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(54) Title: MULTIPLE DIMENSION BEAM, DECK AND COLUMN SYSTEM

(57) Abstract: A method, forming panel and system provide for monolithic pouring of concrete columns, beams and elevated decks. The forming panel may be variously sized and dimensioned to serve as a beam forming member or a column forming member, and includes a frame having at least one reinforcing member having a plurality of penetration indicators which are not in registry, at least initially, with any opening in a face plate of the form. The penetration indicators serve as markers and preferably guide templates for drilling openings at preselected locations in the face plate at corresponding to the indicators. The openings so drilled are part of coupler-receiving passages, whereby forms may be variously configured in different dimensions or arrangements. The forms may be configured to provide column form assemblies, beam form assemblies, or receive floor forms in a variety of configurations, and may be readily reconfigured and reused by plugging openings which are in currently undesired locations.

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MULTIPLE DIMENSION BEAM, DECK AND COLUMN SYSTEM

This application claims the benefit of U.S. Provisional Application No. 60/982,404, filed October 24, 2007 and U.S. Provisional Application No. 61/022,23 1 filed January 18. 2008, the disclosures of which are incorporated herein by reference.

Background of the Invention

1. Field of the Invention

The present application concerns a form, a system and a method for forming columns, decks and beams of cementatious material such as concrete. More particularly, it is concerned with a forming system which provides adaptation to different lengths and dimensions of upright support columns and beams for building construction, particularly those with poured concrete decks supported by the columns and beams.

2. Description of the Prior Art

One type of building construction which has been common in commercial and industrial businesses uses poured concrete columns and beams for a structural framework. The concrete columns are upright, typically vertical, and extend upwardly from a basement, floor or slab. Beams are also formed of poured concrete and extend laterally, and decks of poured concrete are supported by the beams and columns. Steel reinforcing bars or steel mesh are embedded within the concrete to provide additional strength, thus when used the concrete construction is typically referred to as "reinforced concrete." Within this structural framework, walls are provided of materials such as tile, masonry block, glass, precast concrete panels, glass block or similar materials to enclose the building.

In order to form the concrete columns, forms are used. Such forms have historically been constructed of wood which, when stripped from the cured concrete, is no longer of use. Metal forms, of aluminum and/or steel, have been custom manufactured for a particular building configuration. Other types of forms include tubing made of high strength water resistant paper, such as those sold under the trademark SONOTUBE®. Again, these forms are constructed in aparticular dimension for single use. Other forming panels of metal such as aluminum forming panels including those shown in U.S. Patent Nos. 4,708,315, 4,744,541, 4,976,401 and 4,978,099 have been used to form columns, but these have not produced a flexible, integrated, reusable system for forming concrete columns, beams and slabs.

Summary of the Invention

The present invention provides a column and beam system which is adaptable to form columns and beams of different sizes as well as decks which are poured with the beams and columns in a monolithic poured concrete structure. That is to say, the forming system hereof enables the use of forming panels to provide columns and beams of not only their greatest dimension, but also a number of smaller dimensions as well, and is both environmentally and economically superior to custom forming systems because it reduces the number of forming members required because the forming system is adaptable and reusable. In addition, the forming system hereof permits the use of column forms, beam and slab forms and associated hardware for columns to be formed in a plurality of configurations, reduces the amount of time required to complete the concrete forming and pouring of the structure. and by minimizing the number of concrete pouring operations, provides a more monolithically poured structure.

The system hereof permits the formation of beams, and adjacent decks, which are formed together with the columns in a monolithic pour, or alternatively in sequential concrete pours. The beam forms are complemental to the column forms, so that the beams, columns and an elevated deck can be poured in a monolithic pour. In addition, the forming system provides templates for drilling through a face sheet so that the connections can be made a regularly spaced locations. Because the frame of the forming panels include holes which serve as a template, openings are drilled in the face plate only when required and ready for use. and the worker uses the existing holes in the forming panels as a guide. When the openings are drilled, the openings are at regular, preselected intervals. This makes matching and coupling to adjacent forming panels and forming members a much simpler task requiring fewer adjustments. As a result, the forming system is more readily assembled in a desired manner by unskilled workers. The openings can be plugged, such that the forming panels can be readily reused in a forming system reconfigured for a different structure having columns, beams and decks of a different size or configuration..

Broadly speaking, the system of the present invention includes column forming panels which preferably primarily of aluminum and are connected together to provide forms for the columns, with beam forms preferably primarily of aluminum including joist ledgers and sill plates to provide forms for the beams. Transition forms also preferably primarily of aluminum are used to provide connections between the beams and columns. and ceiling forms are connected to and provided intermediate the beam forms in order to receive concrete for forming a deck. The column forms include a face sheet, side. top and bottom rails, and reinforcing members or hats. The hats are provided with a plurality of selectively spaced holes, e.g. 1" on center. The holes are spaced longitudinally along a back plate of the hats. Holes are also selectively spaced, most preferably in groups which have the holes at the same interval (e.g. 1"), along the side, bottom and top rails of the column form. These holes may be reinforced with steel, either as steel plates or steel wire positioned adjacent the holes. The hats, identified in the accompanying drawing by reference character 8, include upper and lower bolt slot rails and a center groove which is U-shaped with the back plate of the hat forming the bight of the U and opposing panels each presenting opposite ridges extending longitudinally therealong. Most preferably, the bolt slots are of a smaller transverse dimension than the center groove. Most preferably, U shaped collars are welded to the hats and to the side rails and positioned at the ends of the grooves to abut the side rails. These U shaped collars include a pair of opposed arms which extend longitudinally along the groove and a back plate adjacent and preferably secured to the side rail by welding or mechanical fasteners. The U shaped collars including opposed flanges which extend from the arms and are spaced from the back plate so that a collar nut having a rectangular plate and which is internally threaded may be received and held in place by the U shaped collars. The forming panels may include additional U shaped channels also presenting a plurality of selectively spaced holes therealong. Advantageously, the holes in the hats and channels need not extend into the face plate, which is typically of a relatively thin sheet of aluminum. Plugs are provided to close holes when the face plate is drilled to receive fasteners such as pins, tie bars, or the like therethough, but after the pins or tie bars are removed and relocated.

The system hereof provides a number of unique advantages over prior column, deck and beam forming systems. These include:

The provision of aplurality of selectively and commonly spaced holes which are located along the hat adjacent the face plate;

The use of holes in the face plate which enable the forms to be coupled together in different configurations and readily reused, such that the column forms and beam forms may be coupled in different sizes and configurations;

The holes, which may be stamped or drilled in the hat or other parts of the frame of the forming members provide:

a locator to ensure even spacing so that when the forms are coupled together, the holes are aligned with or "match up'"with the holes in the railings of the adjacent, commonly configured forms;

the holes in the hat provide a drill guide when drilling the face plate;

the drilled holes in the face plate are thereby ensured to be in proper alignment;

the hats, being of an additional thickness, may also be of steel to provide strength and need not be drilled, but may help to retain plugs which would be readily dislodged if held only in the face plate.

The hats include a bolt slot which enables the attachment of a bolt by only insertion of the bolt head and rotation thereof within the slot; this thereby allows attachment of various hardware. In addition, it provides a boss against which a backing plate of steel or other metal may be placed so that a pin may thereby be passed through the hole in a side rail and also through a hole the hat, then through the backing plate and a wedge passed through a slit in the pin to hold the adjacent forms in a secure, tight relationship;

The provision of the U shaped collar and collar nut reduces the span along which the rail must carry bowing or torsional loads caused by the pressure exerted by the concrete against the face plate of each form. Because the pressure exerted by the concrete is in four divergent directions in a column when viewed in plan, each of the side flanges is normally subject to enhanced torsional loading, particularly where the pins couple adjacent forms. With the U shaped collar, preferably of an aluminum alloy or steel, welded at the ends of the grooves in the hats, the collar is reinforced at the primary location where the outward and torsional loading is applied, and can be further secured by the use of the collar nuts. As a result, the outward and torsional loads are primarily directed within the hat, rather than along the rails between the hats.

The provision of uniform hole spacing which is complemental to the side rail provides the ability to assemble the columns in a variety of configurations, for example, at least fourteen configurations, while still preserving the ability to add additional forms to increase the dimensions. This provides not only a great deal of economy over typical column forms which are dimensioned for connection in only a single configuration by reducing inventory, but greatly increases the flexibility of the on-site applications. That is, the forms may be assembled and adapted as site conditions require, without the necessity of delaying in waiting for new column forms or the necessity of building forms of wood on site. Waste is reduced by avoiding the need for single-use forms. In addition, the ability to insert plugs ensures that the form is not rendered into scrap merely by drilling through the face plate in one of the preselected locations. Finally, if not then in use as a column form, the forming panel hereof is most preferably dimensioned common to other forms so that it may be used, if desired, as a wall form.

Angle braces are used at the corners and are provided with selectively spaced holes complemental to the holes in the side rails of the forms. The angle braces may be dispensed with when the forms are combined so that the adjacent forms are positioned narrower than the side rails of the first form. Also, box corner forms are preferably provided for use in combination with the adjustable columns and beam ledgers of the system to thereby permit the depth of the beam to be adjusted by movement of the beam ledger forms and/or the sill plate forms without encountering interference with the column forms.

