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(54) **REUSABLE ADJUSTABLE HANGER FOR USE WITH JOISTS AND/OR DOUBLE WALES**

Publication Classification

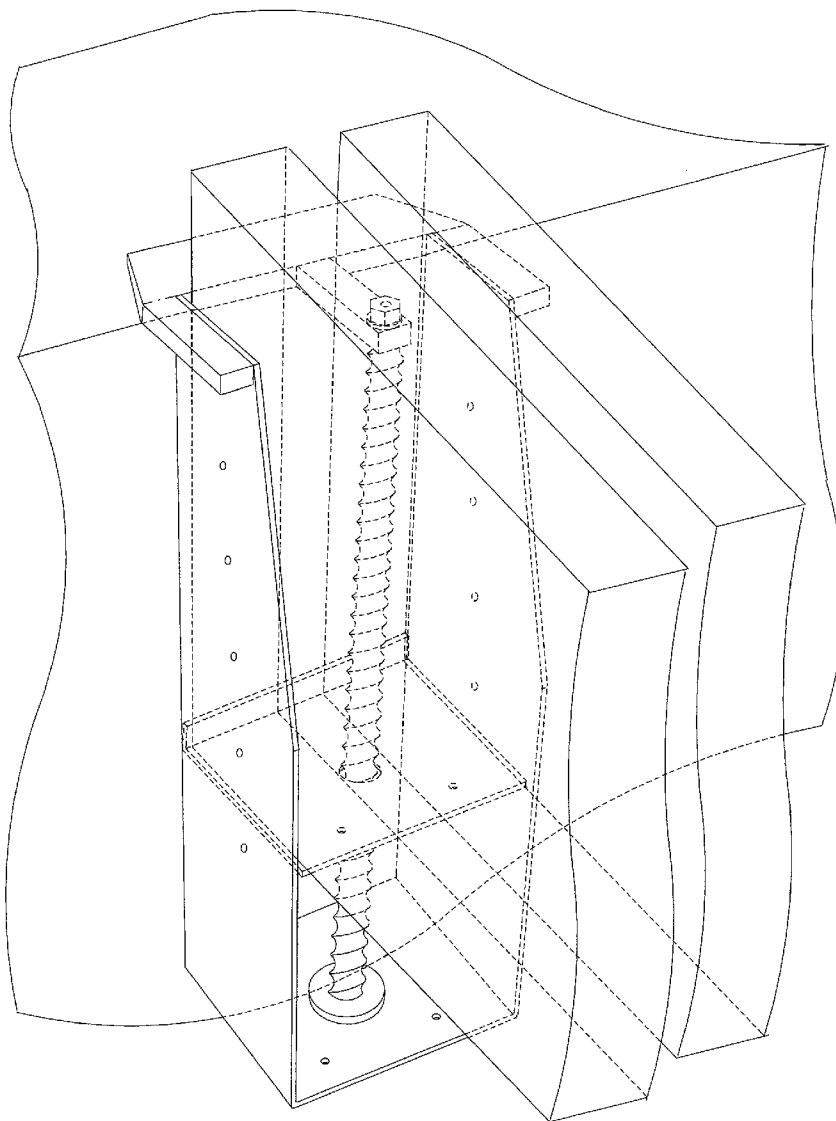
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(51) **Int. Cl.** *E04C 5/12* (2006.01)
(52) **U.S. Cl.** 52/702
(57) **ABSTRACT**

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A reusable adjustable hanger, including multiple embodiments having varied features and attributes, for general use in forming horizontal concrete structures having permanent vertical support, depending on a supporting structure for horizontal support, vertically adjustable from both top and bottom, capable of receiving and supporting any or all of the following primary spanning ledgers: double walers, single joists, and dual joist structures joined at the middle and having a single joist member at each end, optionally comprising a vertical support structure, optionally comprising an attachable and removable central vertical structure allowing the use of 4x lumber as primary spanning ledgers.

