to a neutral axis of one said side plate at and spanning said end gap.
- 15 13. A method of making a building framework, said method comprising steps of:
providing a pair of vertical column assemblies; and configuring each of said pair of vertical column assemblies to include a vertically elongate column member defining a horizontal dimension, providing each of said vertical column assemblies additionally with a respective pair of horizontally spaced vertically and horizontally extending side plates
20 spanning the horizontal dimension of the respective one of said column members and projecting generally horizontally toward the other column assembly of said pair;
providing a full-length beam assembly for being disposed between said pairs of projecting side plates of said pair of column assemblies, providing for said full-length beam assembly to be fillet welded to said projecting side plates, said full-length beam assembly
25 including a beam member for defining an end gap with each column member of said pair of column assemblies;

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including in said full-length beam assembly a pair of opposite cover plates each extending along an end portion of said beam member at each opposite end of said full-length beam assembly; and

5 disposing one of said end portions of said beam member between a respective pair of projecting side plates of a respective one of said pair of column assemblies;

whereby said cover plates at one of said opposite ends of the full-length beam assembly can be attached to said respective pair of side plates to form a beam-to-column joint assembly;

10 and further including the step of configuring one of said pair of cover plates at one of the of the opposite ends of said full-length beam assembly to be received between said pair of projecting side plates and the other of the pair of opposite cover plates at one of the opposite ends of said full-length beam assembly to be wider in horizontal lateral dimension transverse to a length dimension of said full-length beam assembly than a spacing between said pair of projecting side plates.

15 14. The method of Claim 13, further including welding said one cover plate to said respective pair of side plates at said respective one of said pair of column assemblies along the length of said cover plates.

20 15. The method of Claim 13 further including providing said full-length beam assembly with an end portion at each opposite end thereof, and a pair of cover plates at each end portion, each of said pairs of cover plates at each end portion including an upper cover plate and a lower cover plate, and disposing said pairs of cover plates each respectively adjacent to one of the end portions of said beam member.

25 16. The method of Claim 15 including the step of making said upper cover plates wider than said spacing between said projecting pair of side plates, whereby said upper cover plates may rest upon said projecting pair of side plates.

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17. The method of Claim 15 including the step of making said lower cover plates wider than said spacing between said projecting pair of side plates, whereby said lower wider cover plates are disposed adjacent to and are welded in the horizontal welding position as opposed to the overhead welding position to said projecting pairs of side plates along a lower
5 outer edge portion thereof.

18. The method of Claim 13 further including providing said full-length beam assembly at opposite end portions thereof with an opposite pair of bracket members, configuring said opposite pair of bracket members each to extend vertically between upper and lower flange portions of said beam member, and including in each of said opposite pair of
10 bracket members a respective first leg portion attaching to a web portion of said beam member, and providing each of said opposite pair of bracket members with a second leg portion extending from said first leg in an opposite direction from an adjacent end of said beam member, and configuring said pair of bracket member so that said second leg portion
15 extends generally parallel with a length dimension of said beam member and further provides an outer surface disposed generally in vertical alignment with an outer edge of one of said pair of cover plates, whereby said projecting pair of side plates may each be attached to and drawn toward a respective one of said opposite pair of bracket members preparatory to welding of said side plates to said cover plates.

19. A full-length beam assembly for construction of a building framework, said
20 building framework including a pair of spaced apart column assemblies each including a column member and a pair of laterally spaced apart side plates spanning said column member and projecting toward the other column assembly of said pair of column assemblies, said full-length beam assembly comprising:

25 a beam member for extending between said column members of said pair of spaced apart column assemblies and for defining an end gap with each column member;

said full-length beam assembly including an end portion at each opposite end thereof, and each end portion of said full-length beam assembly including a pair of opposite cover plates each extending along said end portion of said beam member, each pair of

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opposite cover plates including an upper cover plate and a lower cover plate, and one of said upper cover plates and said lower cover plates being configured and sized for receipt between a respective pair of projecting side plates of a respective column assembly of said pair of column assemblies, while another of said upper and lower cover plates is sized and configured
5 to be wider than the spacing of a respective pair of projecting side plates, and said another cover plate confronting and being engageable with said projecting pair of side plates.

20. The full-length beam assembly of Claim 19 wherein said upper cover plates are sized and configured for receipt between a respective pair of side plates of a column assembly.

10 21. The full-length beam assembly of Claim 19 wherein said lower cover plates are sized and configured for receipt between a respective pair of side plates of a column assembly.

22. The full-length beam assembly of Claim 19 wherein said full-length beam assembly further includes at one of the end portions thereof a pair of opposite bracket
15 members extending vertically between upper and lower flange portions of said beam member, and each of said pair of bracket members including a respective first leg portion attaching to a web portion of said beam member, and a second leg portion extending from said first leg away from an adjacent end of said beam member and extending in a direction along the length of said beam member and providing an outer surface disposed generally in vertical alignment
20 with an outer edge of one of said pair of cover plates.

23. The full-length beam assembly of Claim 22, wherein said second leg portion outer surface extends generally parallel with said length dimension of said beam member and is disposed approximately coextensive with or beyond a vertical edge of a respective one of said pair of side plate members, whereby said second leg portion provides a welding surface
25 to permanently join said second leg portion with said one side plate member by welding.

24. The full-length beam assembly of Claim 19 wherein said full-length beam assembly further includes at an end portion thereof a through hole aligned between upper and

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lower flange portions of said beam member, and said through hole aligning in a design position of said end portion relative to a projecting pair of side plates of a column assembly with a pair of through holes defined by said projecting pair of side plates, whereby a tension rod member extending through said aligned holes of said pair of side plates and said beam member can draw said pair of side plates toward said beam member and toward opposite edges of one of said cover plates securing thereto.

25. A full-length beam assembly for construction of a building framework, said building framework including a pair of spaced apart column assemblies each including a column member and a pair of laterally spaced apart side plates spanning said column member and projecting toward the other column assembly of said pair of column assemblies, said full-length beam assembly comprising:

a beam member for extending between said column members of said pair of spaced apart column assemblies and for defining an end gap with each column member;

said full-length beam assembly including an end portion at each opposite end thereof, and each end portion of said full-length beam assembly including a pair of opposite cover plates each extending along said end portion of said beam member, each pair of opposite cover plates including an upper cover plate and a lower cover plate, and one of said upper cover plates and said lower cover plates being configured and sized for receipt between a respective pair of projecting side plates of a respective column assembly of said pair of column assemblies, while another of said upper and lower cover plates is sized and configured to be wider than the spacing of a respective pair of projecting side plates, and said another cover plate confronting and being engageable with said projecting pair of side plates.

26. The full-length beam assembly of Claim 25 wherein said one cover plate has a configuration selected from the group consisting of: rectangular, trapezoidal with a narrower end disposed toward said column member, and trapezoidal with a narrower end disposed away from said column member.

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27. A method of making a building framework utilizing pairs of spaced apart vertical column assemblies interconnected by full-length beam assemblies, the column assemblies and full-length beam assemblies being united to one another to form beam-to-column joint assemblies, said method comprising steps of:

5 providing a pair of vertical column assemblies; and configuring each of said pair of vertical column assemblies to include a vertically elongate column member defining a horizontal dimension, providing each of said vertical column assemblies additionally with a respective pair of horizontally spaced vertically and horizontally extending side plate members spanning the horizontal dimension of the respective one of said column members
10 and projecting generally horizontally toward the other column assembly of said pair;

disposing between said pairs of projecting side plates of said pair of column assemblies respective end portions of a full-length beam assembly, providing for said full-length beam assembly to include a beam member defining an end gap with each column member of said pair of column assemblies; and including in said full-length beam assembly at
15 each respective end portion thereof a pair of opposite cover plates each extending along the end portion of said beam member; and including in said pair of opposite cover plates at each end portion of said full-length beam assembly an upper cover plate and a lower cover plate, one of the upper and lower cover plates being received between the projecting side plates and the other of the upper and lower cover plates having a width greater than a transverse
20 dimension between the side plates and greater than a width of said one of the upper and lower cover plates; and

providing for said upper cover plate and said lower cover plate at each end portion of said full-length beam assembly to be welded to said projecting side plates to form a beam-to-column joint assembly at each of said spaced apart column assemblies.

25 28. The method of Claim 27, wherein said one of the upper and lower cover plates received between the side plates is welded to each one of said pair of projecting side plates at one of said pair of column assemblies along the length of said one cover plate to form a

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respective portion of said beam-to-column joint assembly, said one of the upper and lower cover plates being welded to inside surfaces of the side plates.

29. The method of Claim 27, wherein the cover plate that is wider in transverse dimension than the spacing of said associated pair of projecting side plates can confront and
5 engage a horizontal edge surface of the associated pair of projecting side plates and is welded to the associated pair of projecting side plates along the length of the cover plate and at a horizontal outside edge of said associated pair of projecting side plates to form a respective portion of said beam-to-column joint assembly.

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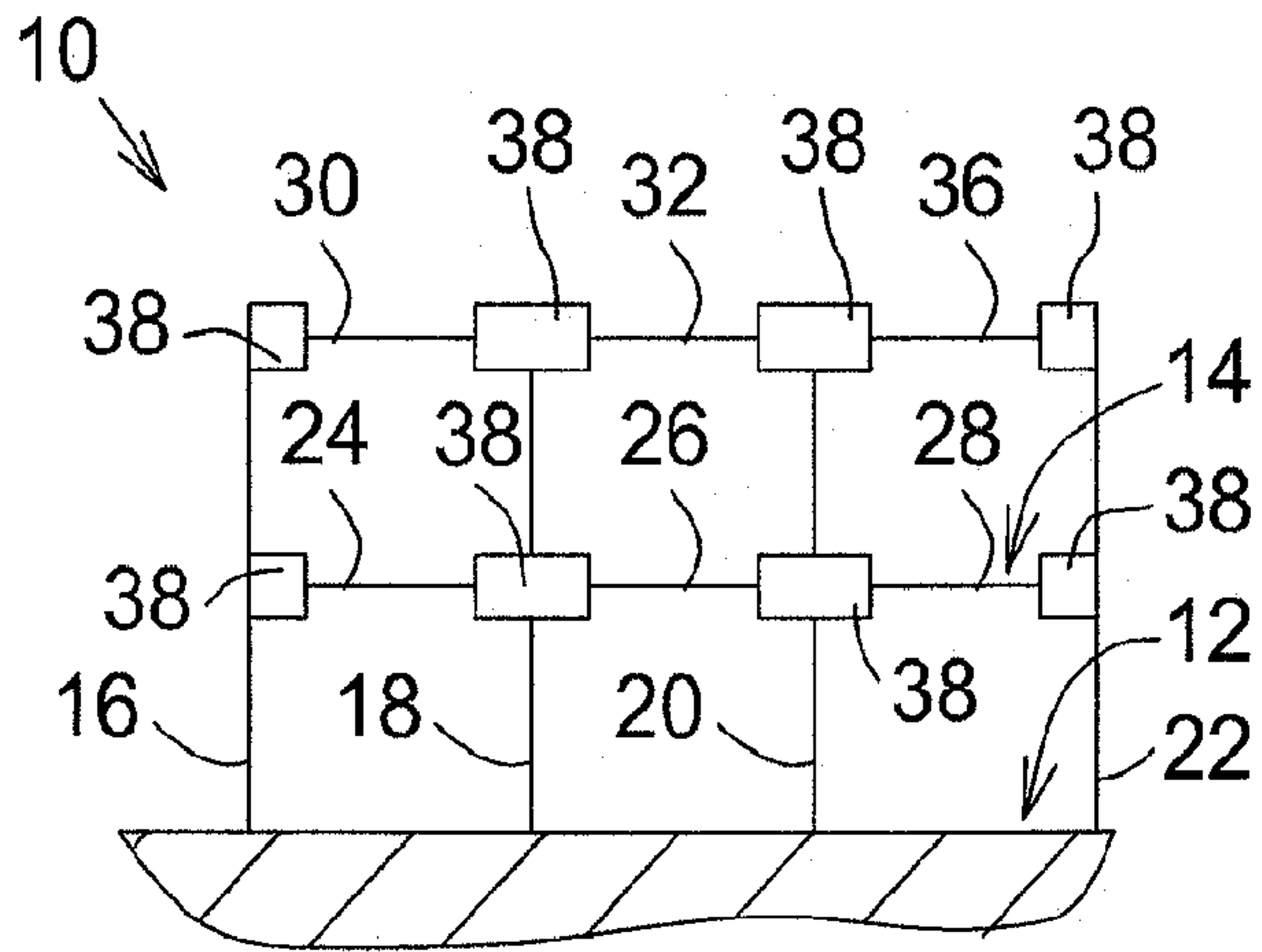