With respect to the beam, it is greatly desirable to standardize the floor to floor height, but to accommodate different beam cross-sectional dimensions. In accordance with the present invention, it is possible to replace one sill panel with another and thereby to expand or contract the width of the beam by moving the beam ledgers farther or closer together. Similarly, it is readily possible to move and reattach the sill plate at different heights along the beam ledger. This is possible because not only is the beam ledger provided with a plurality of selectively spaced holes along its top, bottom and side rails, but also because the beam ledger is preferably provided with at least one perforated interior brace, the holes defining the perforations also being selectively spaced in common (e.g., 1 inch) with the holes in the rails. Preferably, the beam ledgers are provided with ledger extensions which extend along at least one edge, preferably the top edge, to provide an extended surface and support for receiving ceiling forms thereon. The present system not only permits the designer to adapt the same forms to change the floor to floor height within a building, but also to change the beam and deck thickness and width, and also to provide different deck thicknesses on the same level, to omit a beam or a part of a beam, or to change the top surface of the deck on the same general level.

Another advantage of the present invention is that the same forming system can be used and reconfigured not only from one building to the next, but also from one level to the next within the same building, not only with the same arrangement of beams, columns and decks, but with different beam, column and deck sizes, depths and configurations within the building.

These and other advantages will be readily appreciated by those skilled in the art with reference to the drawings.

Brief Description of the Drawings

Fig. 1 is a left front top perspective view of a representative portion of a multiple dimension beam and column forming system in accordance with the present invention showing the use of forming panels for forming an elevated floor or deck extending from the panels for forming beams extending between columns;

Fig. 2 is a right rear top perspective view of the multiple dimension beam and column forming system shown in Fig. 2, showing the use of the system in forming columns of different cross-sectional configurations and intersecting beams of different depths;

Fig. 3 is a left front upper perspective view of the system hereof similar to Fig. 1 but partially exploded and with some of the column-forming and beam-forming panels removed to show the configuration for forming beams of different depths;

Fig. 4 is a top plan view of the multiple dimension beam and column forming system shown in Fig. 1. illustrating representative cross-sectional configurations of the columns and showing additional floor forming panels;

Fig. 5 is an enlarged fragmentary exploded view of two of the column forming panels of Fig. 1 showing the use of pins and wedges to connect the column forming panels and the reinforcing guides along the back side of the face sheet, and showing the use of plugs in the face sheet of one of the column forming panels to inhibit the passage of cementatious material therethrough;

Fig. 5a is an enlarged perspective view of one of the plugs shown in Fig. 5;

Fig. 6 is an enlarged fragmentary exploded view of the two column forming panels of Fig. 5 taken to show the back side of the column forming panels;

Fig. 7 is an enlarged fragmentary exploded view of the multiple dimension beam and column forming system hereof showing box corner forms for attachment to column extension ledger forms, and sill plates and beam ledgers for forming the beams above the column forms;

Fig. 8 is an enlarged, fragmentary view of the multiple dimension beam and column forming system hereof showing the positioning of the beam sill plates to the beam ledgers and the column extension ledger forms;

Fig. 9 is an enlarged, fragmentary view of the multiple dimension beam and column forming system hereof showing the positioning of the beam ledgers and box corner forms, and a floor form attached to the beam ledgers for forming a floor extending from two intersecting beams;

Fig. 10 is a enlarged vertical cross-sectional view taken along line 10-10 of Fig. 8. showing the positioning of a U-shaped collar in a channel of one of the column forming panels;

Fig. 11 is an enlarged vertical cross-sectional view taken along line 11-11 of Fig. 8 showing the coupling of a beam ledger above a column forming panel;

Fig. 12 is an enlarged horizontal cross-sectional view taken along line 12-12 of Fig. 8, showing the use of an angle connector to couple two column forming panels when adjacent column forming panels are placed at their maximum cross-sectional intersecting positions, using a pin and wedge between an angle connector and one column forming panel, and a coil bolt and coil nut held by a U-shaped collar;

Fig. 13 is a vertical cross-sectional view taken along line 13-13 of Fig. 9, showing the coupling of a beam sill plate and a floor panel to a beam ledger;

Fig. 14 is a fragmentary perspective view of a beam and column monolithic construction in accordance with the present invention, with portions of a beam and the elevated deck broken away for clarity to show the floor and beam depth and configuration;

Fig. 15 is an enlarged, fragmentary vertical cross-sectional view taken through the channels of two adjacent perpendicular interconnected column forming panels, showing the use of a plate and coil bolt threaded into a coil nut of a U-shaped collar in the channel of another forming panel;

Fig. 16 is an enlarged, fragmentary vertical cross-sectional view taken through channels of two adjacent perpendicular interconnected column forming panels similar to Fig. 16, but showing an alternate connection including a plate, bushing and ring interconnected together and threadably engaged with ribs of the channel, and the use of a long pin and wedge to securely couple the adjacent column forming panels; and

Fig. 17 is an enlarged, fragmentary bottom plan view of an alternate coupling arrangement of a sill plate form to the ledger extension of an adjacent beam ledger panel.

Description of the Preferred Embodiment

Referring now to the drawings, a multi-dimensional beam and column forming system 100 in accordance with the present invention is shown in Figs. 1

through 3, it being understood that only a portion of the system 100 is illustrated for clarity. It will be understood by those skilled in the art that a completed column-and-beam building framework would require additional forming panels for further columns, beams, and floor elements and that the system 100 as shown herein may be readily expanded to complete the framework by adding the components disclosed herein in desired configurations.

The system 100 hereof broadly includes column forms 102 which are configured and adapted for coupling together in a variety of column configurations and dimensions as shown in Fig. 1, column extension forms 104, beam ledger forms 106, sill plate forms 108 and floor forms 110. In addition, the system may include box corner forms 112, angle connectors 114, and may utilize various couplers such as pins 116 and wedges 118, threaded connectors 300, and/or latching bolt assemblies such as those shown in U.S. Patent No. 5,058,855, the entire disclosure of which is incorporated herein by reference, to connect various forms used herein. The system 100 permits the various forms as further described herein to be arranged in a variety of orientations and then reused. As may be seen in Figs. 1, 2, 3 and 4, the column forms 102 may be arranged and connected by couplers variously as column assembly 120 having a relatively small cross-sectional dimension, as column assembly 122 having an intermediate cross-sectional dimension, or as a column assembly 124 having a full dimension whereby the column forms 102 are arranged to have concrete poured against the entire width of the form 102. In addition, the beam ledger forms 106 and sill plate forms 108 are intended to be combined and connected by couplers into beam assemblies 126. which may have different configurations such as beam assembly 250 or beam assembly 252 to provide beams of different lengths, widths or depths. The column assemblies and the beam assemblies are interconnected by, for example, couplers which connect column extension forms, corner forms and the like to provide an integrated system 100 which defines concrete receiving regions into which flowable concrete may be received and move in fluidic communication to provide a monolithically poured-in-place structure.

Column forms 102 are constructed of metal, preferably an alloyed aluminum, and include a frame 128 and a face plate 130 which has a front, concrete-receiving side 132 and a rear side 134 and an edge 135 which surrounds the face plate 130. The frame 128 preferably includes horizontally-extending channels 136, side rails 138 and 140, top rail 142 and bottom rail 144, as well as supports 146. The rails may be provided with grooves which receive flexible barriers such as brush-like filaments positioned proximate the face plate to inhibit the passage of fine particles of concrete therepast. The channels 136 serve as reinforcing members and preferably include a front wall 148 located adjacent the face plate 130, a pair of side walls 150 each having elongated, opposed ribs 152 which define a slot 153 therebetween and serve as threads for the attachment of threaded members thereto, and divergent outer walls 154 and 155, whereby the channel 136 is similar in construction to the horizontal channels 30 of U.S. Patent No. 7.144,530, the entire disclosure of which is incorporated herein by reference. As shown in Figs. 5 and 6, the front wall 148 is provided with a plurality of holes 156. These holes are provided in the front wall 148 and spaced across the width of the front wall at regular intervals. e.g. 50 mm or 2 inches, to facilitate receipt by couplers such as pins 116. In addition, holes 156 are also provided in braces 158 which serve as reinforcing members and extend across the top and bottom of the column forms 102. The holes 156 in the braces 158 are at predetermined locations and also spaced at the same regular intervals with the holes 156 in the channels 136. Most preferably, the holes in each of the channels, and the holes in the braces, are in substantial vertical alignment as well substantial horizontal alignment in order to provide regular spacing which corresponds to the holes 160 in the side rails, top rail and bottom rail. That is, as seen in Fig. 5, for example, the holes 156 in the braces 158 are most preferably spaced at predetermined regular intervals therebetween, and while their axis extends perpendicular to the axis of the holes 160 in the rails 138 and 140, the holes 156 in the braces are in substantial horizontal alignment (i.e.. the same horizontal plane) as corresponding holes 160 in the side or top or bottom rails. Similarly, the holes 156 in the channels 136 are most preferably spaced at predetermined regular intervals therebetween, and while their axis extends perpendicular to the axis of the holes 160 in the rails 138, the holes in the channels are in substantial horizontal alignment (i.e.. substantially the same horizontal plane) as the corresponding holes in the side or top or bottom, and can be either parallel to or perpendicular to the holes 160 in the braces 158. The channels 136 and braces 158 are preferably aluminum and attached by welding to the rails and the face plate, but may be provided of alternate materials such as, for example, steel and attached by rivets or other mechanical fasteners as is well known in the art. The description of the orientation of the channels 136 and braces 158 and their corresponding holes 160 as well as other structural features of the invention as horizontal or vertical corresponds to their depiction in the drawings, but it is to be understood that the forms hereof can be positioned in other orientations as well depending on the particular application and use. Steel reinforcements 162 may also be attached by rivets or the like along the side, top and bottom rails, and provided with holes therethrough which are in registry with the corresponding holes 160 in the rails.