(21) Appl. No.: **11/625,547**
(22) Filed: **Jan. 22, 2007**



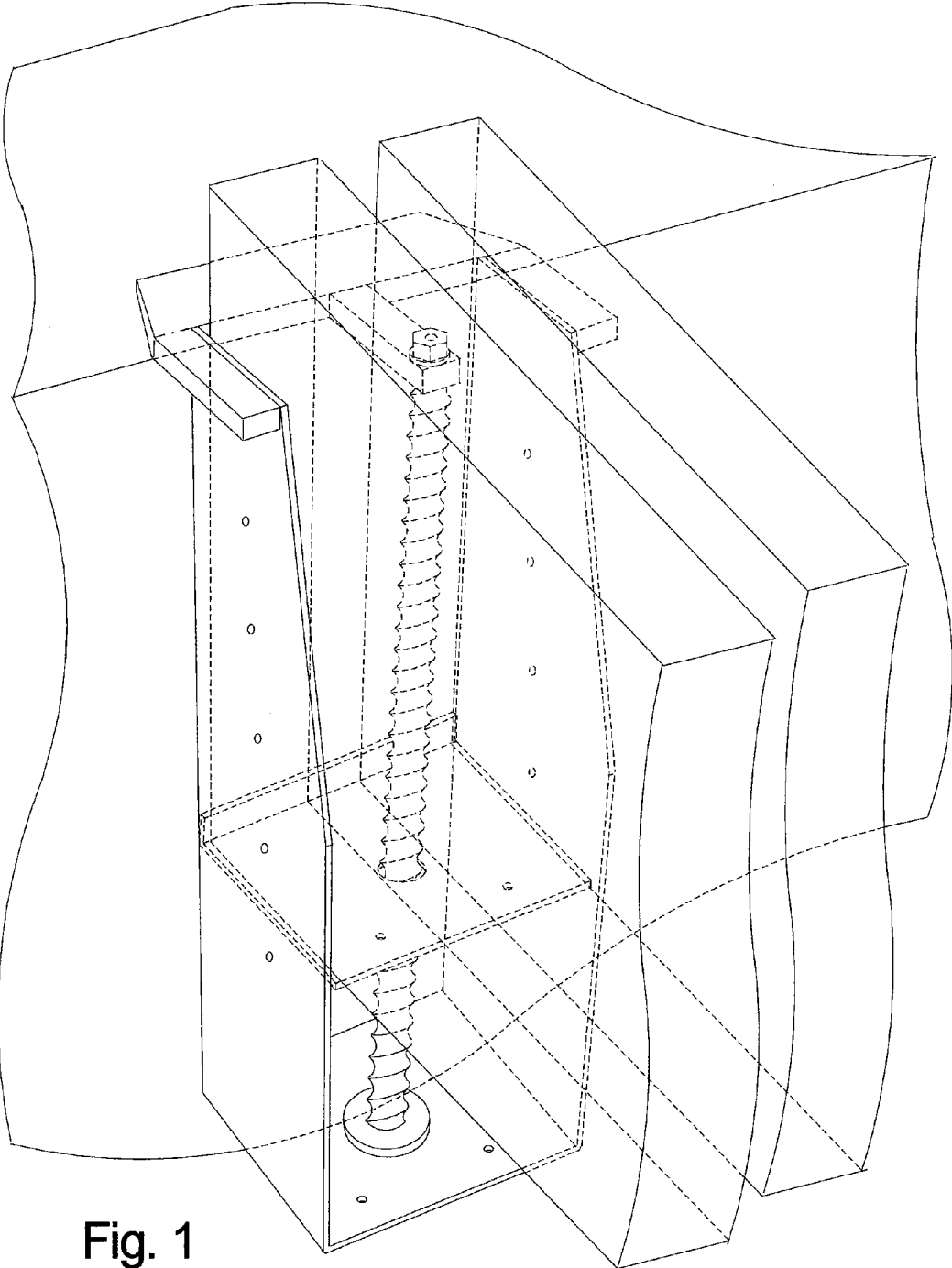


Fig. 1

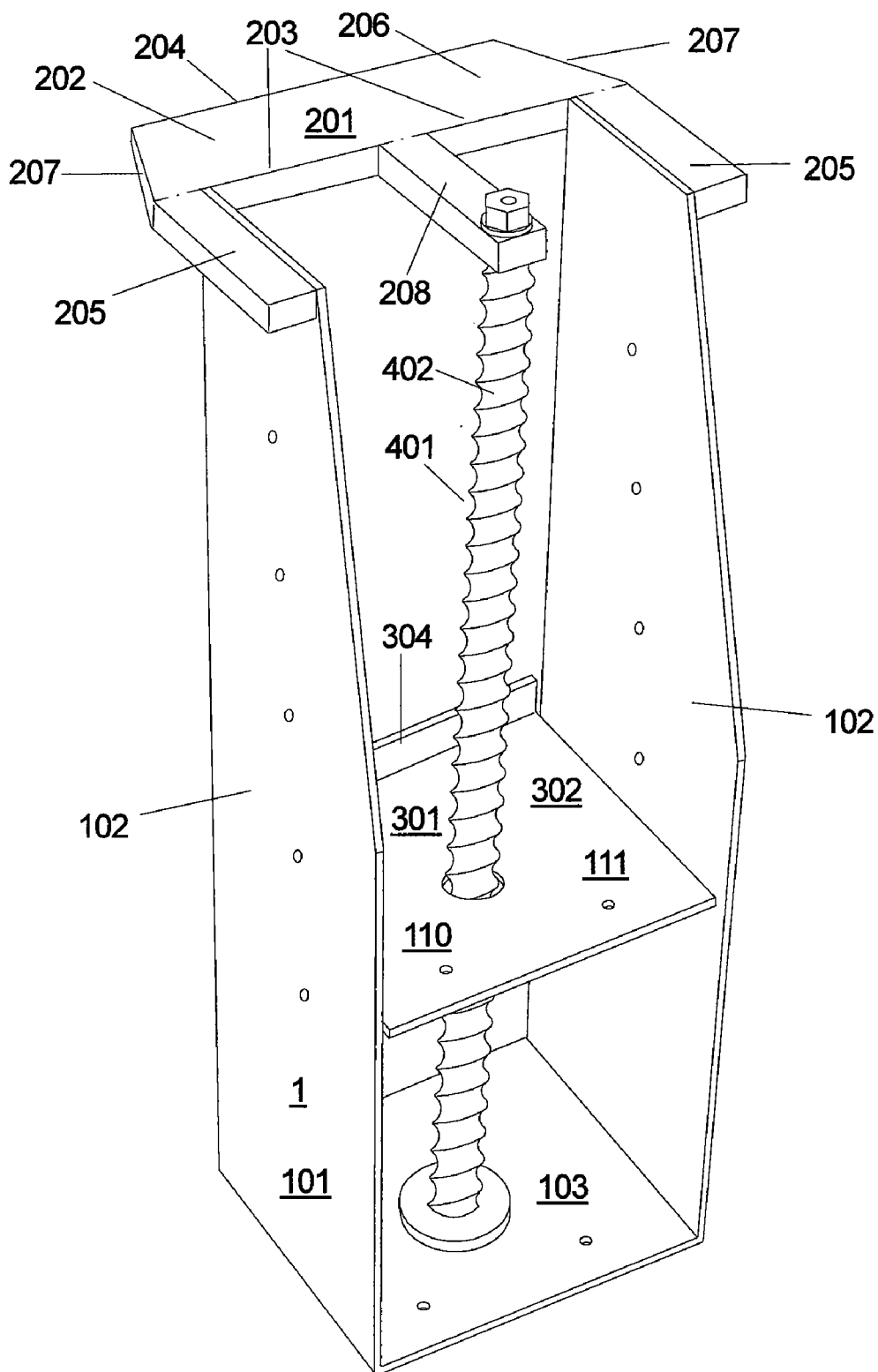


Fig. 2

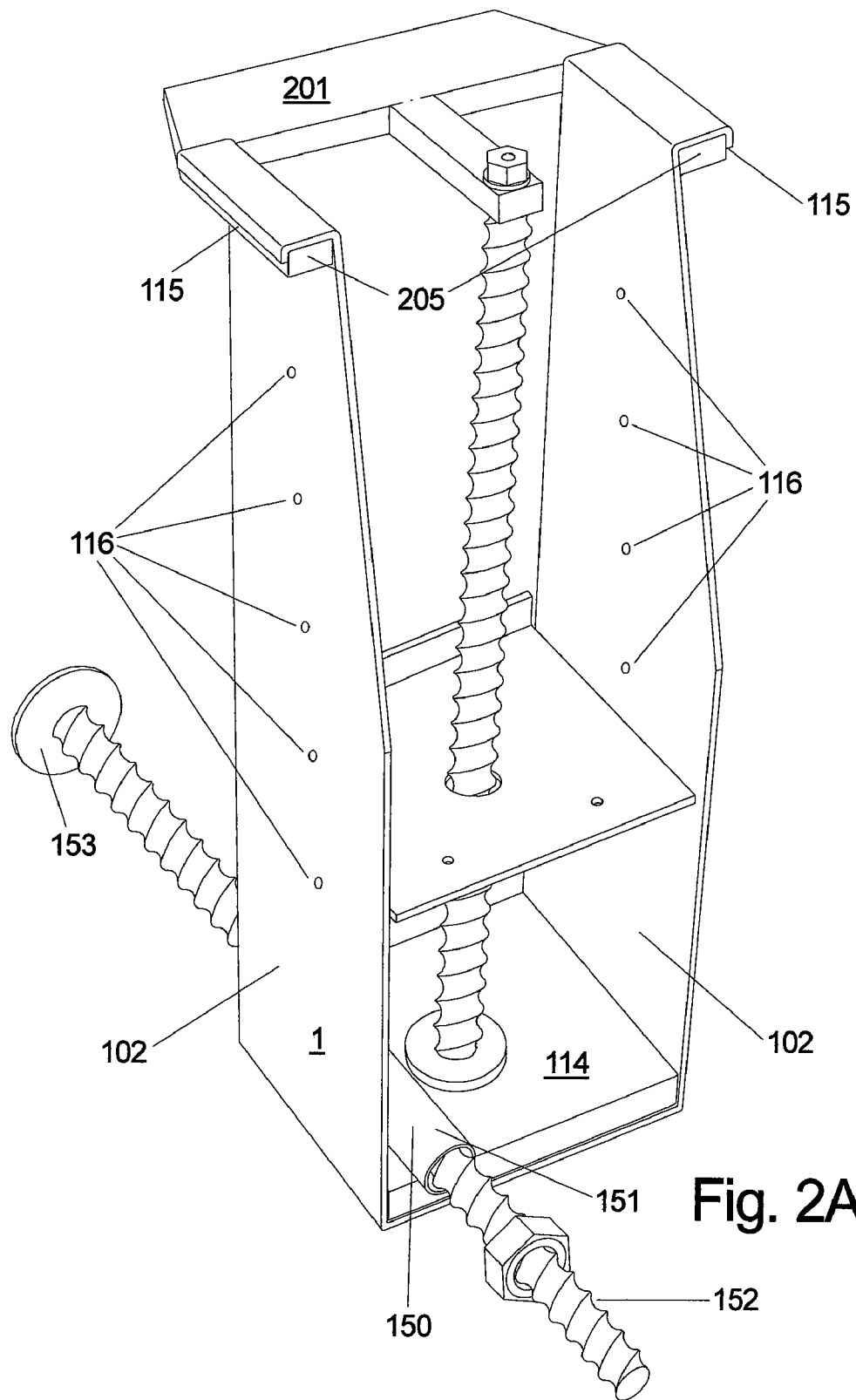


Fig. 2A

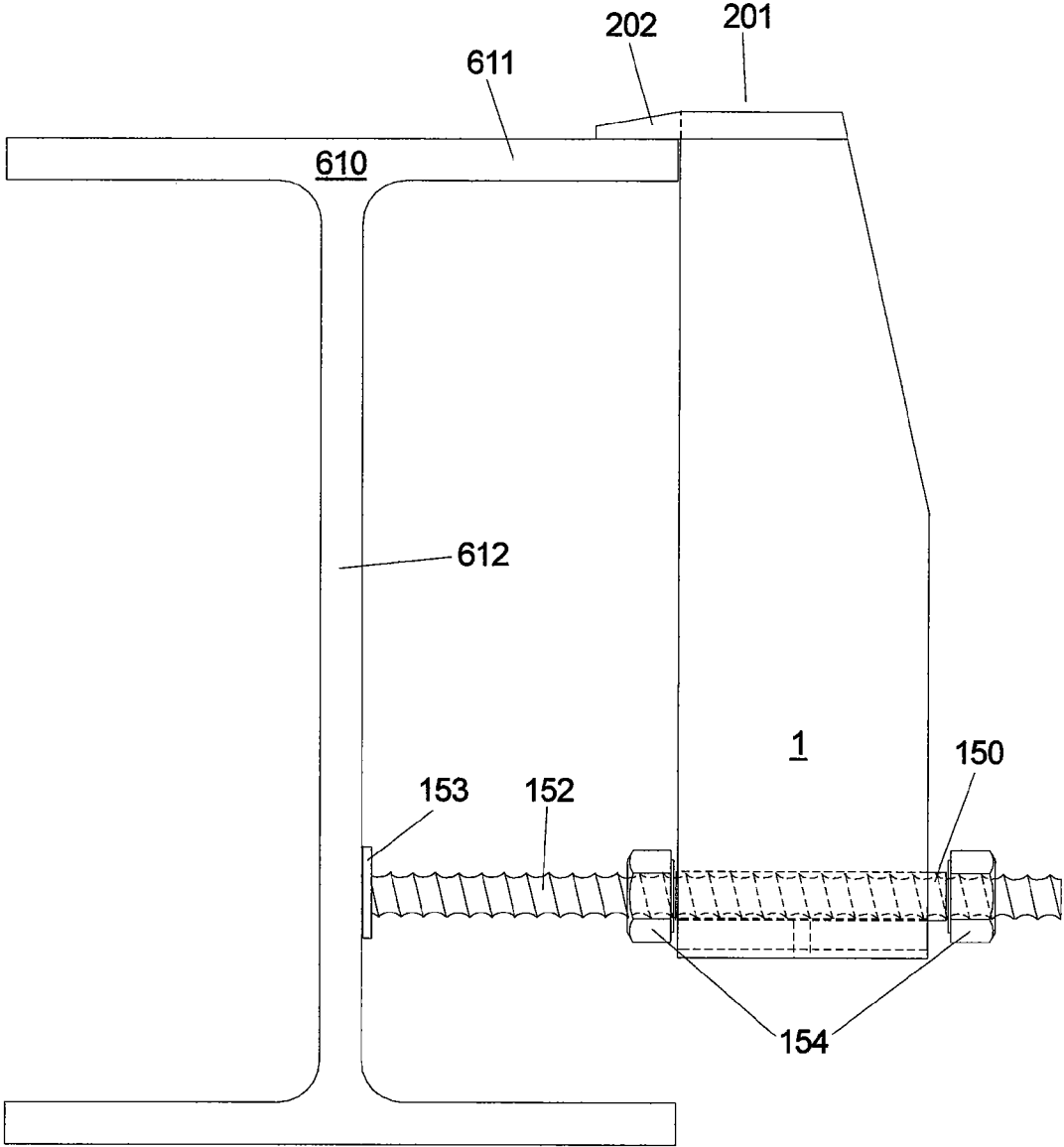


Fig. 2B

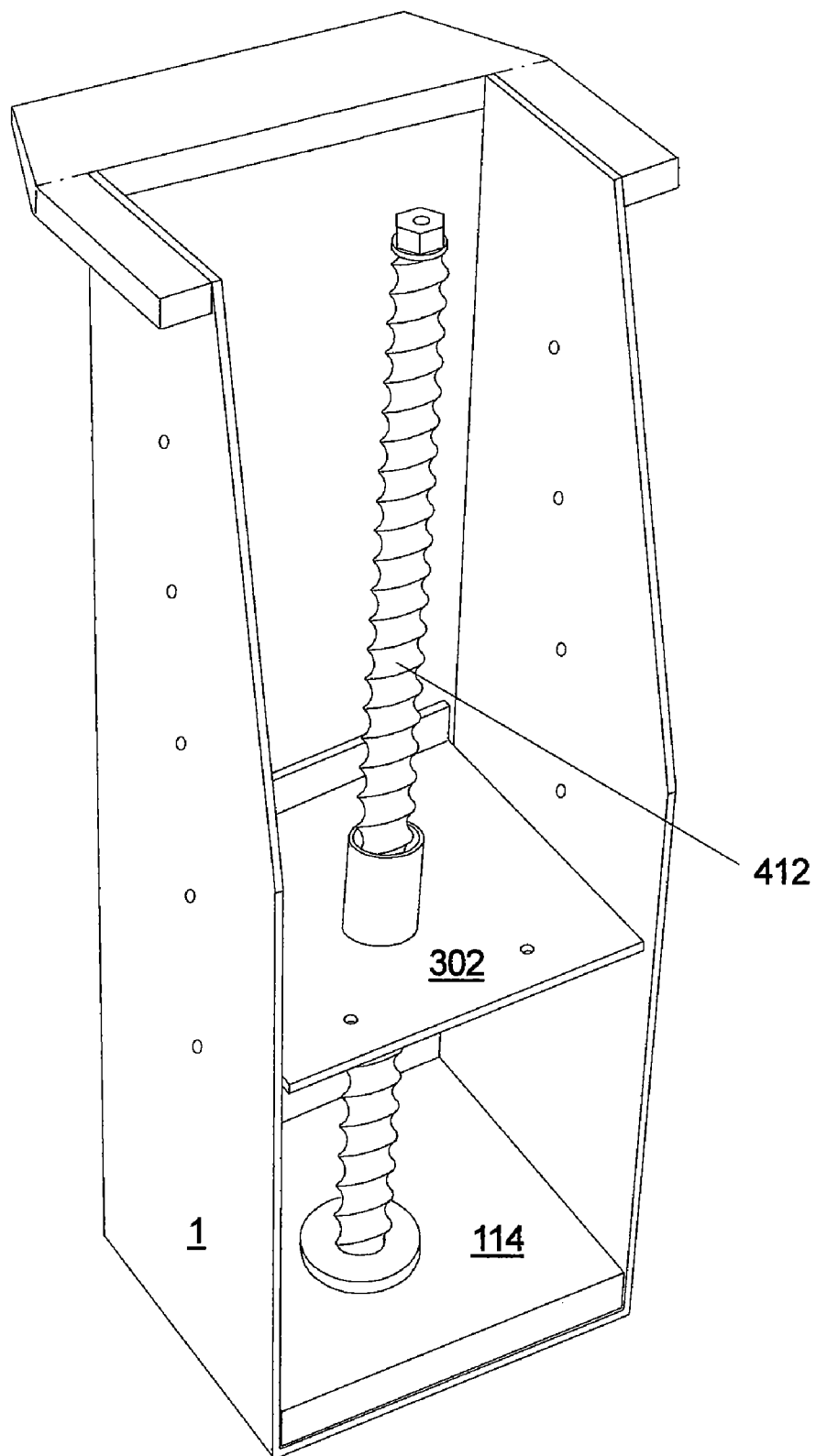


Fig. 2C

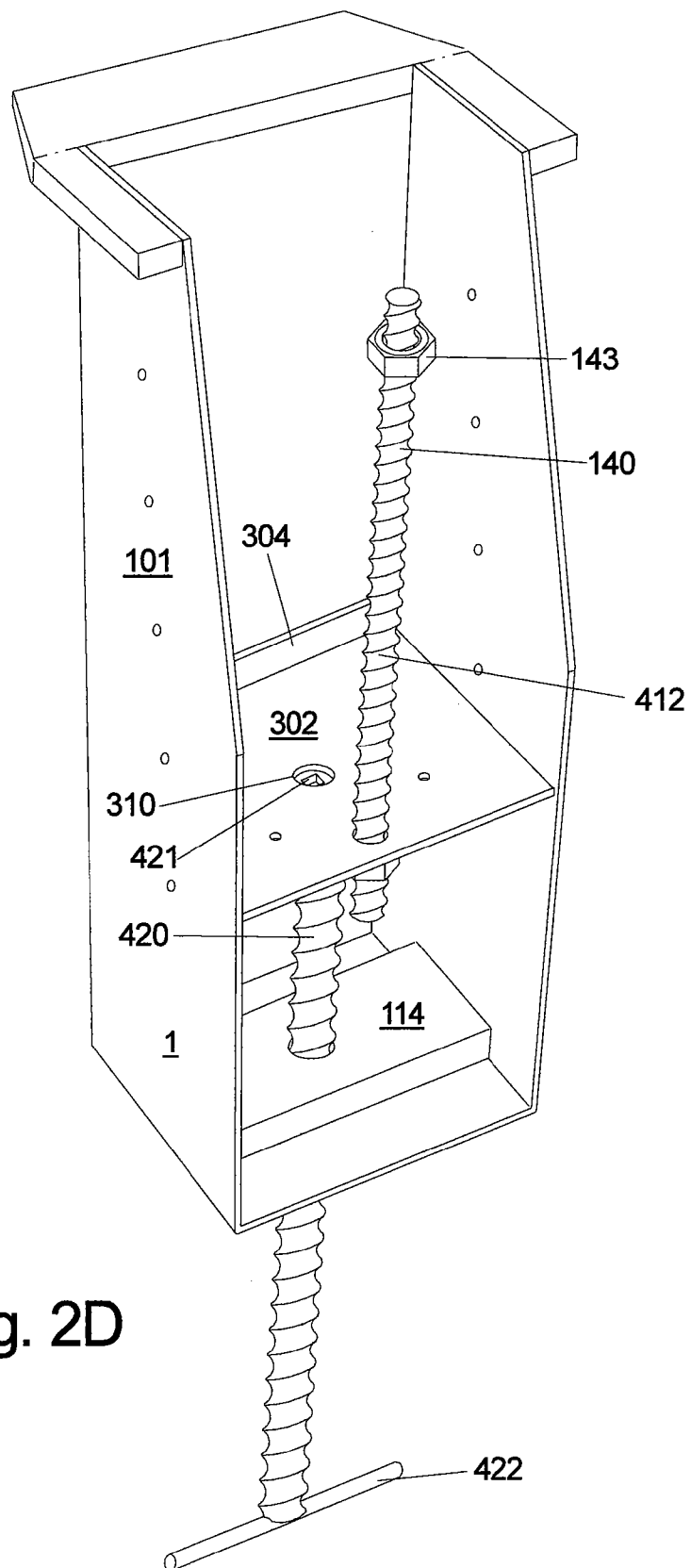


Fig. 2D