FIG. 1

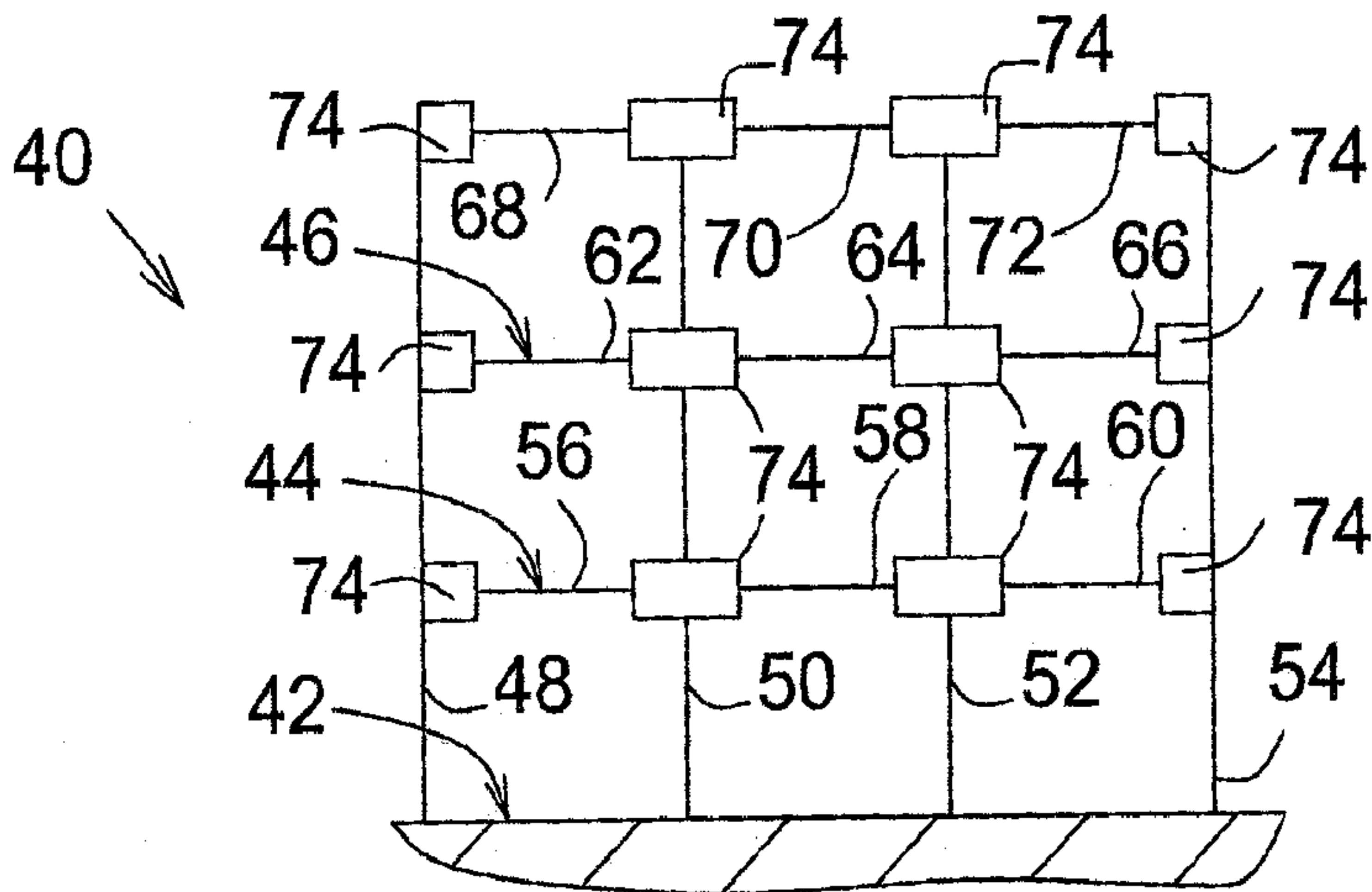


FIG. 2

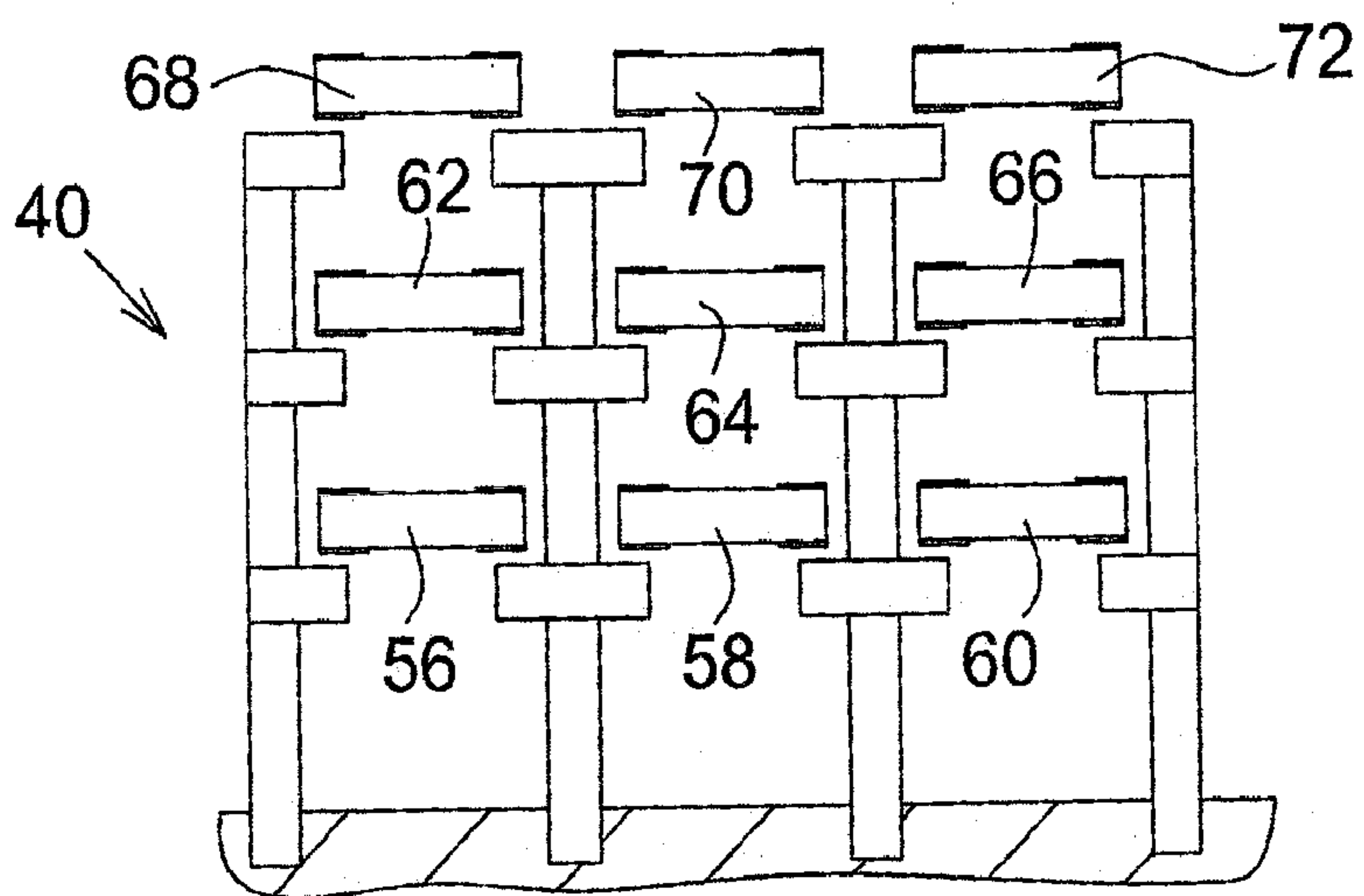
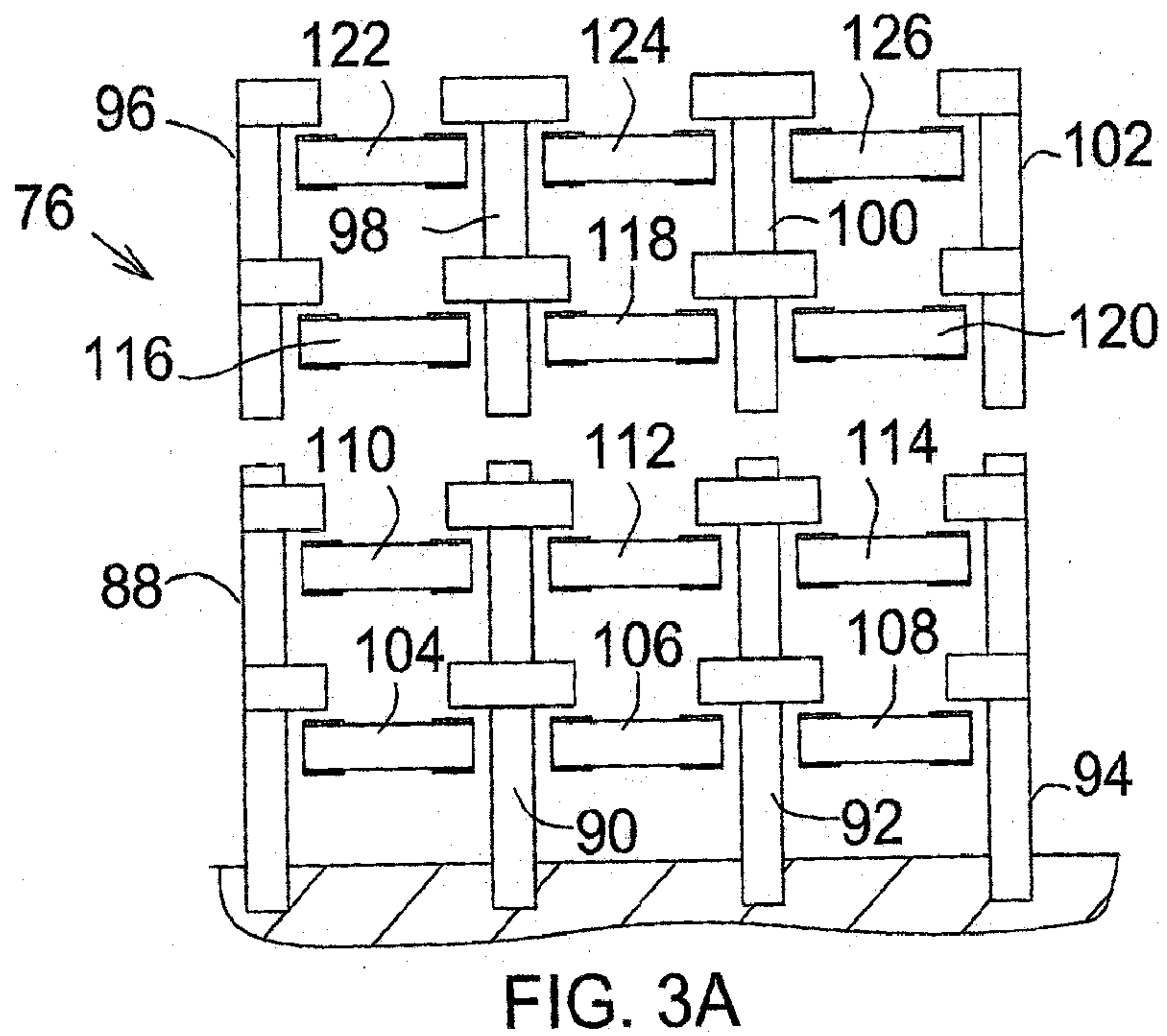
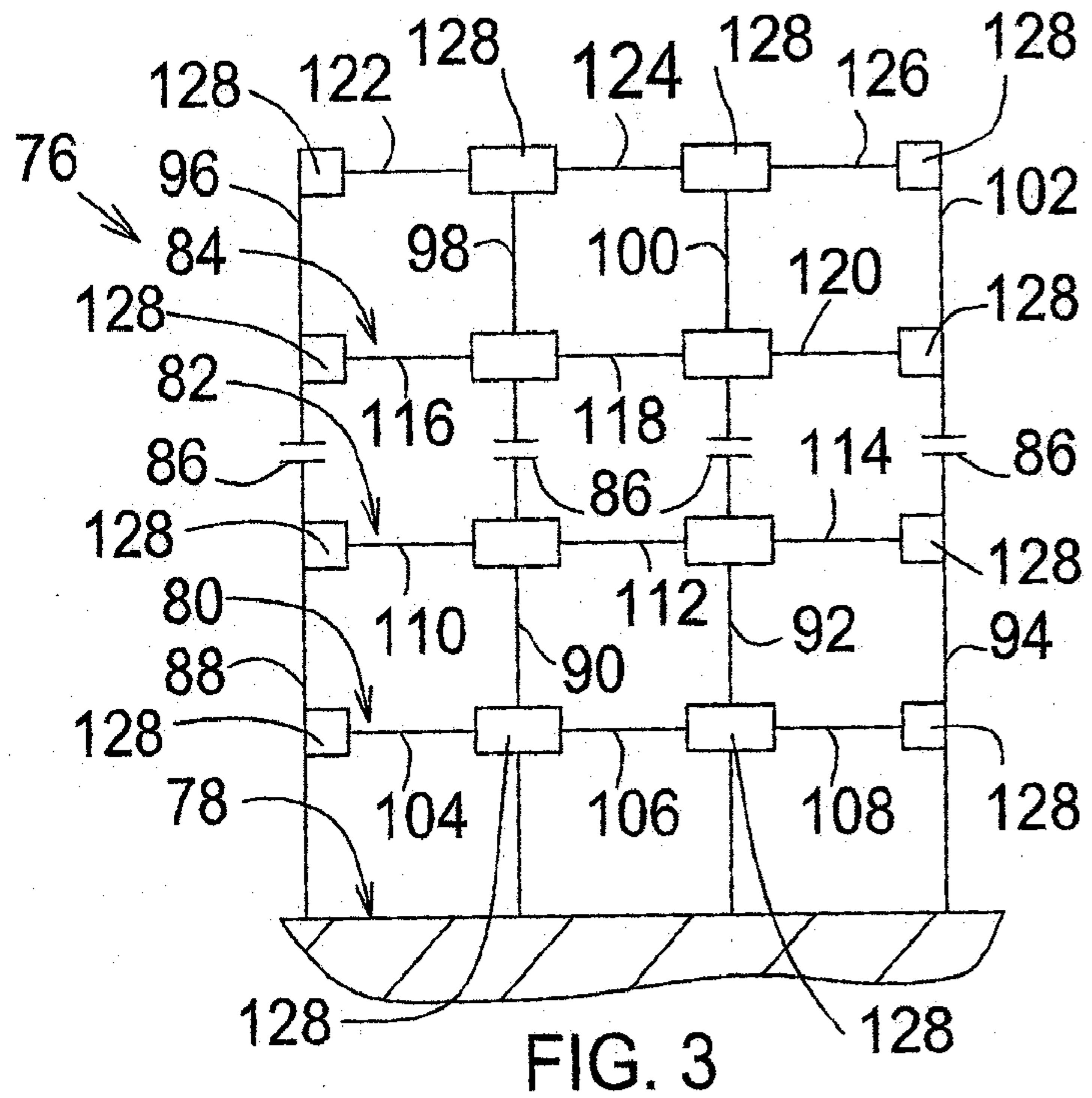


FIG. 2A



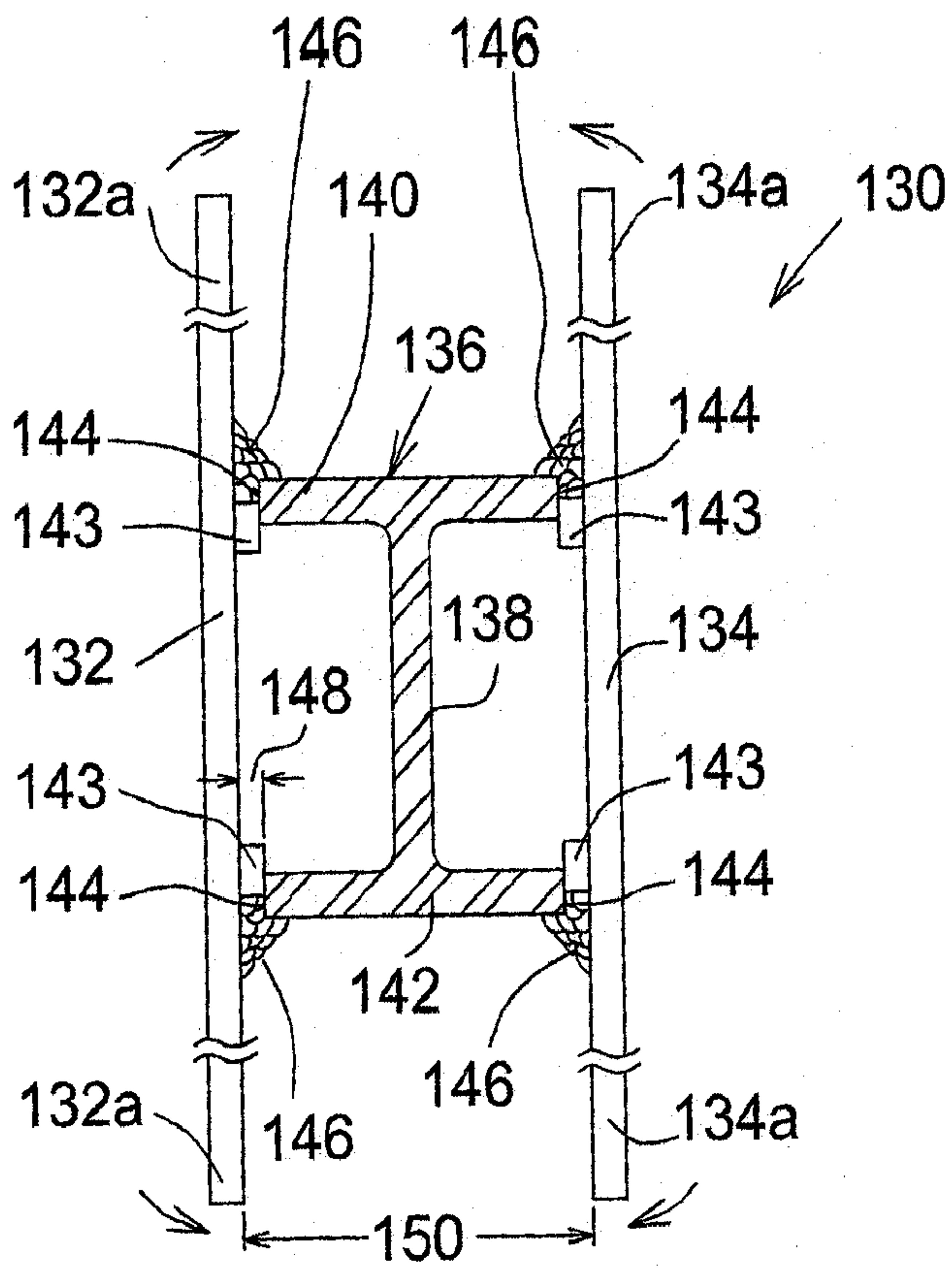


FIG. 4

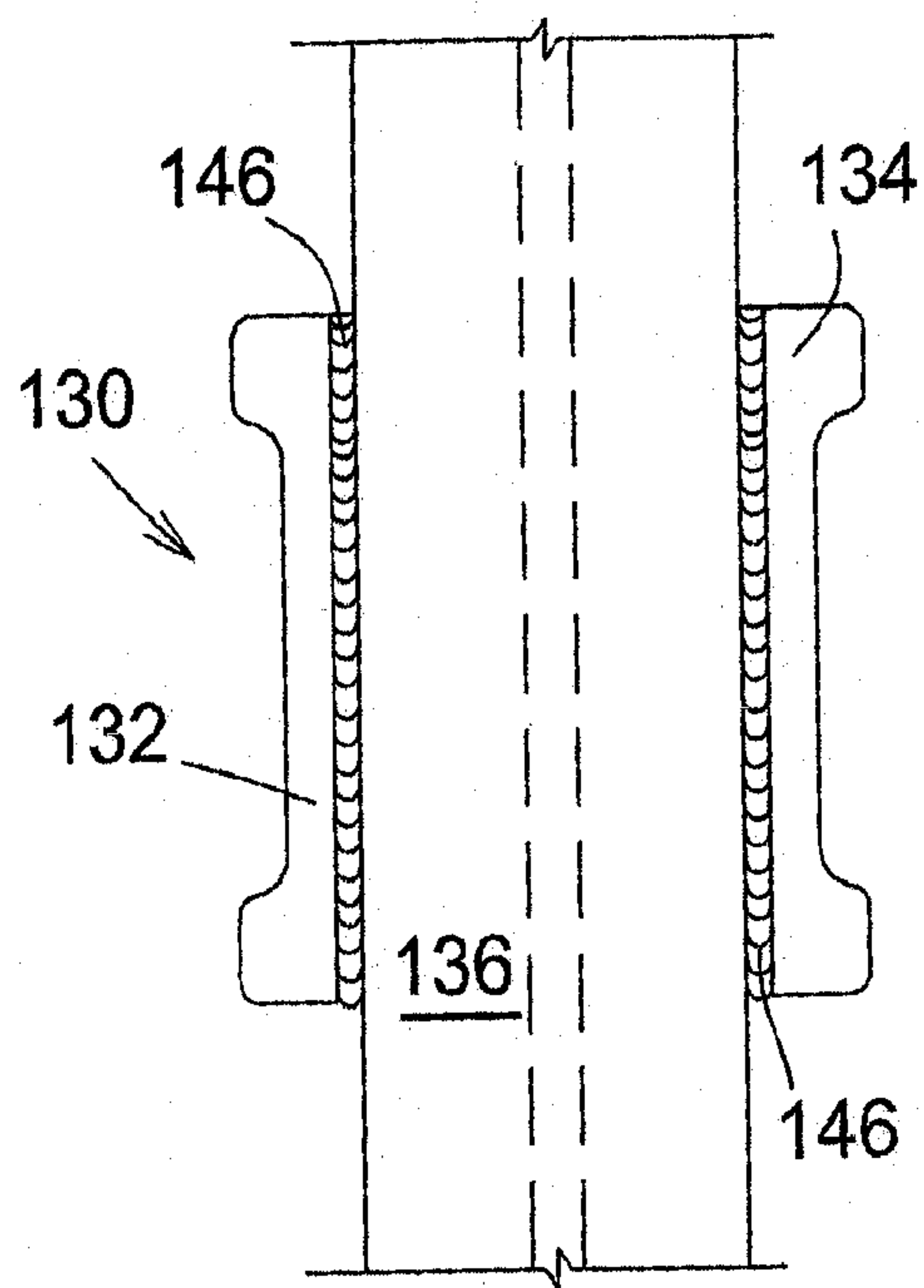


FIG. 5

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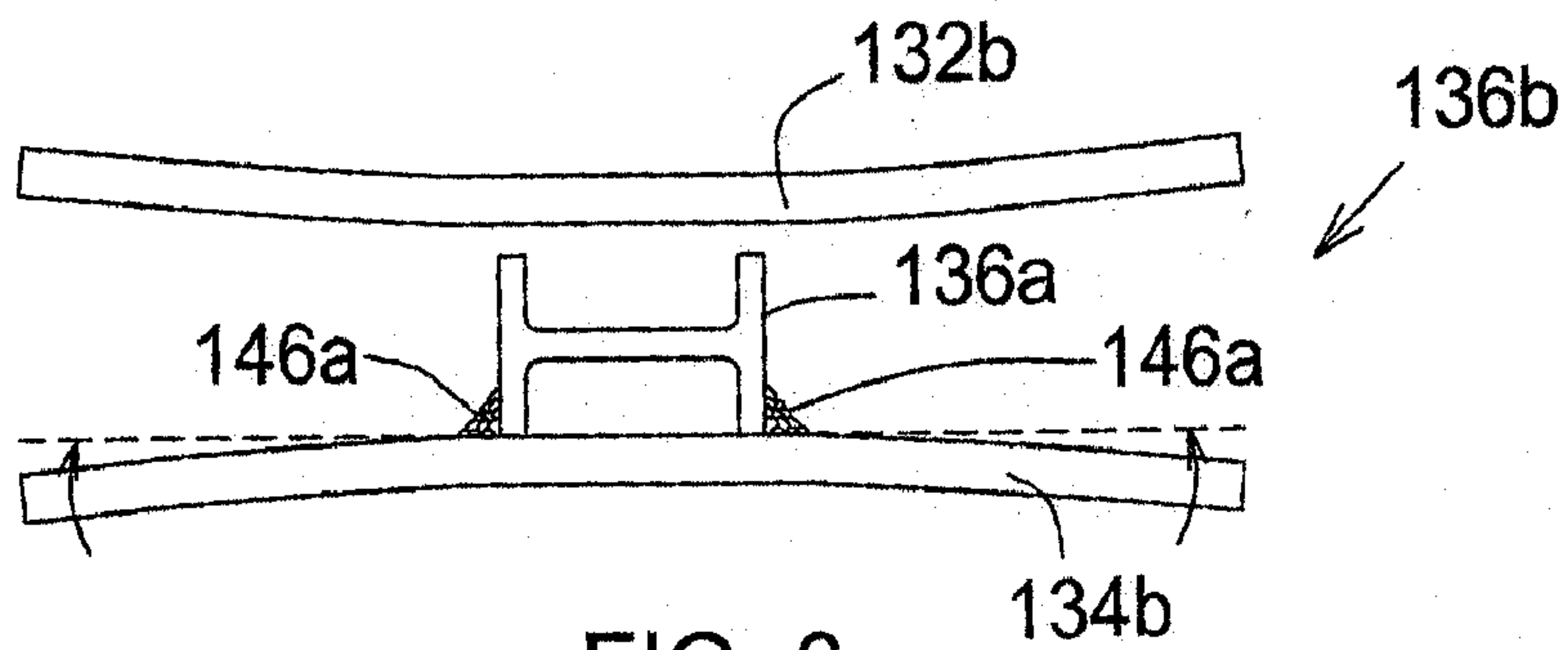


FIG. 6

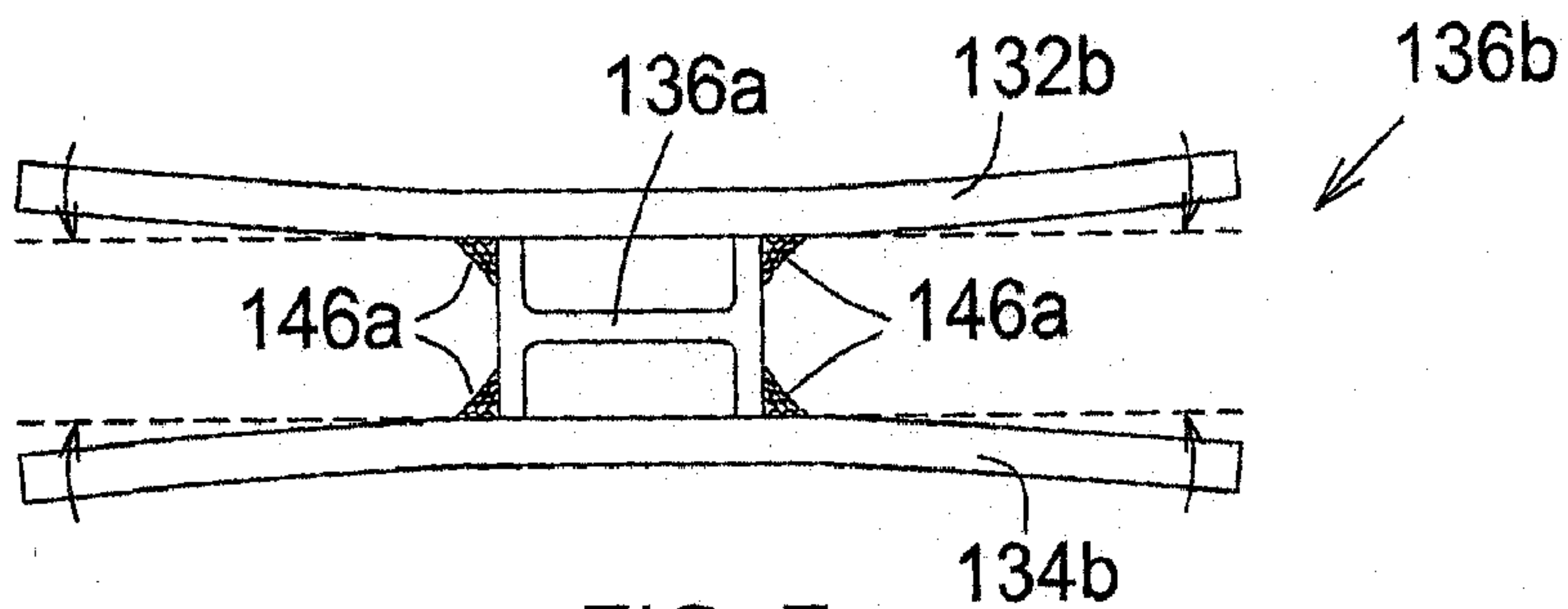


FIG. 7

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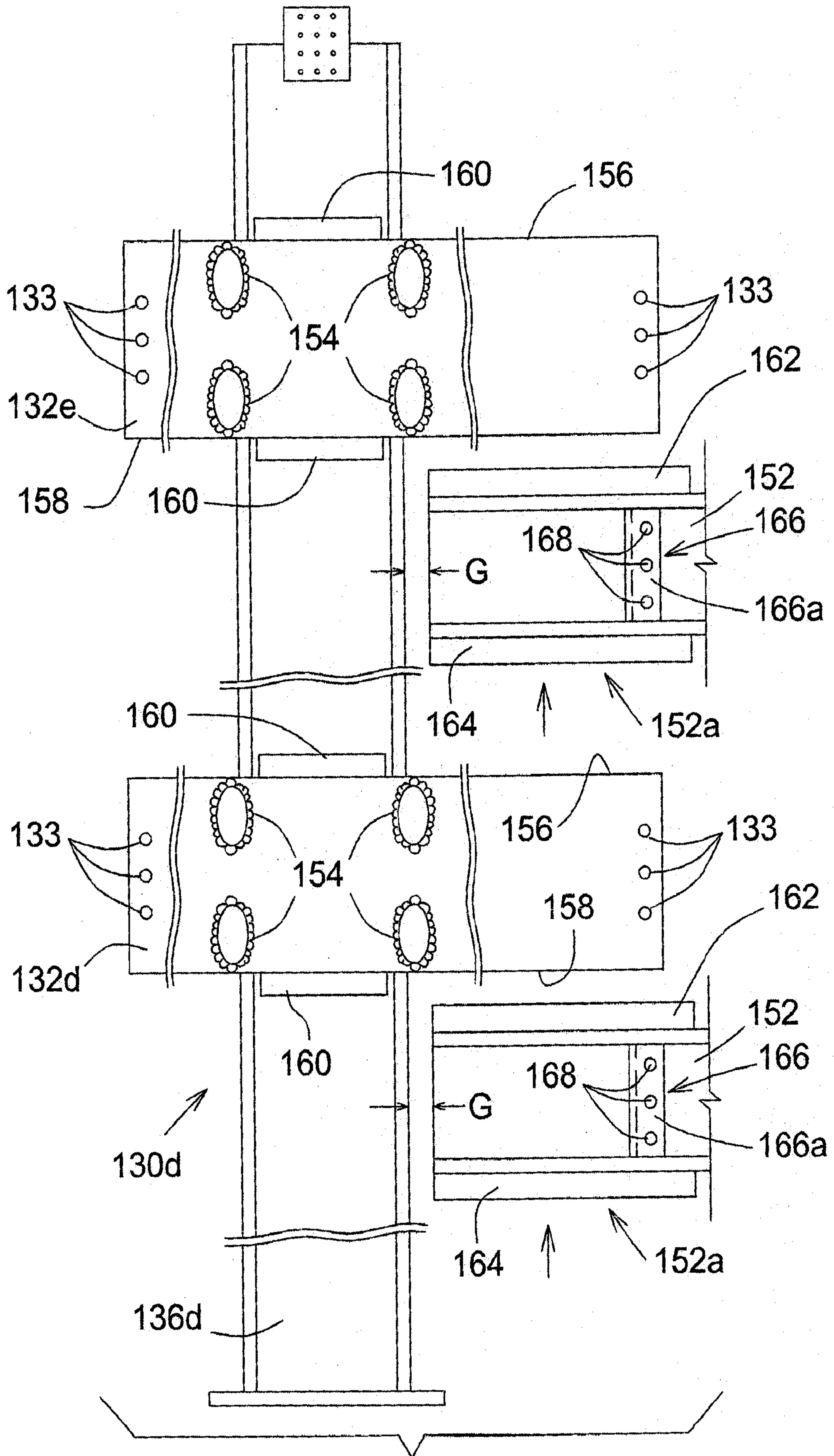