The holes 156 serve as drill guides for accurate sizing and positioning when it is desired to drill openings 164 in the face plate 130. The face plate 130 is normally initially in a non-perforated condition, and holes 164 are drilled only as needed and appropriate at the jobsite. Thus, at least some of the holes 156 in the reinforcing members (braces 158 and channels 136) are adjacent and face an imperforate portion of the face plate. When an opening 164 previously drilled is not used, and would be in a concrete-receiving location on the column assembly, the opening 164 may be temporarily covered and filled by removable plugs 166 of an elastomeric material as shown in Fig. 5a. Additionally, to facilitate attachment of one of the column forms 102 to an adjacent, transversely oriented form as shown in Figs. 5 and 6, a U-shaped collar 168 is provided which is sized for receipt in the slot 153. The U-shaped collar 168 protects the side rails by reinforcing the side rail surrounding the adjacent hole 160 and spreading the forces transmitted by the weight of the concrete received on the form and supported by the pin or other coupler to a larger area. The U-shaped collar 168 preferably includes a backing 170 having a hole 172 therethrough which is aligned with one of the holes 160 which is located in the adjacent one of the side rails and is aligned along the slot 153 as shown in Figs. 5 and 6. A pair of spaced apart flanges 174 and 176 extend from the backing 170 along the side walls 150 of the channel 136. The U-shaped collar is preferably welded or otherwise permanently secured to the channel 136 within the slot 153. A crease 178 is preferably provided in each of the flanges 174 and 176 adjacent the backing 170. The crease helps to receive and hold in position an internally threaded coilnut 300 which is coarsely threaded to receive a coarsely threaded member 302, such as threaded member 60 shown in U.S. Patent No. 7,144,530. Alternatively, as shown in Figs. 5 and 6, the coilnut need not be used, and adjacent, perpendicularly oriented column forming panels 102 may be connected by pins and wedges. The column forms 102, which may also be used in forming concrete walls, may also include baseplates for mounting latching bolt mechanisms as shown in U.S. Patent No. 5,058,855, the entire disclosure of which is incorporated herein by reference.

The column extension forms 104 and the beam ledger forms 106 also include face plates 180 andl82 having a concrete-receiving front side 184 and 186 respectively, and a back side 188 and 190, and have a surrounding edge 189, 191, the column extension forms 104 and the beam ledger forms 106 also having frames 192 and 194, respectively. The frames 194 of the beam ledger forms 106, and optionally the frames 196 of the column extension forms 104, extend rearwardly of their respective face plates and preferably include braces 198 which are oriented vertically along the back side of the face plate, and are provided with holes 156 in side and end rails as described above. The frames 192 and 194 also may include supports 200 and 202. The frames of the column extension forms 104 and beam ledger forms 106 also include a rearwardly extending L-shaped ledger extension 204 which extends rearwardly a greater dimension than the rearwardly extending width of side and bottom rails of the frames 192, and may be extruded and attached to the face plate and the side rails, bottom end rails and the remainder of the frame 192. as well as the face plate, by welding. The ledger extension 204 permits connection of floor forms 110 and other forming members, and includes a pair of opposed flanges 206 and 208 presenting a gap 210 therebetween, and a mounting wall 212 having a plurality of holes 214 therein. There is provided a space between the mounting wall and the face plates 180 and 182 whereby access may be gained for inserting pins through the holes 214 in the mounting wall 212. As may be seen in Fig. 7, for example, the ledger extension 204 extends rearwardly of the side rails and bottom rails of the respective frames 192 and 194. The face plates 180 and 182 are initially not perforated or at least there are imperforate portions which lie adjacent with the holes 156, but openings 216 may be drilled using the holes 156 in the braces 198 as drill guides. Thus, the holes 156 in the braces 198 serve as penetration indicators at preselected locations. The holes 156 in the braces 198 are in substantially linear alignment and also aligned with a corresponding hole 160 in rails of the frames 192 and 194. When a previously drilled opening 216 is in a concrete-receiving position but not used for receiving a pin or other coupler, plugs 166 shown in Fig. 5a may be inserted into the vacant opening 216 to prevent the passage of flowable concrete therethrough.

The ledger extensions 204 are useful for attaching sill plate forms 108 and floor forms 110 to the column extension forms 104 and beam ledger forms 106 using pins and wedges. As shown in Figs. 7 and 8, the sill plate forms 108 are shown for connection with the ledger extensions on the column extension forms 104 and are positioned and coupled at a desired selected location to beam ledger forms 106. Because the present system 100 provides substantial flexibility in the desired depth and width of the beams to be formed, the position of the sill plate form 108 can be moved upwardly and downwardly before coupling the side rails of the sill plate form to lie adjacent the face sheet of the beam ledger form. This permits substantial flexibility in utilizing the forming members hereof to provide beams of different depths. The sill plate forms 108 include a face plate 220 and a frame 222 including side rails 224 and end rails 226 each having a plurality of spaced holes 228 therein. The frames 222 arc connected by couplers such as pins and wedges or by coil bolts and the coil nuts as described above by passing through the holes in the braces and the face plate of the beam ledger forms 106, and to the ledger extensions of the column extension forms 104 as shown in Figs. 7 and 8. The floor forms are attached to the ledger extensions 204 of the beam ledger forms 106 and to the box comer forms 112 through the holes provided therein by pins and wedges. The box corner forms 112 advantageously include first and second elongated walls 270 and 272 which are oriented in substantially perpendicular relationship to one another. Each of the elongated walls 270 and 272 have a wall width which is greater than the width W of a rail, and further include a connecting flange 274, 276 provided with holes 160 for receiving pins and other types of form couplers, the connecting flanges extending perpendicular to the respective walls 270 and 272 to which they are attached. The wall width of the walls 270 and 272 is preferably substantially the same as the rearwardly extending dimension of the L-shaped ledger extension and thus facilitates attachment of the beam ledger forms, and permits them to be positioned up or down as desired to avoid interference with the column forming panels 102 when assembled as shown in Figs. 1. 2 and 3. As shown in Figs. 1, 2 and 3, the ledger extensions and box comer forms 112 will typically be connected by pins or the like to the floor forms 110 such that the top surface of the uppermost flange 206 of the ledger extensions will typically be connected substantially coplanar with the concrete-receiving surface 234 of the face plate of the floor forms 110 and the top surface 230 of the box corner forms.

In accordance with the present invention, the various components of the system 100 hereof provide substantial flexibility to make construction of a building framework 240 of poured concrete columns and beams more affordable, by increased flexibility of design to make some beams of different dimension than others, and to make some columns of different dimensions of others. Labor costs may be reduced as the components may be readily adjusted to site conditions by the flexibility provided herein, and by permitting a monolithic pour and construction of beams, columns and floors. Reinforcing steel may be installed at one time for the entire beam, column and floor, waste is reduced by reducing transportation costs by utilizing, for example, column forms in wall construction, and avoiding the necessity for custom-sizing of forms for a particular building design.

When it is desired to construct a column 242 of a smaller dimension or cross-section as shown in Fig. 14, the system 100 is arranged to provide a column form assembly 120, for example. The column form assembly 120 positions each of the side rails 138 and 140 to intersect with the face plate of an adjacent, perpendicularly oriented column forming panel 102 intermediate the width of the face plate 130 and thus between the side rails 138 and 140 of the adjacent forming panel 102A as shown in

Figs. 5 and 6. The opening 164 created by drilling through the face plate is thereby aligned with the selected hole 156 in the reinforcing member to provide a passage 290 (as opposed to "dead-end" 292), and also with a selected hole 160 in one of the rails, here siderail 138. A pin 116 is placed through the selected hole 156 in the side rail and the pin extends through the opening 164 drilled in the face plate and through either the brace 158 or front wall 148. The pin 116 secures the adjacent forms 102 and 102A by using a wedge 118. In addition, a plate 232 with a hole therethrough may receive the pin so that the force applied by driving the wedge into the pin is distributed and not applied directly to the rear side of the channel 136, whereby the plate 232 is positioned on the pin and located between the wedge and the channel 136. Typically a number of such connections are provided along the vertical length of the side rail to the adjacent face plate. The regular spacing intervals of the holes 156 and their provision across the width of the column form 102 facilitates the designer's ability to select the dimension of the resulting column.