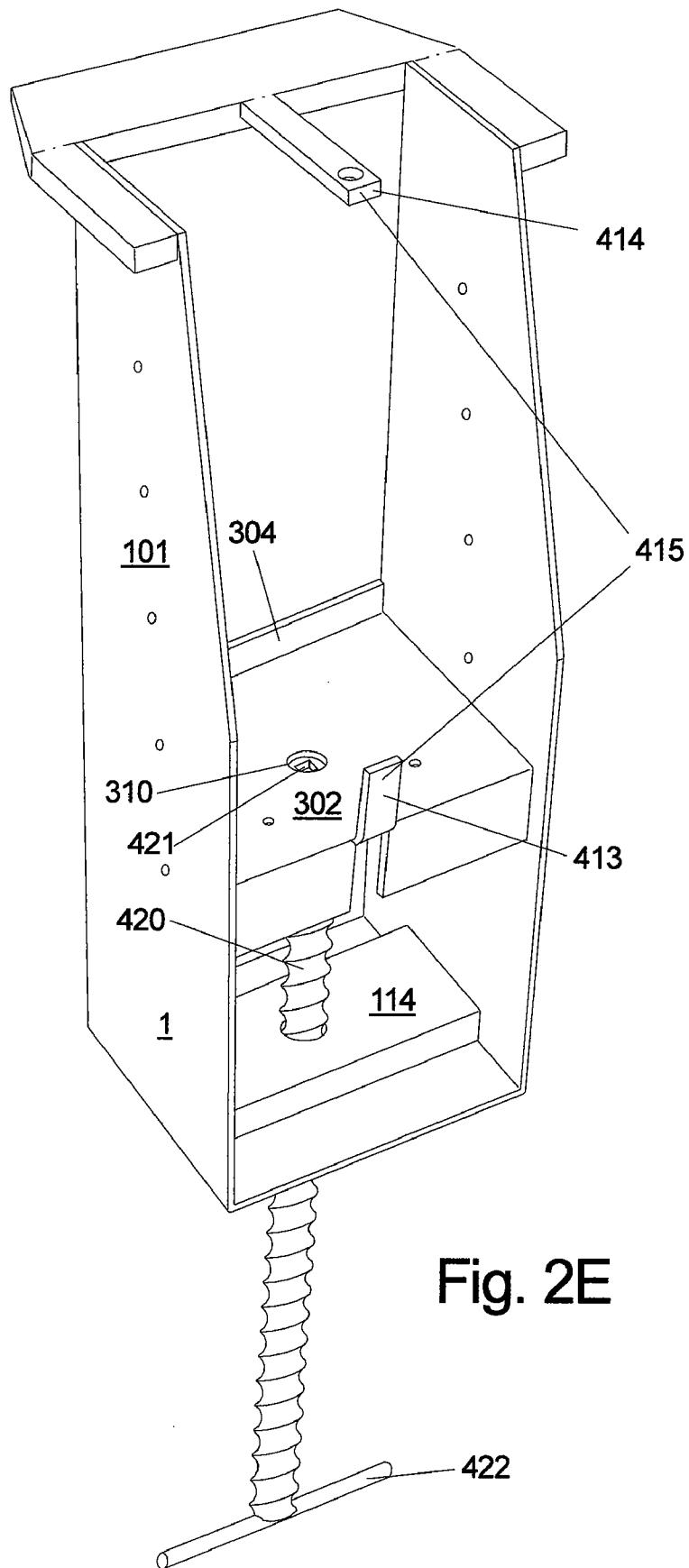


Fig. 2E

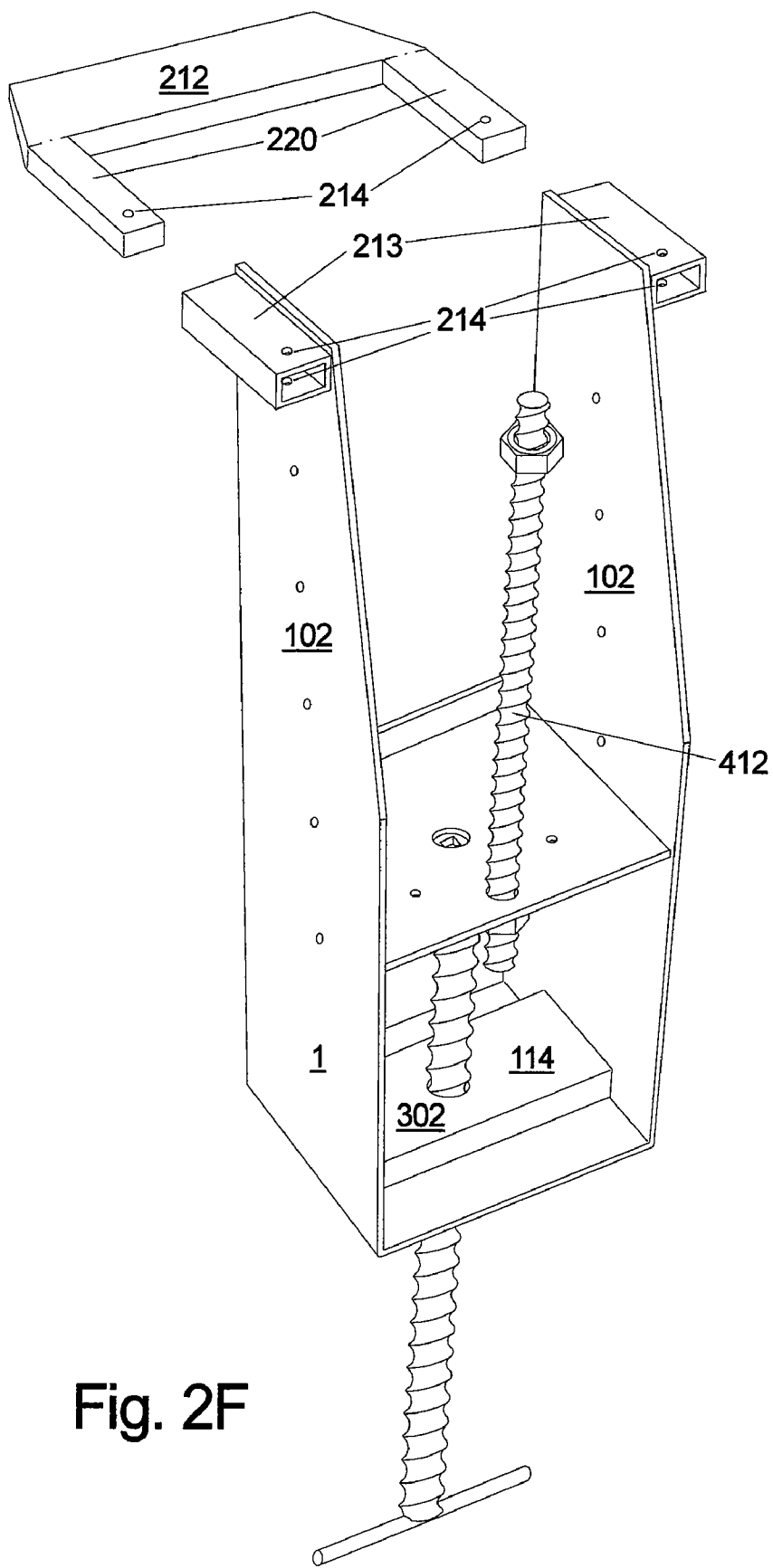


Fig. 2F

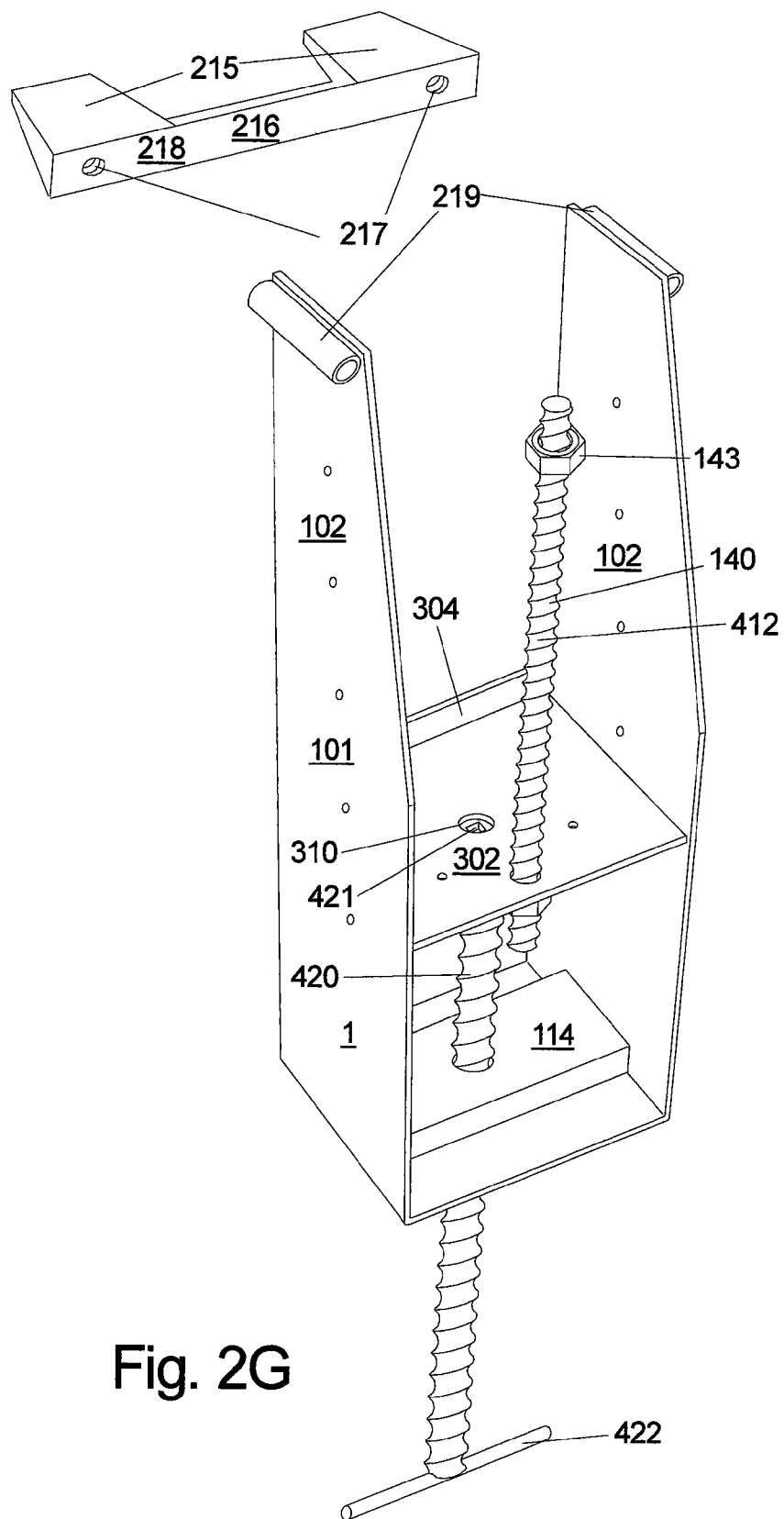


Fig. 2G

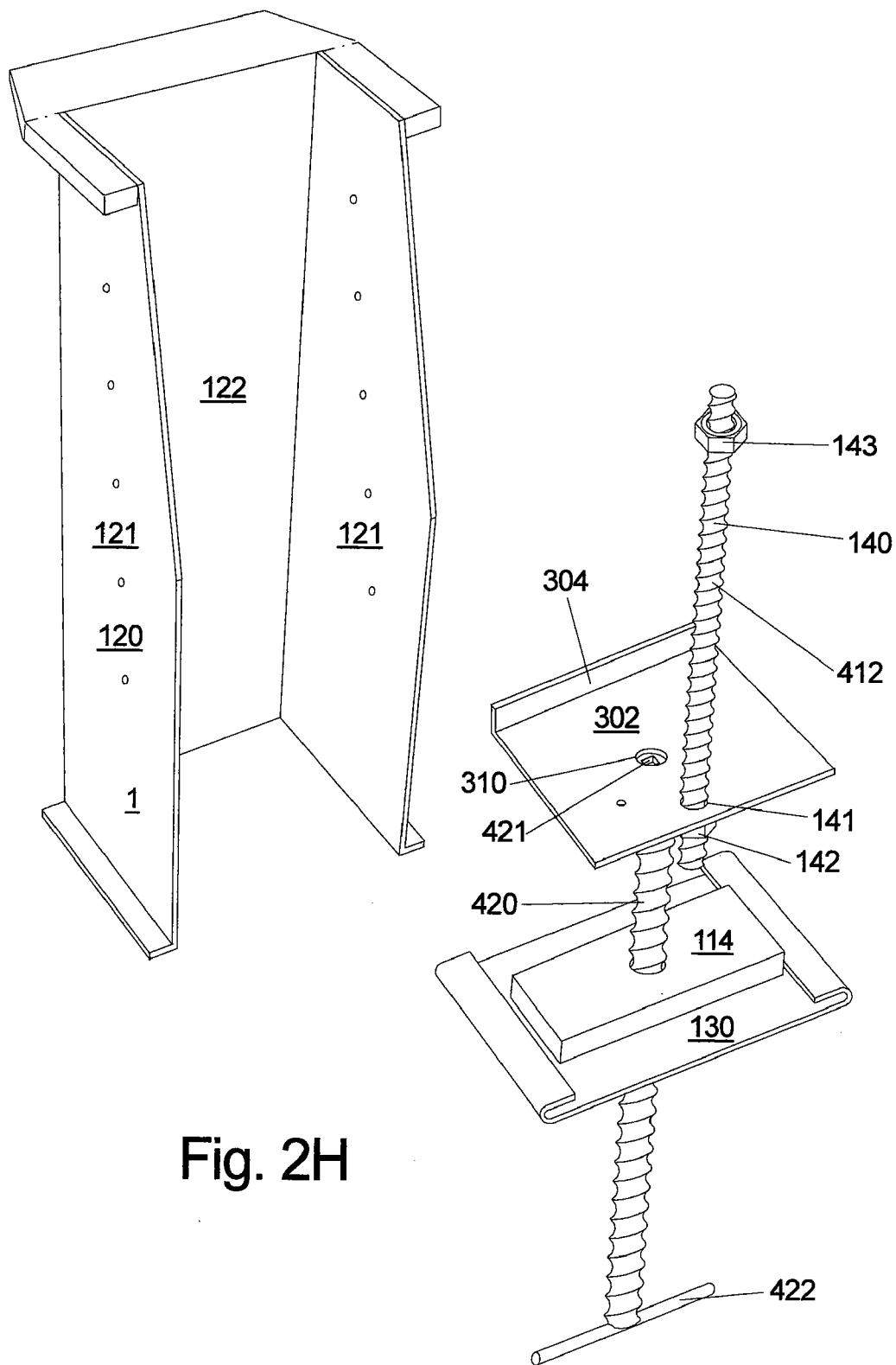


Fig. 2H

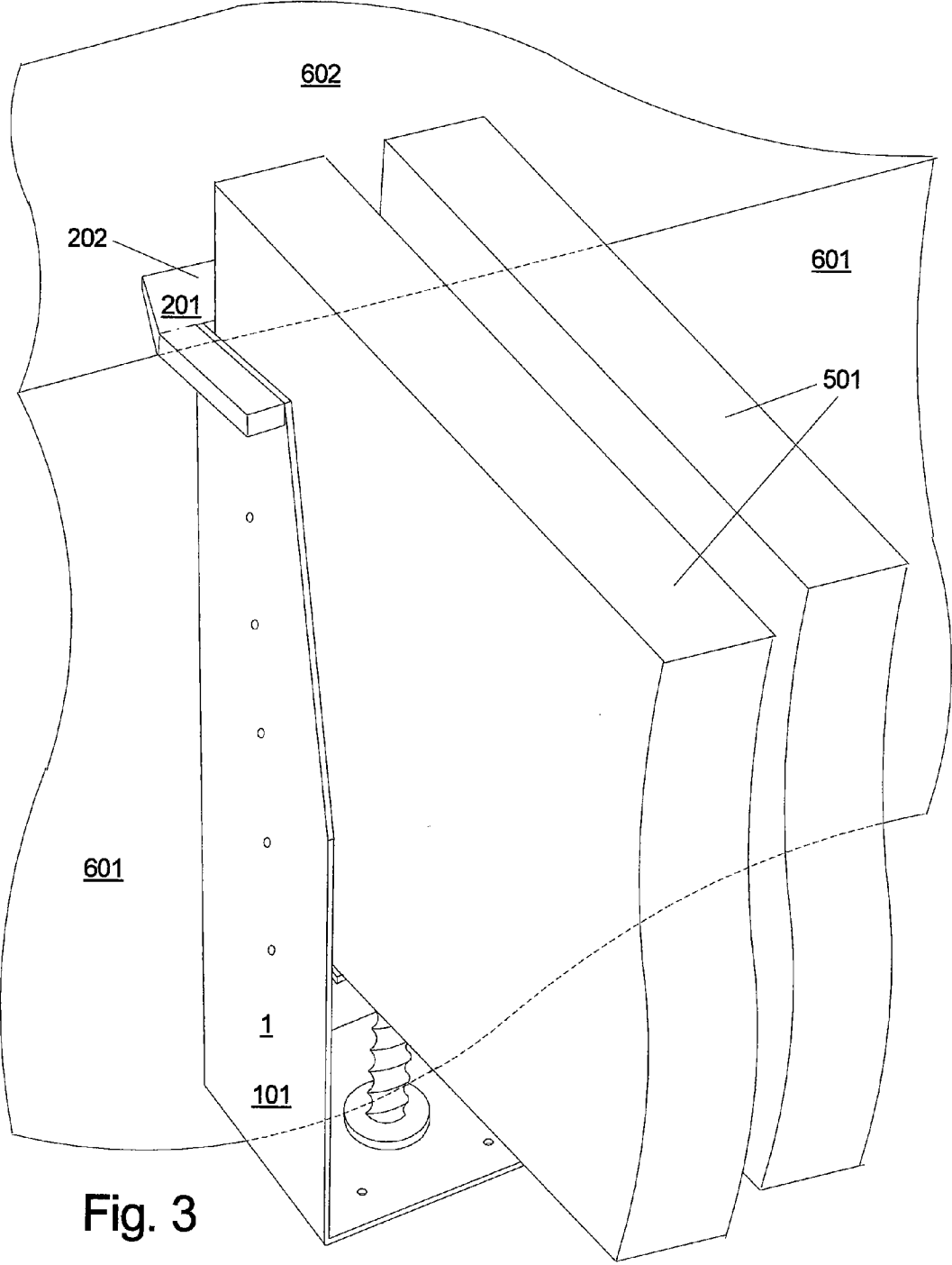


Fig. 3

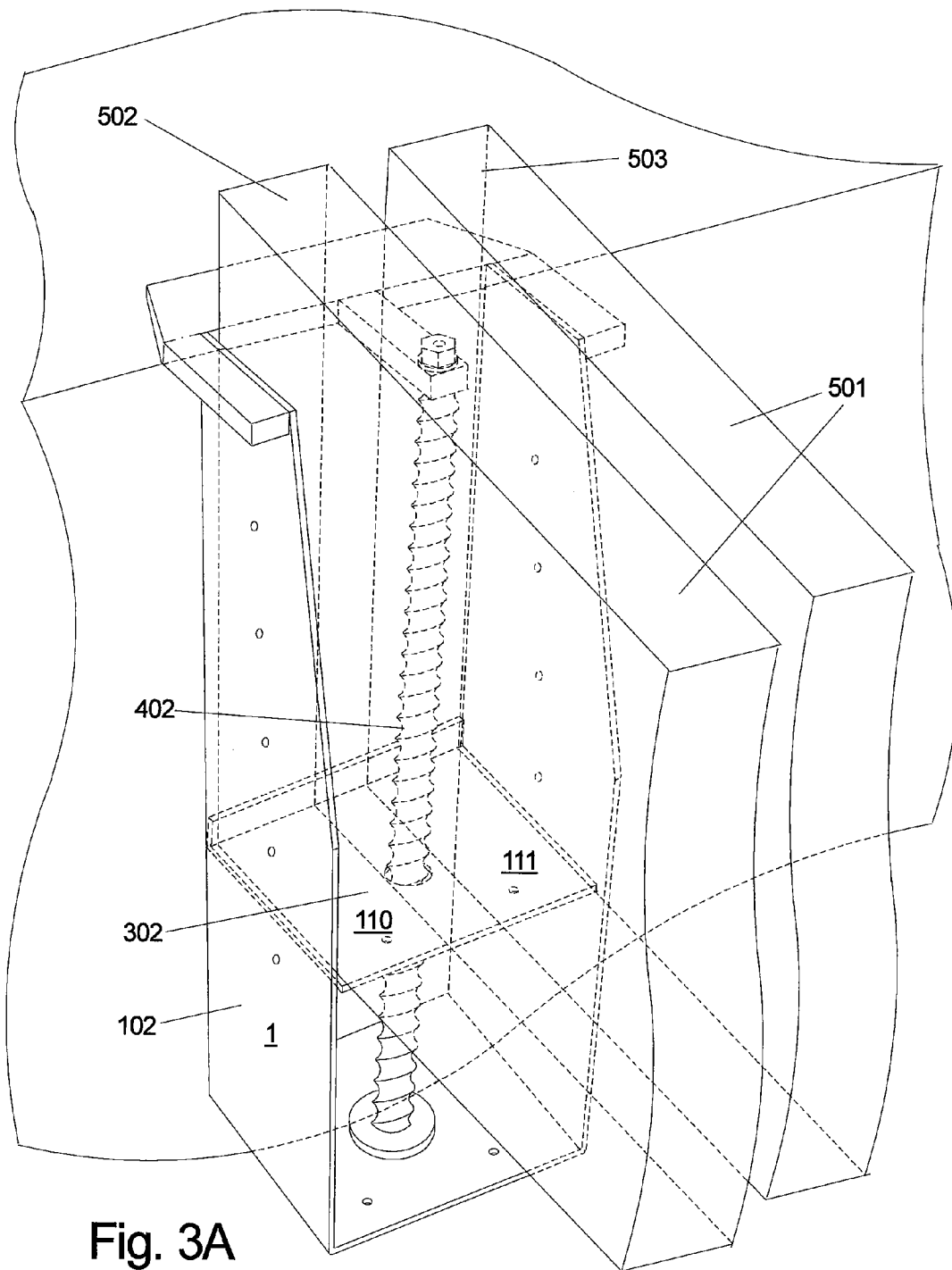
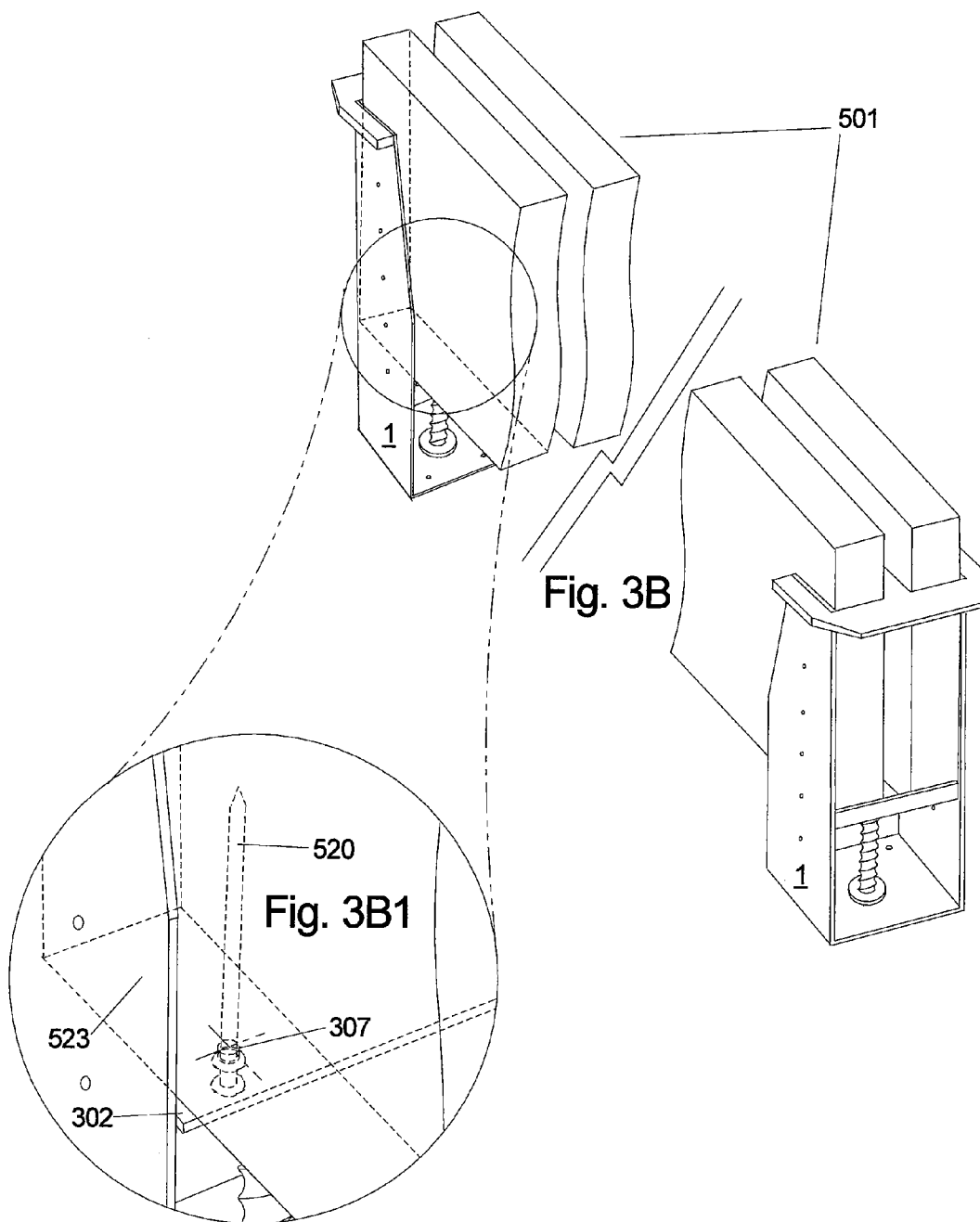
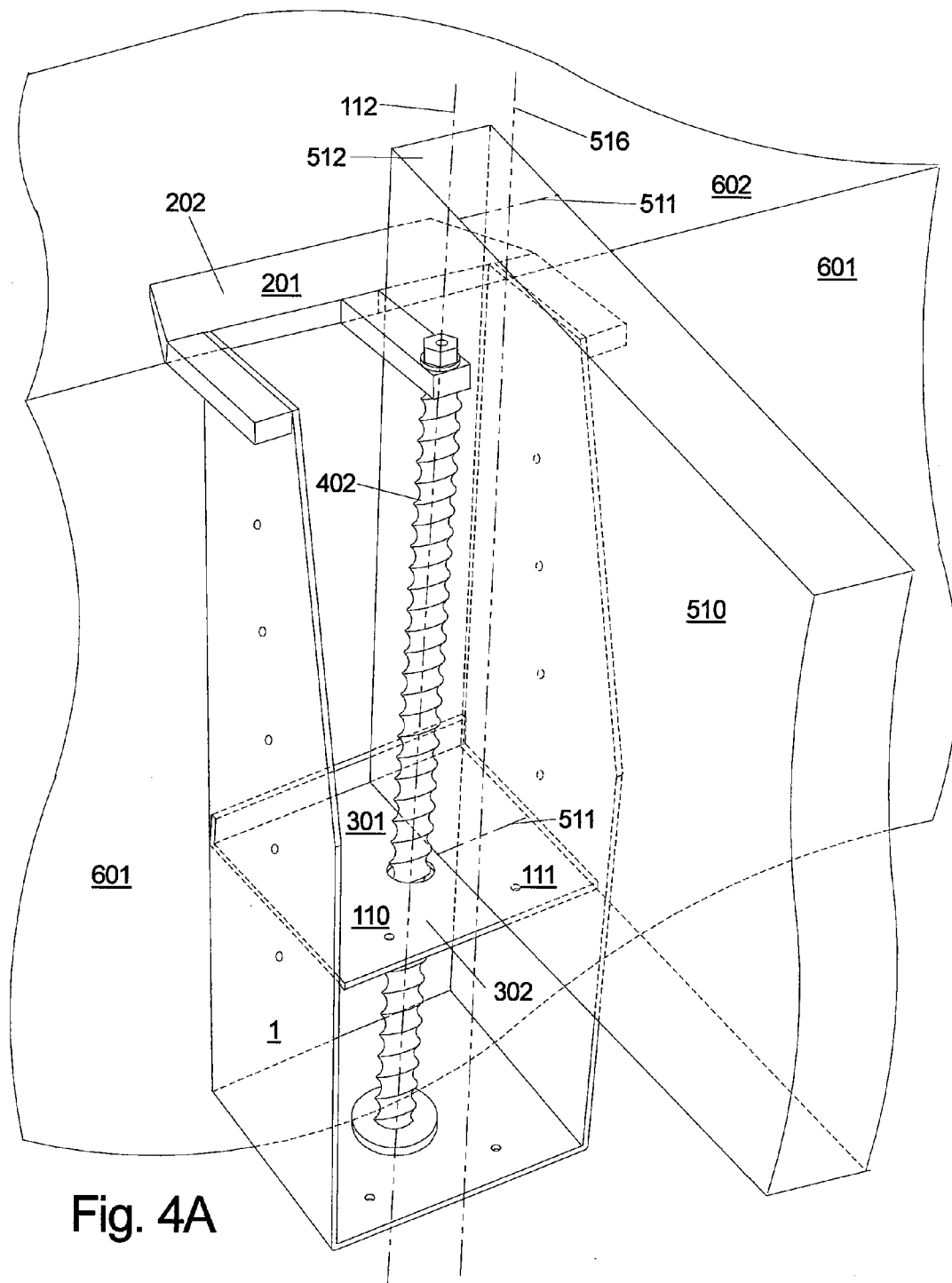