FIG. 8

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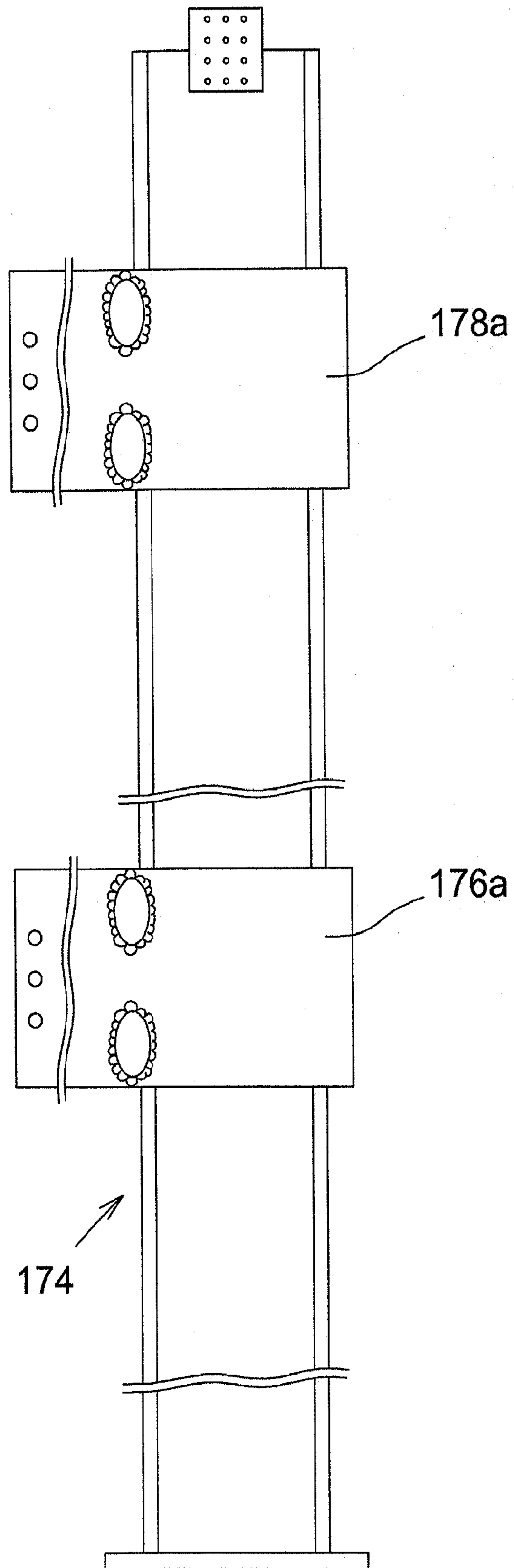


FIG. 8A

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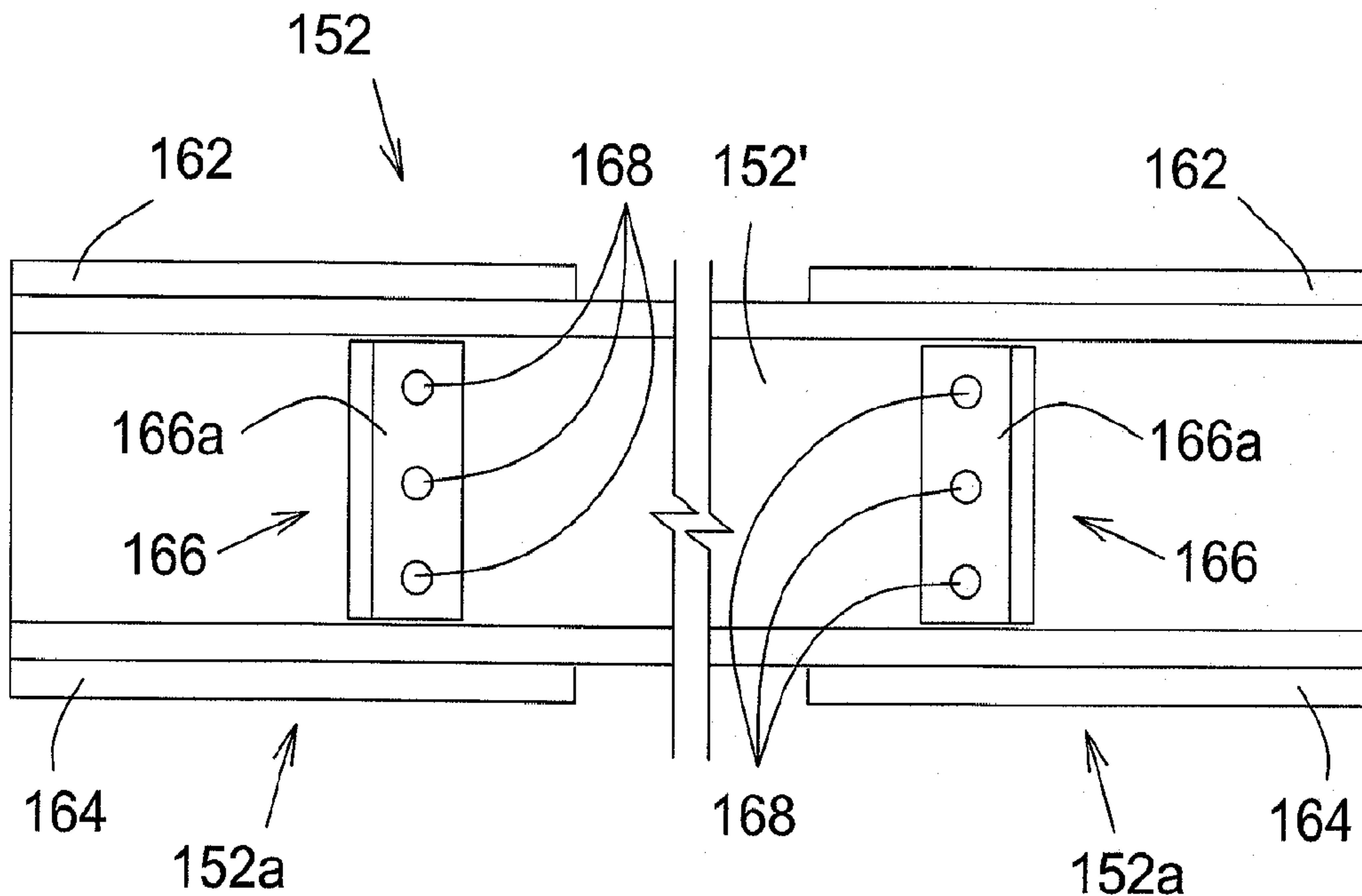


FIG. 9

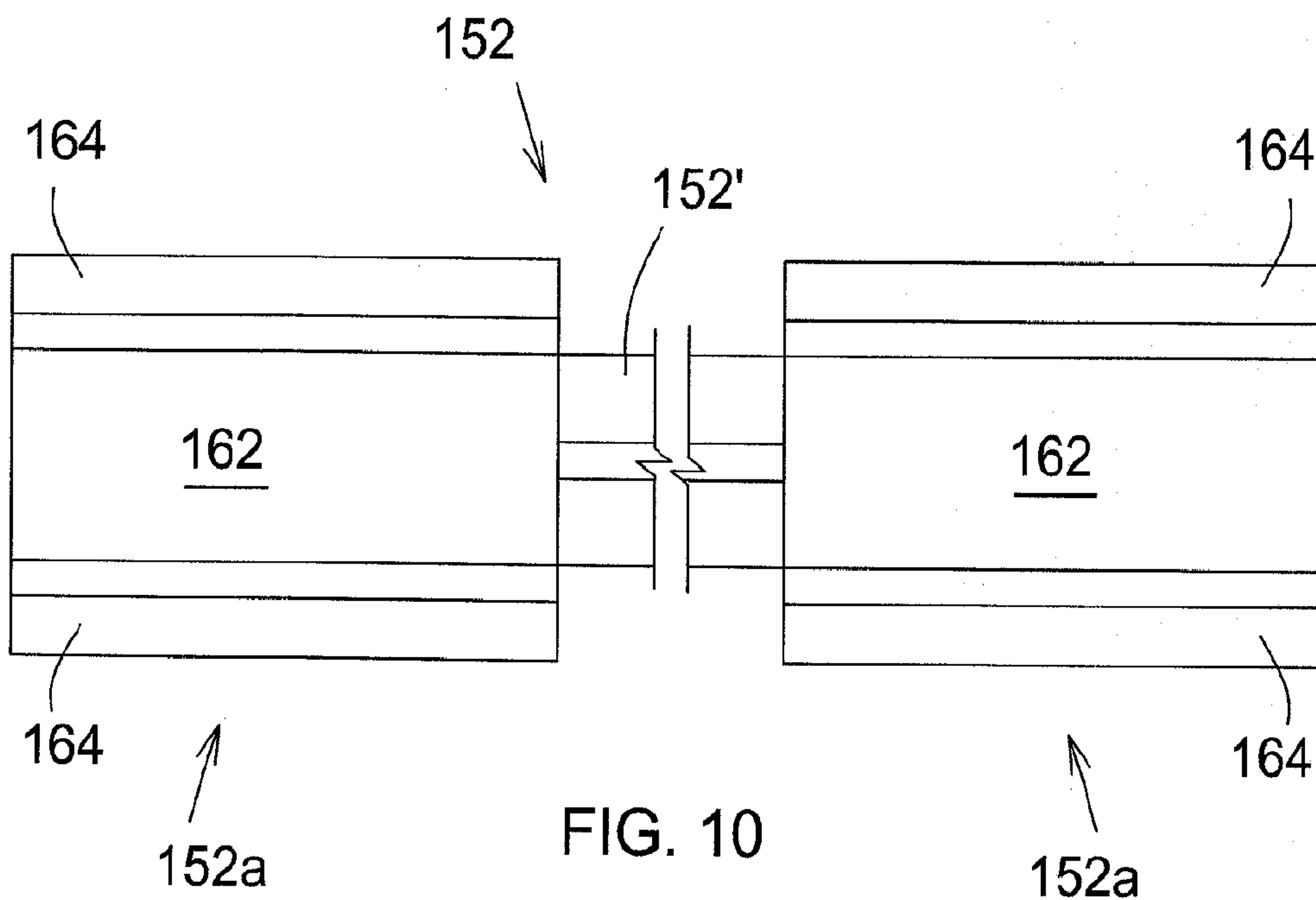


FIG. 10

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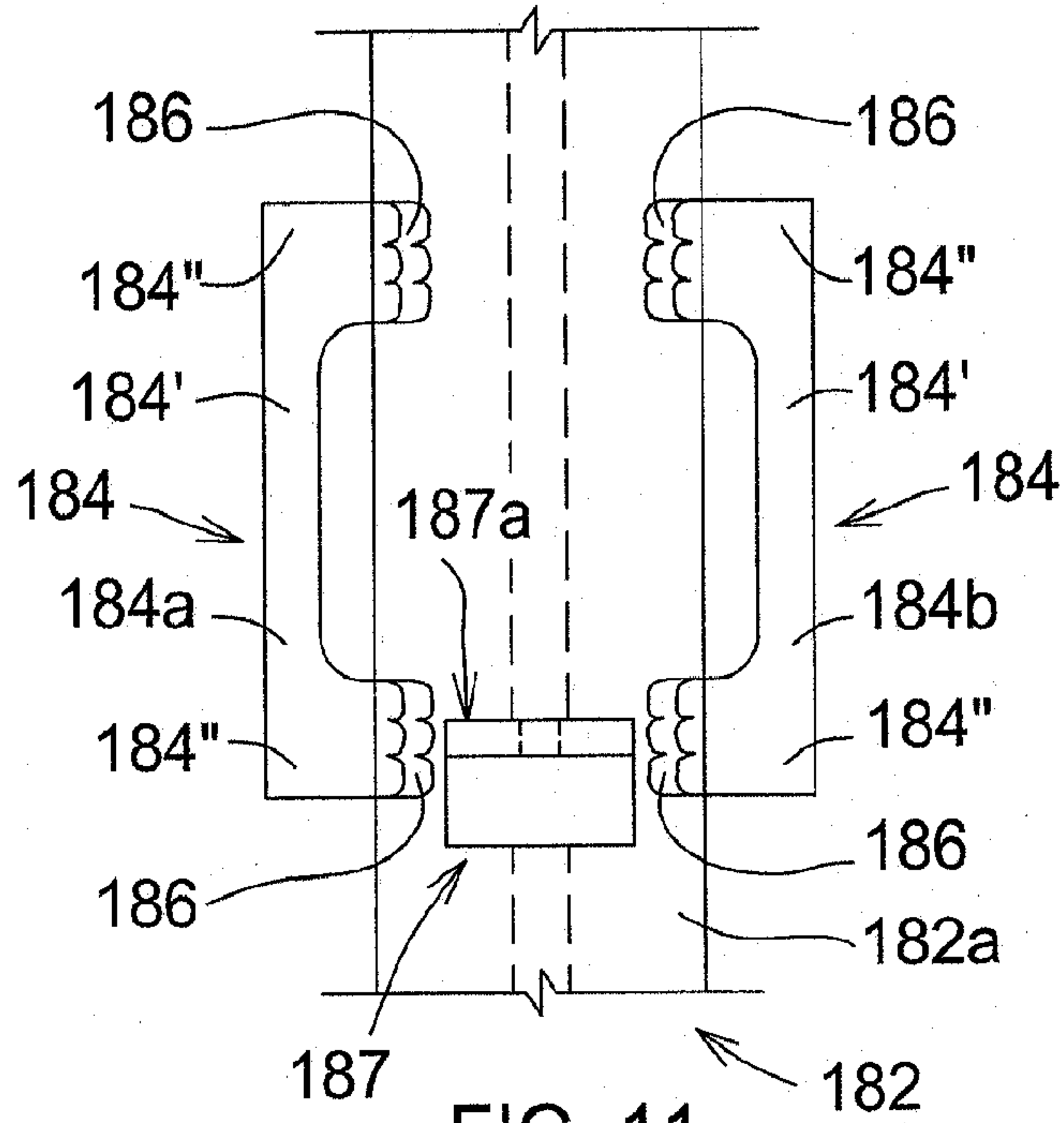