As seen in Fig. 4. the column form assembly 120 is relatively small, as will be the dimension of the column 242 formed thereby, when compared with the column form assembly 122 and its resulting column 244 as shown in Fig. 14. In that arrangement, the column forms 102 are arranged so that of the four intersections between the four column forms 102, two intersections are where the column forms intersect with a side rail lying in perpendicular, abutting relationship to an adjacent face plate as described with regard to the column form assembly 120, while the other two intersections have the side rails of the adjacent columns forming a corner. In this orientation, angle connectors 114 as shown in Figs. 7 and 8 are used to connect the adjacent column forms only by their respective siderails and does not require insertion of a pin or other coupling member through the face plate of one of the column forms. Column form assembly 124 carries this expansion forward to provide a column 246 of a maximum dimension in cross-section wherein each of the column forms 102 are connected to the other at their siderails oriented at 90° angles to one another by angle connecters 114 and associated couplers such as pins 116 and wedges 118. As may be appreciated, without sacrificing the integrity of the strength of the form assemblies. a variety of different combinations of the column forms 102 be made to provide columns of a variety of different dimensions using the intervals between the holes in the channels 136 and braces 158. The column form assemblies enclose concrete-receiving regions 280 into which concrete or other cementatious material is poured and cured to a self-sustaining condition of hardness to provide columns 242, 244 and 246, for example.

In addition, the system hereof affords the flexibility to pour the concrete for the floors and beams contemporaneously with the formation of the columns in a monolithic pour using reusable and repositionable forming components. For example beam form assembly 250 as shown, for example, in Figs. 1 and 2 produces a beam 260 extending between columns of lesser depth and narrower width than the beam 262 formed by beam form assembly 252. The system 100 hereof permits the designer to use couplers to connect the same column forms 102, the same beam ledger forms 106, and the same box corner forms 112 for beams of varying width, and thus leaving the sill plate forms and the column extension form to be of a selected width for the beam. The ability to provide a different depth of the beam also allows use of the same column forms, beam ledger forms and box corner forms, as well as the same sill plate forms 108. The designer need only specify a depth-specific column extension form 104 with the other forming components being adaptable to the specified beam depth. That is to say. the sill plate forms 108 may be coupled by pins and wedges or other couplers to the beam ledger forms 106 at a variety of locations enabled by the number of holes 156 in the braces 198 which have a regular interval spacing therebetween. The sill plate forms 108 may thus be located either relatively higher or lower on the beam ledger forms 106 and coupled thereto at the desired location using pins which extend through the side rails of the sill plate forms and the holes 164 in the face plate of the beam ledger forms and the holes 156 in the braces 198. The beam form assemblies 250 and 252 define concrete-receiving regions 282 as channels which receive flowable poured concrete or other cementatious material such that the concrete hardens to a self-sustaining condition to provide beams such as beams 260 and 262.

Advantageously, the floor forms may be coupled to the box corner forms and the beam ledger forms so that the elevated deck or floor 264 shown in Fig. 14 is poured contemporaneously with the beam and the columns and thus the top surface of the beams and columns is in fact the top surface also of the floor 264. Only a portion of the resulting floor 264 is shown for clarity. In addition to form forms of a conventional configuration as shown, the beam and column system hereof may be used with a variety of other floor forming systems, such as forming systems which enable supporting structure therein. also known in the trade as "waffle floors." Such systems are shown. for example, in the U.S. Patent Application entitled Apparatus and Method for Forming an Elevated Deck, published under Publication No. US-2007-0 175 14 1-A 1, the entire disclosure of which is incorporated herein by reference.

As will be appreciated by those skilled in the art. the concrete is poured into the concrete-receiving regions and allowed to cured to a self-sustaining condition of hardness. The forming system is then removed, but may be advantageously reused and reconfigured for a second pouring operation. This may include plugging, at least temporarily, some of the openings which have been drilled or otherwise created (e.g., by a punch) in the face plates of the various forming members such as column forms 102, column extension forms 104, and beam ledger forms 106. The forming system may then be reassembled using couplers into a new configuration. For example, when a multistory building is being constructed, the columns of lower floors may be extended upwardly or repositioned or resized by attaching with couplers the same column forms into column form assemblies 120. 122 and 124 or other configurations in the upper floors, with beam form assemblies 250, 252 being reconfigured or repositioned, and using floor forms 110 as appropriate. Alternatively, the system 100 may be moved to a different site and assembled as desired. Beneficially, the provision of the holes 156 in the reinforcing members at predetermined regularly spaced intervals which correspond to vertical or horizontal positioning of at least some of the hole positions of holes 160 in the frames greatly facilitates assembly of the forming system as designed by laborers with little skill or experience.

Figs. 15 and 16 illustrate alternate coupling arrangements for connecting column forming panels 102 herein. In Fig. 15, a coil bolt 302 is inserted through plate 232 and passes through the slot of the channel 136, then through the hole in the front wall of the channel and through a hole 164 in the face plate. A coil nut 300 is used in the U-shaped collar to threadably receive the coil bolt 302. In Fig. 16, a long pin 116 is inserted through the hole in the backing of the U-shaped collar and inserted through the hole in the face plate which is in registry with the hole in the front wall of the channel. In the arrangement of Fig. 16, an abutment member 308 includes a plate 310 which is welded or otherwise affixed to a bushing member 312 which has a central passage and is in turn welded to an annular externally threaded nut 314 provided over the bushing 312. The annular nut 314 is flat on two circumferentially spaced sides and threaded on the remainder of the radially exterior surface of the annular nut 314, to facilitate it fitting into the slot 153 whereby turning the plate 310 causes the bushing and annular nut to threadably engage the ribs 152 and hold the plate, bushing and nut against movement along the channel 136. A pin 116 may be inserted through the passage in the bushing and a wedge 118 used to secure the two adjacent column forming panels 102 together. The plate also provides force distribution and prevents direct engagement between the wedge and the channel to protect the column forming panel 102.

Fig. 17 is a bottom plan view showing in the alternative the use of latching bolt mechanisms 320 received in base mounting plates 322 on the underside of the sill plates 108. The latching bolt mechanisms 320 include a housing 324 having a spring which biases a latching pin 326 outwardly toward an extended position. The latching pin 326 may thus extend through the holes 214 in the ledger extension 204 of the beam ledger form 106 to hold the sill plate 108 at the desired position relative to the beam ledger form 106. A wedge 118 may be used with the latching pin 326 to secure the sill plate 108 in position, either in an extended or retracted condition..

The method of the present invention includes the steps of providing forming panels for the columns, beams and floor, and coupling them to provide forming assemblies for columns, beams and floors. The forming panels are preferably provided in an arrangement for a single, monolithic pour. That is, the method preferably includes the step of pouring flowable concrete or other cementatious material so that it flows into the interior of the column forming assemblies, and such pouring of concrete continues until the regions within the column The method includes the arrangement of the forming panel components in concrete-receiving form assemblies of different dimensions, whereby two or more columns are formed in different configurations or dimensions, and/or two or more beams are formed in different configurations or dimensions. The preferred method further includes the step of adjusting the arrangement of the forming panels to accommodate for different site conditions including, for example, variations in the configuration of reinforcing steel, concrete blocks, wiring or other building components. The preferred method also includes the disassembly, reuse and rearrangement of the forming panel component members described herein to provide forms for alternatively dimensioned beam and column building frameworks in subsequent building constructions.

Although preferred forms of the invention have been described above, it is to be recognized that such disclosure is by way of illustration only, and should not be utilized in a limiting sense in interpreting the scope of rhe present invention. Obvious modifications to the exemplar)' embodiments, as hereinabove set forth, could be readily made by those skilled in the art without departing from the spirit of the present invention.

The inventor hereby states his intent to rely on the Doctrine of Equivalents to determine and assess the reasonably fair scope of his invention as pertains to any apparatus not materially departing from but outside the literal scope of the invention as set out in the following claims.

CLAIMS:

We claim:

1. A method for forming cast-in-place building structures of poured concrete material, comprising the steps of:

providing a forming member including a concrete-engaging member having a rear surface and an opposite front surface adapted for engaging and forming poured concrete material, and a frame connected to the concrete-engaging member and extending rearwardly of the rear surface, said frame being configured and adapted for receiving couplers for connecting respective forming members in adjacency, the frame including at least one reinforcing member positioned along the rear surface, said reinforcing member having a plurality of penetration indicators at predetermined locations opposite and adjacent said concrete-engaging member;

utilizing said penetration indicators to create an opening in said concrete engaging member in registry with a selected one of said penetration indicators to provide a coupler passage extending through said concrete-engaging member and said reinforcing member of said frame;

providing couplers and attaching said forming member to other forming members utilizing said couplers to form a concrete-receiving form assembly defining a region corresponding to a desired configuration of a structural member of the building, at least one of said couplers extending through said passage including the opening created in the concrete engaging member from said front surface to said rear surface and through said reinforcing member at said penetration indicator;

pouring concrete into said region;

allowing the concrete to cure to a self-sustaining condition; and

removing the forming members of the form assembly.

2. A method as set forth in claim 1, wherein said step of utilizing said penetration indicators to create an opening includes drilling through said concrete-engaging member.

3. A method as set forth in claim 2, wherein said penetration indicators are holes in said reinforcing member, and including the steps of positioning a drill bit within the hole and drilling the openings in the concrete-engaging member in registry with the holes in the reinforcing member.