Fig. 3A





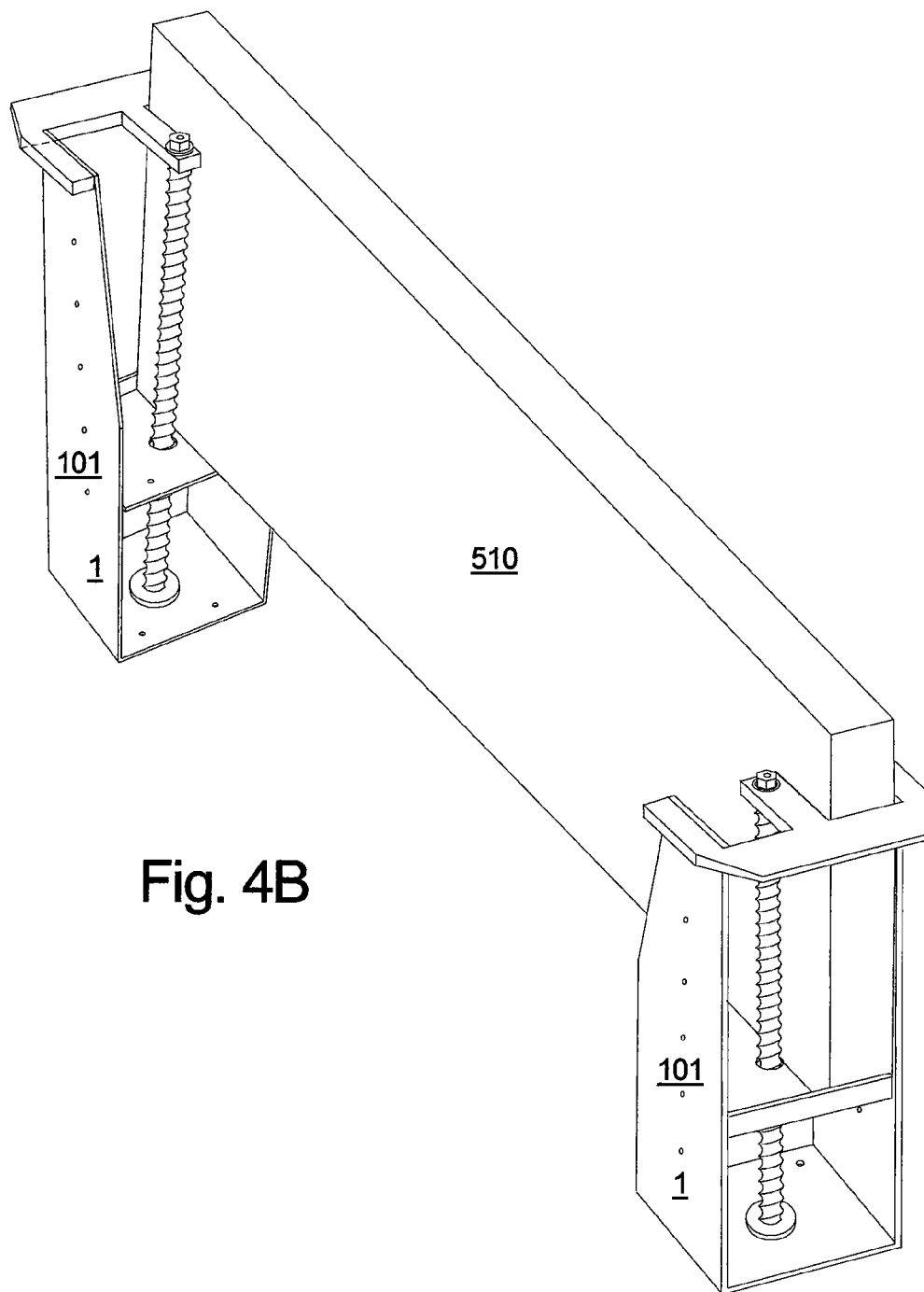


Fig. 4B

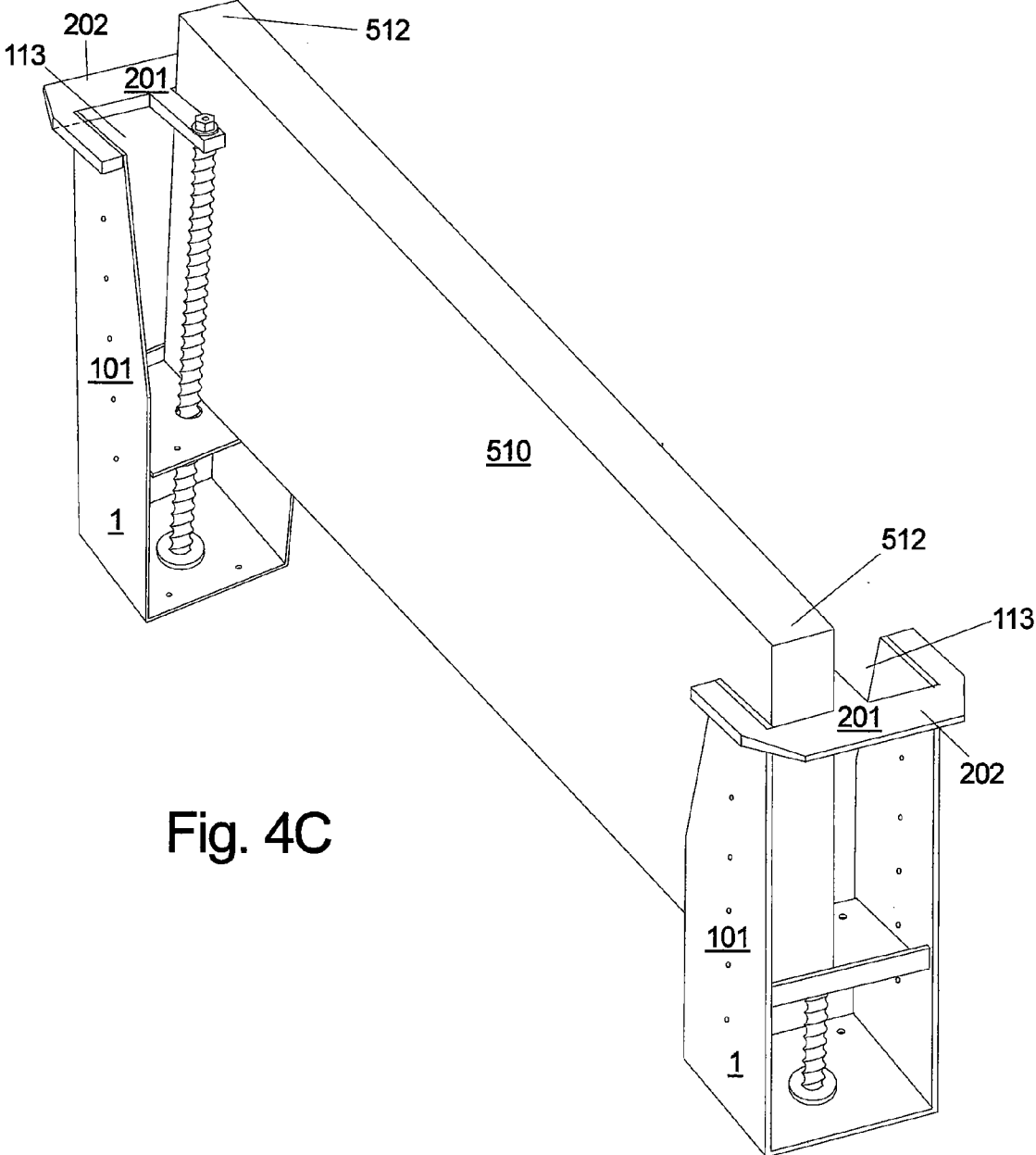


Fig. 4C

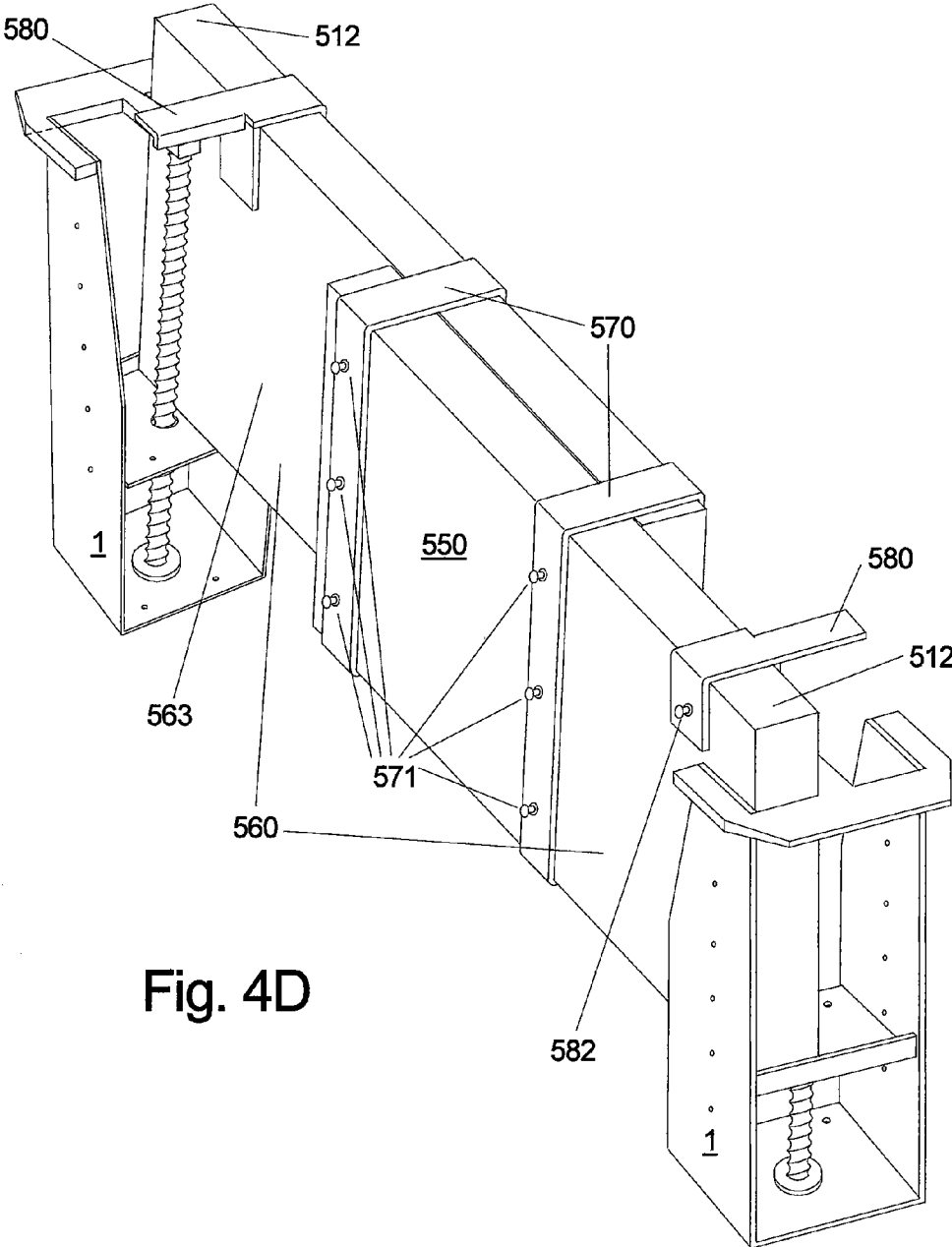


Fig. 4D

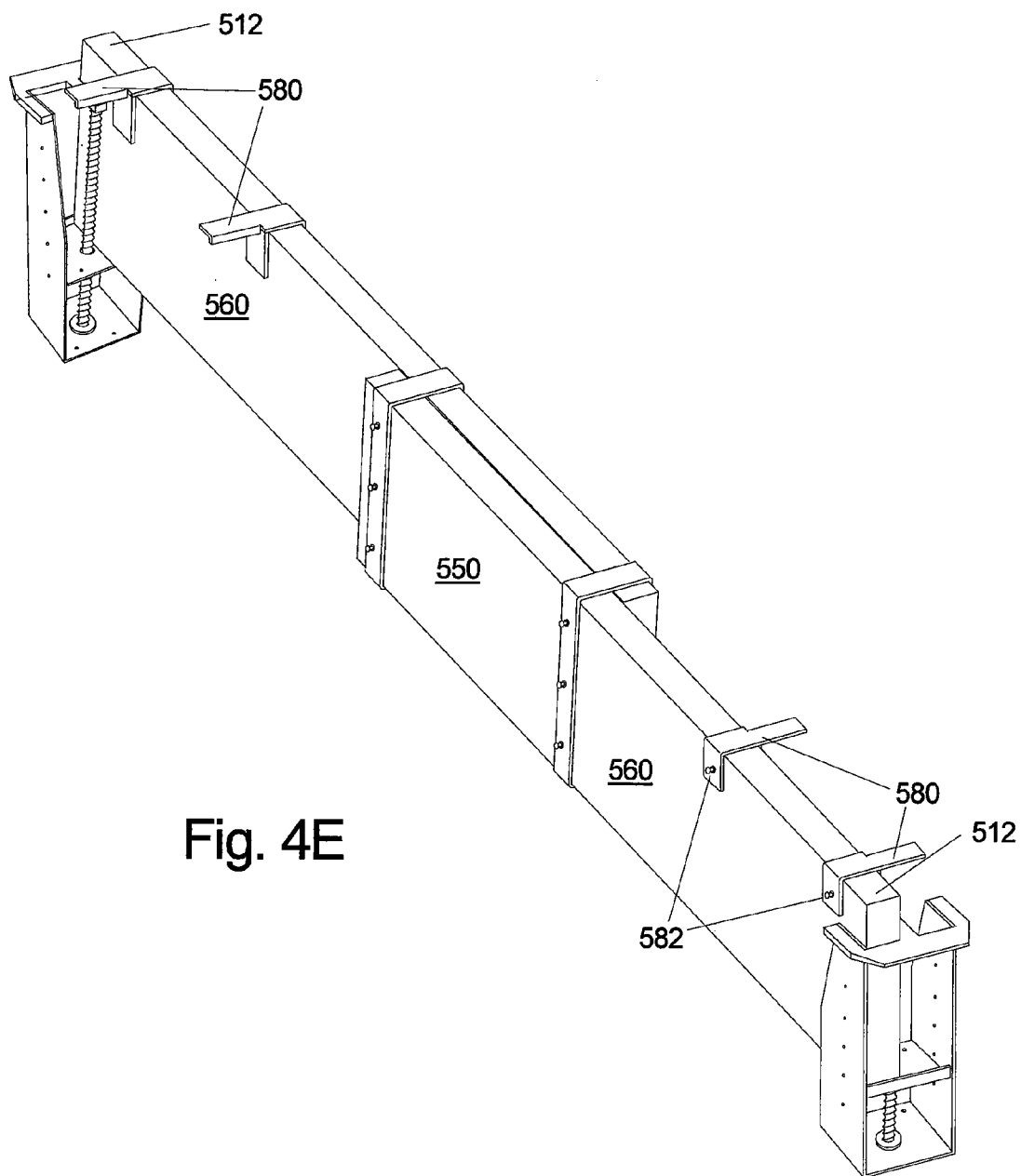


Fig. 4E

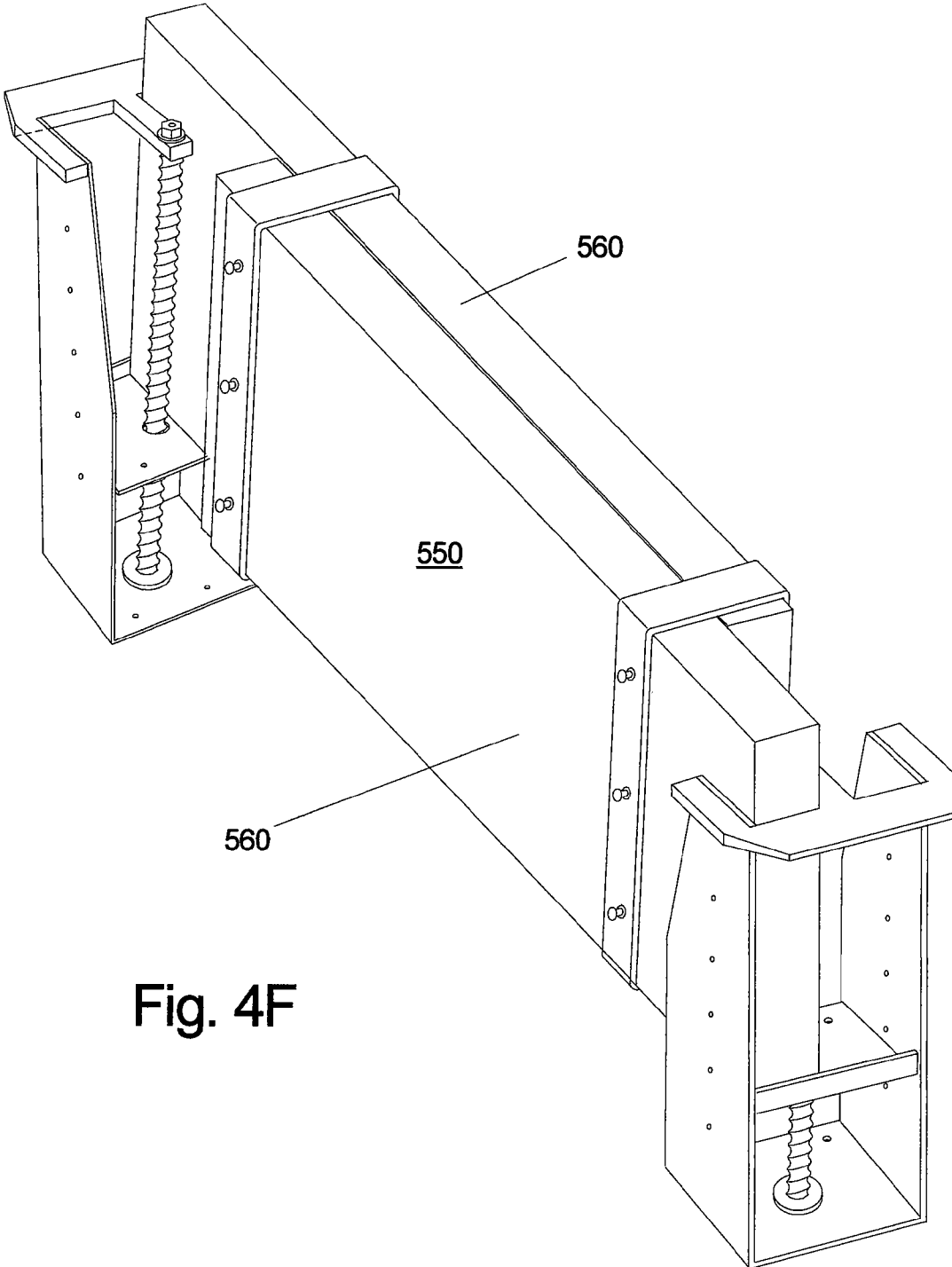


Fig. 4F

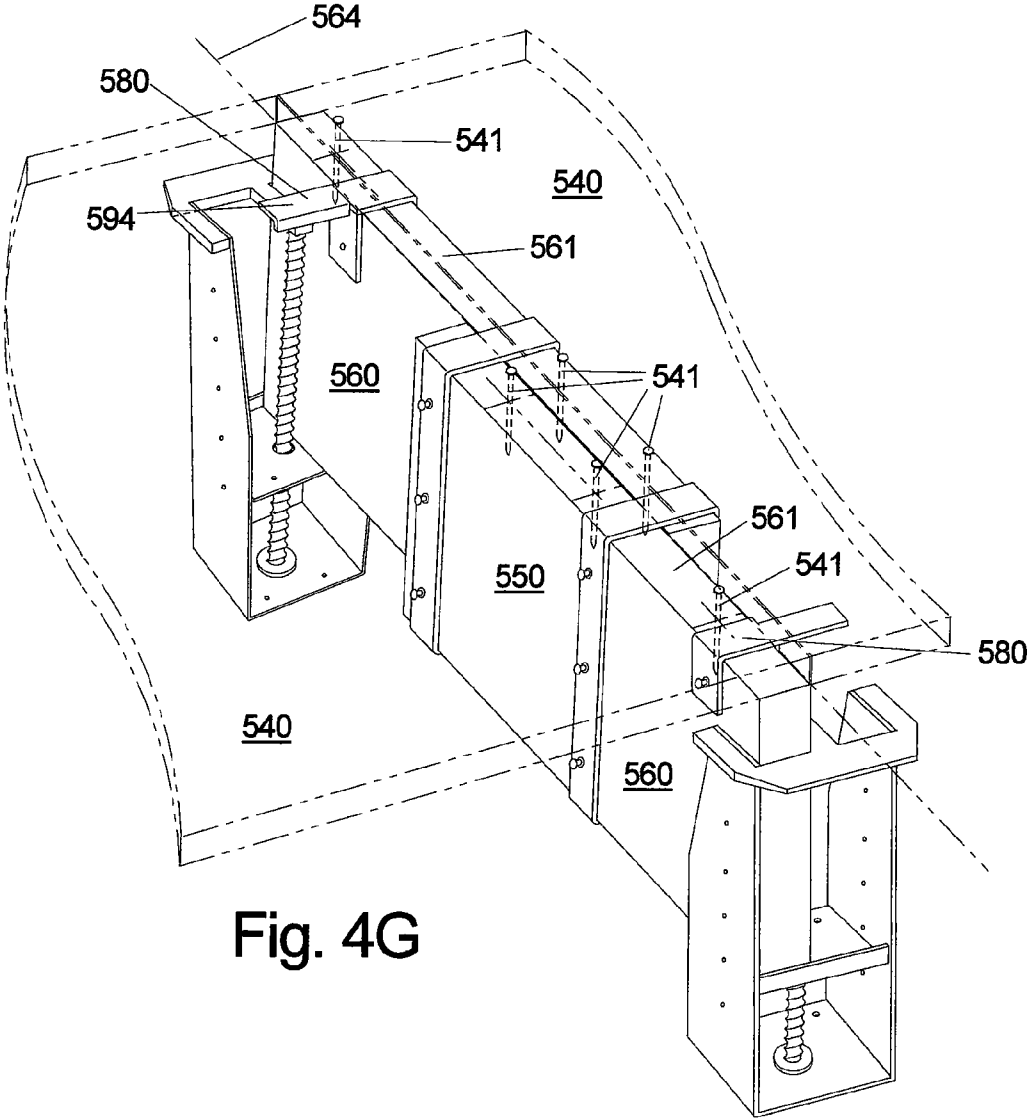
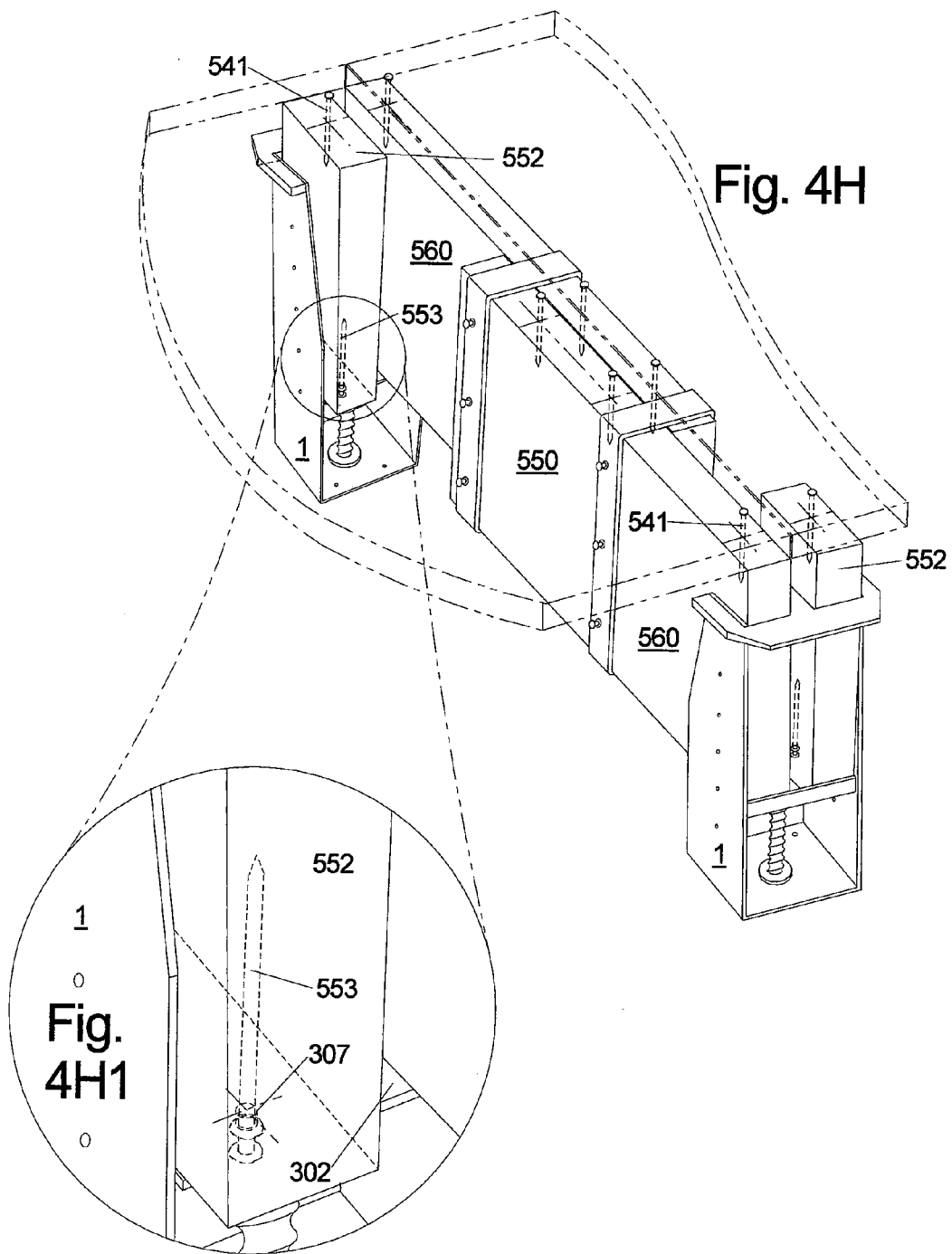