FIG. 11

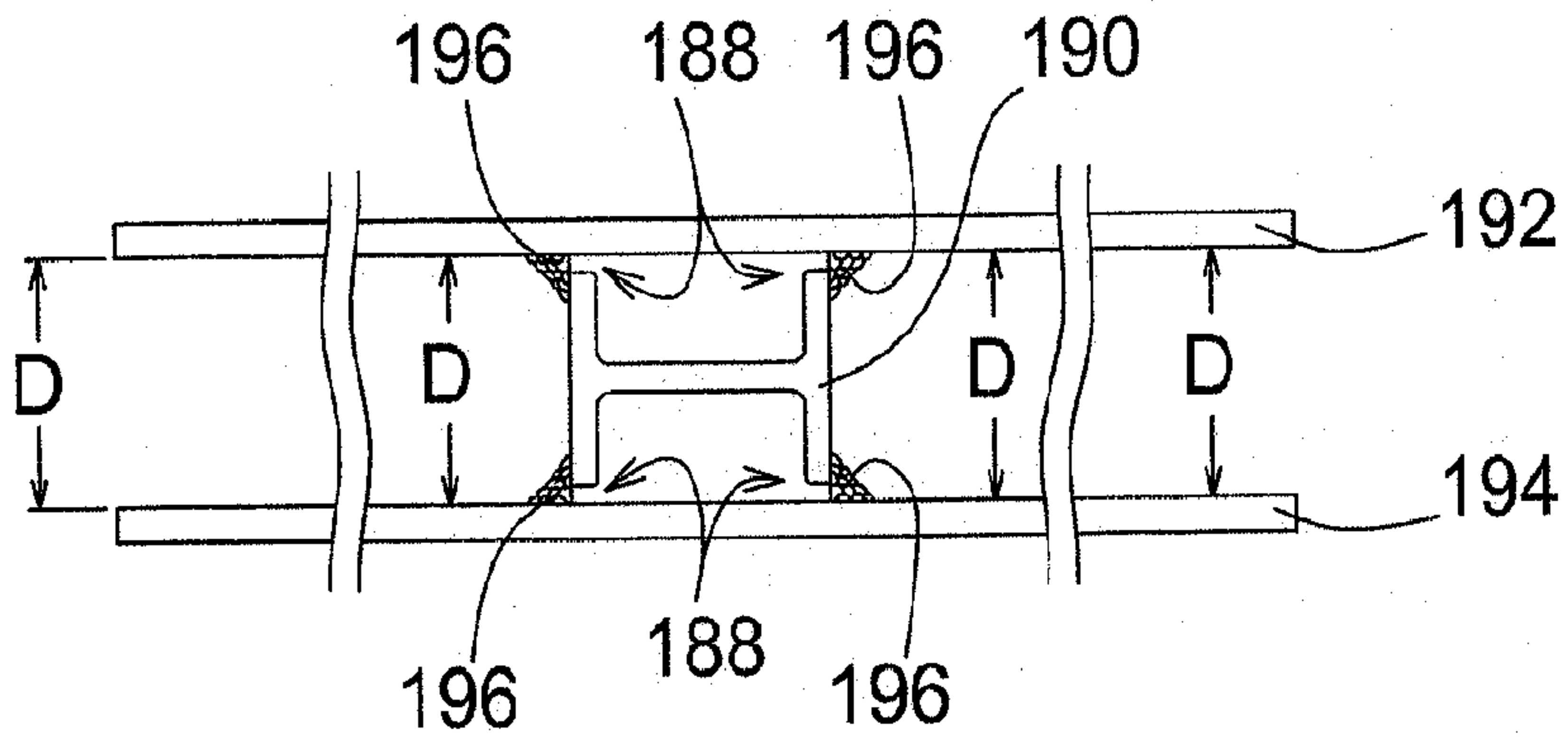


FIG. 12

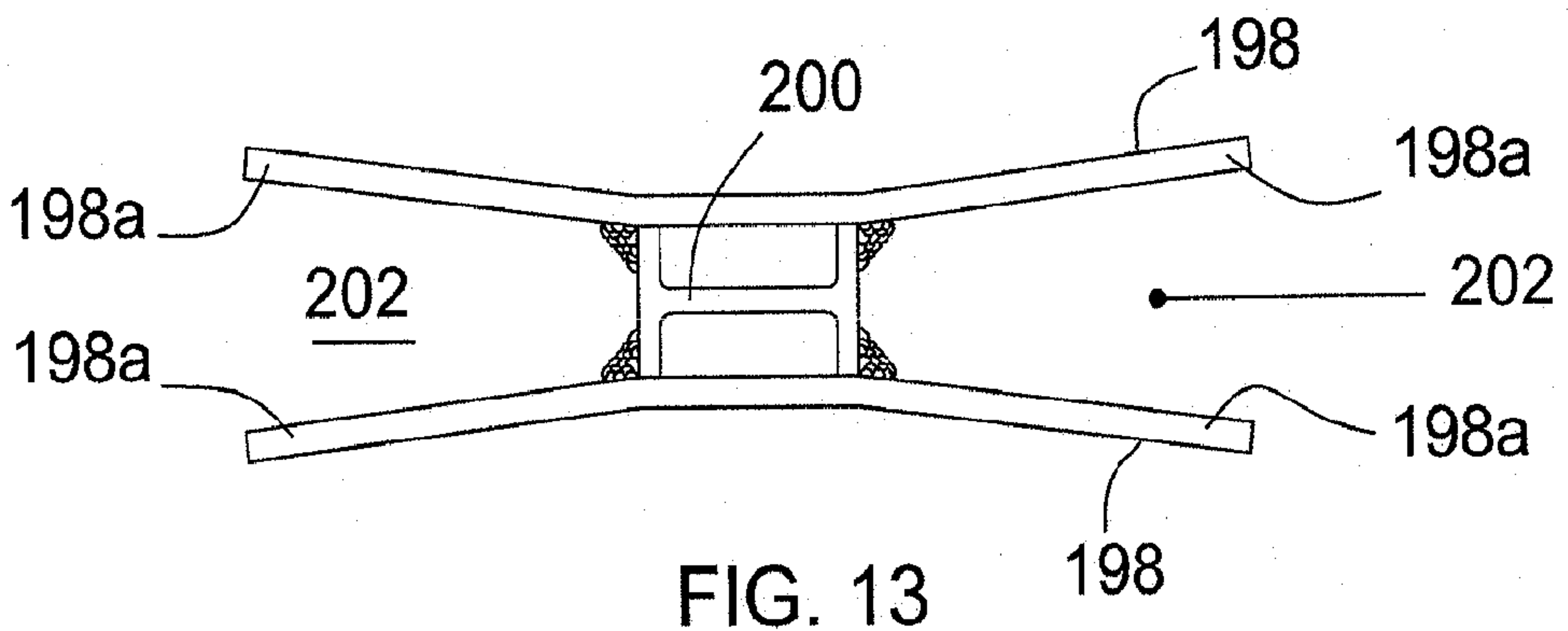


FIG. 13

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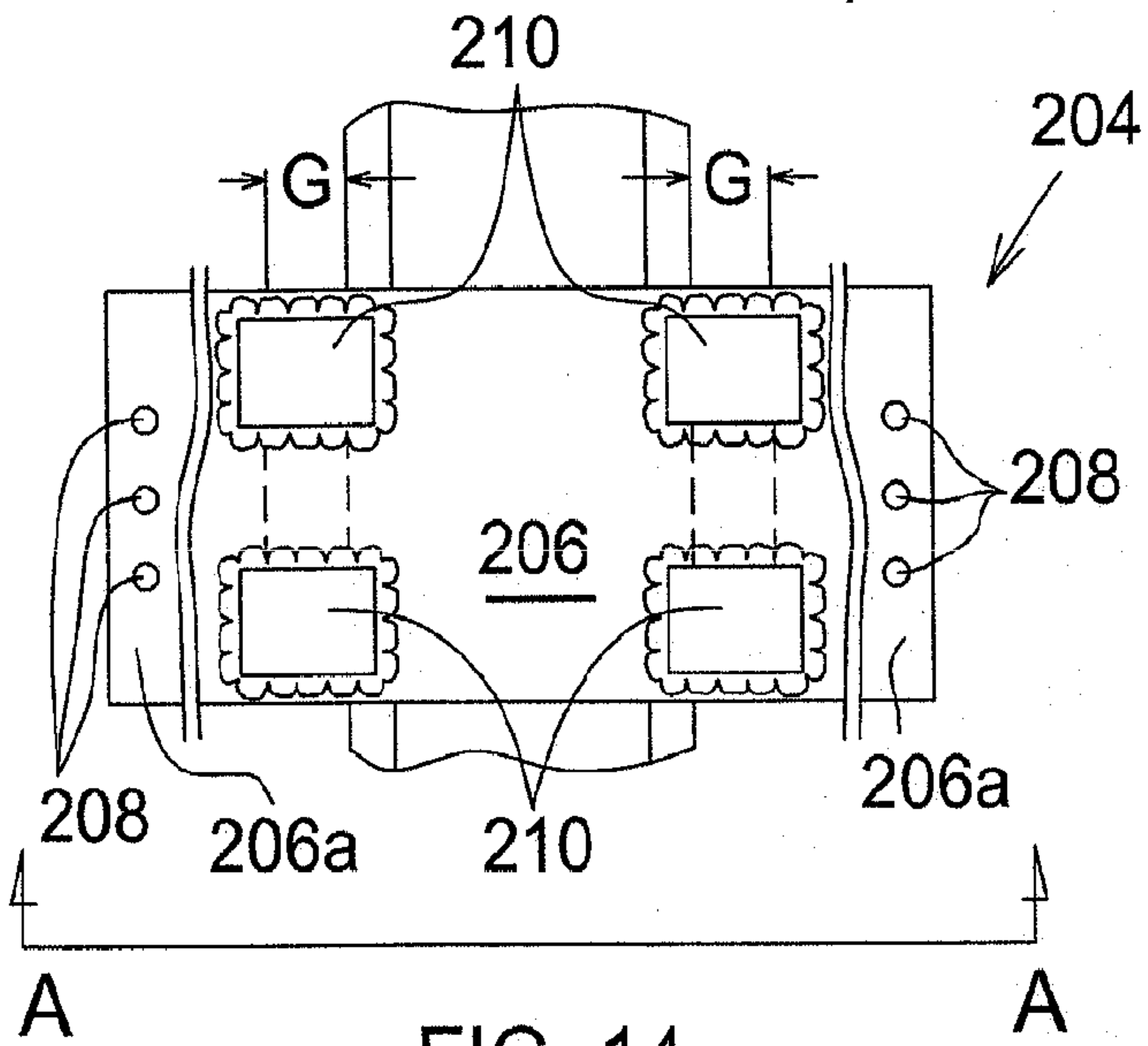
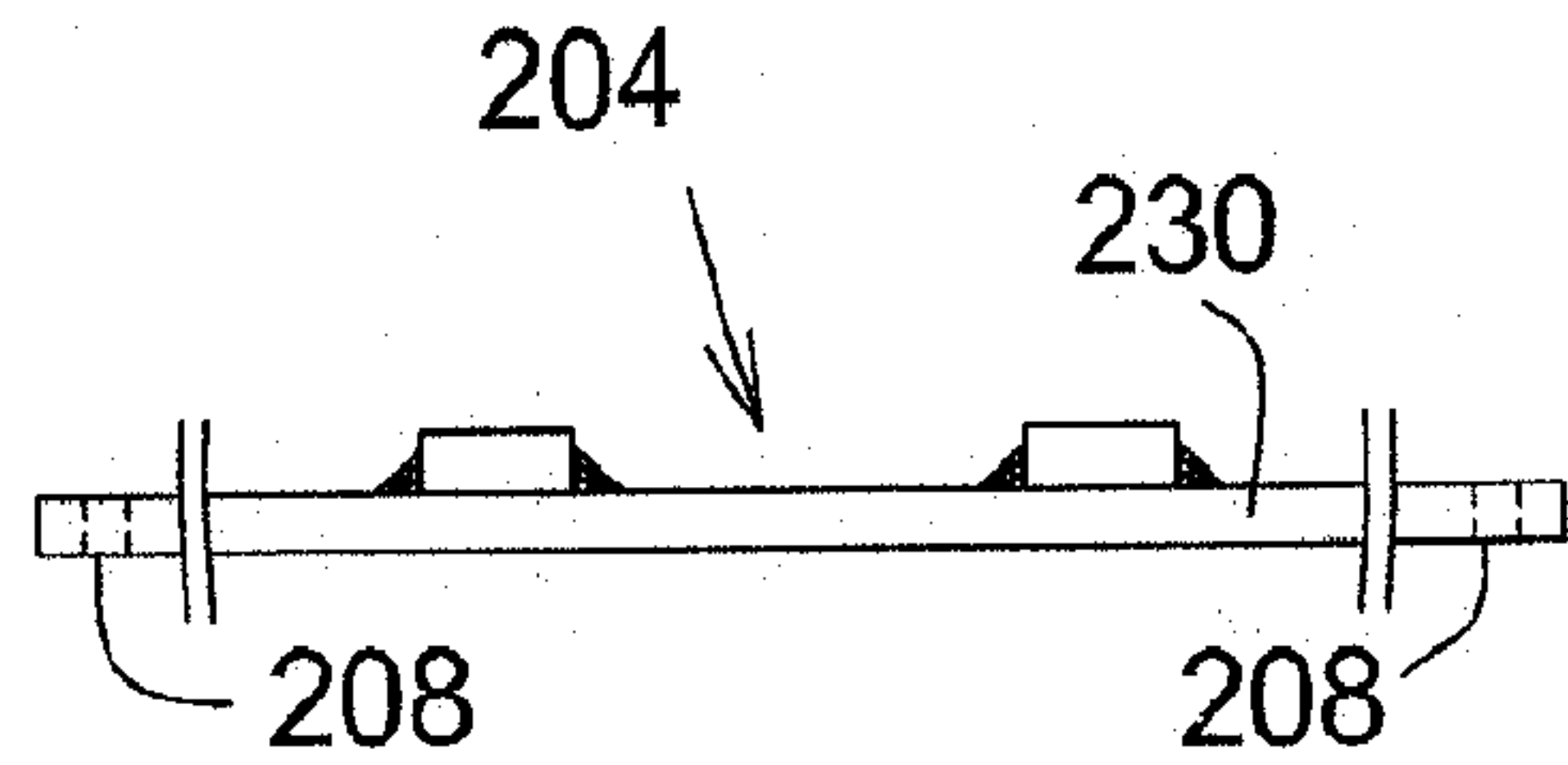


FIG. 14



SECTION A-A
FIG. 14A

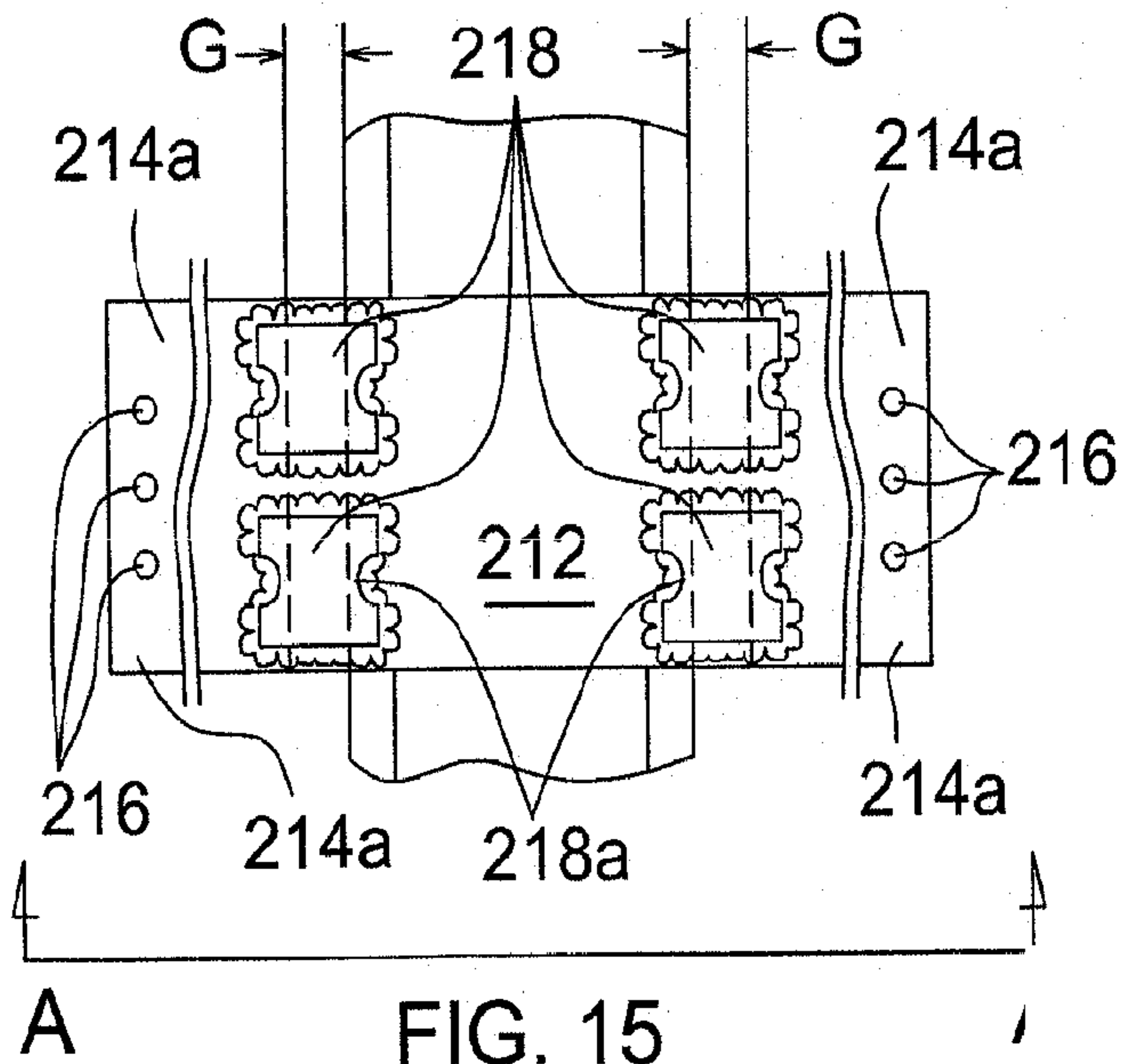
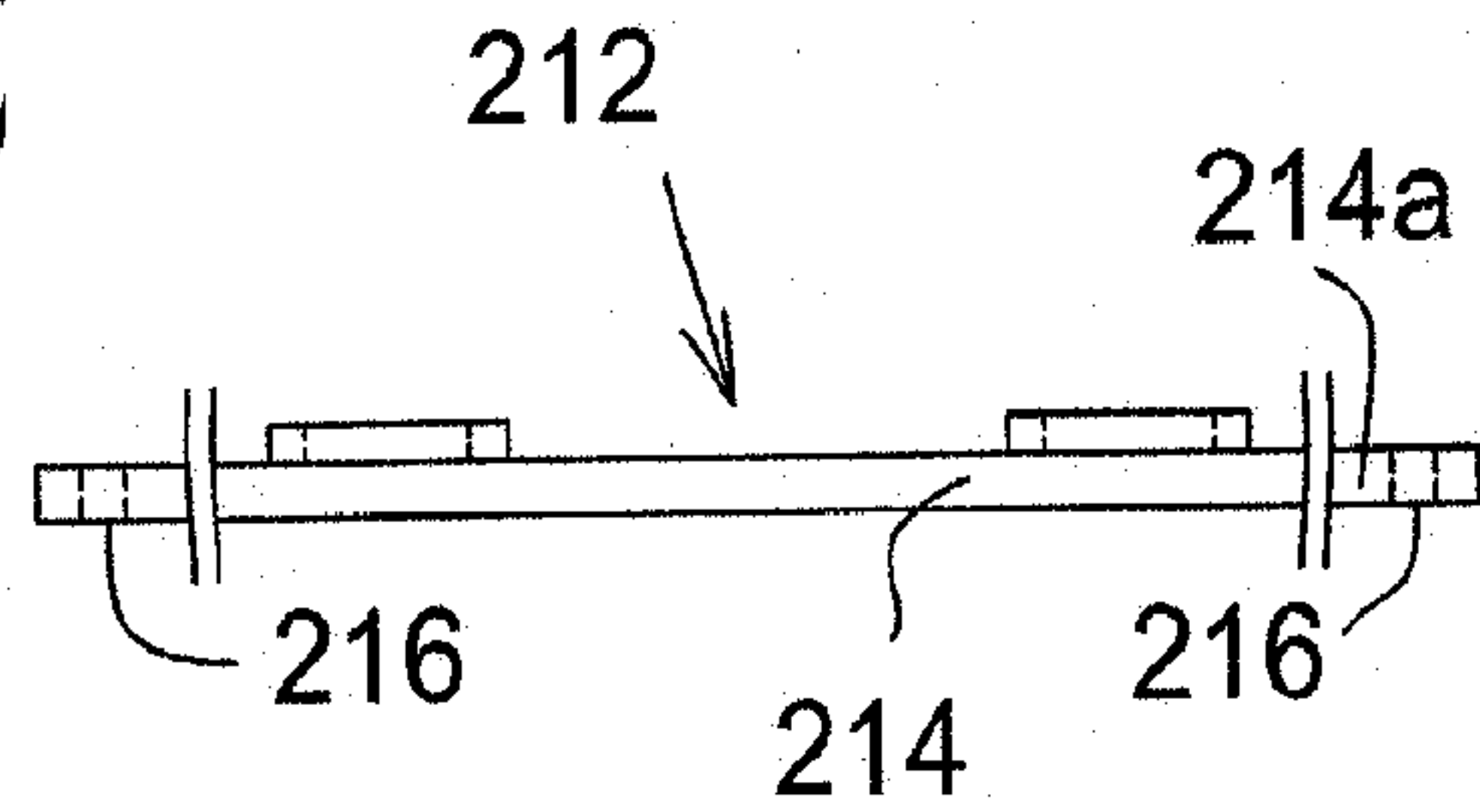


FIG. 15



SECTION A-A
FIG. 15A

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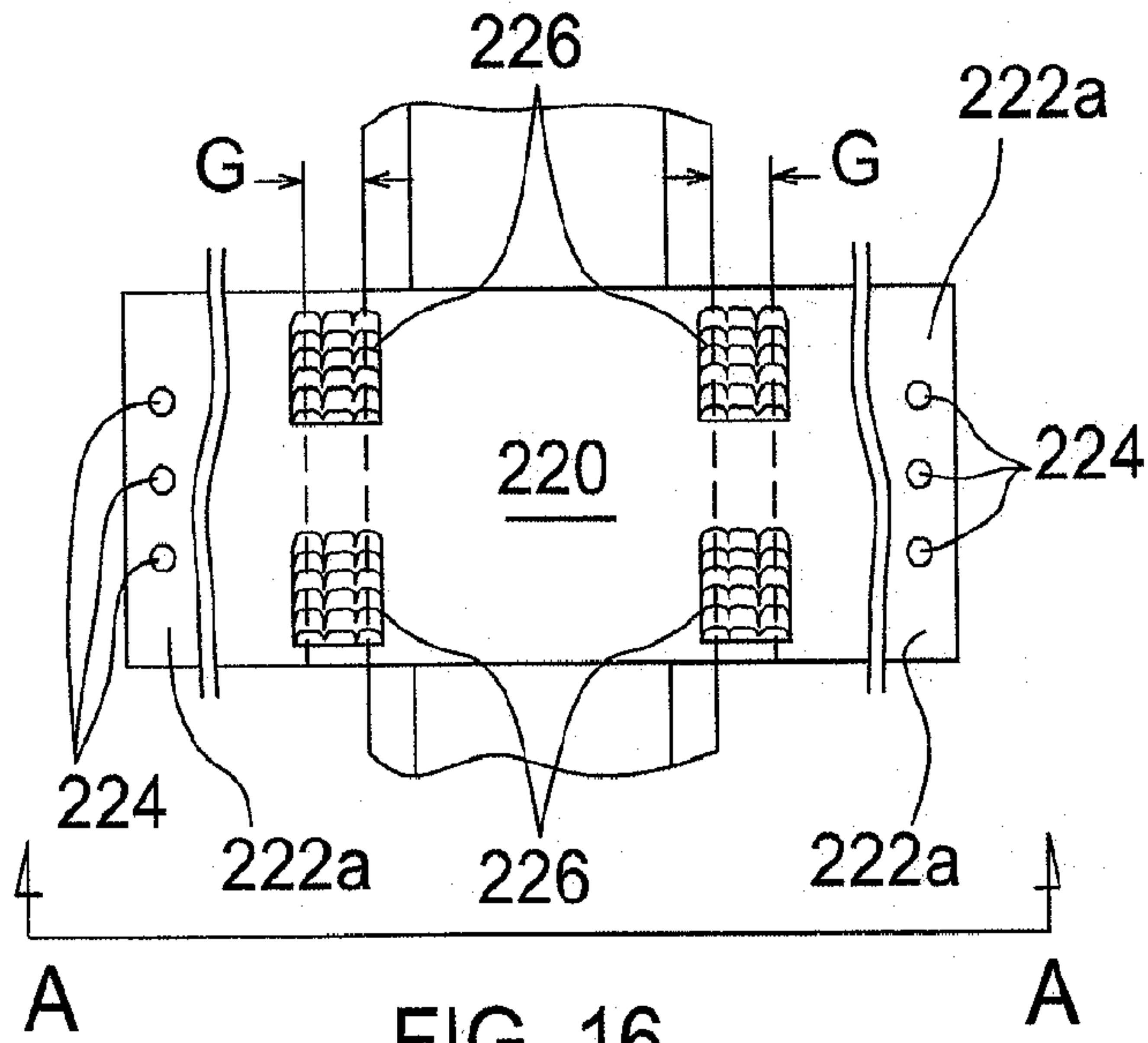
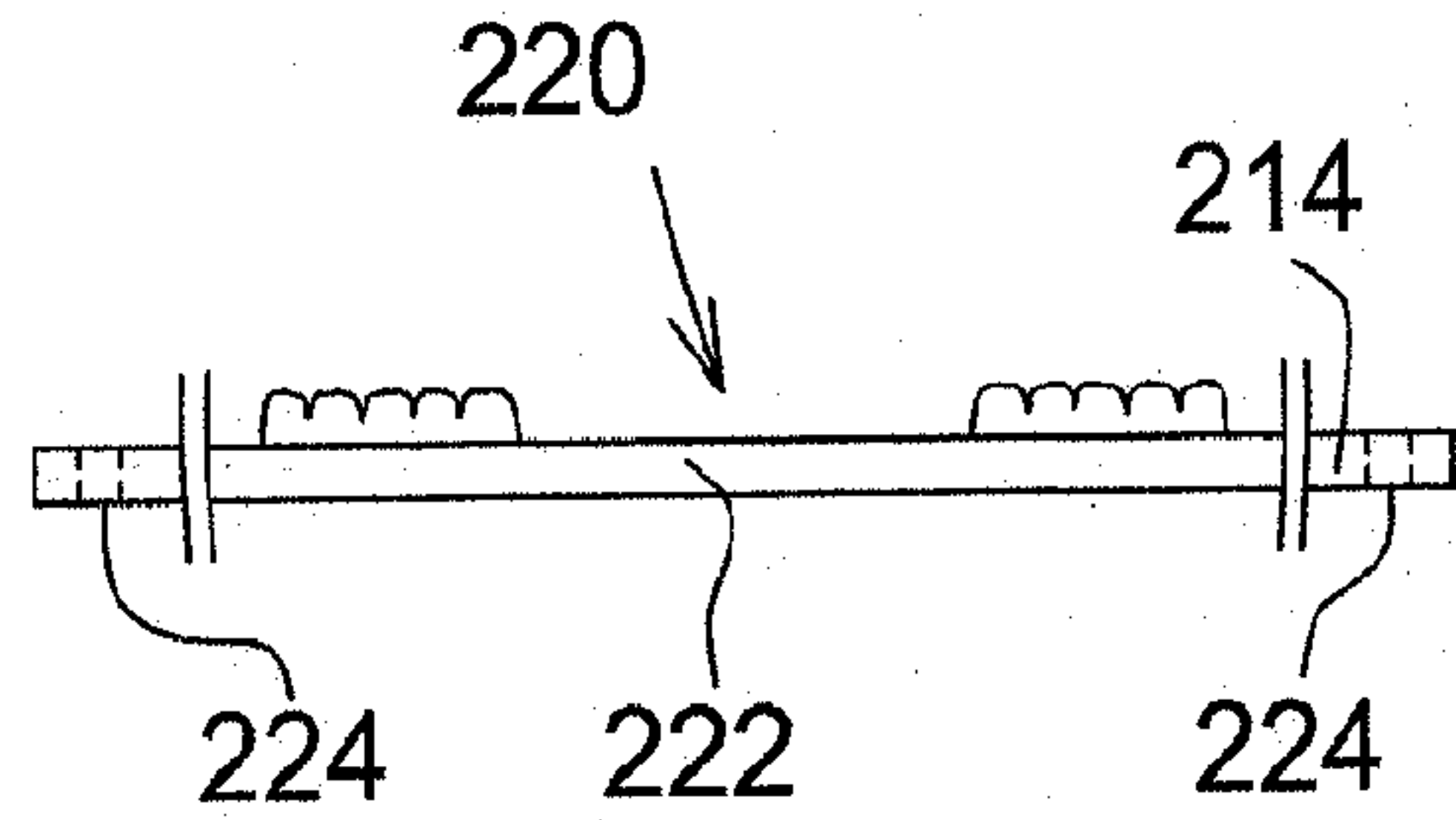