4. A method as set forth in claim 2, including the step of inserting a plug into the opening after removing the forming members of the form assembly.

5. A method as set forth in claim 2, wherein the penetration indicators are spaced at preselected, substantially evenly spaced intervals along the reinforcing member.

6. A method as set forth in claim 5, wherein the concrete-engaging member includes a surrounding edge and the frame includes at least a pair of opposed, spaced apart rails positioned adjacent respective portions of the surrounding edge of the concrete-engaging member and wherein the rails have holes therein, and wherein the step of utilizing the penetration indicators to create an opening includes the step of selecting a penetration indicator corresponding to a desired hole in one of rails and wherein the step of drilling the opening through the concrete-engaging member causes the selected penetration indicator and the opening to be aligned with a selected one of said holes in the rails when said forming member is attached to the other forming members.

7. A method of forming differently configured cast-in-place beam or column concrete structural members for buildings comprising the steps of:

providing a plurality of forming members each including a concrete-engaging member having a rear surface and an opposite front surface adapted for engaging and forming poured concrete material, and a frame connected to the concrete-engaging member and extending rearwardly of the rear surface, said frame being configured and adapted for receiving couplers for connecting respective forming members in adjacency, the frame including at least one reinforcing member positioned along the rear surface. said plurality of reinforcing members each having a plurality of penetration indicators at predetermined locations opposite and adjacent said concrete-engaging member;

utilizing said penetration indicators to create first openings in said concrete engaging members in registry with a selected first one of said penetration indicators to provide first coupler passages extending through the concrete-engaging members and the reinforcing members of the frames;

providing couplers and attaching said forming members to adjacent other forming members utilizing said couplers to form a first concrete-receiving form assembhy defining a region corresponding to a first desired beam or column configuration, at least some of said couplers extending through said first passages including the first openings created in the concrete engaging members from said front surface to said rear surface and through said reinforcing member at said first one of said penetration indicators;

pouring concrete into said region;

allowing the concrete to cure to a self-sustaining condition;

removing the forming members of the first form assembly;

plugging at least temporarily, at least some of the openings in the concrete-engaging members of at least some of the forming members;

utilizing said penetration indicators to create second openings in at least some of said concrete engaging members in registry with a selected second one of said penetration indicators to provide second coupler passages extending through the concrete-engaging members and the reinforcing members of the frames;

attaching said forming members to adjacent other forming members utilizing said couplers to form a second concrete-receiving form assembly differently arranged and configured from said first concrete-receiving form assembly and defining a second region corresponding to a second desired beam or column configuration, at least some of said couplers extending through said second passages including the second openings created in the concrete engaging members from said front surface to said rear surface and through said reinforcing member at said selected second one of said penetration indicators;

pouring concrete into said second region;

allowing the concrete in said second to cure to a self-sustaining condition; and

removing the forming members of the second form assembly.

8. A method as set forth in claim 7, wherein a first set of said first concrete-receiving form assembly is configured as a column form assembly defining a first region having a substantially upright long axis, and including the step of providing a plurality of said first sets and fluidically connecting the first sets.

9. A method as set forth in claim 8, wherein a second set of said first concrete-receiving form assemblies are configured as a beam form assembly having a second region presenting a substantially horizontal long axis, and including the step of connecting said plurality of second sets of first concrete-receiving form assemblies to said second set of said first concrete-receiving walls systems whereby concrete poured into said first regions is in fiuidic communication with concrete poured into said second region.

10. A method as set forth in claim 9, wherein the forming members in said second set of said first concrete-receiving form assemblies include ledger forms having an extension adapted for coupling a floor form thereto, and including the steps of:

providing a plurality of floor forms;

coupling respective ones of said floor forms to the extensions of corresponding ones of said ledger forms to form a deck forming system positioned adjacent said second set; and flowing the poured concrete onto the deck forming system to form an elevated deck, whereby concrete on said deck forming system is in fluidic communication with said first and second regions.

11. A method as set forth in claim 9, wherein a third set of said first concrete-receiving form assemblies are configured as a second beam form assembly having a third region presenting a substantially horizontal long axis, and including the steps of attaching the forming members of said third set in a different configuration than said second set whereby said third region has a different cross-sectional configuration than a cross-sectional configuration of said second set, and connecting said third set of first concrete-receiving form assemblies to said second set and said first set of said first concrete-receiving walls systems whereby concrete poured into said first regions is in fluidic communication with concrete poured into both said second region and said third region.

12. A system for forming beams and columns of poured-in-place concrete for a building, comprising:

a plurality of forming panels each having a face plate presenting a front side for receiving concrete thereagainst and a back side opposite to the front side and a surrounding edge, and a frame coupled to the face plate and presenting at least first and second spaced-apart rails each having a width and positioned adjacent the surrounding edge and extending rearwardly from said rear side, said frame including a reinforcing member positioned adjacent to said rear side, said reinforcing member including a plurality of holes selectively positioned on said reinforcing member opposite a portion of said face plate, said portion of said face plate including at least one opening aligned in registry with a corresponding one of said holes to define a passage located between said rails which is sized and positioned to receive a coupler therethrough;

a first set of couplers operatively connecting a first set of said forming panels to present a first column-forming wall structure substantially enclosing a concrete-receiving volume, at least one of said first set of couplers extending through a selected one of said passages of one of said first set of forming panels to and through a hole in a rail of another of said first set of forming panels;

a second set of couplers operatively connecting a second set of said forming panels to said first set of forming panels whereby said second set of forming panels; and

a third set of couplers operatively connecting said second set of panels to form a first beam-forming wall structure wherein at least some of said second set of panels are opposed, spaced-apart, substantially upright beam ledger forms and some of said second set of panels are substantially horizontal sill plate forms which are connected by ones of said third set of couplers extending through a selected one of said passages of one of said beam ledger forms of said second set of forming panels to and through a hole in a rail of a corresponding one of said sill plate forms whereby said first beam-forming wall structure defines a concrete-receiving channel,

said first beam-forming wall structure being arranged and operatively coupled to said first column-forming wall structure whereby concrete received in said concrete-receiving channel fluidically communicates with concrete received in said concrete-receiving volume of said first column-forming wall structure.

13. A system as set forth in claim 12, further including a plurality of floor forms, wherein said floor forms are coupled to said ledger forms in elevated relationship to said first column-forming wall structure.

14. A system as set forth in claim 12, further including a plurality of box corner forms coupled to and interconnecting said first beam-forming wall structure to said first column-forming wall structure, whereby said box corner forms include first and second elongated walls, said first and second elongated walls being oriented in substantially

perpendicular relationship to each other, each of said elongated walls having a wall width greater than the rail width, and a connecting flange connected to and extending substantially perpendicular to a respective one of said elongated walls and substantially parallel and opposite to the other of said elongated walls, each of said connecting flanges having at least one hole therein sized and configured for receiving a coupler therethrough.

15. A forming system as set forth in claim 14, wherein said ledger form includes a rearwardly projecting extension having a dimension, said dimension being substantially the same as the width of said elongated wall.

16. A forming system as set forth in claim 12. wherein said reinforcing member extends substantially between said rails and said plurality of holes in said reinforcing members are positioned at evenly spaced intervals therebetween, at least some of said holes being located adjacent an imperforate portion of said face plate whereby said at least some of said holes are not in registry with an opening in said face plate.

17. A forming system as set forth in claim 12, wherein said reinforcing member is positioned in substantially perpendicular alignment to said rails and wherein said plurality of holes in the reinforcing member are in lateral alignment with a hole in the rail and oriented such the axes of the holes in the reinforcing member are substantially co-planar with but oriented perpendicular to the holes in the rails.

18. A forming panel for receiving thereagainst pourable cementatious material for forming a building member comprising:

a face plate having a surrounding edge, a front side adapted for receiving poured cementatious material thereagainst and a rear side;

a frame coupled to said face plate and extending rearwardly therefrom, said frame including at least first and second rails spaced apart connected to said face plate proximate the surrounding edge,

wherein said frame further includes at least one reinforcing member extending along said rear side of said face plate between said first and second rails, said reinforcing member having a multiplicity of penetration indicators spaced at preselected locations along said reinforcing member, said penetration indicators being positioned adjacent an imperforate portion of said face plate and configured a hole may be created in said imperforate portion of said face plate in registry with said penetration indicator for receiving therethrough coupling members for coupling the forming panel to an adjacent forming panel.

19. A forming panel as set forth in claim 18, wherein said penetration indicators include holes in said reinforcing member positioned at common spacing intervals in substantially lateral alignment along said reinforcing member.

20. A forming panel as set forth in claim 19, wherein said reinforcing member includes an elongated slot and a U-shaped collar received in said slot having a backing positioned adjacent one of said rails, said backing including a hole positioned in registry with a corresponding hole in the rail.

21. A method of connecting forming members for forming concrete structures comprising the steps of:

providing a first forming member having a face plate having an opening therein to provide a coupler passage and a rearwardly extending frame including a channel having an elongated rearwardly open slot;

providing a second forming member having a face plate and a rearwardly extending frame including at least one siderail having a hole therethrough;

positioning the first forming member substantially perpendicular to the second forming member with the face plate of the first forming member oriented adjacent to the side rail of the second forming member and the opening in the face plate in alignment with the hole in the siderail;

inserting a coupler through the passage and the hole; and

threadably connecting the coupler to one of the first and second forming members.