Fig. 4G



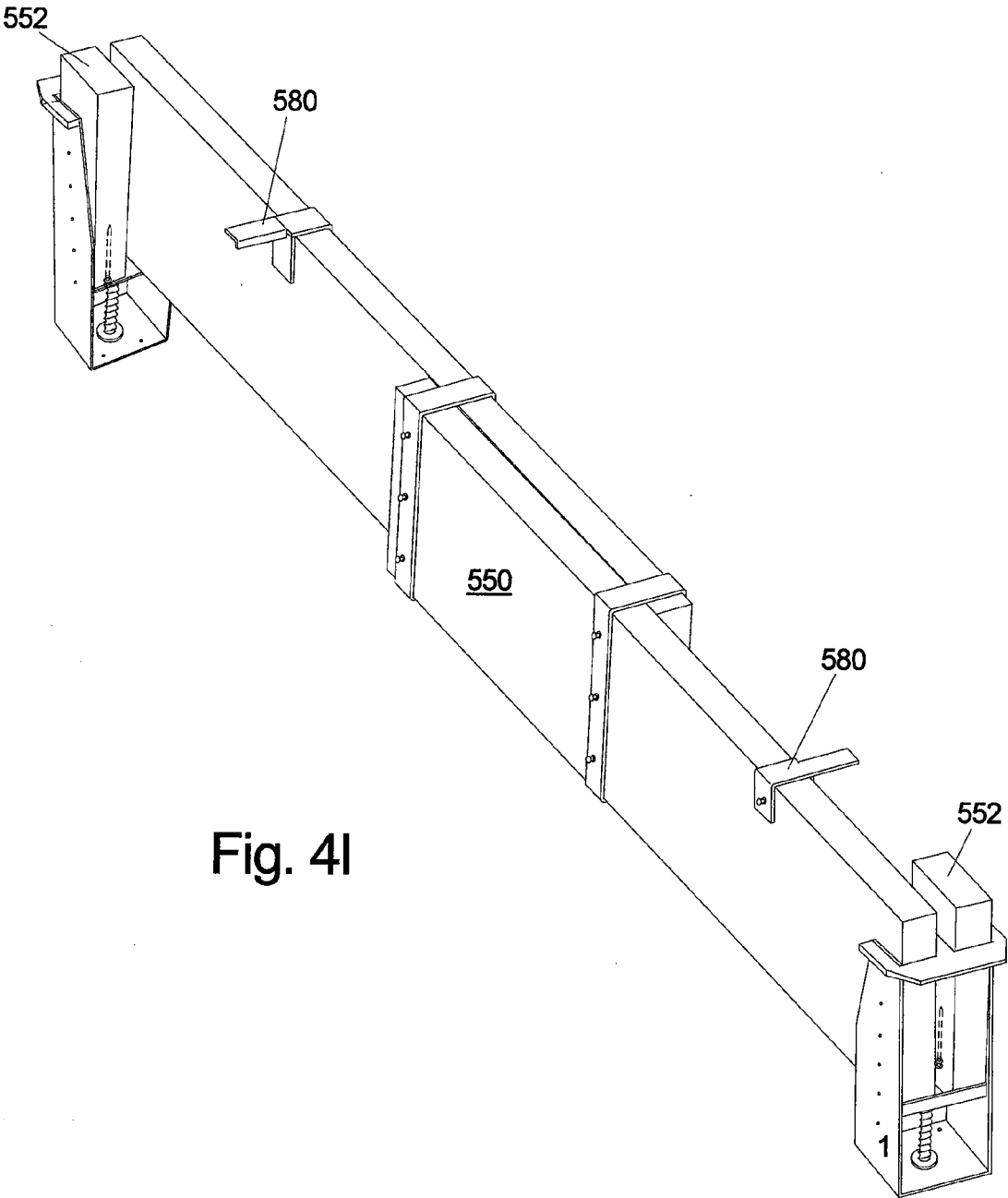


Fig. 4I

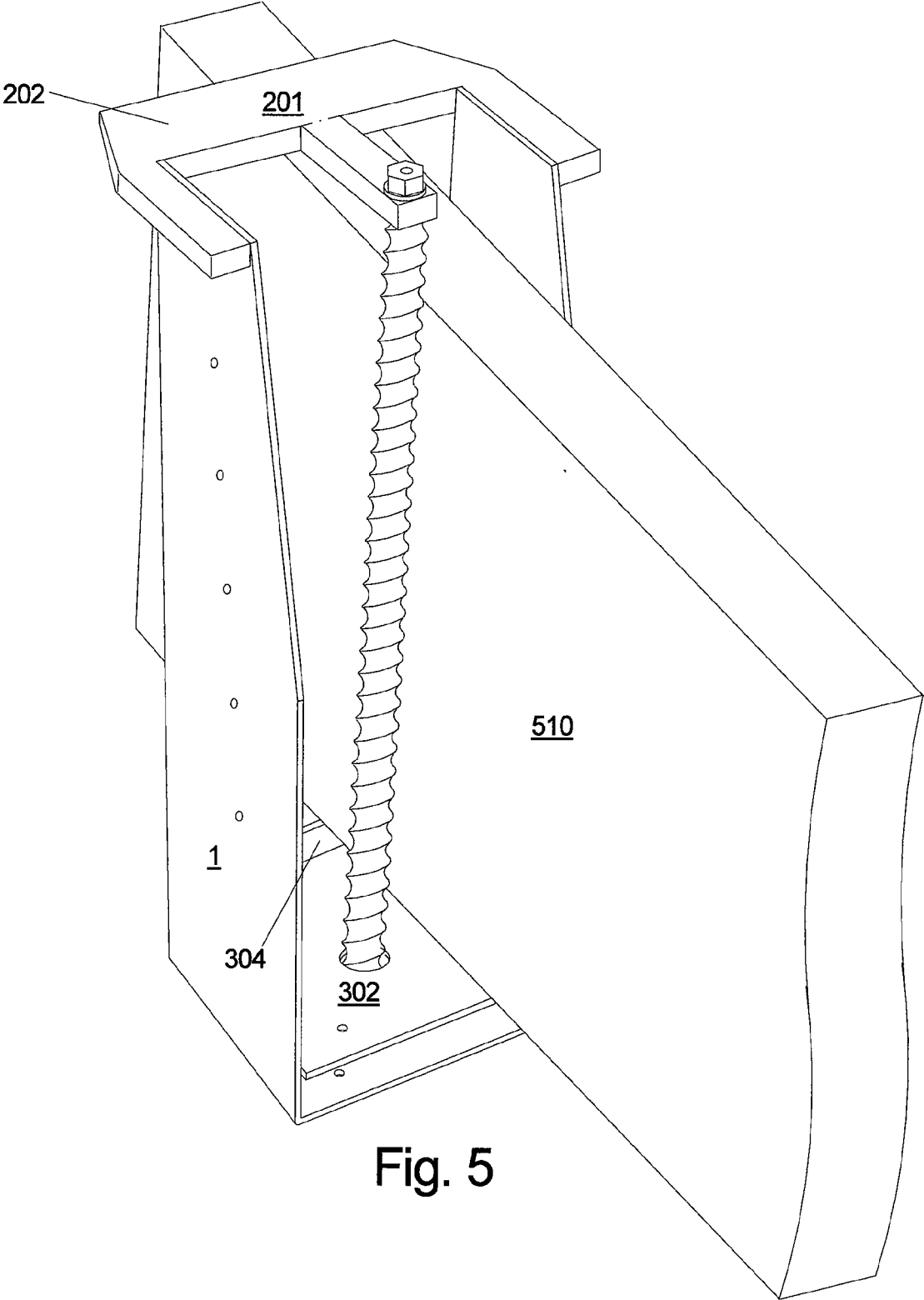


Fig. 5

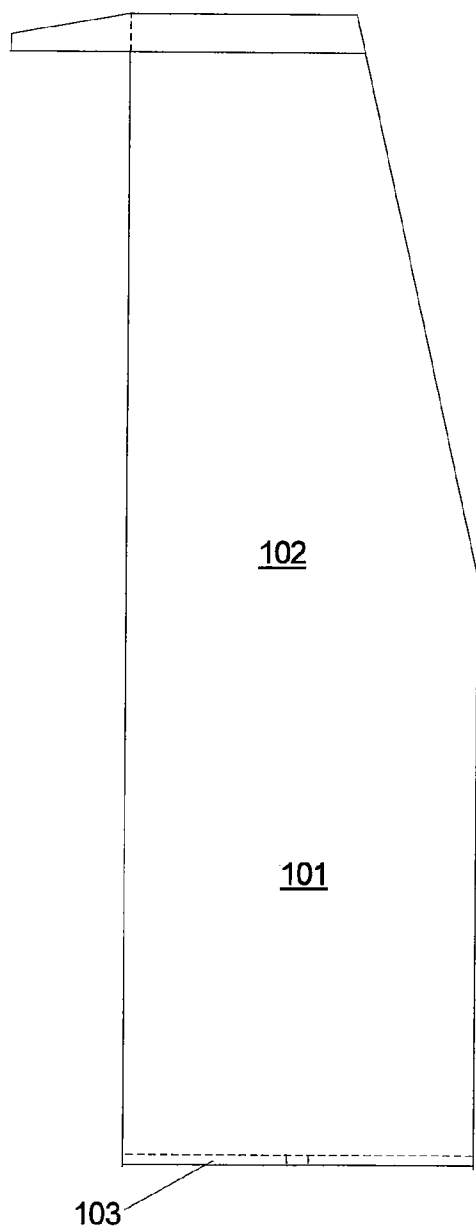


Fig. 6

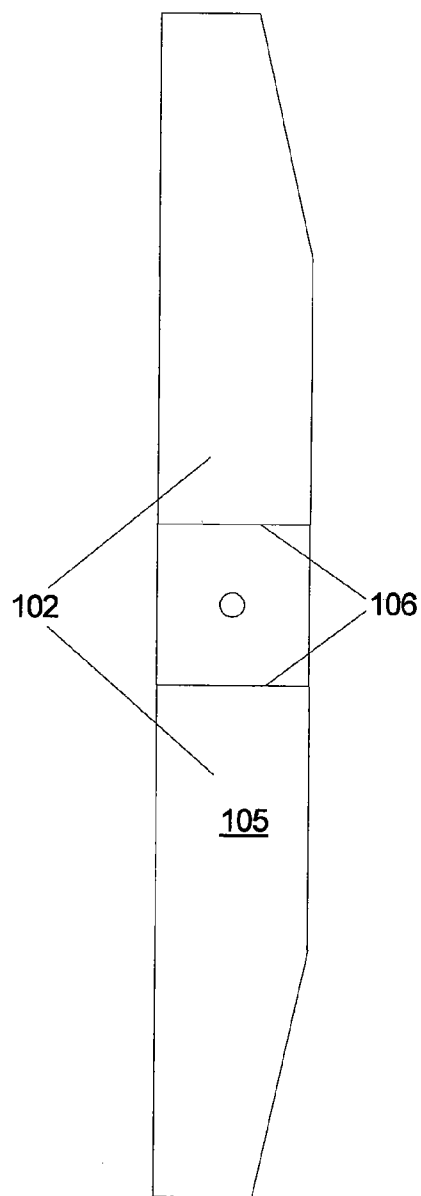


Fig. 6A

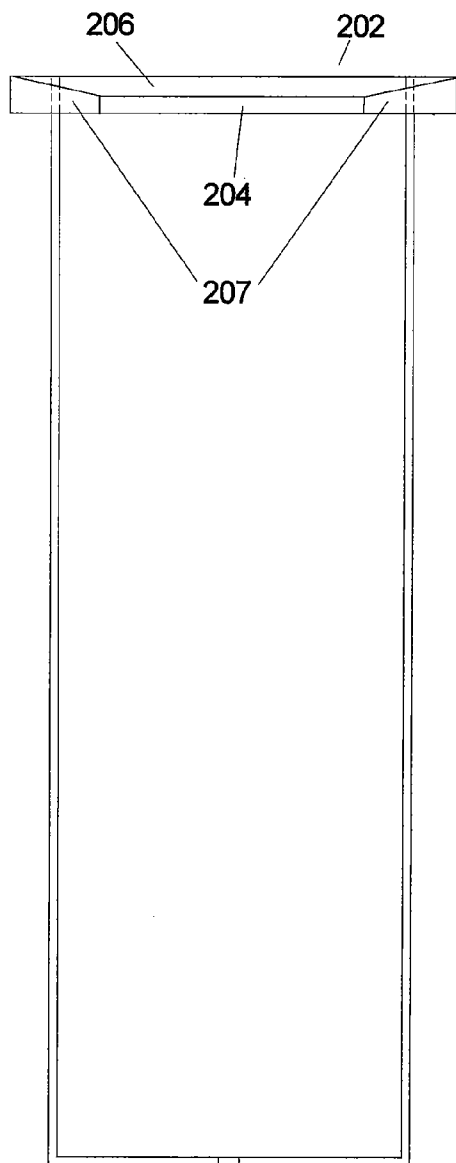


Fig. 7

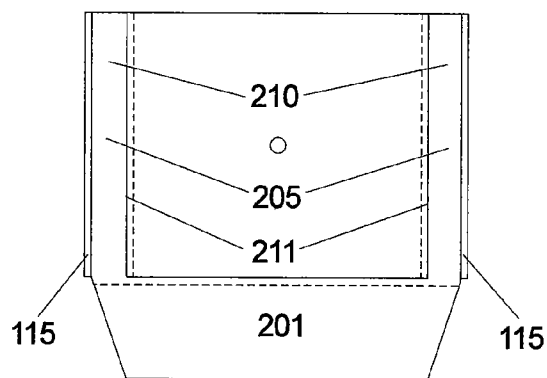


Fig. 7C

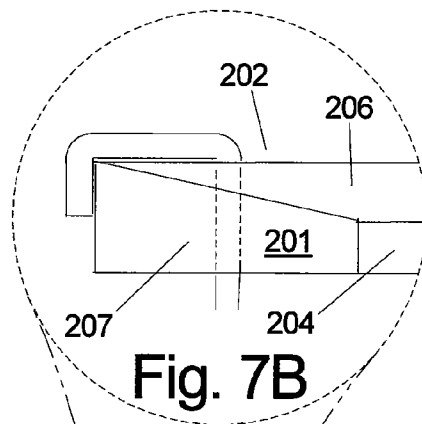


Fig. 7B

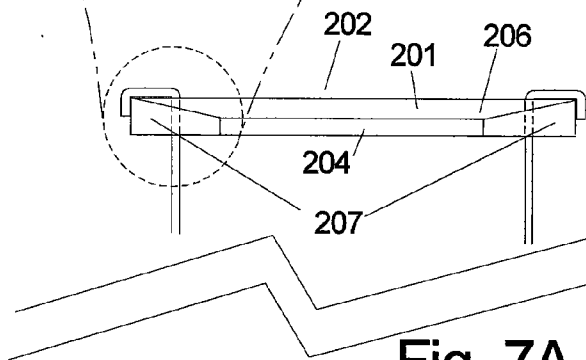


Fig. 7A

Fig. 8

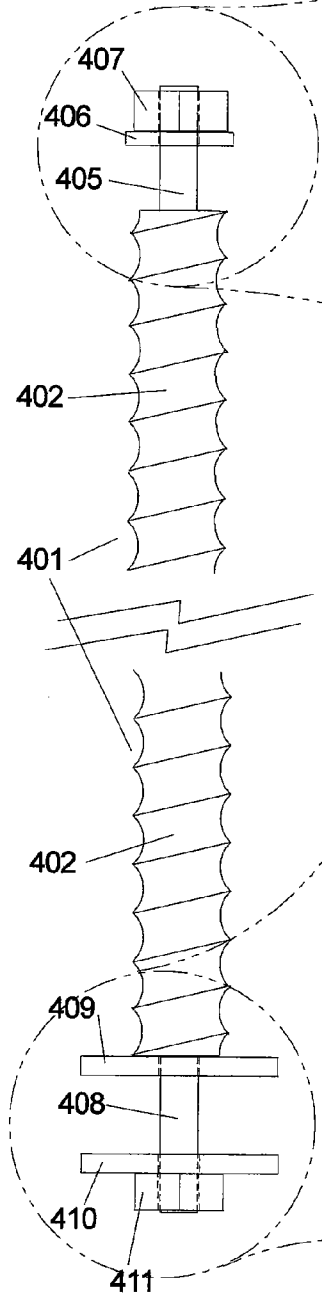


Fig. 8A

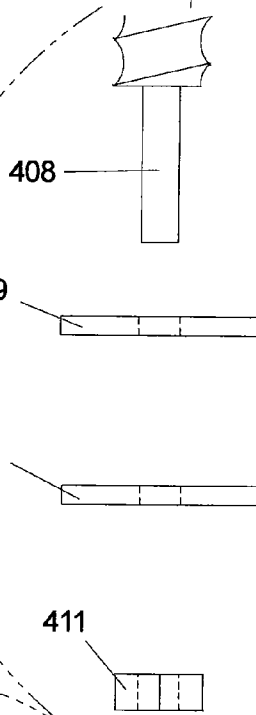
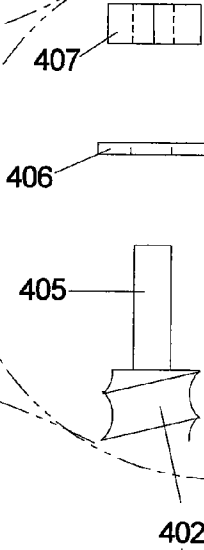


Fig. 8B

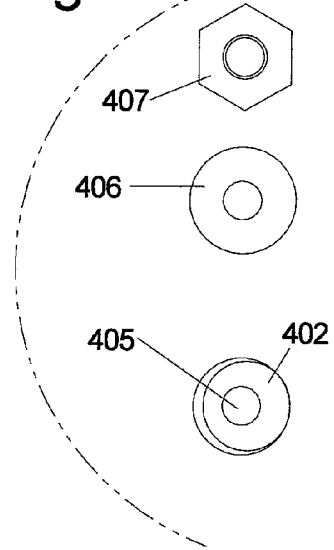
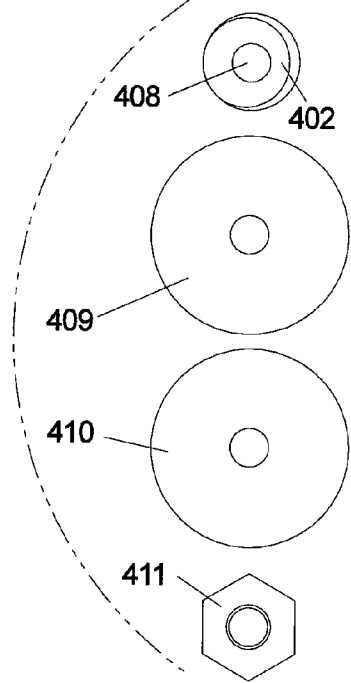
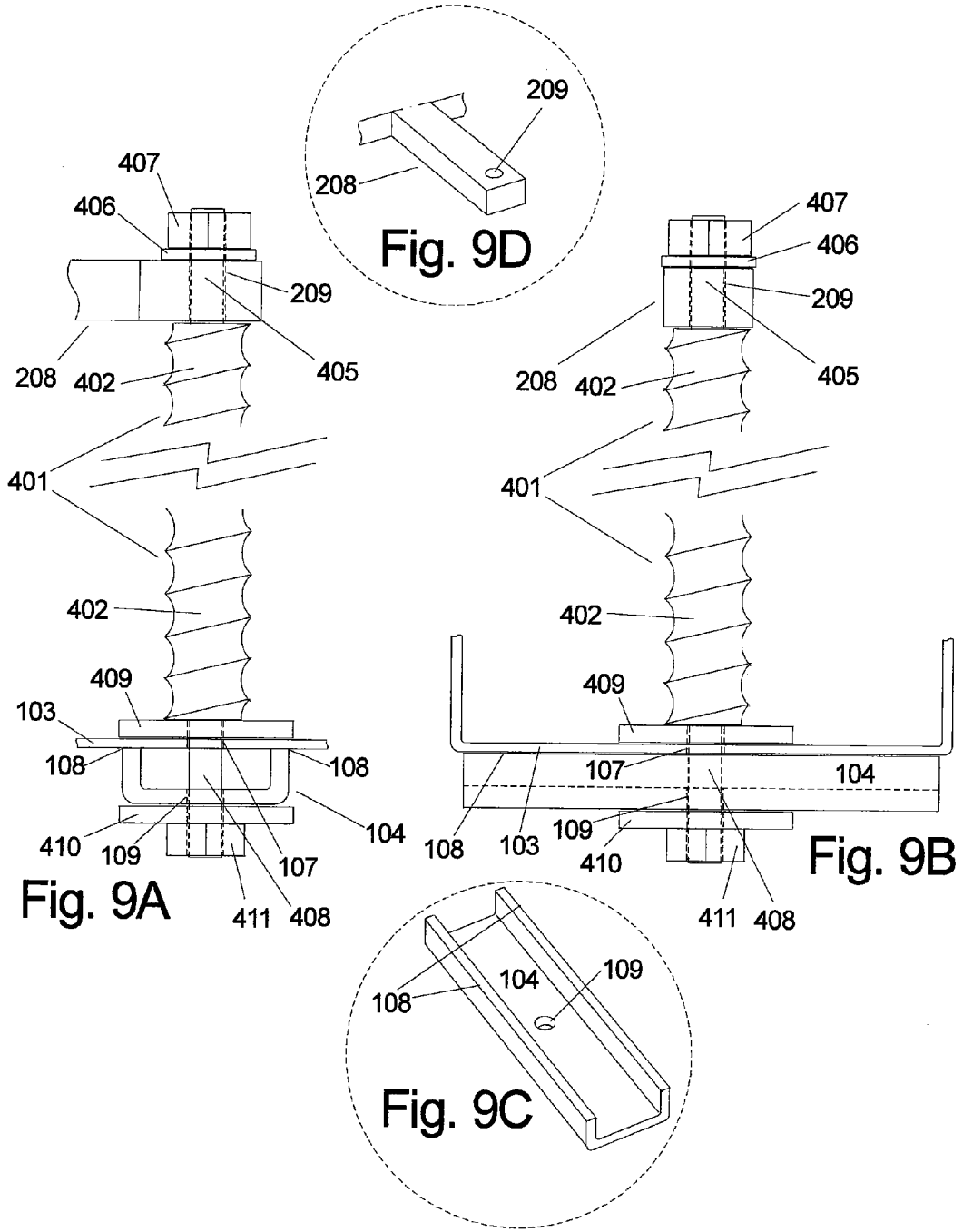