FIG. 16



SECTION A-A
FIG. 16A

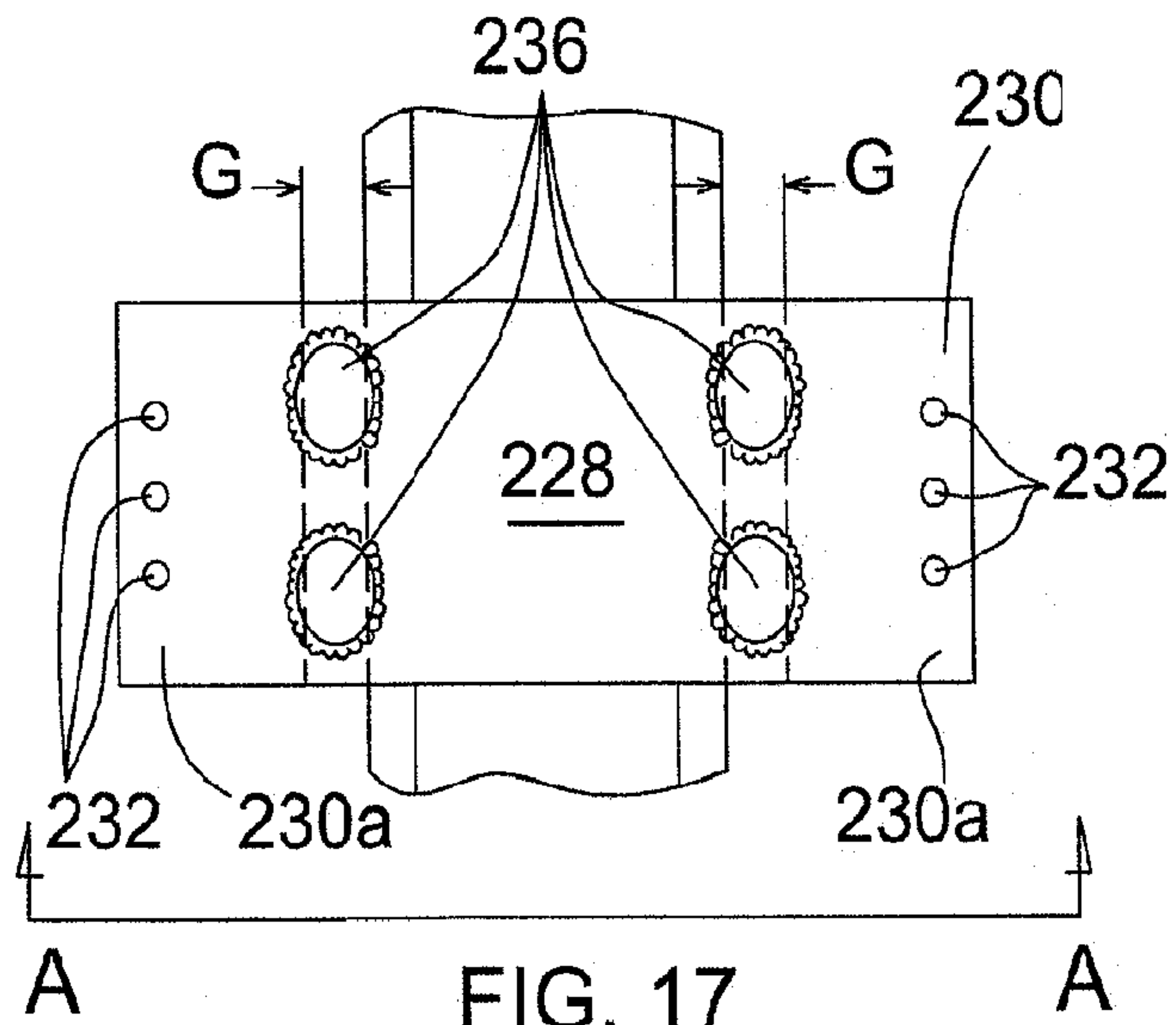
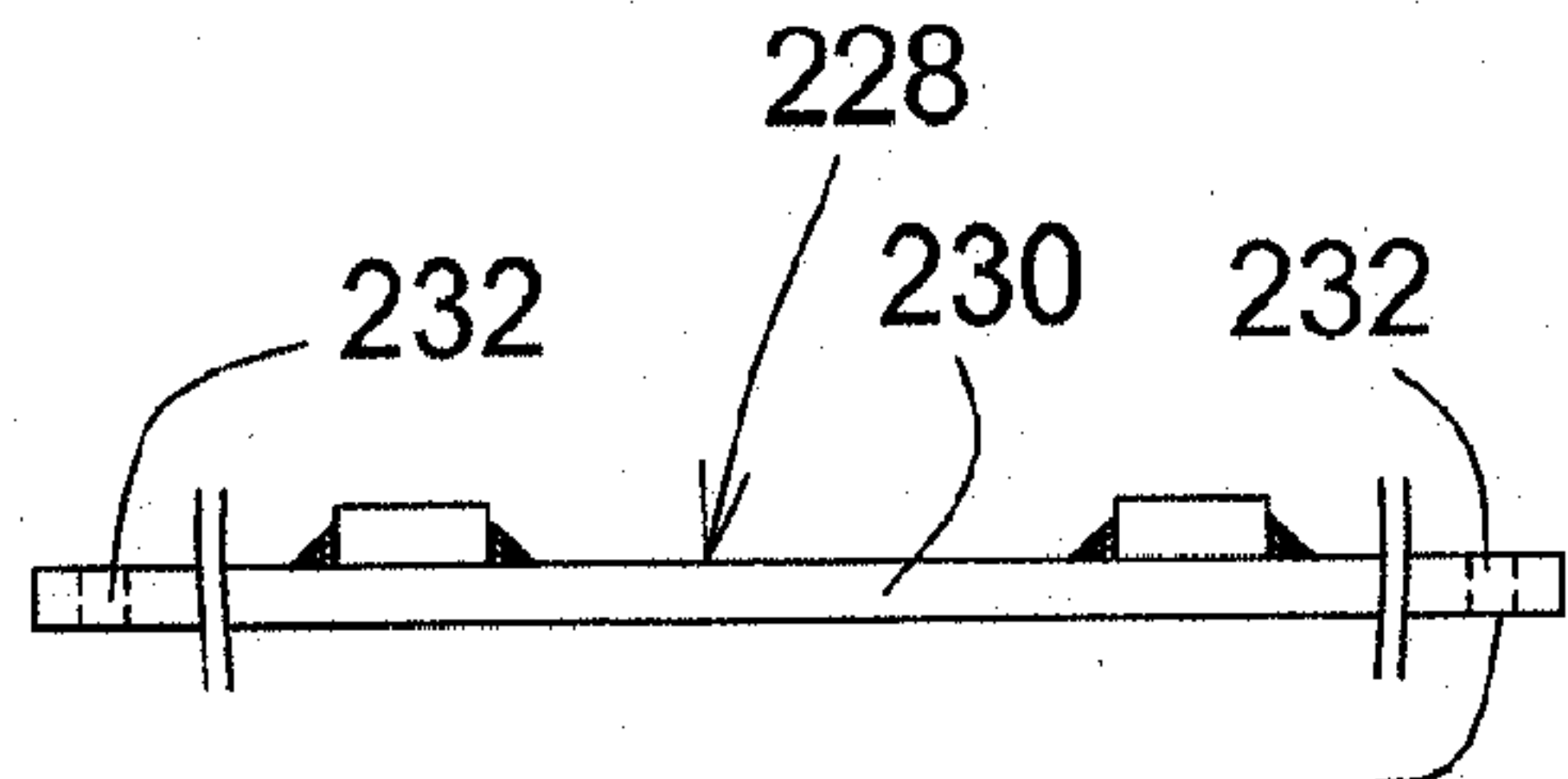


FIG. 17



SECTION A-A
FIG. 17A

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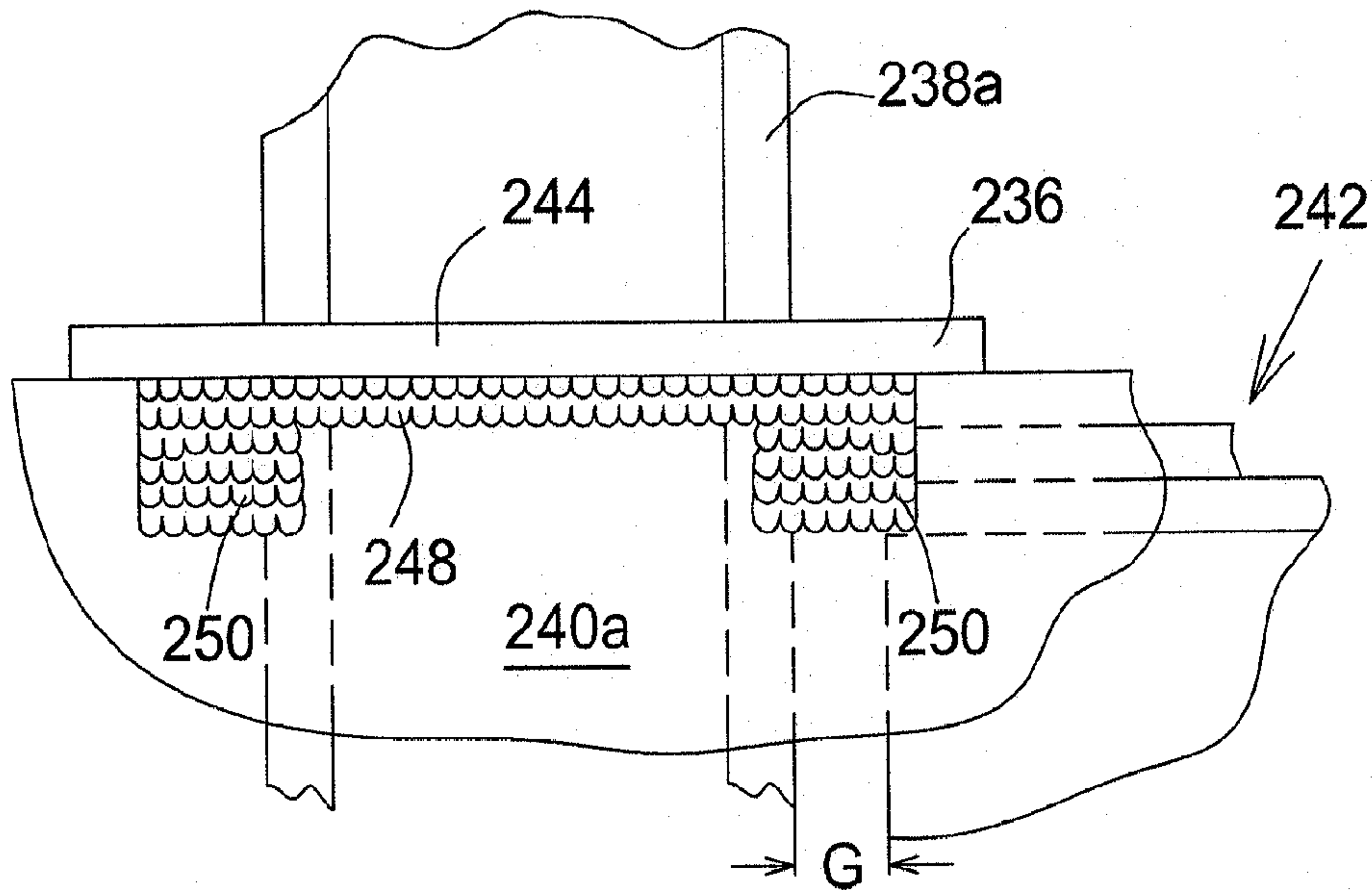


FIG. 18

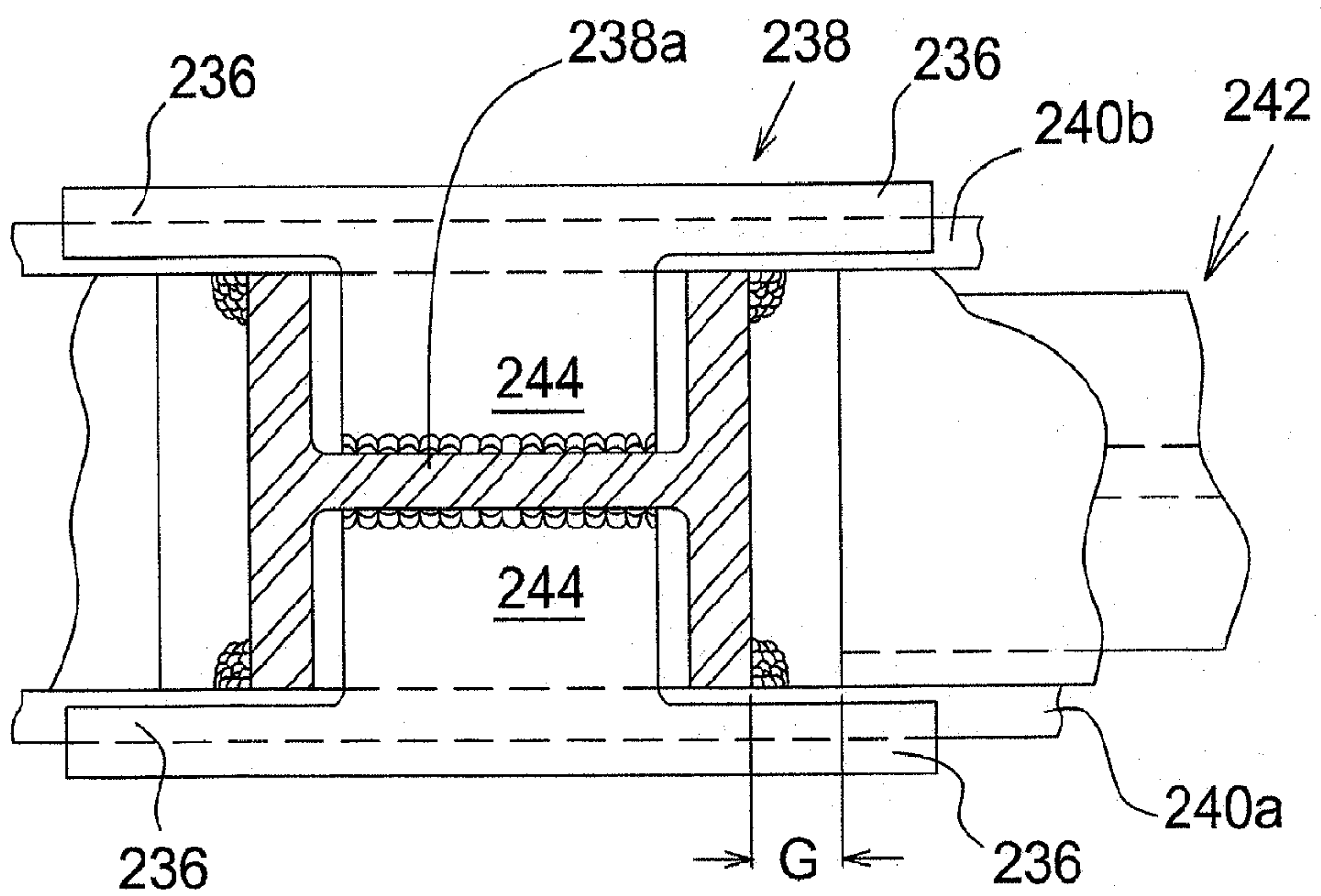


FIG. 18A

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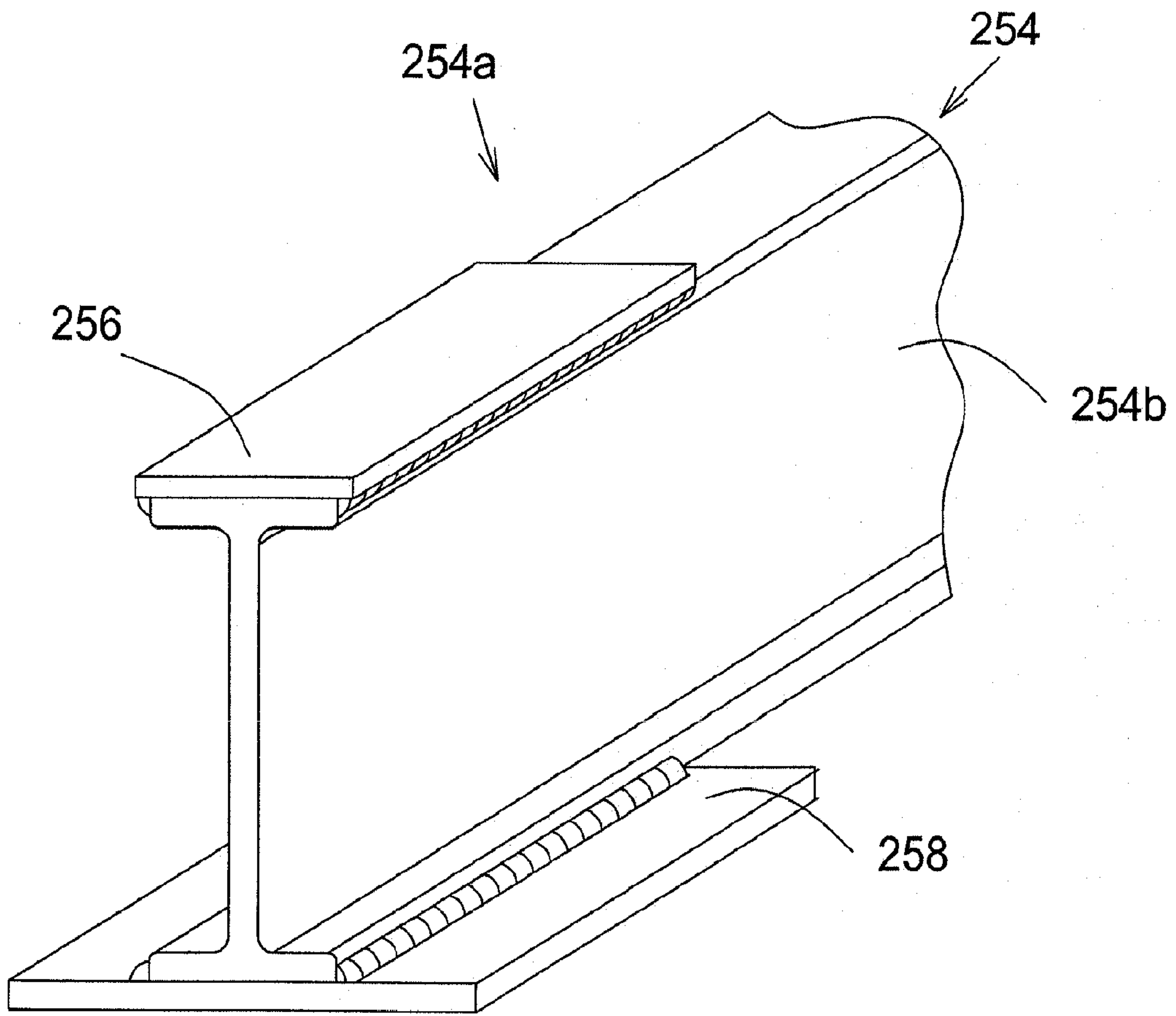