22. A method as set forth in claim 21, wherein the channel includes elonged ribs extending into the slot, and including the steps of providing an externally threaded bushing, threading the bushing onto the channel, and passing the coupler through the bushing.

23. A method as set forth in claim 21, wherein the coupler is threaded, and including the steps of providing a nut complementally configured to threadably receive the coupler and threadably connecting the coupler to the nut.

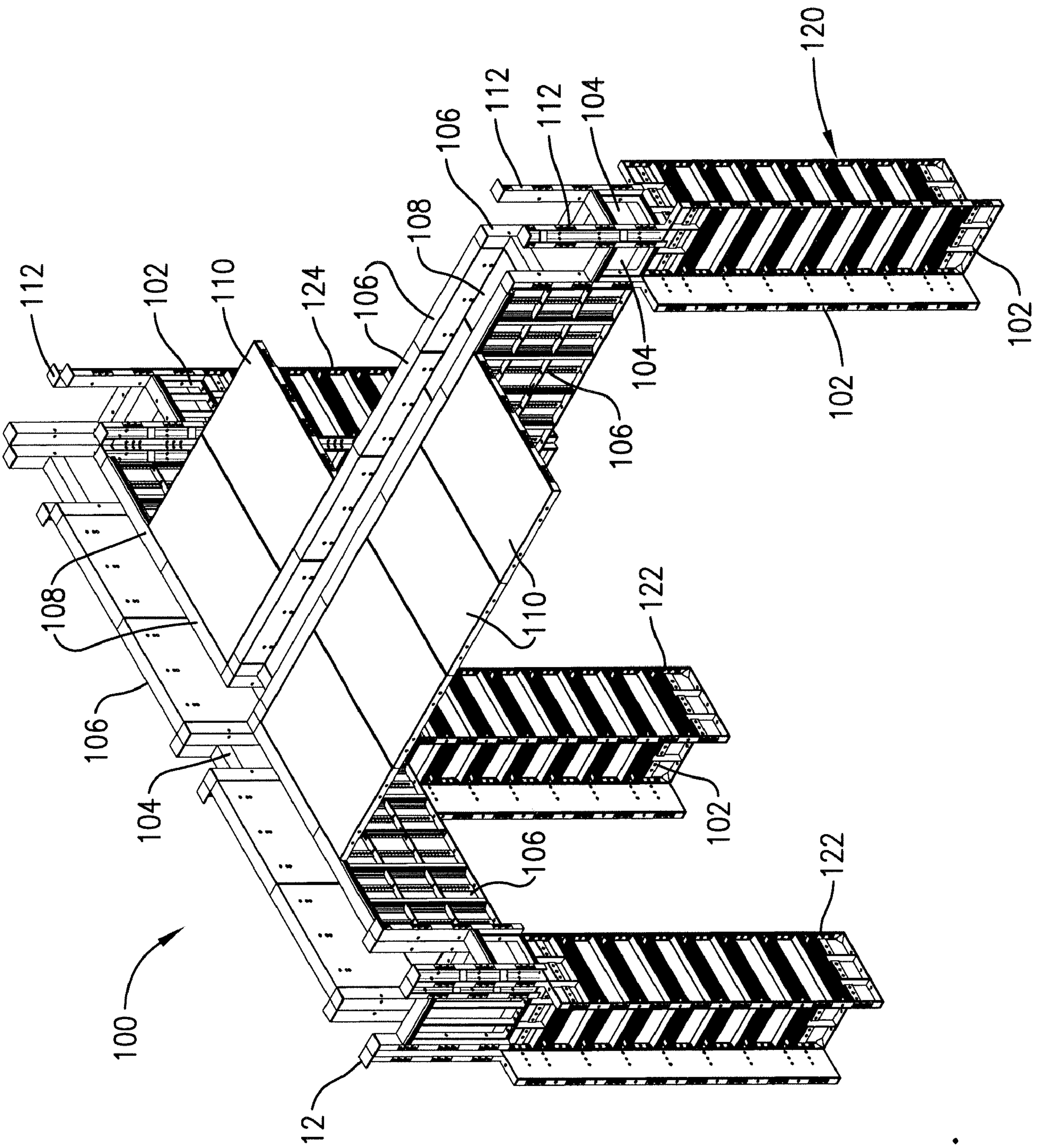

Fig. 1.

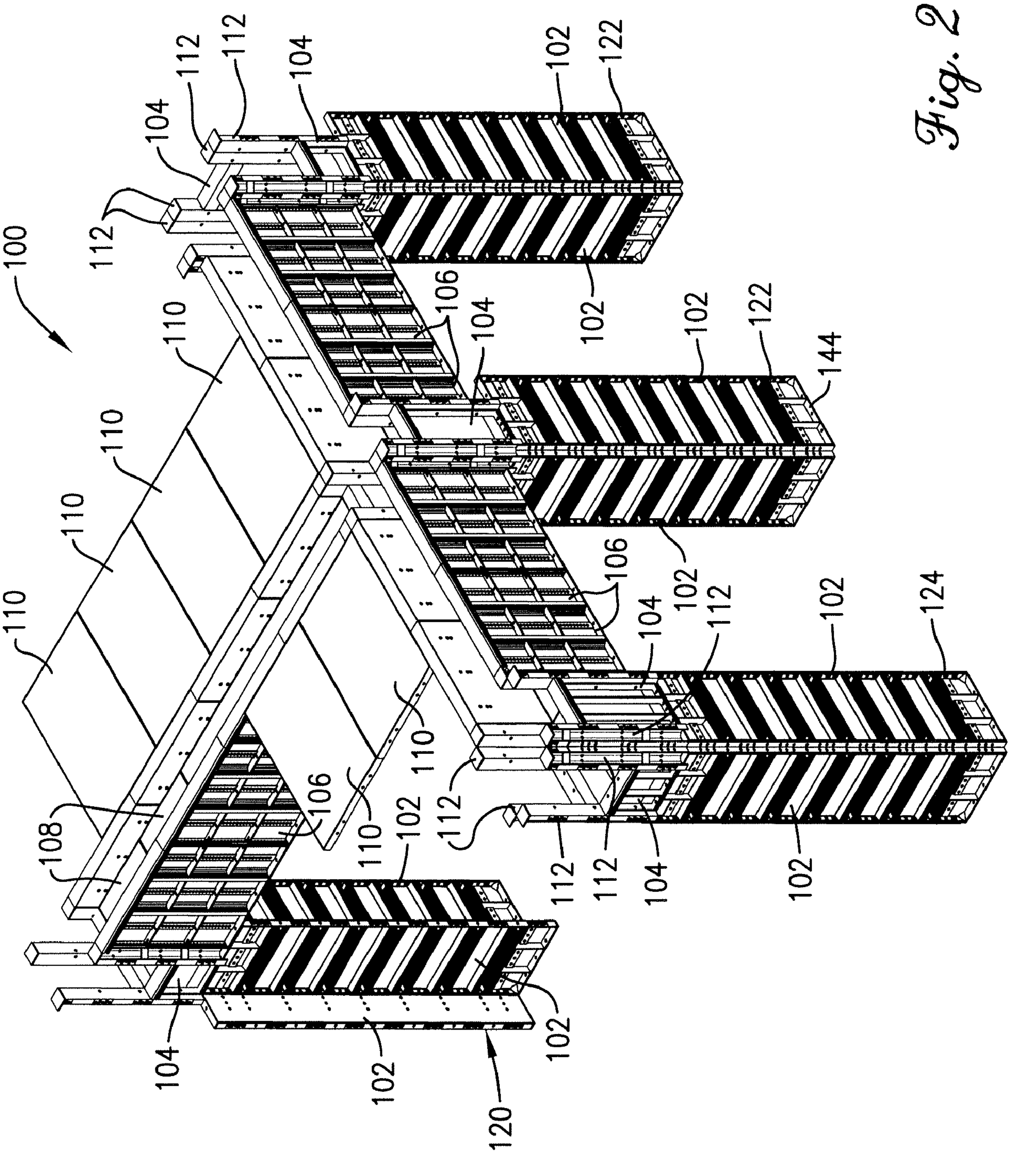
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Fig. 2.