Fig. 8C





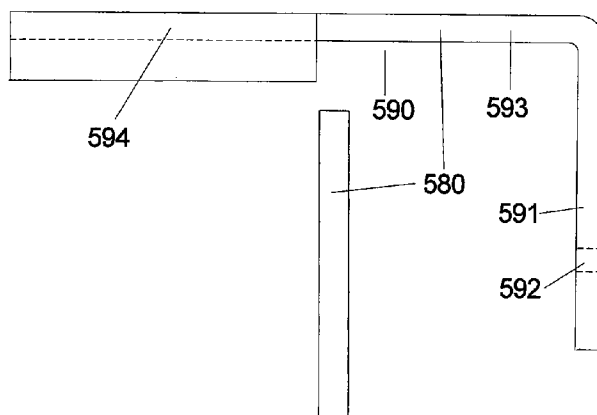


Fig. 10A

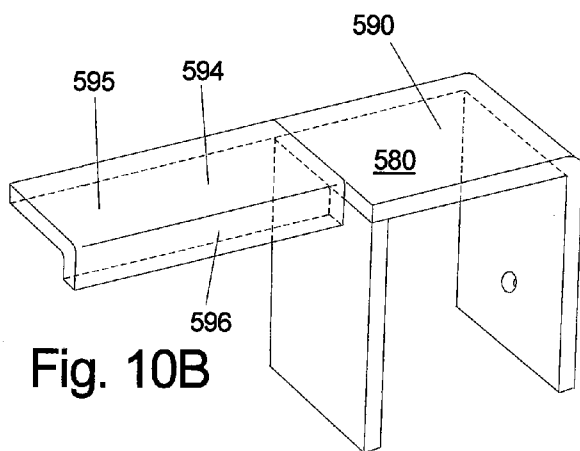


Fig. 10B

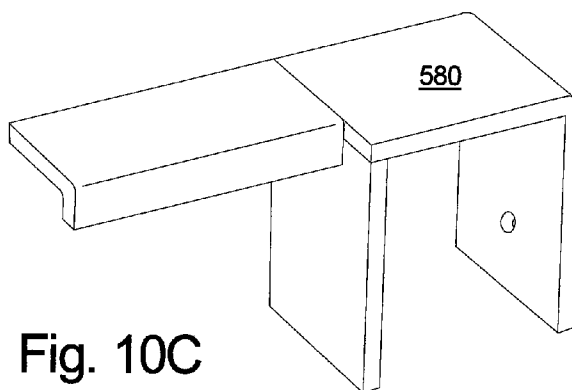
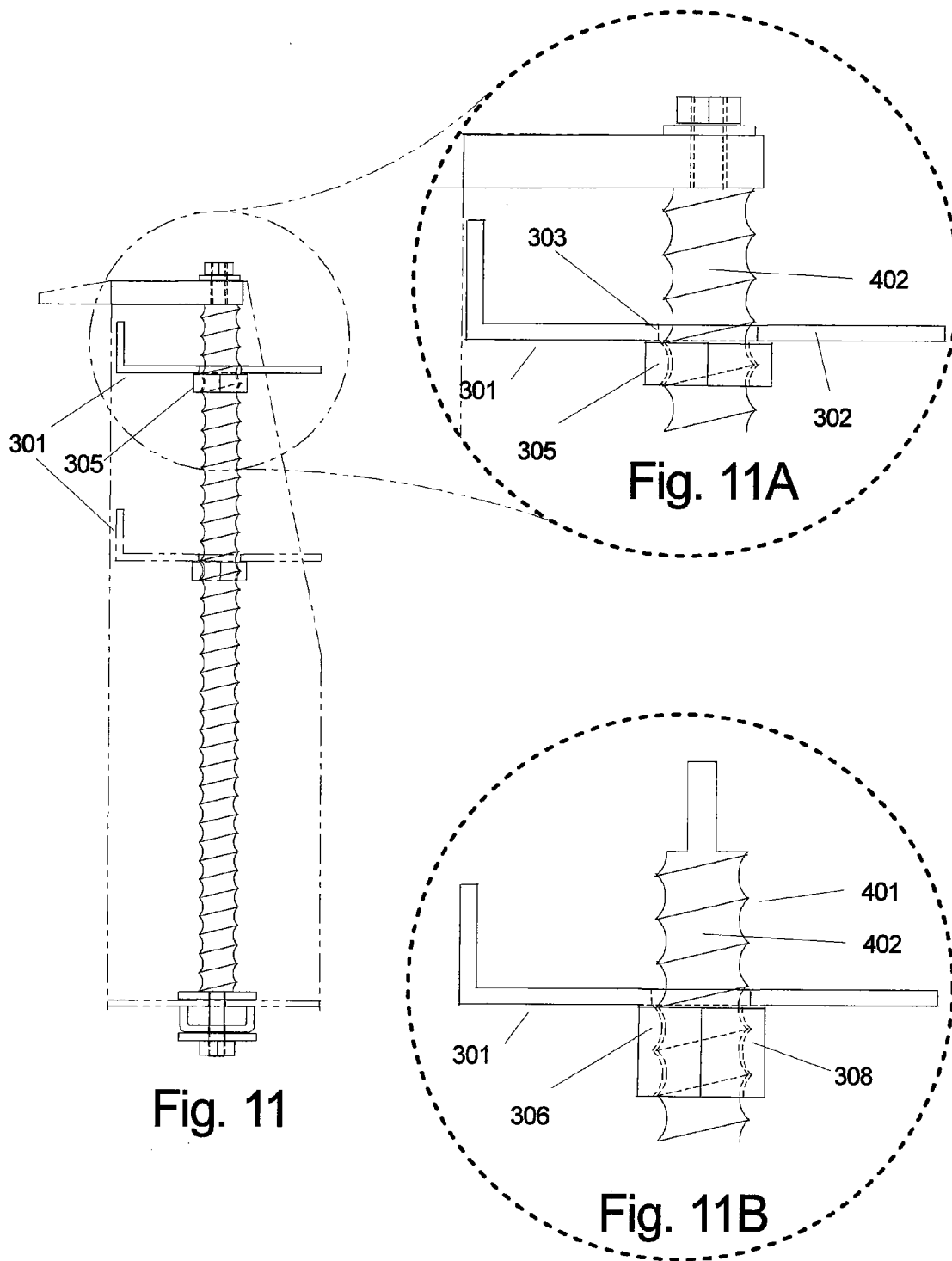


Fig. 10C



REUSABLE ADJUSTABLE HANGER FOR USE WITH JOISTS AND/OR DOUBLE WALES

BACKGROUND OF THE INVENTION

[0001] One embodiment of the present invention comprises a reusable adjustable ledger hanger, to be used as part of the formwork for constructing formed-in-place horizontal concrete surfaces, including bridge decks and building slabs such as floors. While the focus of discussion in the specification will be on bridge decks formed with removable and reusable formwork, it will be understood that the reusable adjustable ledger hanger of the present invention (“the present invention”), is of more general application.

[0002] With respect to formed-in-place bridge decks, the deck typically comprises spans of steel reinforced concrete, each span supported on two opposite sides by permanent steel or reinforced concrete girders or beams. Formed-in-place deck spans can be poured on stay-in-place formwork, on removable formwork, or on formwork having both stay-in-place and removable elements.

[0003] Removable formwork systems include the use of what will be termed primary spanning ledgers, typically joists or double walers, suspended by vertically adjustable means between and perpendicular to permanent bridge concrete girders or beams. Some suspension systems include one-time use elements, such as saddle hangers, called sacrificial elements, that become encased in the poured concrete. Removable and reusable hangers offer the advantage of lower cost: no elements are sacrificial.

[0004] Examples of prior art reusable adjustable hangers are U.S. Pat. Nos. 4,158,940 and 4,192,623. Common features of these patents include: both are designed for and sized for use with single joists, not double walers; both provide for removal of the joist through the bottom during formwork disassembly; both comprise a threaded rod vertical adjustment member that protrudes from the bottom and moves vertically; both have enclosed rear sides and open front sides; both have a lip structure that rests on and depends on an upper surface of a permanent bridge girder or beam. Although there is a commercially available reusable adjustable hanger wide enough for 4× nominal lumber, it is not designed for double wales per se. Reusable adjustable hangers are typically only for 2× nominal lumber. Double waler systems typically depend on suspension systems having sacrificial elements, and including a threaded rod section that inserts between the wales and supports the wales by means of a nut and bottom plate.

[0005] The useful life of joist and double waler material is often shortened when the joists and double walers are shortened to accommodate a specific span length. Sections of primary spanning ledger material are sometimes joined together to render a primary spanning ledger of a specific length.

[0006] Limitations in the prior art for reusable adjustable hangers comprise: Lack of a hanger designed specifically for use with double wales; higher cost and more complicated designs when a removable hanger bottom is used; construction site danger of damage and bending of unenclosed threaded rod sections; lack of structural means for maintaining a single joist in a vertical position when used in a double wide ledger housing; lack of a hanger that can be used with either single joists or double wales; lack of a hanger designed to accommodate sections of joist material joined together to form a primary spanning ledger having a required length;

inability to pre-attach the hanger to a primary spanning ledger and then subsequently adjust the vertical height of the ledger; and narrow nailing surfaces when sections of plywood formwork sheathing abut over a single joist.

BRIEF SUMMARY OF THE INVENTION

[0007] One or more embodiments of the present invention comprise: a ledger housing further comprising a single formed metal piece having two vertical sides perpendicular to a horizontal bottom, for receiving and supporting as a primary spanning ledger: a single joist, or a double waler, or two sections of joist material joined together over a central overlapping section; vertical structural means to prevent lateral movement when the primary spanning ledger is a single joist; means for depending on a supporting structure to provide horizontal support over the entire width of the ledger housing; means for disengaging horizontal support of the hanger by moving the hanger away from the supporting structure during formwork disassembly; and means for adjusting the vertical position of a primary spanning ledger from either the top or the bottom, further comprising an adjustment assembly requiring only one single threaded rod that is enclosed within the ledger housing; and a ledger bearing plate having nailing holes for pre-attachment of the hanger(s) to a primary spanning ledger while still permitting subsequent vertical adjustment of the ledger height. As described in the detailed description of the invention and the claims, the present invention further comprises alternative variations that may omit one or more of the above attributes.

[0008] The present invention comprises one or more of the improvements referenced to prior art stated above.

[0009] Respecting the lack of a reusable adjustable hanger designed specifically for use with double wales, one embodiment of the present invention houses and supports double wales, and provides adjustment means accessible from the top through the center of a double waler. Respecting higher cost and more complicated designs when a removable hanger bottom is used, embodiments of the ledger housing of the present invention can comprise a single formed metal piece having two vertical sides perpendicular to a horizontal bottom, the manufacturing process for the ledger housing of the present invention can thus be both simpler and less material-intensive compared to the process required for rendering a two-piece assembly having a removable bottom. Regarding construction site danger of damage and bending of unenclosed threaded rod sections; embodiments of the present invention can comprise an adjustment assembly requiring only one single threaded rod that is enclosed within the ledger housing, and is thus shielded from construction site damage. Regarding the lack of structural means for maintaining a single joist in a vertical position when used in a double wide ledger housing, the present invention comprises vertical structural means to prevent lateral movement when the primary spanning ledger is a single joist. Regarding the lack of a reusable hanger that can be used with joists and/or double wales, the present invention is designed for use with either type of primary spanning ledger. It should be noted that this advantage gives construction companies much greater flexibility to use what they have on hand for a given construction project. As examples of this flexibility: the present invention can be used for project X, where double waler formwork is preferred, and later on project Y, where single joist formwork is preferred; single joist formwork can be constructed with on-hand material comprising single joist hangers and hangers

of the present invention. Regarding the lack of a hanger designed to accommodate sections of joist material joined together to form a primary spanning ledger having a required length, the present invention provides both vertical structural means to prevent lateral movement when primary spanning ledgers comprise single joist ends, and horizontal support over the entire width of the ledger housing to further prevent lateral movement when the formwork is loaded. Regarding narrow nailing surfaces when sections of plywood formwork sheathing abut over a single joist, single joist formwork systems can be modified to interspace among the single joists one pair of hangers of the present invention and a wider primary spanning ledger every eight feet, providing for a wider nailing surface where eight foot sections of sheathing abut. When formwork is constructed with overlapping joists joined together and sized for a specific span length requirement, these primary spanning ledgers also have a wider nailing surface where the joists overlap. Regarding inability to pre-attach a hanger to a primary spanning ledger and then subsequently adjust the vertical height of the ledger, one embodiment of the present invention comprises a ledger bearing plate having nailing holes for pre-attachment of the hanger(s) to a primary spanning ledger while still permitting subsequent vertical adjustment of the ledger height.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0010]** FIG. 1 is a perspective view similar to FIG. 3A, but having no referencing numbers, and suitable for the front illustration.
- [0011]** FIG. 2 is a perspective view of a hanger of the present invention.
- [0012]** FIG. 2A is a perspective view of a hanger of the present invention having a bottom reinforcing member, ledger housing top sections formed around the lip structure, and a vertical support structure.
- [0013]** FIG. 2B is a side isometric view illustrating a hanger of the present invention as the lip structure and the vertical support structure depend on a steel I-beam permanent bridge girder.
- [0014]** FIG. 2C is a perspective view of a hanger of the present invention having a bottom reinforcing member and a ledger bearing plate upper threaded rod housing, but without an upper central mounting prong.
- [0015]** FIG. 2D is a perspective view of a hanger of the present invention having a top and bottom vertically adjustable threaded rod that moves vertically with the ledger bearing plate, and having a second and removable threaded rod section for preventing lateral movement of a single joist member.
- [0016]** FIG. 2E is a perspective view of a hanger of the present invention having a top and bottom vertically adjustable threaded rod that moves vertically with the ledger bearing plate, the ledger bearing plate being formed with two lower reinforcing flanges and an upper central flange that works in combination with an upper central prong to prevent lateral movement of a single joist member.
- [0017]** FIG. 2F is a perspective view of a hanger of the present invention similar to FIG. 2D, but also having an attachable and detachable upper lip structure.
- [0018]** FIG. 2G is similar to FIG. 2F, but has an alternative design for an attachable and detachable upper lip structure.
- [0019]** FIG. 2H is similar to FIG. 2D, but has an attachable and removable bottom section.
- [0020]** FIG. 3 is a perspective and sectional view of a hanger of the present invention, depending on a permanent bridge girder, and housing and supporting a double waler primary spanning ledger.
- [0021]** FIG. 3A is similar to FIG. 3, but illustrates with dashed lines surfaces of the double waler and the hanger of the present invention not viewable due to obstruction of the double waler.
- [0022]** FIG. 3B is a perspective and sectional view comprising the hanger and double waler of FIG. 3, and further illustrating a second and opposing adjustable hanger at the opposite end of the double waler.
- [0023]** FIG. 3B1 is an enlarged view from FIG. 3B, illustrating a hanger of the present invention as pre-attached, by nailing, to a ledger member, illustrated with dashed lines for hidden surfaces, of a primary spanning ledger.
- [0024]** FIG. 4A is a perspective and sectional view of a hanger of the present invention, depending on a permanent bridge girder, and housing and supporting a single joist primary spanning ledger, with dashed lines for surfaces of the joist and the hanger of the present invention not viewable due to obstruction of other elements.
- [0025]** FIG. 4B is a perspective view comprising the hanger and joist of FIG. 4A, and further illustrating a second and opposing hanger at the opposite end of the joist.
- [0026]** FIG. 4C is a perspective view similar to FIG. 4A, but further illustrating an alternative positioning scheme of the joist ends within the hanger housings.
- [0027]** FIG. 4D is a perspective view similar to FIG. 4A, but further illustrating a primary spanning ledger comprising dual partial spanning joist sections, joined at the middle with metal binding bands and nails, together with the use of one metal sheathing support at each end.
- [0028]** FIG. 4E is similar to FIG. 4D, but illustrates a longer primary spanning ledger, and the use of two metal sheathing supports at each end region where the joist sections do not overlap.
- [0029]** FIG. 4F is similar to FIG. 4D, but illustrates a relatively short primary spanning ledger, with enough overlap of the two partial spanning joist sections to render unnecessary the use of additional formwork sheathing support.
- [0030]** FIG. 4G is similar to FIG. 4D, but further illustrates, in phantom, two top sections of formwork sheathing abutting over and nailed to the primary spanning ledger.
- [0031]** FIG. 4H is similar to FIG. 4D, but further illustrates the use of at each end of a sheathing support block, rather than a metal sheathing support.
- [0032]** FIG. 4H1 is an enlarged section of FIG. 4H, further illustrating a sheathing support block nailed directly to a hanger of the present invention.
- [0033]** FIG. 4I is similar to FIG. 4E, but further illustrates the use, on each end of the primary spanning ledger, of one sheathing support block, and one rather than two metal sheathing supports.
- [0034]** FIG. 5 illustrates a hanger of the present invention slid forward on a joist during the process of disassembling formwork.
- [0035]** FIG. 6 illustrates an isometric side view of the housing and lip structure of a hanger of the present invention.
- [0036]** FIG. 6A illustrates an isometric top view, before forming, of a metal plate section used to form the housing of a hanger of the present invention.
- [0037]** FIG. 7 illustrates an isometric front view of the housing and lip structure of a hanger of the present invention.

[0038] FIG. 7A illustrates an isometric front sectional view of an alternative design for the housing and lip structure of a hanger of the present invention, having the upper sections of the housing formed to fold over and around the lip structure.

[0039] FIG. 7B is an enlarged isometric front sectional view of a portion of the alternative design for the housing and lip structure of FIG. 7A.

[0040] FIG. 7C is a bottom isometric view of the ledger housing and the lip structure of a hanger of the present invention.

[0041] FIG. 8 is a side sectional isometric view of a threaded rod assembly of a hanger of the present invention.

[0042] FIG. 8A is an exploded side sectional isometric view of FIG. 8.

[0043] FIG. 8B illustrates top isometric views the elements shown in the upper section of FIG. 8A.

[0044] FIG. 8C illustrates bottom isometric views of the elements shown in the bottom section of FIG. 8A.

[0045] FIG. 9A is a side sectional isometric view of the threaded rod assembly of FIG. 8, shown as attaching, at the top, to an upper threaded rod mounting prong, and at the bottom, to the ledger housing bottom and a bottom reinforcing member, of a hanger of the present invention.

[0046] FIG. 9B is a front sectional isometric view of the threaded rod assembly of FIG. 8, shown as attaching, at the top, to an upper threaded rod mounting prong, and at the bottom, to the ledger housing bottom and a bottom reinforcing member, of a hanger of the present invention.

[0047] FIG. 9C is a perspective view of a bottom reinforcing member of a hanger of the present invention.

[0048] FIG. 9D is a perspective view of an upper threaded rod mounting prong of a hanger of the present invention.

[0049] FIG. 10A is a side isometric view of a metal sheathing support of a hanger of the present invention.

[0050] FIG. 10B is a perspective view of a metal sheathing support of a hanger of the present invention, having dotted lines illustrating hidden surfaces.

[0051] FIG. 10C is similar to FIG. 10B, but has no hidden surfaces illustrated.

[0052] FIG. 11 is a side isometric view illustrating the ledger plate assembly as operated by means of the threaded rod assembly, with both assemblies situated within in phantom outline rendering of the ledger housing.

[0053] FIG. 11A is an expanded sectional side isometric view from FIG. 11.

[0054] FIG. 11B is similar to FIG. 11A, but shows the threaded rod assembly before it is attached to the central mounting.