FIG. 19

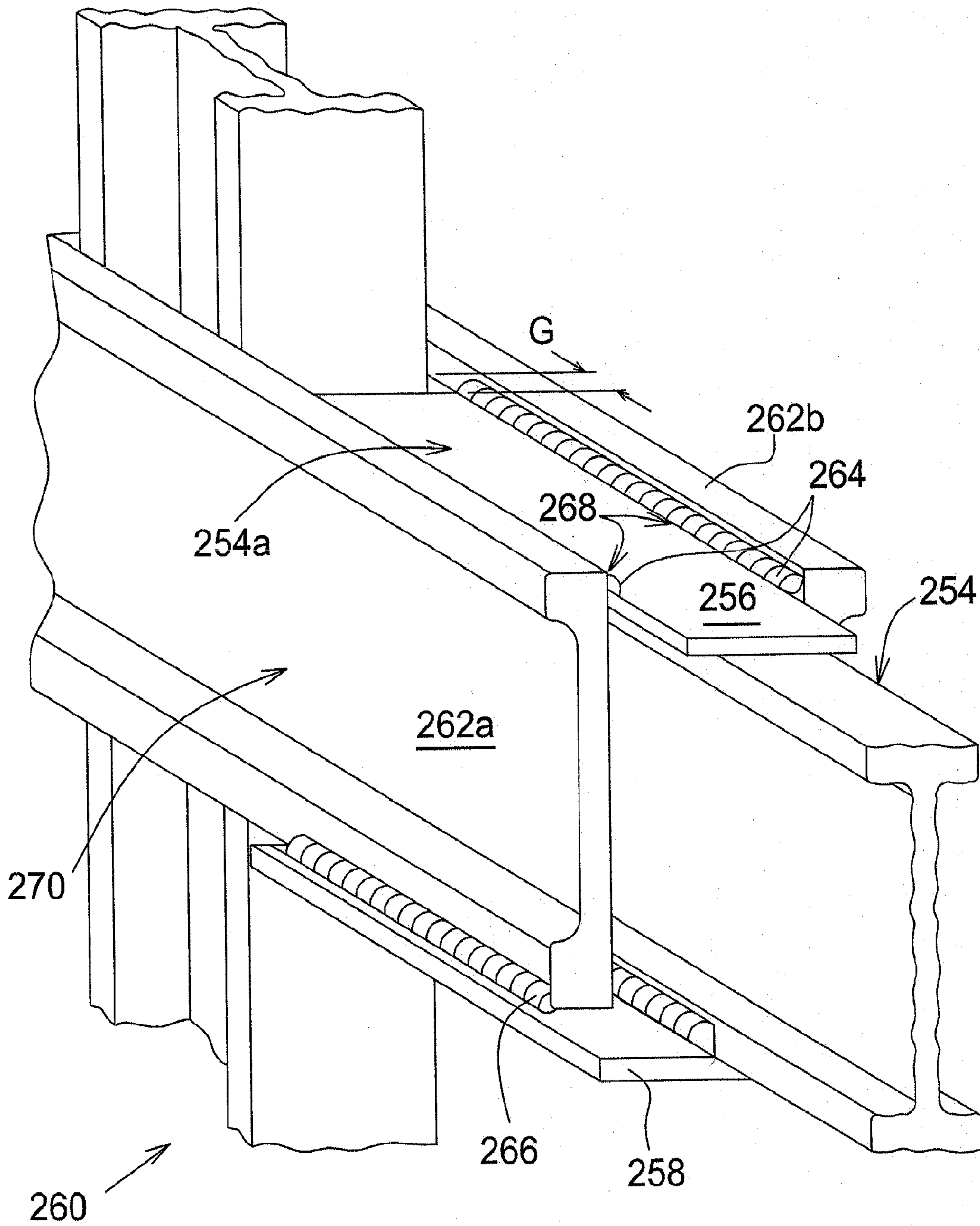


FIG. 20

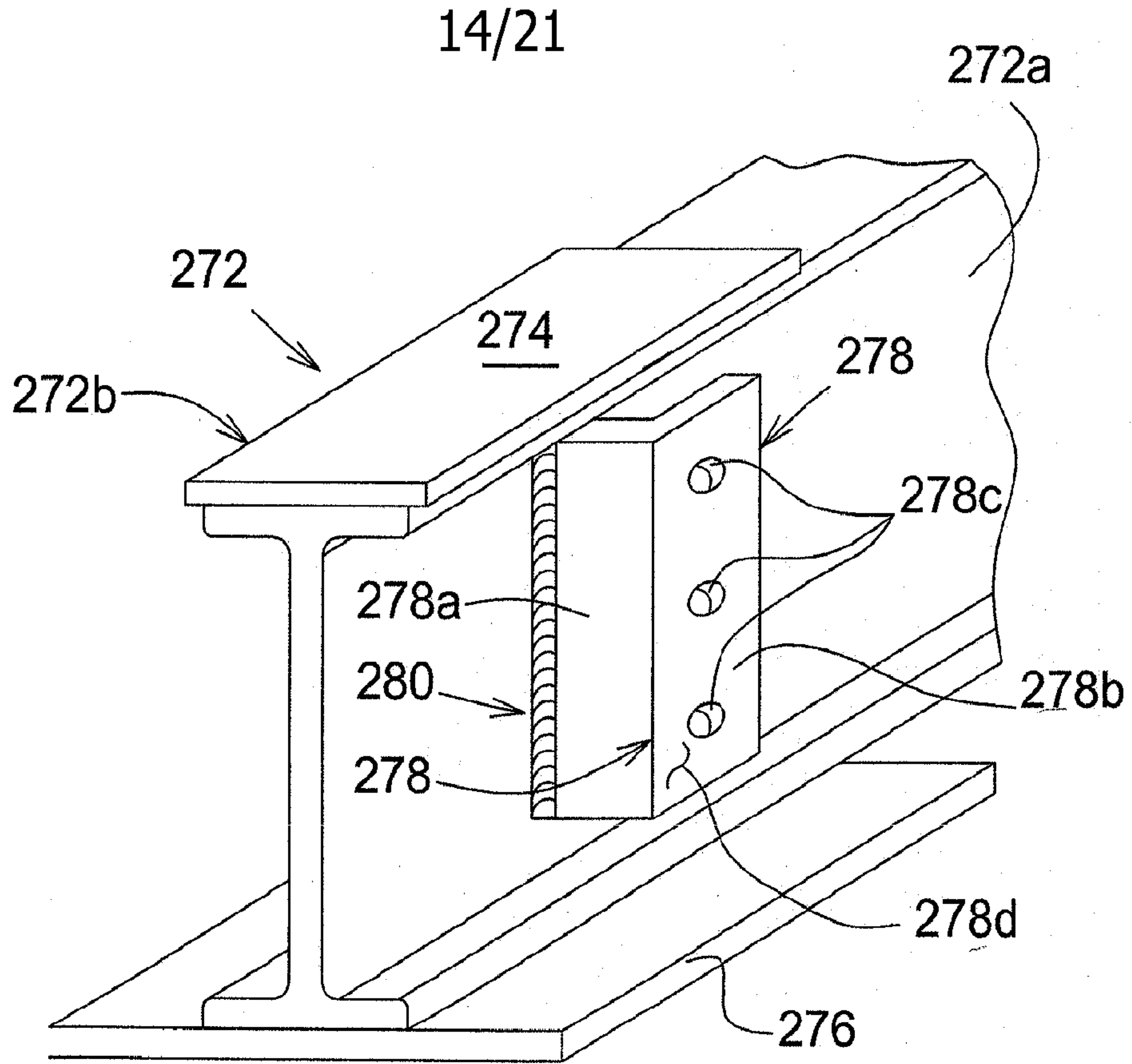


FIG. 21

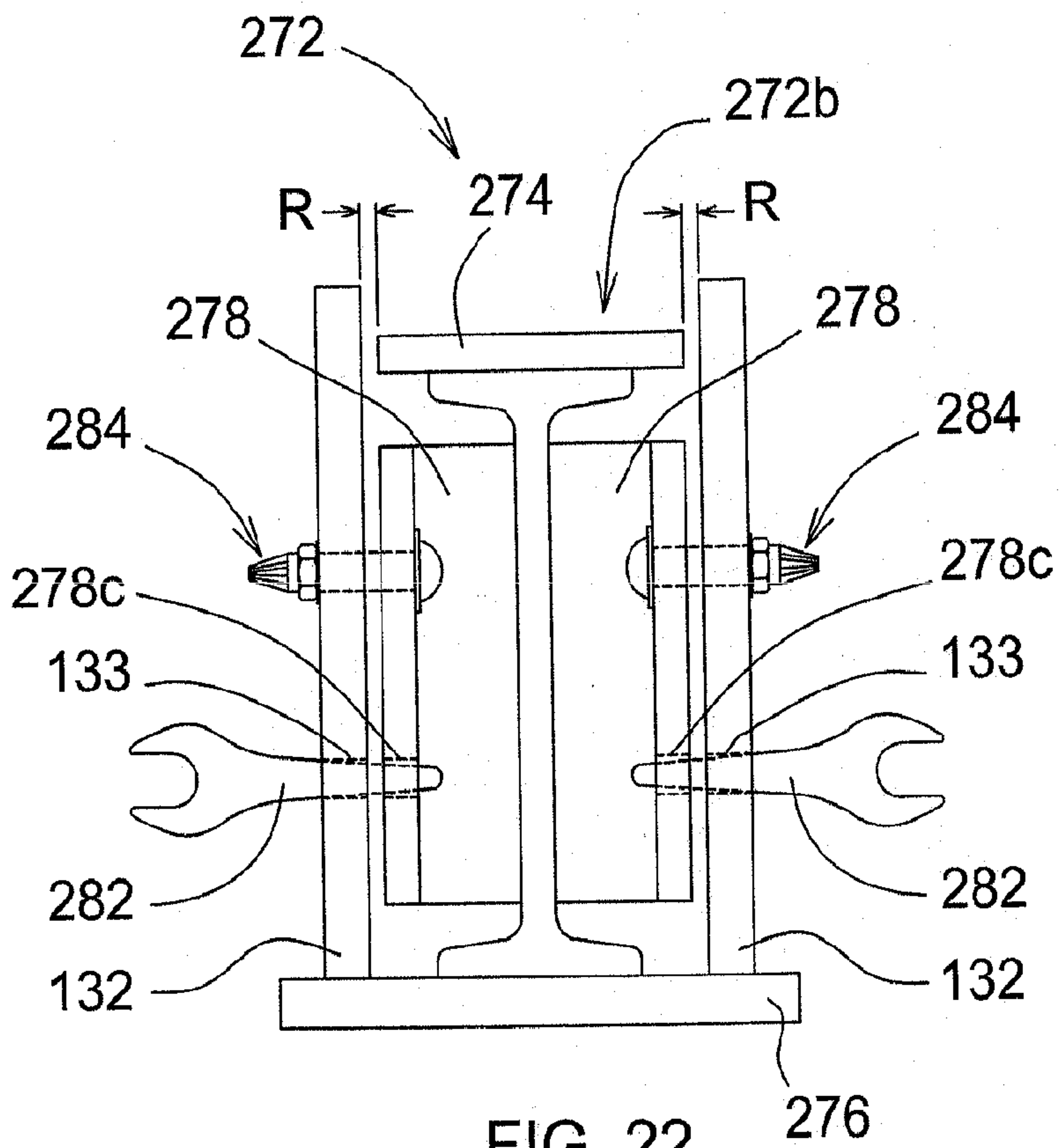


FIG. 22

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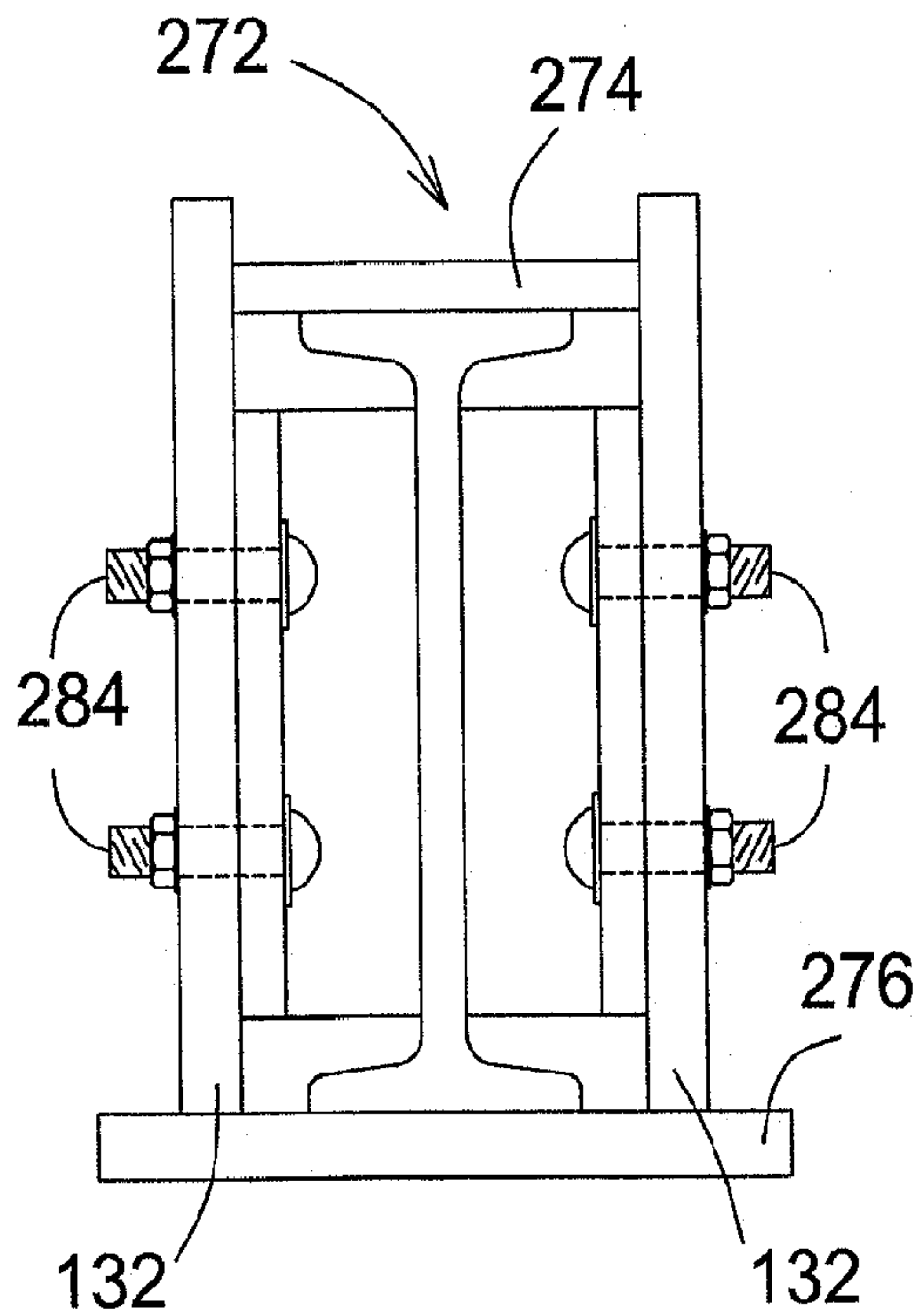


FIG. 23

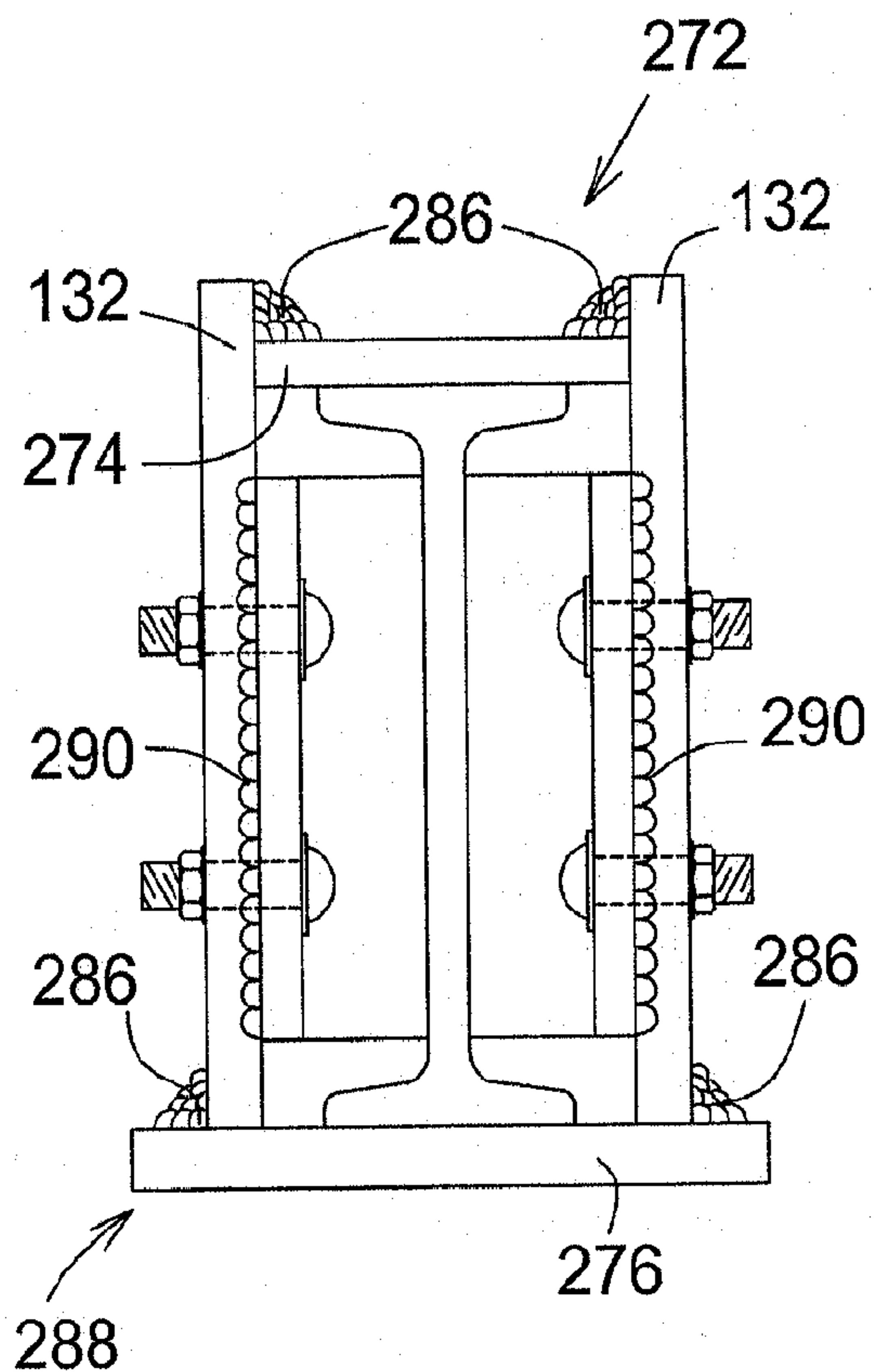


FIG. 24

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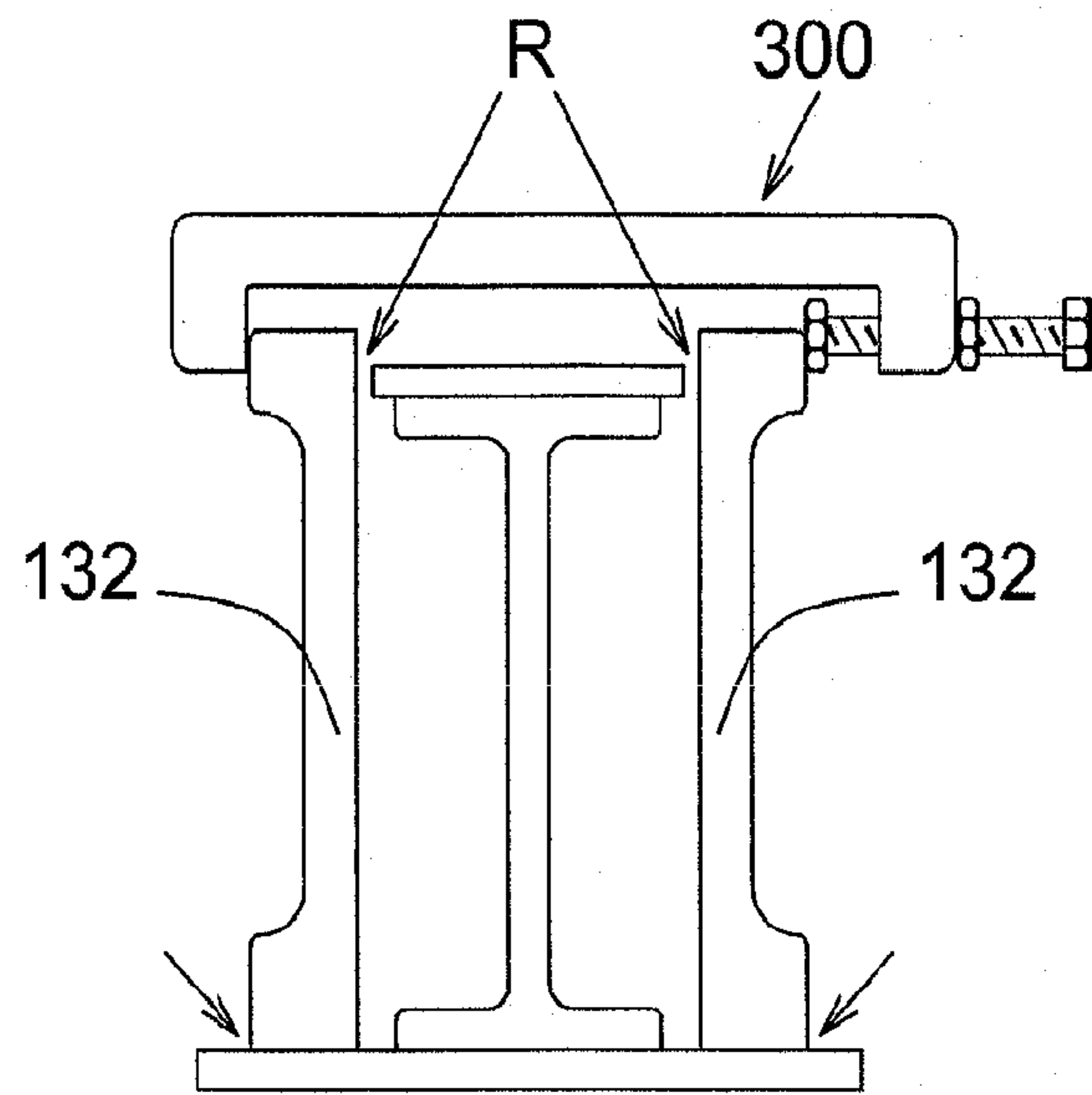