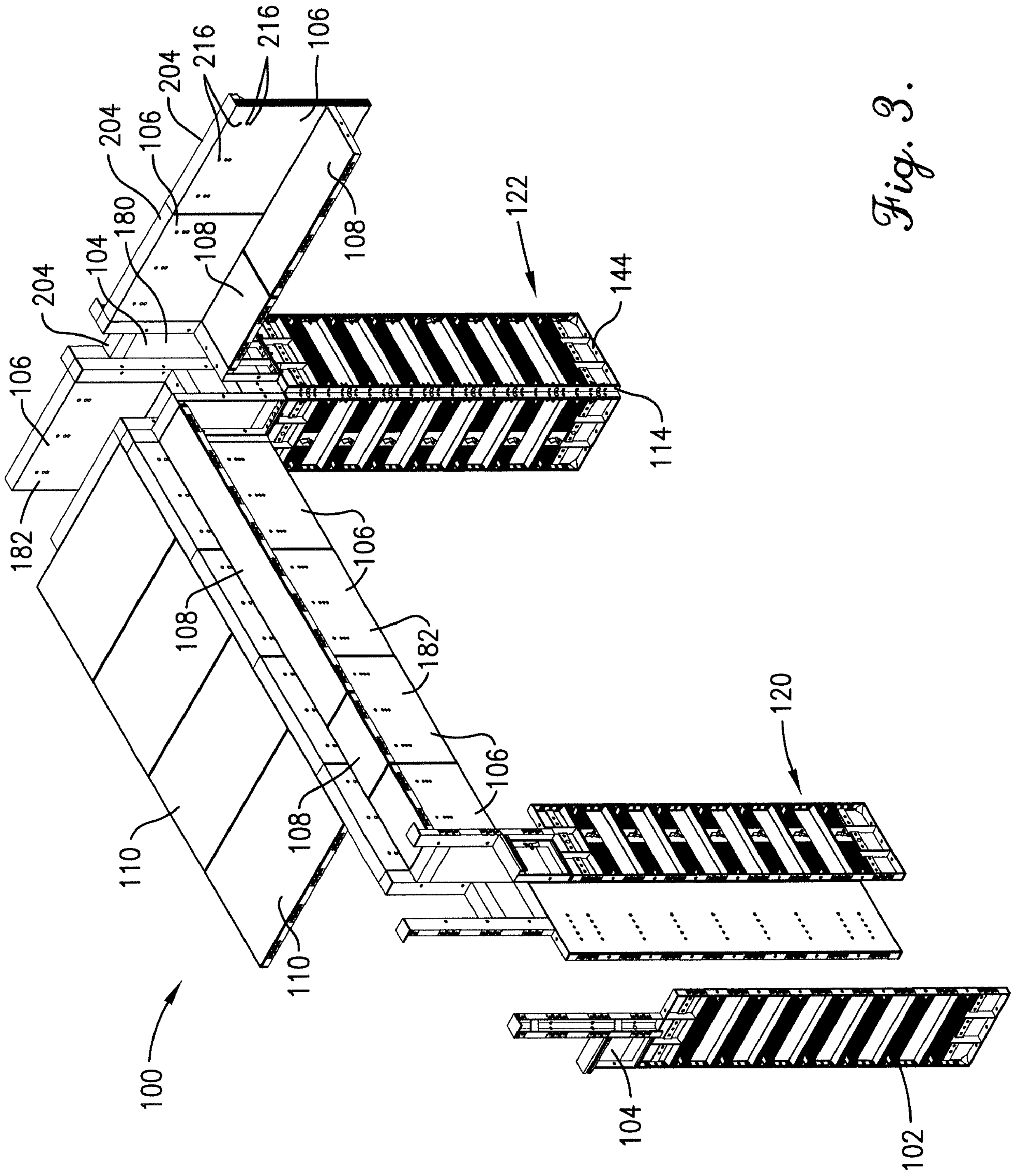
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Fig. 3.

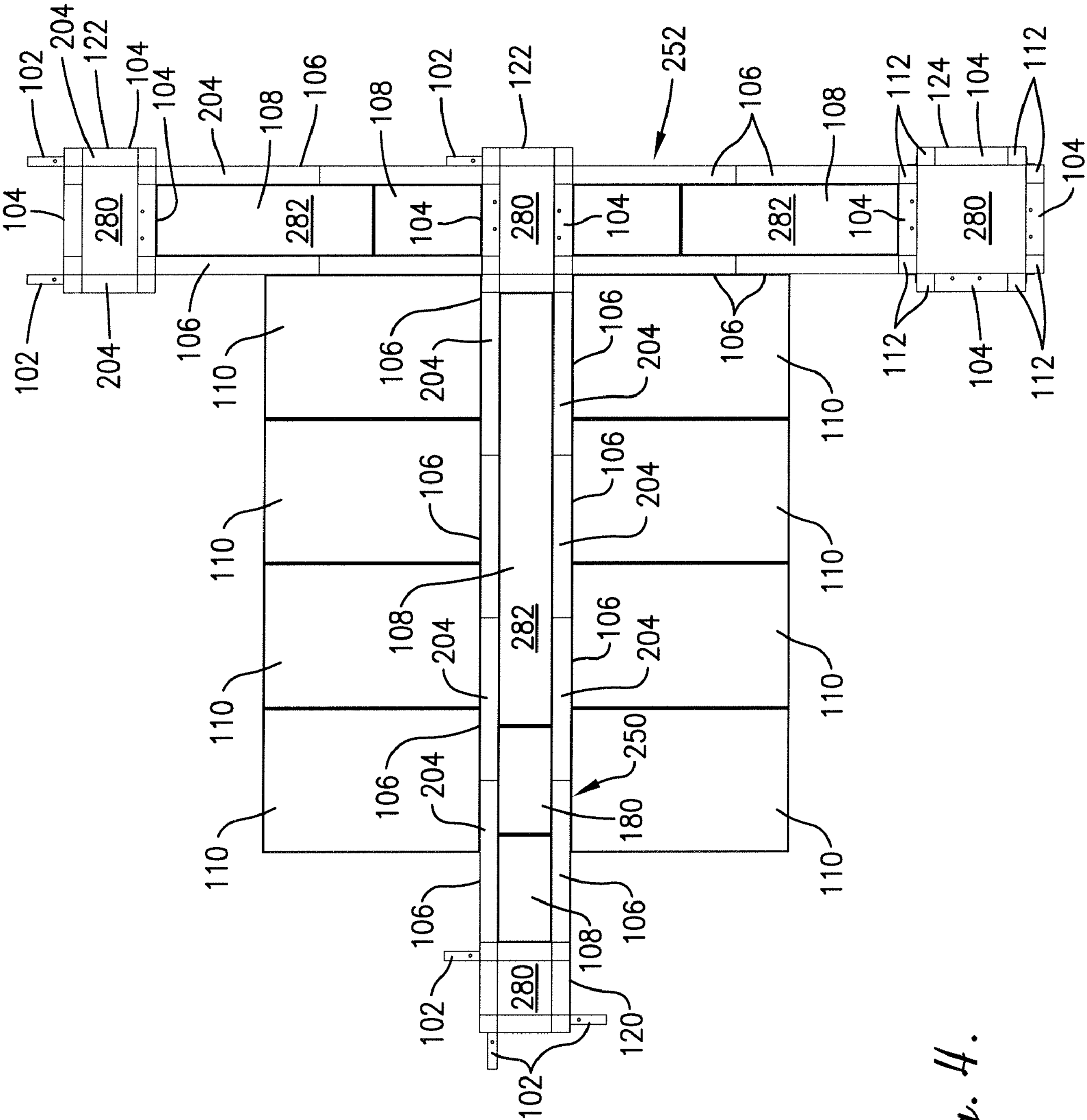

Fig. 4.

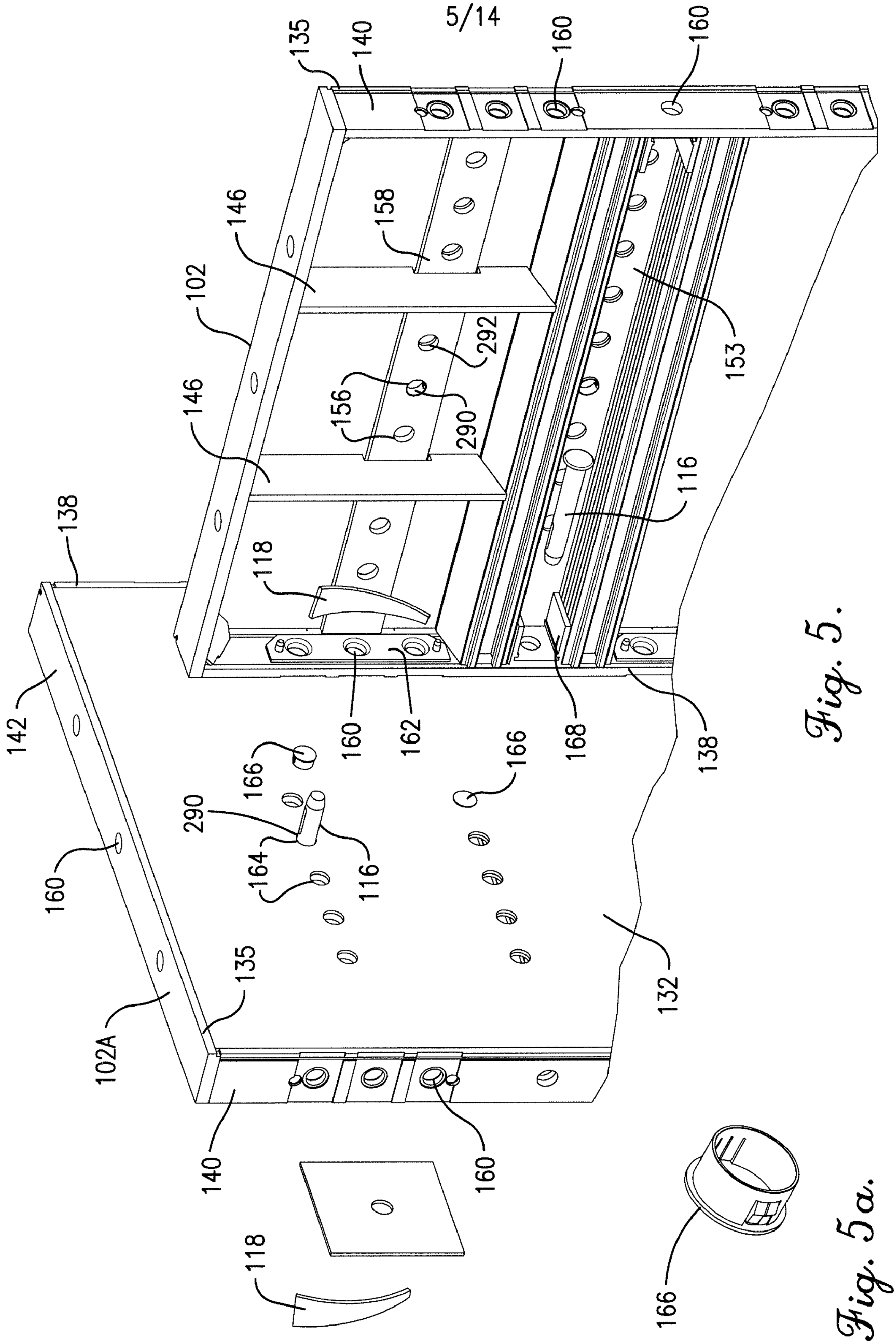
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Fig. 5.