DETAILED DESCRIPTION OF THE INVENTION

[0055] One embodiment of the present invention comprises a reusable adjustable ledger hanger, for general use in forming horizontal concrete structures having permanent vertical support. It should be noted that while some elements and aspects of the present invention described and discussed here do not bear directly on the claims, they do serve to explicate and illustrate the utility of the present invention to the extent that their disclosure is thought to be appropriate.

[0056] FIG. 2 illustrates a reusable adjustable ledger hanger (sometimes simply referred to as "hanger"), 1, of the present invention, comprising a ledger housing, 101, sized to accommodate primary spanning ledgers of a range of sizes and types, and having two sides, 102, and a bottom, 103; a threaded rod assembly, 401; a lip structure, 201, having a

central mounting prong, 208; and a ledger plate assembly, 301, having a ledger bearing plate, 302, and a rear upper flange, 304.

[0057] Before further detailing the structure and function of this embodiment of the hanger, 1, of the present invention, brief initial reference will be made to its use with primary spanning ledgers. FIG. 3 illustrates a section of a double waler, 501, situated within the ledger housing, 101, of the hanger, 1, of the present invention, and supported by the lip section, 202, of the lip structure, 201, as it rests on the upper surface, 602, of a permanent bridge girder, 601, and is supported horizontally by the girder. FIG. 3B illustrates that the adjustable ledger hanger, 1, of the present invention is designed to be used in opposing pairs, each hanger, 1, of a pair of hangers supporting one end of a primary spanning ledger, in this illustration a double waler, 501. FIG. 3B and FIG. 3B1 further illustrate that the hangers, 1, of the present invention, as seen in FIG. 3B, can be pre-attached to a primary spanning ledger; referring to FIG. 3B1, by driving a primary spanning ledger double headed nail, 520, through a nailing hole, 307, in the ledger bearing plate, 302, and into the underside of a ledger member, 523. The ledger can be attached in this way for primary spanning ledgers having either single members, such as a joist, or double members, such as a double waler; additionally, either one or both members of a double member primary spanning ledger can be pre-attached by nailing, as required. Thus, one embodiment of the present invention further comprises nailing holes in the horizontal ledger bearing plate, such that the hanger of the present invention can be pre-attached by nailing to an end of a primary spanning ledger comprising either a single joist or a double waler.

[0058] Returning now to further detail the structure and function of the hanger of the present invention, and referring now to FIG. 3A, a primary spanning ledger comprising a double waler, 501, is housed in and supported by a hanger, 1, of the present invention. Referring now to FIG. 2, the lip structure, 201, the threaded rod, 402, the ledger housing sides, 102, and the ledger plate assembly, 301, combine to form a first ledger member cavity, 110, and a second ledger member cavity, 111, labeled at their bases, for receiving ledgers or ledger members, such as joists or wales. Referring again to FIG. 3A, a first wale, 502, of the double waler, 501, occupies the first ledger member cavity, 110, and a second wale, 503, occupies the second ledger member cavity, 111.

[0059] Thus, with reference to FIG. 3A, the present invention comprises: a central vertical member situated above the said horizontal ledger bearing plate, such as the threaded rod, 402, forming, in combination with the said horizontal ledger bearing plate contiguous with a vertical rear upper flange, such as the ledger bearing plate, 302, and the said two ledger housing side walls, 102, two cavity regions within the said ledger housing, such as the cavity regions 110 and 111, each and/or both of the cavity regions capable of receiving and supporting a primary spanning ledger member, and of preventing lateral movement of a primary spanning ledger when the end of the primary spanning ledger occupies only one of the two said cavity regions.

[0060] While the embodiment of the present invention illustrated in FIG. 3A illustrates a central vertical member, the threaded rod, 402, which is attached to an upper mounting prong, 208, FIG. 2C, FIG. 2D, FIG. 2F, FIG. 2G, FIG. 2H all represent a central vertical member not attached to the upper mounting structure, 412. FIG. 2E illustrates an embodiment having a central vertical structure, 415, comprising two ele-

ments: a central vertical structure lower member, **413**, and a central vertical structure upper member, **414**. As illustrated in FIG. 2C, FIG. 2D, FIG. 2F, FIG. 2G, FIG. 2H, the central vertical member not attached to the upper mounting structure, **423**, and, as illustrated in FIG. 2E, the central vertical structure, **415**, both serve the same function with respect to the present invention. Referring now to FIG. 2C, FIG. 2D, FIG. 2F, FIG. 2G, FIG. 2H, the central vertical member not attached to the upper mounting structure, **423**, represents an alternative embodiment of the present invention, with the distinguishing characteristic being the lack of attachment to an upper structure such as the upper mounting prong, **208**, of FIG. 3A. It will be understood however that all instances of what will be termed "a central vertical member not attached to the upper mounting structure", illustrated as **412**, of FIG. 2C, FIG. 2D, FIG. 2F, FIG. 2G, FIG. 2H, have two common attributes that both serve to prevent lateral movement of a primary spanning ledger when the end of the primary spanning ledger occupies only one of the two said cavity regions: first, they have sufficient engineering attributes of rigidity and strength, and second, although, referring now to FIG. 2C, the central vertical member not attached to the upper mounting structure, **412**, does not have to move as the ledger bearing plate, **302**, moves, all instances of a central vertical member not attached to the upper mounting structure must be of a height such that a sufficient length of their structure remains above the ledger bearing plate throughout the vertical range over which the ledger bearing plate moves during normal use. Thus, the phrase "situated above" serves to indicate that the referenced central vertical member is of a height such that a sufficient length of its structure remains above the ledger bearing plate throughout the vertical range over which the ledger bearing plate moves during normal use to prevent lateral movement when a primary spanning ledger occupies only one of the two said cavity regions.

[0061] FIG. 2H illustrates an embodiment of the present invention having one prior art attribute: the ability to remove the bottom structure of the hanger. This embodiment comprises: a hanger, **1**, having a ledger housing, **120**, that in this embodiment further comprises an open front side, but a closed rear side, **122**, that is contiguous with two vertical side walls, **121**, each side wall attaching to a rectangular, horizontal and removable bottom section, **130**. It should be noted that this is for illustrative purposes; due to engineering requirements of the present invention, which must bear more weight and is subject to more stress than single joist hangers, additional reinforcing structure and or design modification may be required. The central vertical member not attached to the upper mounting structure, **412**, situated above the horizontal ledger bearing plate, **302**, is, in this embodiment, a removable section of threaded rod, **140**, inserted through a front hole, **141**, in the ledger bearing plate, **302**, and screwed into a lower threaded rod nut, **142**, that is welded to the underside of the ledger bearing plate, **302**. An upper threaded rod nut, **143**, may be placed on the section of threaded rod, **140**, of this embodiment, referring now to FIG. 3A, serving to narrow the width of the cavity regions, **110** and **111**, further restricting and preventing lateral movement of a primary spanning ledger when the end of the primary spanning ledger occupies only one of the two cavity regions.

[0062] As has been seen, the central vertical structure of the present invention can comprise an attachable and removable threaded rod, having a lower section that may be screwed into, and unscrewed from, a threaded part of the structure of the

vertically adjustable horizontal ledger bearing plate, **302**, of FIG. 3A. It should be noted with reference to FIG. 2D, FIG. 2F, FIG. 2G, and FIG. 2H, that because the central vertical member not attached to the upper mounting structure of these embodiments is comprised of the removable threaded rod, **140**, when the threaded rod, **140**, is removed, the hanger can accommodate 4x lumber as primary spanning ledgers, although it is no longer adjustable from the top when 4x lumber is used.

[0063] Referring to FIG. 2H, the section of threaded rod, **140**, having an upper threaded rod nut, **143**, and representing a central vertical member not attached to the upper mounting structure, is also comprised in embodiments of the invention illustrated in FIG. 2D, FIG. 2E, and FIG. 2G, all of which do not have an attachable and removable bottom section, illustrated in FIG. 2H as the rectangular, horizontal and removable bottom section, **130**. Having noted this exception regarding the attachable and removable bottom section of FIG. 2H, the embodiments of the present invention of FIG. 2D, FIG. 2E, FIG. 2G, and FIG. 2H all comprise a vertically adjustable horizontal ledger bearing plate, **302**, contiguous with a vertical rear upper flange, **304**, that is within the ledger housing, represented in FIG. 2D, FIG. 2E, and FIG. 2G as **101**, and represented in FIG. 4H as **120**.

[0064] The following test regarding the means for vertical adjustment of the ledger bearing plate is referenced to FIG. 2D, FIG. 2E, FIG. 2G, and FIG. 2H. The adjustment means of the ledger bearing plate, **302**, comprises a threaded rod, **420**, connected to and supporting the ledger bearing plate, **302**, from below, but free to rotate, having a rectangular adjustment head, **421**, accessible from above through a threaded rod adjusting hole, **310**, in the ledger bearing plate, **302**, thus providing for vertical adjustment of the ledger bearing plate, **302**, from above. It should be noted that for this embodiment, the bearing surface of the threaded rod, **420**, beneath and supporting the ledger bearing plate, **302**, can be increased by welding on a widening member, such as a thick washer, as indicated by engineering requirements; however, such a possible required enhancement is not illustrated here. For this embodiment, the threaded rod, **420**, is supported at the bottom by threading in the bottom reinforcing member, **114**. As illustrated, the threaded rod, **420**, can also be rotated from below by turning the adjustment handle, **422**. As an alternative or a supplement to the illustrated adjustment handle, **422**, a hex nut section could also be welded to the bottom of the threaded rod, **420**.

[0065] Referring to FIG. 6, this illustrated embodiment of the present invention comprises a continuous ledger housing, **101**, having an open front side, and having an open rear side, and further comprising two opposite, symmetrical, and parallel vertical side walls, termed ledger housing sides, **102**, each side being perpendicular to and contiguous with a rectangular ledger housing bottom, **103**. FIG. 6A is a top isometric view of a planar section, **105**, of sheet metal, from which the structure of the continuous ledger housing, **101** of FIG. 6, is formed, referring again to FIG. 6A, by bending the planar section, **105**, at 90 degree angles along the forming lines, **106**, thus forming, referring to FIG. 2 and FIG. 6, the ledger housing sides, **102**, and, referring to FIG. 2, the ledger housing bottom, **103**.

[0066] One embodiment of the hanger of the present invention further comprises an upper mounting structure, further comprising: means for depending on a support structure; a horizontal central section spanning the two ledger housing

side walls; means of attachment to an upper section of both of the ledger housing side walls, and a central mounting prong protruding frontward. Referring to the embodiment illustrated in FIG. 2, the upper mounting structure of the hanger, 1, of the present invention comprises a planar lip structure, 201. This lip structure further comprises: a protruding quadrilateral lip section, 202, which provides means for depending on a support structure. The lip section, 202, further comprises a horizontal central section, spanning the two ledger housing side walls, 102; this horizontal central section further comprises a first inner side, 203, and a second outer side, 204, these inner and outer sides being opposite and parallel. As means of attachment to an upper section of both of the ledger housing side walls, 102, the lip structure, 201, further comprises two opposite outer prongs, 205, each outer prong being perpendicular to the first inner side, 203. The lip structure further comprises a central mounting prong, 208, which protrudes frontward, and is equidistant from and parallel to the two outer prongs, 205.

[0067] For the embodiment of FIG. 2, the lip structure is sized such that the space between the inner sides of the two outer prongs, 205, is equal to the distance between the outer surfaces of the two ledger housing sides, 102, such that the length of the two outer prongs, 205, is equal to the top width of the ledger housing sides, 102, and such that the central mounting prong, 208, fits between the wales of a double waler. The lip section, 202, further comprises a tapered upper surface, 206, that is thickest along the lip section first inner side, 203, and is thinnest at the opposite lip section second outer side, 204. The two remaining quadrilateral sides of the lip section, 202, will be referred to as the lip section tapered sides, 207, these sides are symmetrically tapered such that the lip section second outer side, 204, is shorter than the lip section first inner side, 203. The front isometric views of FIG. 7, FIG. 7A, and FIG. 7B, also illustrate the tapered lip section, 202, as comprising the tapered upper surface, 206, the tapered sides, 207, and the lip structure second outer side, 204. Because some or all of the lip section, 202, can become embedded in concrete in the normal course of the use of the hanger of the present invention, the tapered structure of the lip section, 202, together with the use of a release agent, facilitate dislodging the hanger of the present invention when the formwork is disassembled and removed.

[0068] FIG. 2F and FIG. 2G illustrate further embodiments of the present invention. The upper mounting structures illustrated in FIG. 2F and FIG. 2G comprise an attachable and removable upper mounting structure, such that a variety of such removable upper mounting structures may be attached to, and detached from the hanger, respective to variations in the interface of each such removable upper mounting structure with supporting structures. Referring to FIG. 2F, the detachable lip structure, 212, is similar to the structure illustrated in FIG. 2; however, while that lip structure, 201, is similar, referring now to FIG. 2F, to the detachable lip structure, 212, the detachable lip structure, 212, offers this advantage: during formwork disassembly, when the lip structure, 212, is detached, the hanger can be moved forward without having to dislodge the lip structure from the concrete; this can facilitate formwork removal. The means for attachment to an upper section of both of the ledger housing side walls, 102, comprises the lip structure housings, 213. As noted above, the lip structure housings, 213, can also accommodate alternative upper mounting structures, as means for depending on a support structure. The holes, 214, in the detachable lip struc-

ture, 212, and the lip structure housings, 213, allow for the use of means such as a spring cotter pin to secure the lip structure within the housing until removal is required. Alternative designs are also possible, for example, including a spring-operated pin within one or both of the prongs, 220, of the detachable lip structure, which must be pushed in to allow removal of the lip structure, 213, from the lip structure housing, 214. It should be noted that embodiments of the present invention may be rendered such that the upper mounting structure is attachable and removable, but, referring to FIG. 2, the central mounting prong, 208, is not attachable and removable.

[0069] FIG. 2G illustrates a hanger, 1, of the present invention comprising an alternative embodiment of the upper mounting structure means of the present invention. Although similar in many respects to FIG. 2F, the rendering of FIG. 2G differs in illustrating the use of a dual tapered lip assembly, 218, comprising dual tapered lip structures, 215, each structure having a threaded bolt hole, 217, with the bolt size determined by engineering requirements, the two tapered lip structures, 215, offering the advantages from tapering as described above with reference to FIG. 2 and the FIG. 7 series. Referring again to FIG. 2G, the two tapered lip structures, 215, are joined by a horizontal central structure, 216. This upper mounting structure embodiment further comprises as attachment means two bolt housings, 219, through which bolts may be inserted and screwed into the bolt holes, 217, to attach the upper mounting structure to an upper section of both of the ledger housing side walls, 102. In addition to the advantages described for the design of FIG. 2F, the upper mounting structure design of FIG. 2G offers this advantage: when the bolts are removed, the hanger can drop down vertically, with no prior horizontal motion required. The design of the upper mounting structure of FIG. 2G can be varied to ensure the area under each of the tapered lip structures is sufficient for adequate horizontal support, per engineering requirements.

[0070] Referring to FIG. 2, this embodiment of the present invention further comprises enclosure within the ledger housing of the threaded rod adjustment means for the vertically adjustable horizontal ledger plate. Referring to FIG. 2, within the ledger housing, 101, the ledger plate assembly, 301, illustrated for one embodiment of the present invention, further comprises: a vertically adjustable horizontal ledger bearing plate, 302, having a centered threaded rod hole, 303, sized to accommodate the threaded rod, 402, of the threaded rod assembly, 401, and a contiguous vertical rear upper flange, 304, of height approximately one-half inch. This embodiment of the present invention further comprises a hole, 303 in the illustration of FIG. 2, or alternatively, a recessed area within the outer perimeter of the ledger bearing plate, such that the ledger plate moves around or about a continuous central vertical member as the position of the horizontal ledger bearing plate is adjusted vertically. This process is described below with reference to the hole, 303, of FIG. 2, and to a continuous central vertical member comprising a threaded rod. The functionality described below with reference to the specific embodiment can be accomplished more generally with the use of: a variety of continuous central vertical members; a variety of vertical adjustment means for the horizontal ledger bearing plate; and a hole or a recessed area within the outer perimeter of the ledger bearing plate.

[0071] FIG. 11A is an enlarged side isometric view of an embodiment of the ledger plate assembly, 301, illustrating

that a threaded rod hex nut, **305**, sized for the threaded rod, **402**, is centered on the threaded rod hole, **303**, and is welded to the underside of the ledger bearing plate, **302**. FIG. 11B illustrates an alternative, sized threaded hex nut section, **306**, which may be used, based on engineering requirements, to provide additional structural support for the threaded rod, **402**. Referring to FIG. 2, when the threaded rod, **402**, is rotated, the ledger plate assembly, **301**, is constrained by the opposite ledger housing sides, **102**, and thus, referring to FIG. 11, the threaded rod hex nut, **305**, causes the ledger plate assembly, **301**, to move vertically, in the illustrated example from an upper position to a lower position drawn in phantom.

[0072] One embodiment of the present invention further comprises a continuous central vertical member; this member further comprises: a lower end mounted in a fixed vertical position to the horizontal bottom of the ledger housing, and an upper end mounted to the central mounting prong of the upper mounting structure. FIG. 2 illustrates, for this embodiment of the present invention, a hanger, **1**, comprising: as a continuous central vertical member, a threaded rod, **402**, as part of a threaded rod assembly, **401**; a central mounting prong, **208**, and, as an upper mounting structure, the lip structure, **201**. The FIG. 8 series of figures, including FIG. 8, and the exploded side, top, and bottom views of FIG. 8A, FIG. 8B, and FIG. 8C, respectively, are limited to illustrating only elements comprising an embodiment of the threaded rod assembly, **401**, of FIG. 2. The FIG. 9 series of figures comprises the threaded rod assembly elements of the FIG. 8 series of figures, together with additional elements of other embodiments of assemblies of the hanger of the present invention attaching to the threaded rod assembly when a hanger of the present invention is fully assembled. In the following text, while most references are to the FIG. 9 series, FIG. 8 series drawings will be referenced in parenthesis; thus the numbered elements referenced to the FIG. 9 series can also be located in the FIG. 8 series for additional illustrative clarity.

[0073] Referring to FIG. 9A, (optionally to FIG. 8), the threaded rod assembly, **401**, comprises a threaded rod, **402**, having an upper end that is turned in to form an upper central shaft section, **405**, and having a lower end that is turned in to form a lower central shaft section, **408**. As an embodiment of a hanger of the present invention is fully assembled, referring to FIG. 11B, before the threaded rod assembly, **401**, is attached at the top, the ledger plate assembly, **301**, is first attached to the threaded rod assembly, **401**, by screwing the threaded rod, **402**, into a ledger plate assembly threaded rod hex structure, **308**, which can be the threaded hex nut section, **306**, the threaded hex nut, **305**, of FIG. 1A, or a functionally equivalent threaded structure having additional properties based on engineering requirements. Referring to FIG. 9A, FIG. 9B, and FIG. 9C (optionally also to the FIG. 8 series), the hanger components are then inverted, a ledger housing bottom reinforcing member, **104**, having a centered hole, **109**, sized to the lower central shaft section, **408**, is placed on the ledger housing bottom, **103**, the ledger housing bottom hole, **107**, is aligned with the bottom reinforcing member hole, **109**; and the bottom reinforcing member side edges, **108**, are welded along their length to the ledger housing bottom, **103**. Referring to FIG. 9A and FIG. 9B (and optionally also to the FIG. 8 series), while the hanger components remain inverted the lower end of the threaded rod assembly, **401**, and the ledger housing bottom, **103**, may then be assembled and attached as follows: a first lower threaded rod washer, **409**, is placed on the lower central shaft section, **408**; the lower

central shaft section, **408**, is inserted through the ledger housing bottom hole, **107**, and through the ledger housing bottom reinforcing member hole, **109**; a second lower threaded rod washer, **410**, is placed on the lower central shaft section, **408**; and a lower threaded rod hex nut, **411**, is placed on and welded to the lower central shaft section, **408**, of the threaded rod, **402**. As thus described, the lower end of the central vertical member, comprising the threaded rod, **402**, is attached to the ledger housing horizontal bottom, **103**.

[0074] Referring to FIG. 9A, FIG. 9B, and FIG. 9D (and optionally also to the FIG. 8 series), as an embodiment of the hanger of the present invention is fully assembled, the hanger components are turned upright, and the threaded rod assembly, **401**, and the central mounting prong, **208**, are assembled and attached as follows: the upper central shaft section, **405**, is inserted through a sized central mounting prong hole, **209**, an upper threaded rod washer, **406**, is placed on the central mounting prong, **208**; and an upper threaded rod hex nut, **407**, is placed on and welded to the upper central shaft section, **405**, of the threaded rod, **402**. Referring to FIG. 2, the lip structure outer prongs, **205**, are then welded to the ledger housing sides, **102**. As thus described, the upper end of the central vertical member, comprising the threaded rod, **402**, is attached to the central mounting prong, **208**, of the upper mounting structure, comprising the lip structure, **201**.