FIG. 25

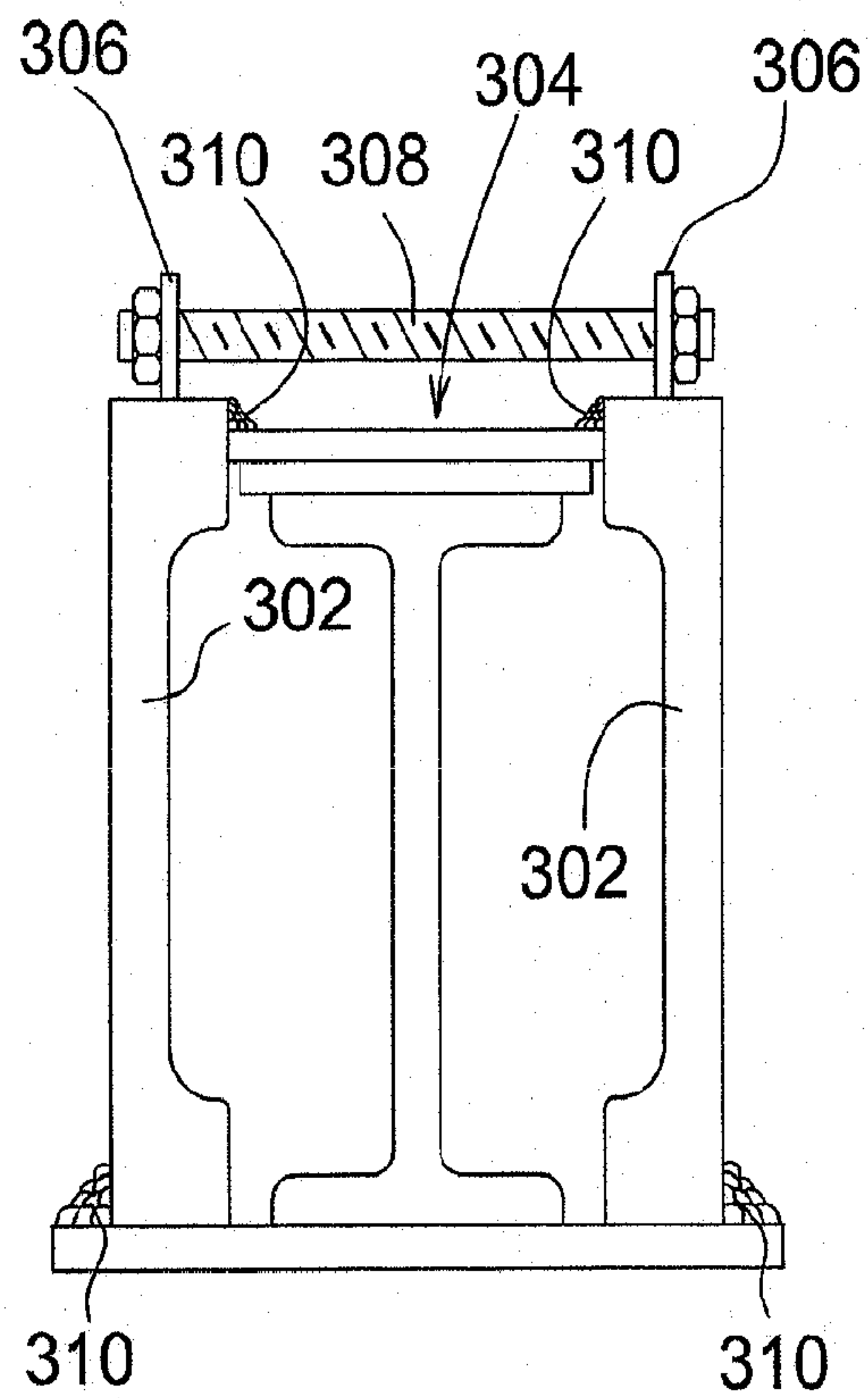


FIG. 26

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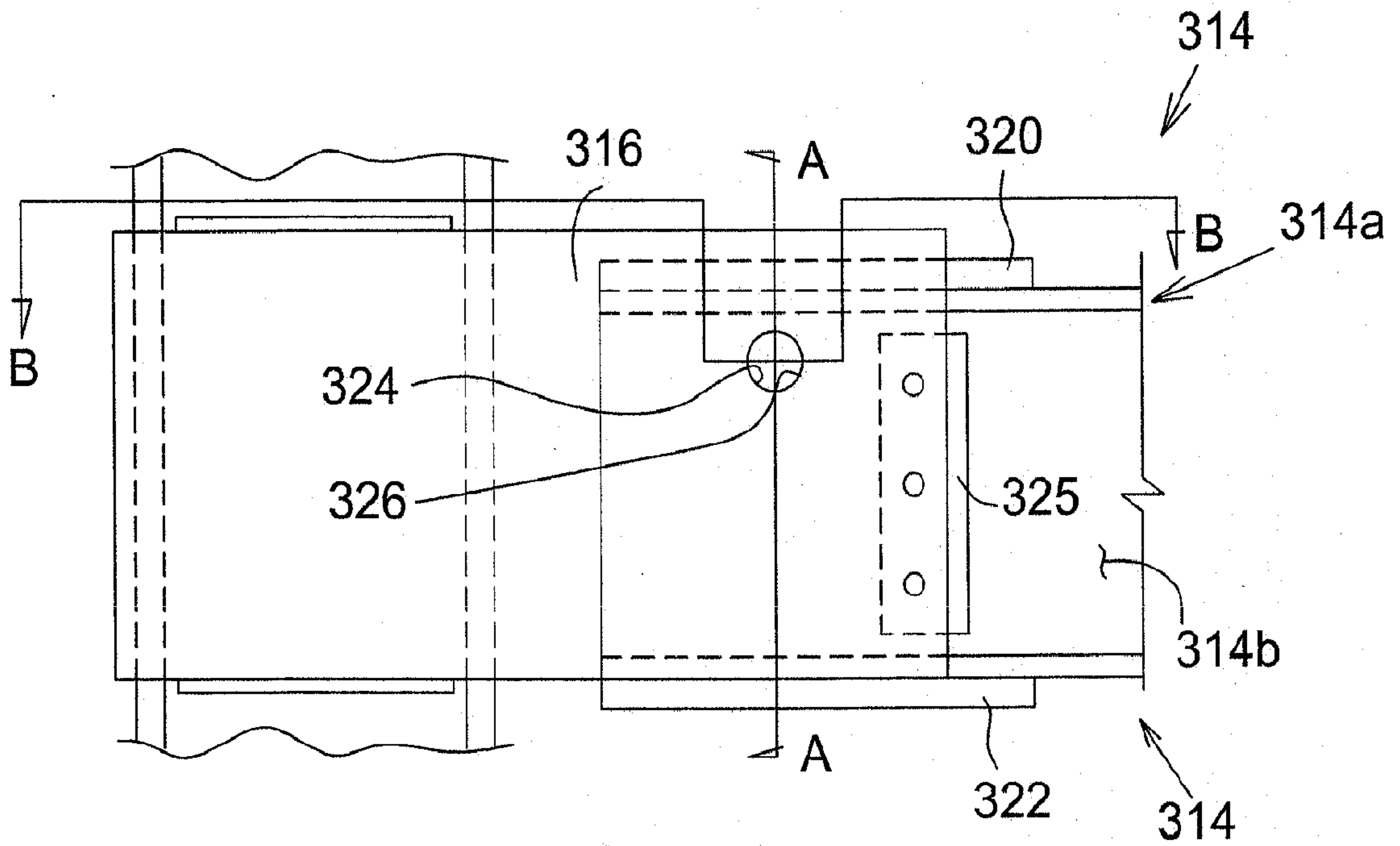
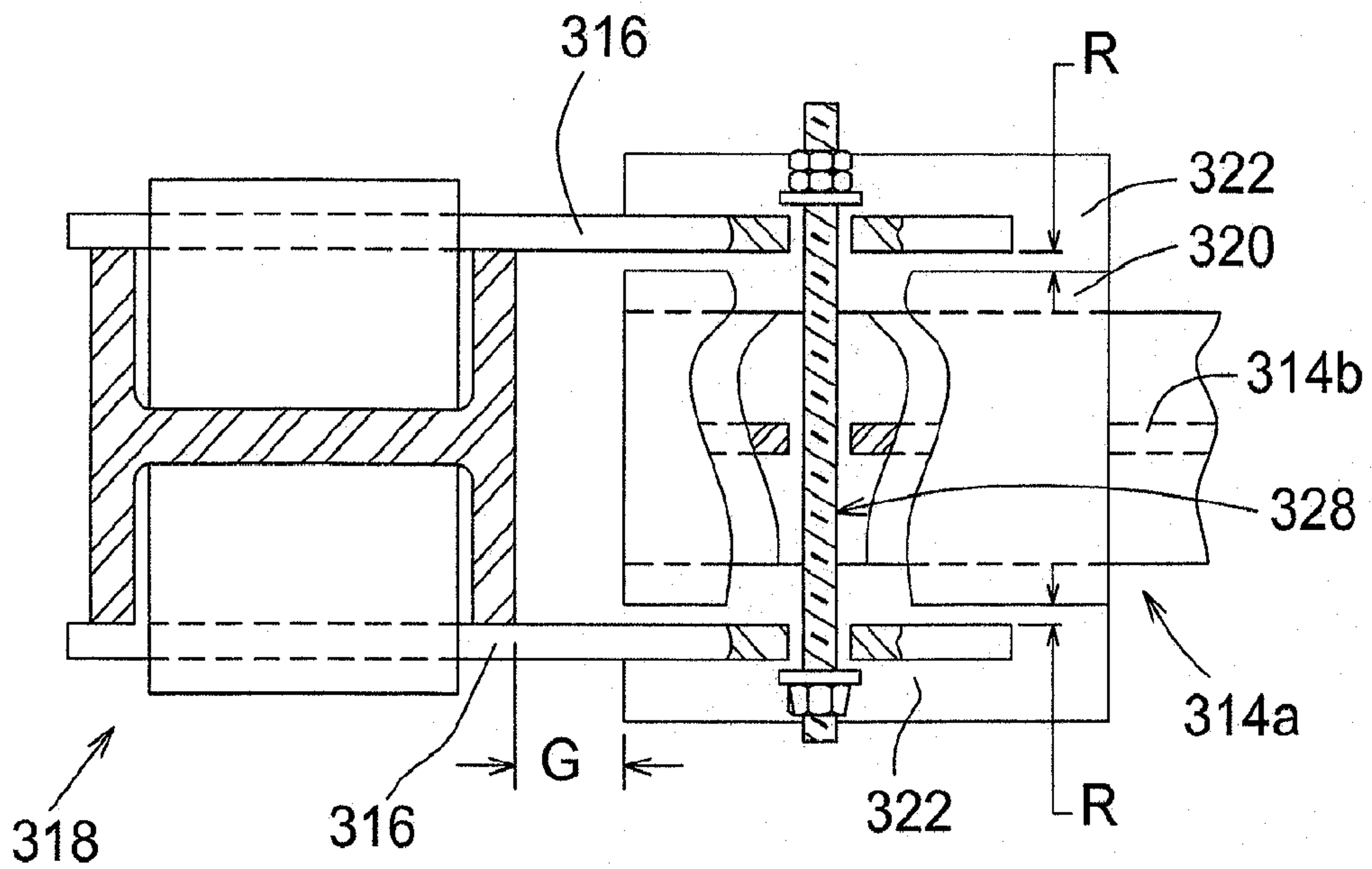


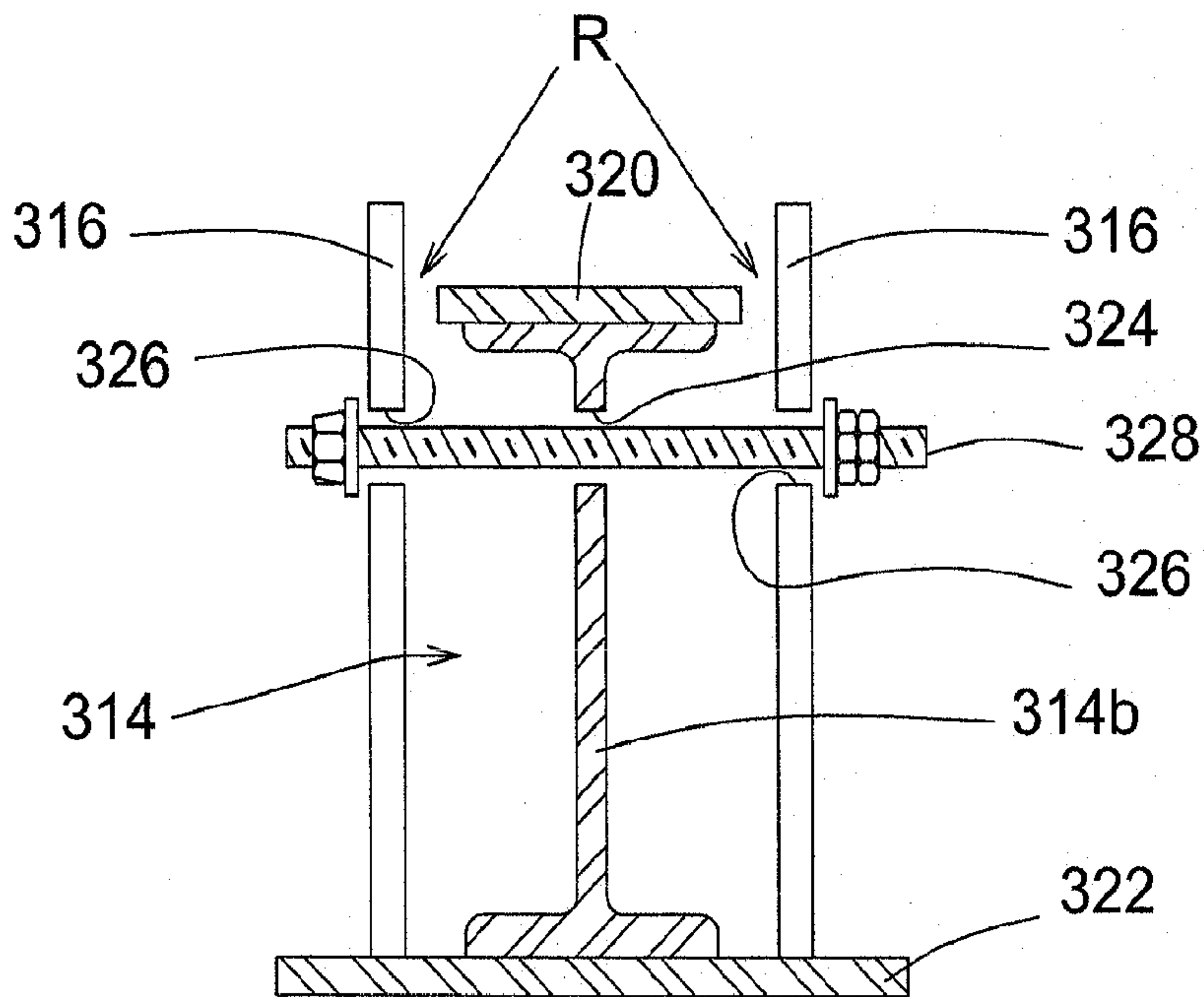
FIG. 27



SECTION B - B

FIG. 28

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SECTION A - A
FIG. 29

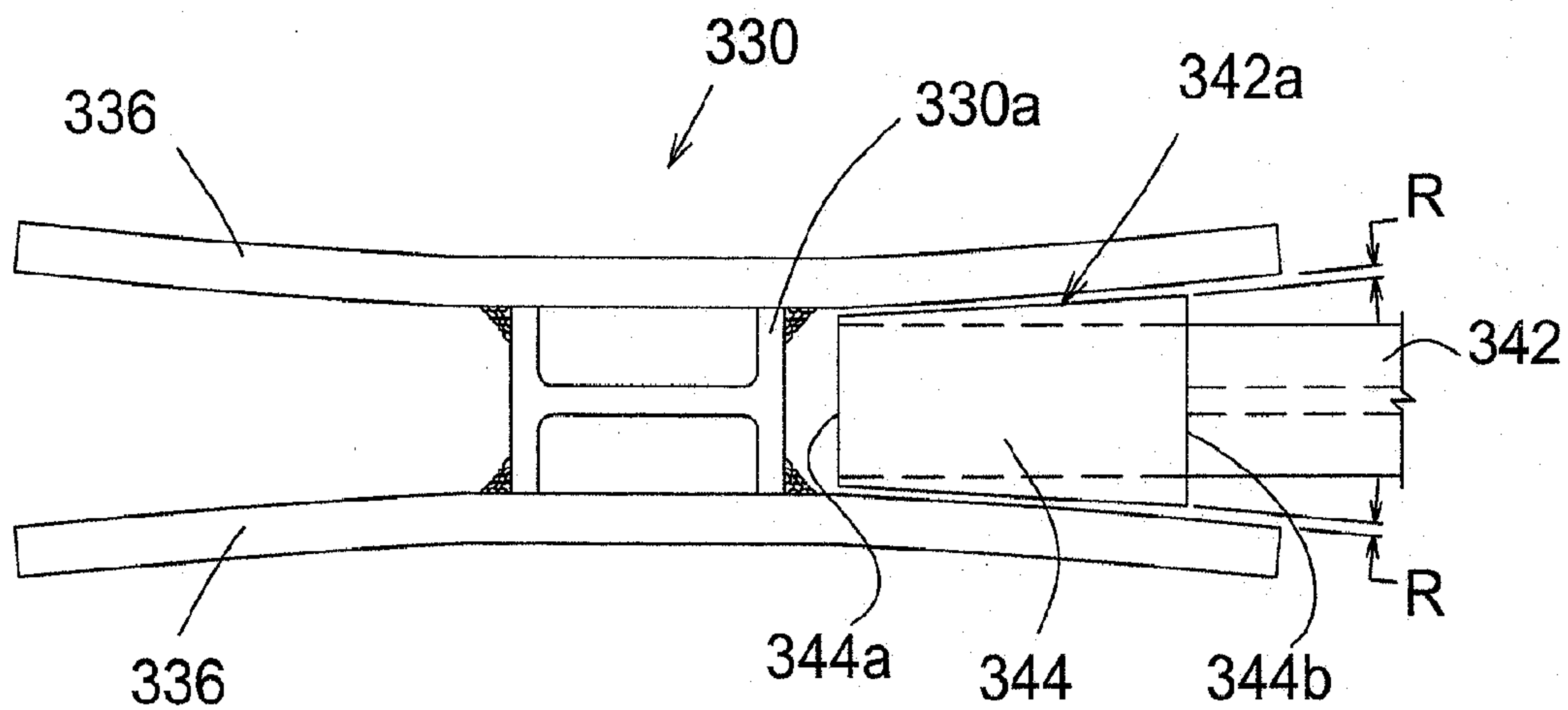


FIG. 30

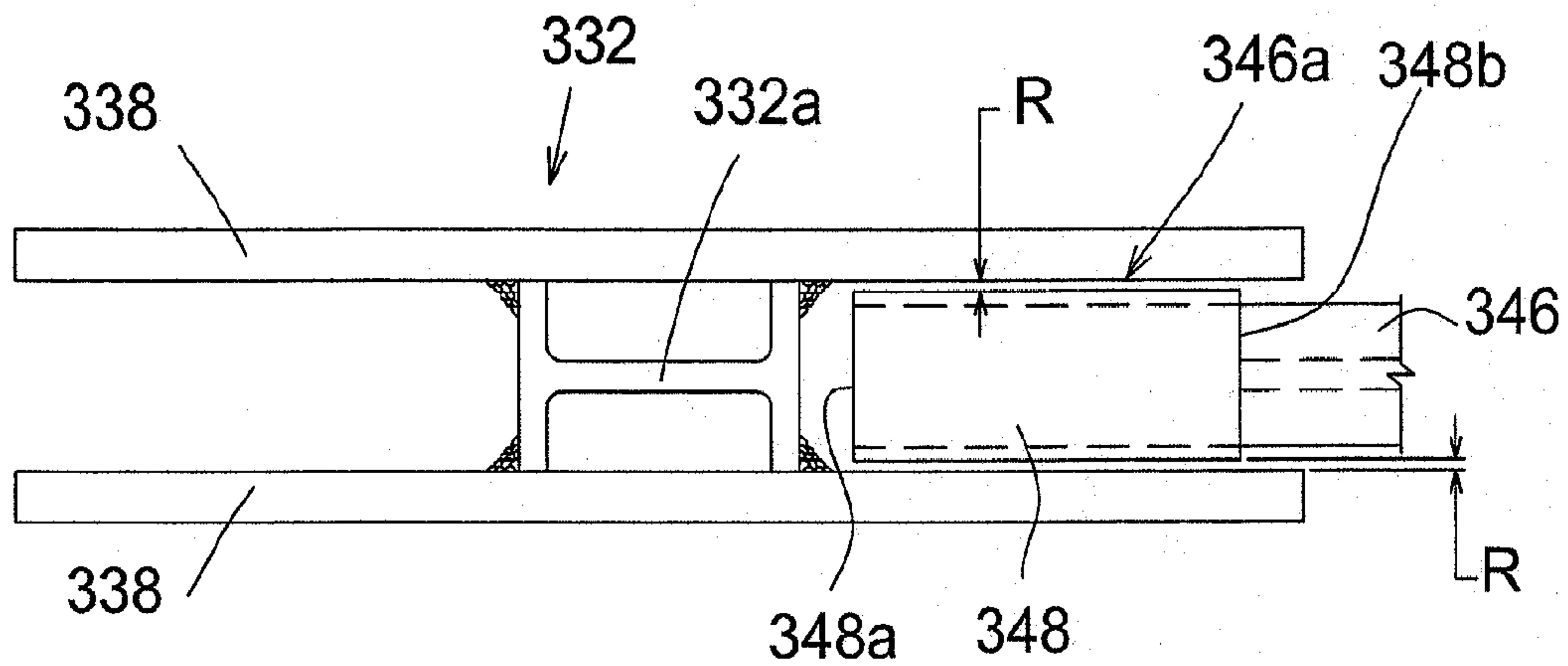


FIG. 31

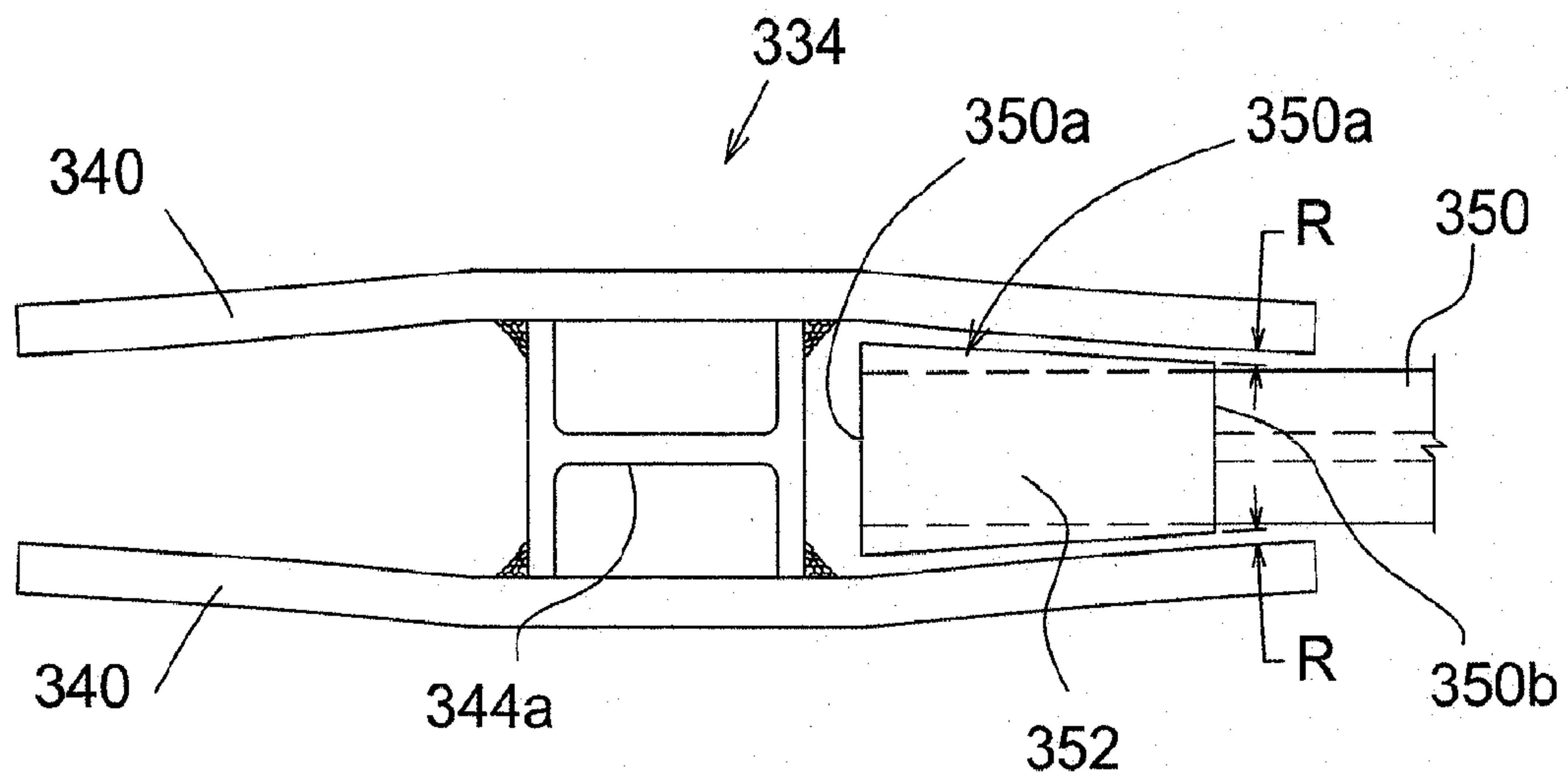
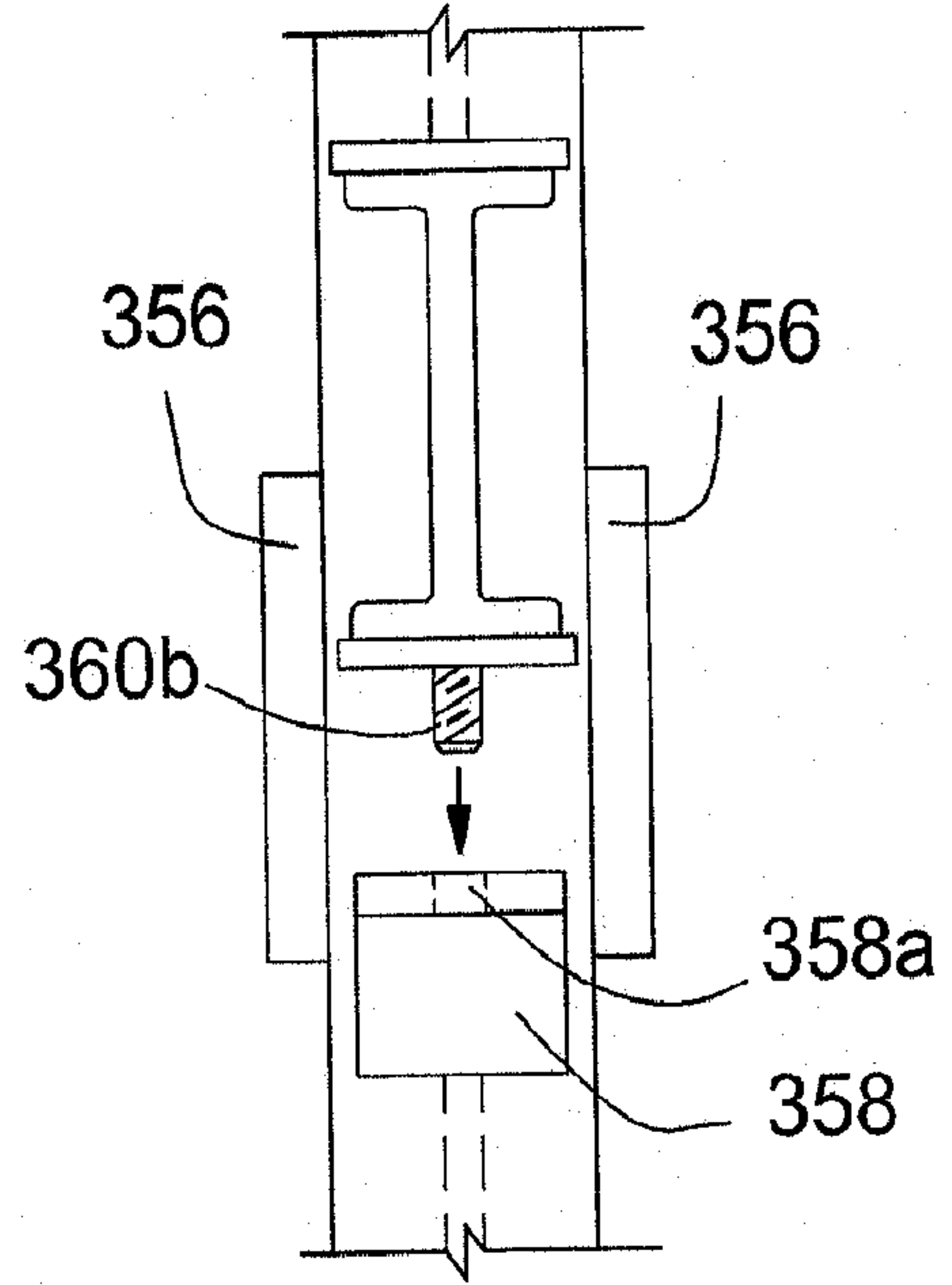
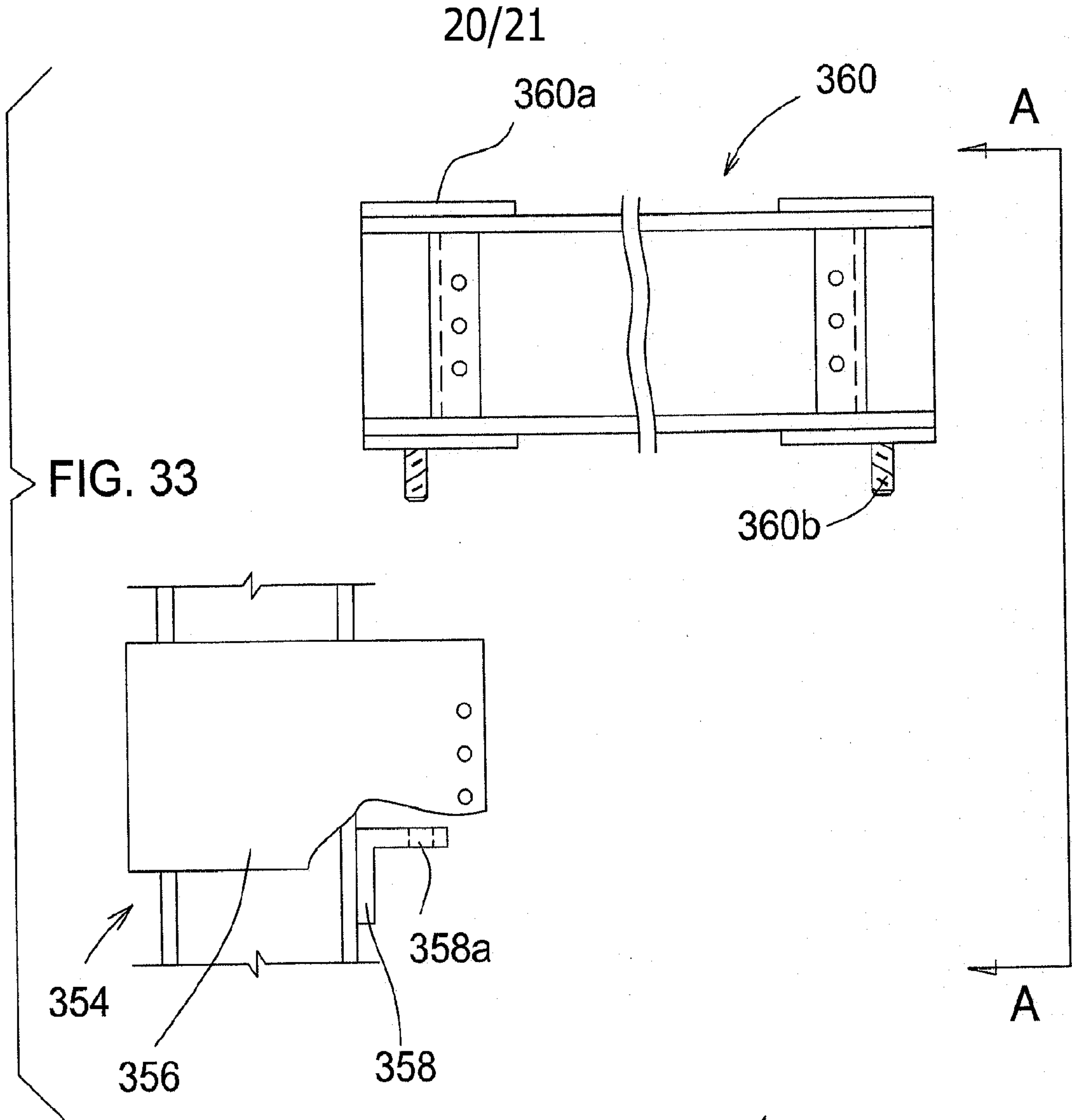


FIG. 32



SECTION A-A
FIG. 33A

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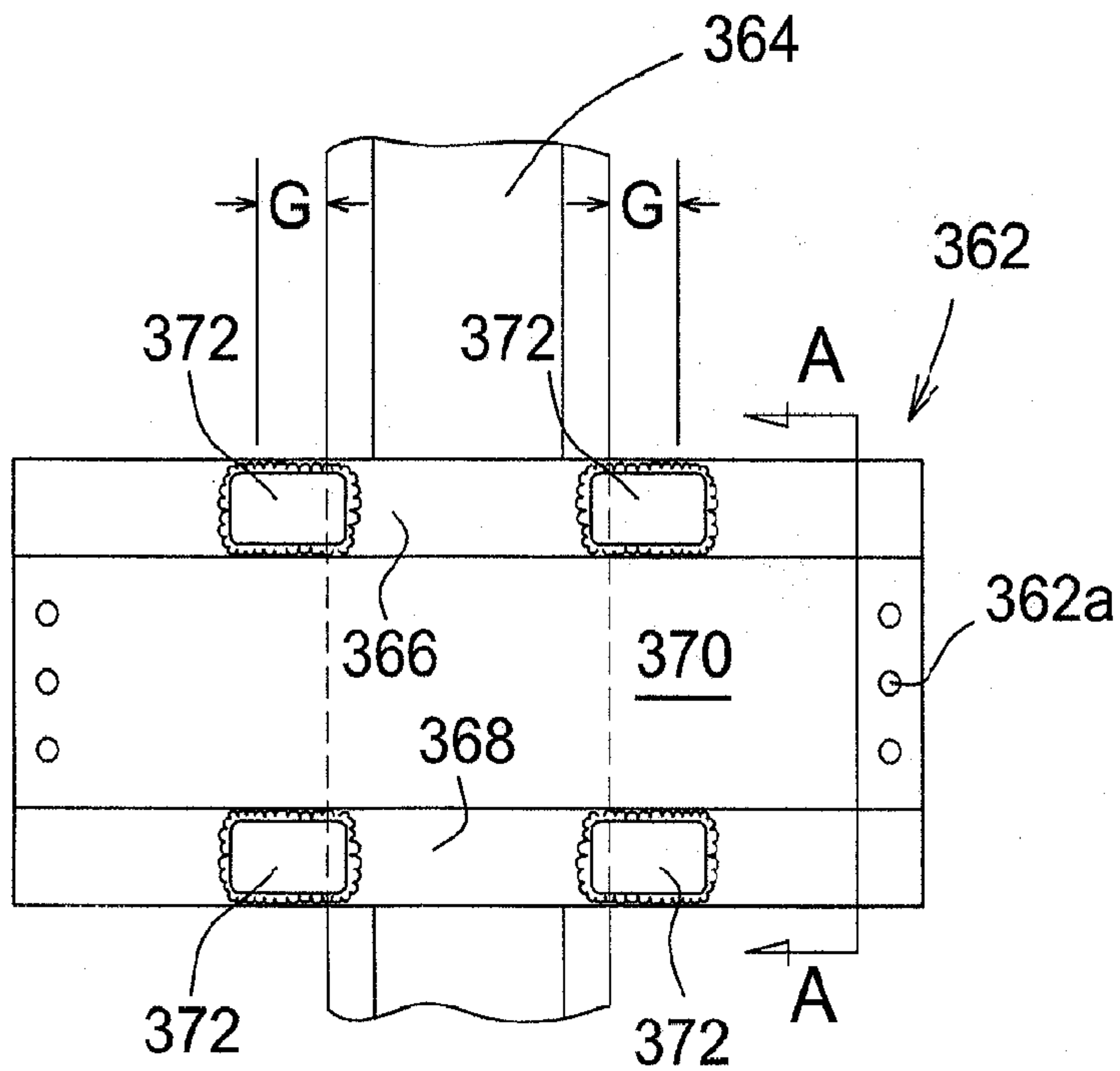
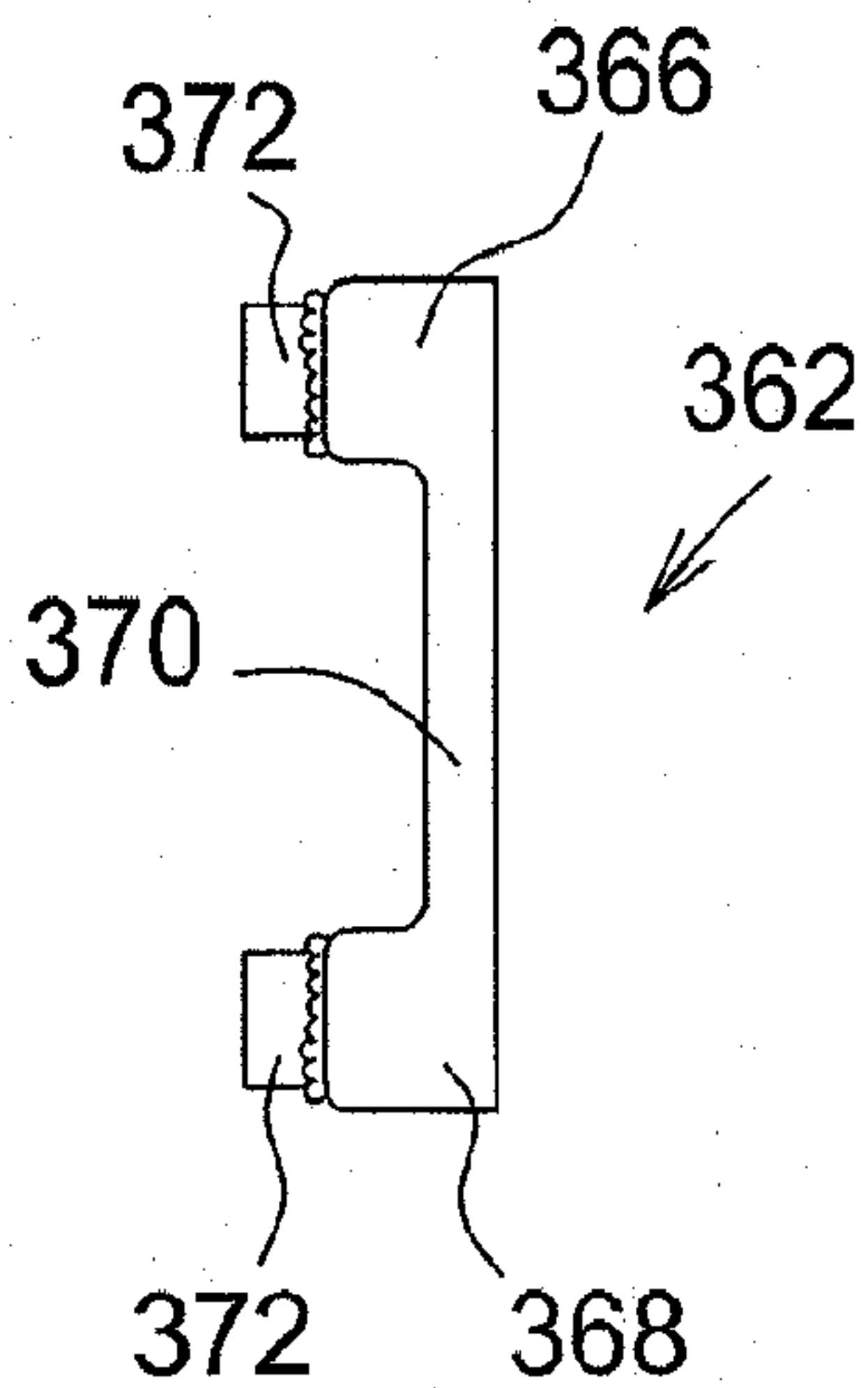


FIG.34



SECTION A-A
FIG.34A