[0075] As described above, the threaded rod, **402**, is adjustable from the top and the bottom, and serves as an adjustment means for the vertically adjustable horizontal ledger plate. Threaded rod sections have been shown to perform a similar function in other embodiments of the present invention that have been described in this section.

[0076] As described above, and referring to FIG. 9A, FIG. 9B, and FIG. 9C, the bottom reinforcing member, **104**, is welded along its length to the ledger housing bottom, **103**, for the purpose of additional structural support. Alternative embodiments of bottom reinforcing members, **114**, comprising a steel plate, are illustrated and referenced in FIG. 2A, FIG. 2C, FIG. 2D, FIG. 2E, FIG. 2F, FIG. 2G, and FIG. 2H. Referring to FIG. 2, in general, a bottom reinforcing member must provide sufficient strength and rigidity to prevent the ledger housing bottom, **103**, from deforming due to supported weight and/or impact forces.

[0077] FIG. 2A, FIG. 7A, FIG. 7B, and FIG. 7C further illustrate the use of an alternative way of joining the lip structure, **201**, to the ledger housing sides, **102**. Referring to FIG. 2A, with this method the upper edges, **115**, of the ledger housing sides, **102**, are formed to fold over and partially around the two outer prongs, **205**, of the lip structure, **201**. Referring to the bottom isometric view of FIG. 7C, the ledger housing side edges, **115**, may then be welded along their length to the outer sides of the outer prongs, **205**; the outer prong under sides, **210**, may additionally be welded to the outer surfaces of the ledger housing sides along the length of their lines of abutment, **211**.

[0078] FIG. 2A and FIG. 2B further illustrate the use of an embodiment of a vertical support structure, **150**. Referring to FIG. 2A, this structure comprises a tube, **151**, a threaded rod section, **152**, and a back side vertical support flange, **153**. Referring now to FIG. 2B, the vertical support structure, **150**, further comprises two threaded rod nuts, **154**. Continuing to refer to FIG. 2B, in operation, the hanger, **1**, of the present invention is supported by the lip structure, **201**, as the lip section, **202**, depends for horizontal support on the upper flange, **611**, of a permanent bridge girder, in this illustration,

an I-beam, 610. The threaded rod section, 152, and the threaded rod nuts, 154, are positioned such that the vertical support flange, 153, depends on the web, 612, of the I-beam, 610, and maintains the hanger, 1, in a vertically upright position. Referring to FIG. 2A, the purpose of maintaining the hanger, 1, in a vertically upright position can be accomplished in alternate ways, including nailing of the hanger to ledgers through the nailing holes, 116, in the ledger housing sides, 102; however, for this example of an alternative method, securing the hanger's vertically upright position can only be done after the final vertical height adjustment of the primary spanning ledger is made.

[0079] Returning now to a discussion of the use, with formwork elements, of embodiments of the hanger of the present invention, FIG. 4B illustrates that a pair of hangers, 1, of the present invention can also be used with a single joist, 510, as the primary spanning ledger, rather than the double waler, 501, of the FIG. 3 series. In considering the use of the hanger with various types and placement of primary spanning ledgers, design symmetry of the embodiment of the hanger with respect to the central plane of double waler primary spanning ledgers, and the support derived from the upper lip section, are both crucial factors. In general, embodiments of the present invention lacking symmetry with respect to the central plane of a double waler are not to be preferred. As illustrated in FIG. 4A, embodiments of hangers of the present invention comprise an upper mounting structure having an upper lip section, 202, that is sufficiently wide to provide vertical support over and across the entire width of the horizontal ledger bearing plate, 302. Referring to FIG. 4A, the joist, 510, further comprises a joist end, 512, situated within the second ledger member cavity, 111. While the vertical central axis, 112, of the hanger, 1, of the present invention is approximately through the axis of the threaded rod, 402, and therefore the joist vertical central axis, 516, is offset from the hanger vertical central axis, 112, the width of the lip section, 202, of the lip structure, 201, is sufficient to provide upper vertical support for the joist, 510, along the entire joist width, 511. Due to the symmetry of many embodiments of the hanger, 1, of the present invention, if a single joist primary spanning ledger were to be situated in the first ledger cavity, 110, rather than the second ledger cavity, 111, it would still have upper vertical support from the lip structure, 201, along its entire width. Therefore, when a symmetrical hanger, 1, of the present invention is in use, with its lip section, 202, resting on an upper edge, 602, and depending on, a supporting structure, such as the permanent bridge girder, 601, of FIG. 4A, any weight placed on the formwork structure will not result in a lateral force acting on either the hanger, 1, of the present invention, or on a single joist, 510, primary spanning ledger. As FIG. 4C illustrates, when a single joist, 510, primary spanning ledger is used, the joist ends, 512, can be situated within ledger housings, 101, of the two opposite and opposing hangers, 1, of the present invention, such that the open ledger section cavities, 113, are on opposite sides of the joist, 510, rather than on the same side, as illustrated in FIG. 4B. As already noted, due to symmetry of the embodiment of the hanger, 1, of the present invention, referring to FIG. 4B and FIG. 4C, these two alternative illustrations of the situation of the joist ends, 512, within the ledger housings, 101, are seen as equivalent with respect to the absence of lateral forces on the joist, 510, or the hangers, 1, arising from weight placed on the formwork structure. However, because moving machines and pouring concrete can cause lateral forces for very short

time periods on the hanger, 1, of the present invention, and on supported primary spanning ledgers, the joist placement arrangement of FIG. 4C offers, in one respect, an advantage in obviating the effects of such brief lateral stresses, in that the situation of one open ledger section cavity, 113, on either side of the joist, 510, has the effect of extending the horizontal support from one hanger lip section, 202, of one hanger lip structure, 201, outward from both opposite directions perpendicular to the vertical plane of the joist, 510.

[0080] FIG. 4D illustrates two opposing hangers, 1, of the present invention supporting a primary spanning ledger comprising what will be termed a dual joist structure, 550, having two partial spanning joist sections, 560, connected by both two metal binding bands, 570, and by binding band double headed nails, 571, driven through nailing holes in the binding bands, 570, and into and substantially through both partial spanning joist sections, 560. The positioning of the partial spanning joist sections, 560, can provide for a greater or a lesser extent of their overlap, and thus for a greater or lesser overall length of the dual joist structure, 550, facilitating reuse of partial joist spanning sections for construction projects having varying length requirements for primary spanning ledgers. It should be noted that the present invention can comprise the use of dual joist structures, 550, joined in alternative ways to the use of binding bands, 570, and double headed nails, 571, as long as the particular dual joist structure used is sufficiently strong and rigid for a particular application.

[0081] As illustrated in FIG. 4E, in some situations each of the partial spanning joist sections, 560, may run almost the full length of the dual joist structure, 550. However, referring now to both FIG. 4D and FIG. 4E, in many situations the dual joist structure, 550, may further comprise one or multiple metal dual joist structure formwork sheathing supports, 580. FIG. 10A, FIG. 10B, and FIG. 10C provide respectively: a side isometric exploded view, and two perspective views, of a formwork sheathing support, 580, comprising, as seen in FIG. 10A, a main formed section, 590, which can be produced by metal stamping, and which further comprises: an outer side mounting section, 591, having a nailing hole, 592, a central bearing section, 593, and an angled sheathing support flange, 594. Referring now to FIG. 10B, the sheathing support flange, 594, further comprises a sheathing bearing surface, 595, and an angled support structure, 596. The sheathing support, 580, further comprises a central side mounting section, 597, which is welded to the main formed section, 590.

[0082] FIG. 4G illustrates with phantom lines two sheathing sections, 540, that abut approximately over the central horizontal axis, 564, of the dual joist structure, 550, and are nailed to the partial spanning joist sections, 560, with single headed sheathing nails, 541. The sheathing sections, 540, are supported by both the upper sides, 561, of the partial spanning joist sections, 560, and by the sheathing support flanges, 594, of the sheathing supports, 580. Both FIG. 4D and FIG. 4E illustrate that the sheathing supports, 580, are attached to the partial spanning joist sections, 560, with double headed nails, 582, and that one sheathing support, 580, is placed at or near the joist end, 512, at each end of the dual joist structure, 550. FIG. 4E illustrates that multiple sheathing supports, 580, can be used on each end of the dual joist structure, 550, to provide support for sheathing at regular intervals, as needed, where the two partial spanning joist sections, 560, do not overlap. Thus, with the use of sheathing supports, 580, as described, the sheathing supporting width of the dual joist structure, 550,

is effectively twice the width of a single joist along its entire length. This ensures both an ample central nailing area, and adequate support for sheathing, referring to FIG. 4G, even when two sheathing sections do not abut exactly over the central horizontal axis, 564, of a dual joist structure, 550.

[0083] FIG. 4H and FIG. 4I illustrate the use of joist material, sized to the height of a joist, and cut into short sheathing support blocks, 552, as an alternative to the use of a metal sheathing supports, 580 in FIG. 4I, for providing sheathing support at the ends of a dual joist structure, 550, when, referring to FIG. 4G, two sheathing sections, 540, abut over the dual joist structure, 550. Referring to FIG. 4H, the use of a sheathing support block, 552, offers advantages over the use of a metal sheathing support, 580: a single headed sheathing nail, 541, can be driven through the sheathing, 540, and into the sheathing support block, 552; in addition, the sheathing support block, 552, is supported directly by the hanger, 1, of the present invention, rather than by a partial spanning joist section, 560. As illustrated in both FIG. 4H and the enlarged view of FIG. 4H1, the sheathing support block, 552, can also optionally be pre-attached to the hanger, 1, of the present invention, with a sheathing support block double headed nail, 553, referring to FIG. 4H1, driven through a nailing hole, 307, in the ledger bearing plate, 302. As illustrated in FIG. 4I, a combination of sheathing support blocks, 552, and metal sheathing supports, 580, can be used.

[0084] During formwork disassembly, FIG. 5 illustrates the disassembly process for embodiments of the present invention having an open rear side. The ledger bearing plate, 302, is moved to a lower position, the primary spanning ledger, in this case a single joist, 510, is lifted above the ledger plate assembly rear upper flange, 304, and the hanger, 1, is then slid forward, such that the lip section, 202, is no longer depending on a supporting structure. The process works the same way for double walers; as the hanger slides forward, the central vertical structure or member slides between the two walers. To enable the hanger, 1, to slide forward, the primary spanning ledger must first have to be pried away and down from the formwork sheathing by means such as a crowbar, to free a space within which the lip structure, 201, can move; this separation of the ledger and the sheathing is a normal part of the formwork disassembly in any case.

[0085] The hanger of the present invention comprises the following advantages over the current state of the art for reusable adjustable hangers supporting primary spanning ledgers:

- 1) It eliminates the cost of using sacrificial elements, such as saddle hangers, typically used with double walers.
- 2) It can be used with primary spanning ledgers sized for the length requirement of a specific construction project and comprising any or all of three alternative types: a) single joists, b) double walers, and c) two partial spanning joists joined at the middle to form a single primary spanning ledger. This maximizes the ability of a construction company to use what they have on hand for primary spanning ledgers, and minimizes or eliminates the need to buy or fabricate new primary spanning ledgers for a given construction project. This also facilitates the use of a combination of wider nailing surfaces for primary spanning ledgers beneath adjacent and abutting sections of sheathing material, and single joist primary spanning ledgers not beneath the points of abutment of the sheathing material.
- 3) It can be used in combination with existing adjustable single joist hangers when the use of only single joists is

preferable or acceptable for a project. For companies who already own adjustable single joist hangers, this is another instance of maximizing the ability of companies to use what they have. The use of this combination of single joist hangers and the adjustable ledger hanger of the present invention, also offers wider nailing surfaces when needed for primary spanning ledgers beneath adjacent and abutting sections of sheathing material.

4) Some embodiments of the present invention can also be configured to be used with 4× lumber as primary spanning ledgers, by removing an upper threaded rod section. Although the ability to adjust the vertical height from the top is lost, the ability to use 4× lumber, exclusively or in combination with the above cited other types of primary spanning ledgers, further enhances the ability of companies to use what they have.

5) If a sufficient quantity of hangers of the present invention is not available for a particular project, the project can still be done using the available hangers in combination with current double waler methods that involve the use of sacrificial elements, thus reducing, but not eliminating, the cost of the sacrificial elements.

6) In contrast to prior art adjustable joist hangers that have a back side, and that involve the use of a joist supporting plate that is removed from the bottom during disassembly of the formwork, some embodiments of the adjustable ledger hanger of the present invention do not require a back side, having instead a ledger housing formed of a single continuous sheet of material, and thus can be both simpler to manufacture, and can require less material than was previously possible.

7) In contrast to prior art adjustable joist hangers having detachable assemblies, including unshielded threaded rod, that can become lost or separated, some embodiments of the adjustable ledger hanger of the present invention offer a single, compact, unitary structure, offering ease of storage and management.

8) In contrast to prior art adjustable joist hangers, which cannot be nailed to a joist without restricting the ability to adjust the vertical height of the joist, for some embodiments of the present invention, because the ledger bearing plate of the adjustable ledger hanger of the present invention can be nailed directly to a ledger without affecting the ability to subsequently adjust the vertical position of the ledger, hanger-and-ledger combinations can be pre-assembled when this facilitates more efficient placement of the formwork. This ability to pre-assemble hanger- and ledger combinations and then place them transverse to permanent bridge beams or girders may also in some cases obviate the need for vertical support of the hangers against a recessed lower surface of a permanent bridge beam or girder.

9) The use of metal sheathing supports and support blocks provides a wider nailing surface, and a wider sheathing support area, when dual joist structures are used as primary spanning ledgers. These advantages facilitates reuse and extension of the useful life of ledger material.

What is claimed is:

1. A reusable adjustable ledger hanger, for general use in forming horizontal concrete structures having permanent vertical support, comprising:
 - a. a continuous ledger housing, having two vertical side walls, each said side wall being contiguous with a rect-

- angular, horizontal bottom; the said ledger housing further comprising an open front side and an open rear side, and,
- b. an upper mounting structure, further comprising:
 - i. means for depending on a support structure, and,
 - ii. a horizontal central section, spanning the two said ledger housing side walls, and,
 - iii. means of attachment to an upper section of both of the said ledger housing side walls, and,
 - iv. a central mounting prong protruding frontward, and,
 - c. a continuous central vertical member, further comprising a lower end mounted in a fixed vertical position to the said horizontal bottom of the said ledger housing; the said continuous central vertical member further comprising an upper end mounted to the said central mounting prong of the said upper mounting structure, and,
 - d. within the said ledger housing, a vertically adjustable horizontal ledger bearing plate contiguous with a vertical rear upper flange, the said horizontal ledger bearing plate further comprising a hole or recessed area within its outer perimeter such that the said horizontal ledger bearing plate moves around or about the said continuous central vertical member as the position of the said horizontal ledger bearing plate is adjusted vertically.
2. The reusable adjustable ledger hanger of claim 1, further comprising as adjustment means for the said vertically adjustable horizontal ledger plate, a threaded rod, the said threaded rod being adjustable from the top or bottom.
3. The reusable adjustable ledger hanger of claim 1, further comprising a vertical support structure.
4. The reusable adjustable ledger hanger of claim 1, further comprising an upper mounting structure having an upper lip section sufficiently wide to provide vertical support over and across the entire width of the said horizontal ledger bearing plate.
5. The reusable adjustable ledger hanger of claim 1, further comprising an attachable and removable upper mounting structure, such that the said mounting prong element is not attachable and removable, and such that a plurality of the said removable upper mounting structures may be attached to and detached from the hanger, respective to variations in the interface of each said removable upper mounting structure with supporting structures.
6. The reusable adjustable ledger hanger of claim 1, further comprising nailing holes in the said horizontal ledger bearing plate, such that the said hanger of the present invention can be pre-attached by nailing to an end of a primary spanning ledger comprising either a single joist or a double waler.
7. A reusable adjustable ledger hanger, for general use in forming horizontal concrete structures having permanent vertical support, comprising:
- a. a continuous ledger housing, having two vertical side walls, each said side wall being contiguous with a rectangular, horizontal bottom; the said ledger housing further comprising an open front side and an open rear side, and,
 - b. an upper mounting structure, further comprising:
 - i. means for depending on a support structure, and,
 - ii. a horizontal central section, spanning the two said ledger housing side walls, and,
 - iii. means of attachment to an upper section of both of the said ledger housing side walls, and,
 - c. within the said ledger housing, a vertically adjustable horizontal ledger bearing plate contiguous with a vertical rear upper flange, and,
 - d. a central vertical structure, or a central vertical member not attached to the upper mounting structure, situated above the said horizontal ledger bearing plate, forming,
- c. within the said ledger housing, a vertically adjustable horizontal ledger bearing plate contiguous with a vertical rear upper flange, and,
 - d. a central vertical structure, or a central vertical member not attached to the upper mounting structure, situated above the said horizontal ledger bearing plate, forming, in combination with the said horizontal ledger bearing plate contiguous with a vertical rear upper flange and the said two ledger housing side walls, two cavity regions within the said ledger housing, each and/or both of the said cavity regions capable of receiving and supporting a primary spanning ledger member, and preventing lateral movement of a primary spanning ledger when the end of the said primary spanning ledger occupies only one of the two said cavity regions.
8. The reusable adjustable ledger hanger of claim 7, further comprising as adjustment means for the said vertically adjustable horizontal ledger plate, a threaded rod, the said threaded rod being adjustable from the top or bottom.
9. The reusable adjustable ledger hanger of claim 7, further comprising as a central vertical structure, an attachable and removable threaded rod, the said threaded rod having a lower section that may be screwed into, and unscrewed from, a threaded part of the structure of the said vertically adjustable horizontal ledger bearing plate.
10. The reusable adjustable ledger hanger of claim 7, further comprising an attachable and removable upper mounting structure, such that a plurality of the said removable upper mounting structures may be attached to and detached from the hanger, respective to variations in the interface of each said removable upper mounting structure with supporting structures.
11. The reusable adjustable ledger hanger of claim 7, further comprising a vertical support structure.
12. The reusable adjustable ledger hanger of claim 7, further comprising an upper mounting structure having an upper lip section sufficiently wide to provide vertical support over and across the entire width of the said horizontal ledger bearing plate.
13. The reusable adjustable ledger hanger of claim 7, further comprising nailing holes in the said horizontal ledger bearing plate, such that the said hanger of the present invention can be pre-attached by nailing to an end of a primary spanning ledger comprising either a single joist or a double waler.
14. A reusable adjustable ledger hanger, for general use in forming horizontal concrete structures having permanent vertical support, comprising:
- a. a ledger housing, having two vertical side walls, each said side wall attaching to a rectangular, horizontal and removable bottom section; the said ledger housing further comprising an open front side, and,
 - b. an upper mounting structure, further comprising:
 - i. means for depending on a support structure, and,
 - ii. a horizontal central section, spanning the two said ledger housing side walls, and,
 - iii. means of attachment to an upper section of both of the said ledger housing side walls, and,
 - c. within the said ledger housing, a vertically adjustable horizontal ledger bearing plate contiguous with a vertical rear upper flange, and,
 - d. a central vertical structure, or a central vertical member not attached to the upper mounting structure, situated above the said horizontal ledger bearing plate, forming,

in combination with the said horizontal ledger bearing plate contiguous with a vertical rear upper flange and the said two ledger housing side walls, two cavity regions within the said ledger housing, each and/or both of the said cavity regions capable of receiving and supporting a primary spanning ledger member, and preventing lateral movement of a primary spanning ledger when the end of the said primary spanning ledger occupies only one of the two said cavity regions.

15. The reusable adjustable ledger hanger of claim **14**, further comprising as adjustment means for the said vertically adjustable horizontal ledger plate, a threaded rod, the said threaded rod being adjustable from the top or bottom.

16. The reusable adjustable ledger hanger of claim **14**, further comprising as a central vertical structure, an attachable and removable threaded rod, the said threaded rod having a lower section that may be screwed into, and unscrewed from, a threaded part of the structure of the said vertically adjustable horizontal ledger bearing plate.

17. The reusable adjustable ledger hanger of claim **14**, further comprising an attachable and removable upper

mounting structure, such that a variety of the said removable upper mounting structures may be attached to and detached from the hanger, respective to variations in the interface of each said removable upper mounting structure with supporting structures.

18. The reusable adjustable ledger hanger of claim **14**, further comprising a vertical support structure.

19. The reusable adjustable ledger hanger of claim **14**, further comprising an upper mounting structure having an upper lip section sufficiently wide to provide vertical support over and across the entire width of the said horizontal ledger bearing plate.

20. The reusable adjustable ledger hanger of claim **14**, further comprising nailing holes in the said horizontal ledger bearing plate, such that the said hanger of the present invention can be pre-attached by nailing to an end of a primary spanning ledger comprising either a single joist or a double waler.

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