Fig. 5a.

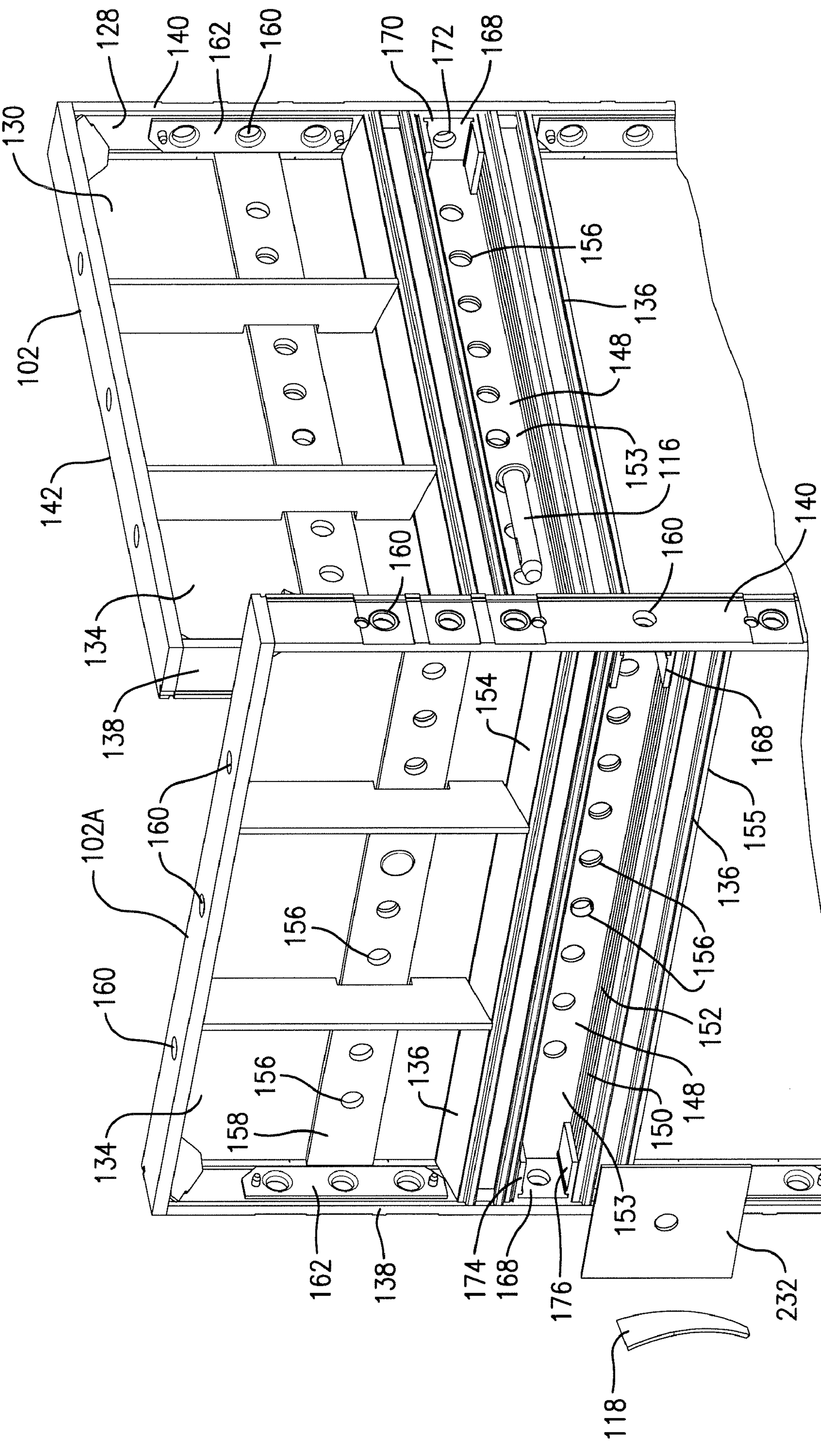
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Fig. 6.

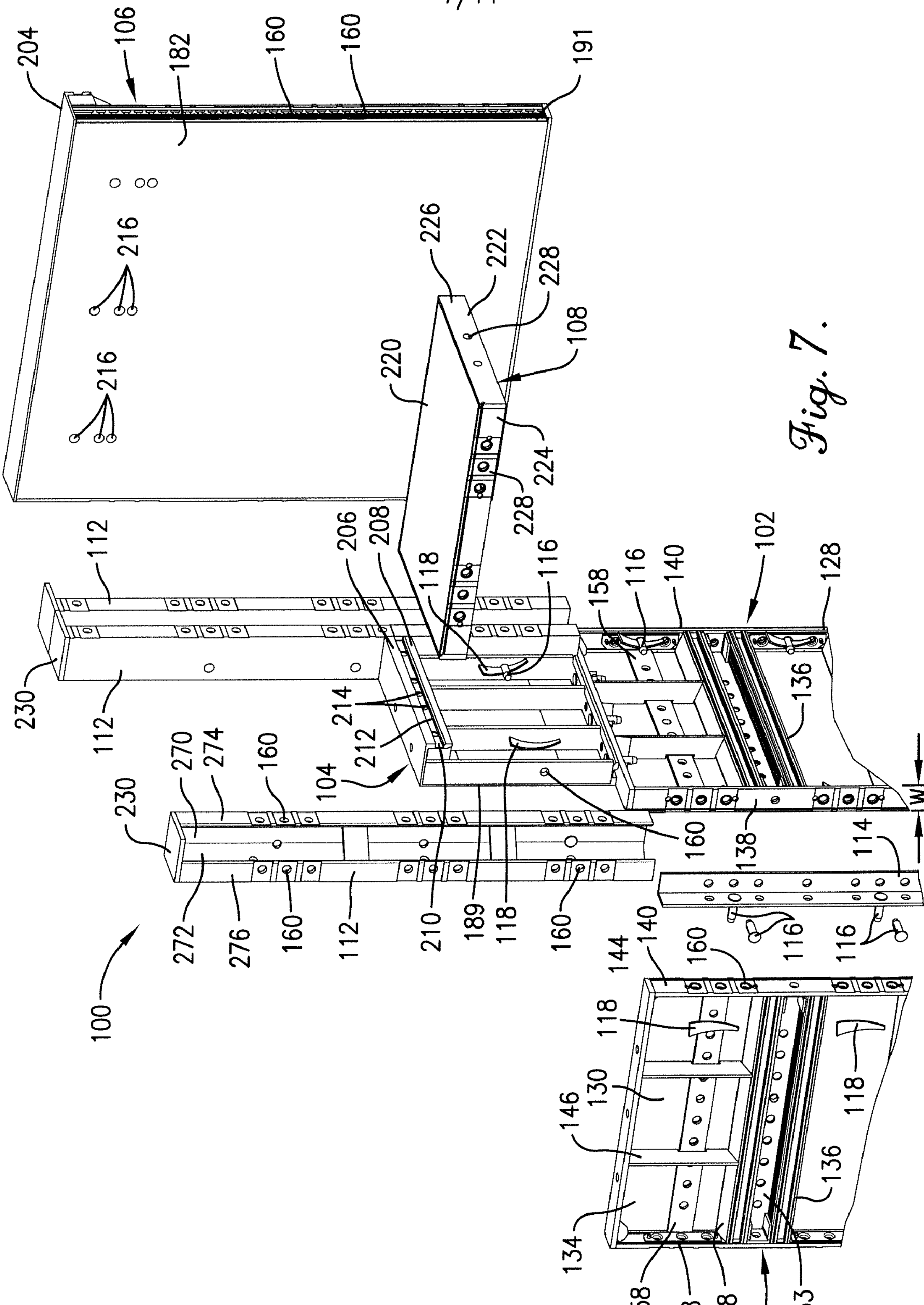
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Fig. 7.

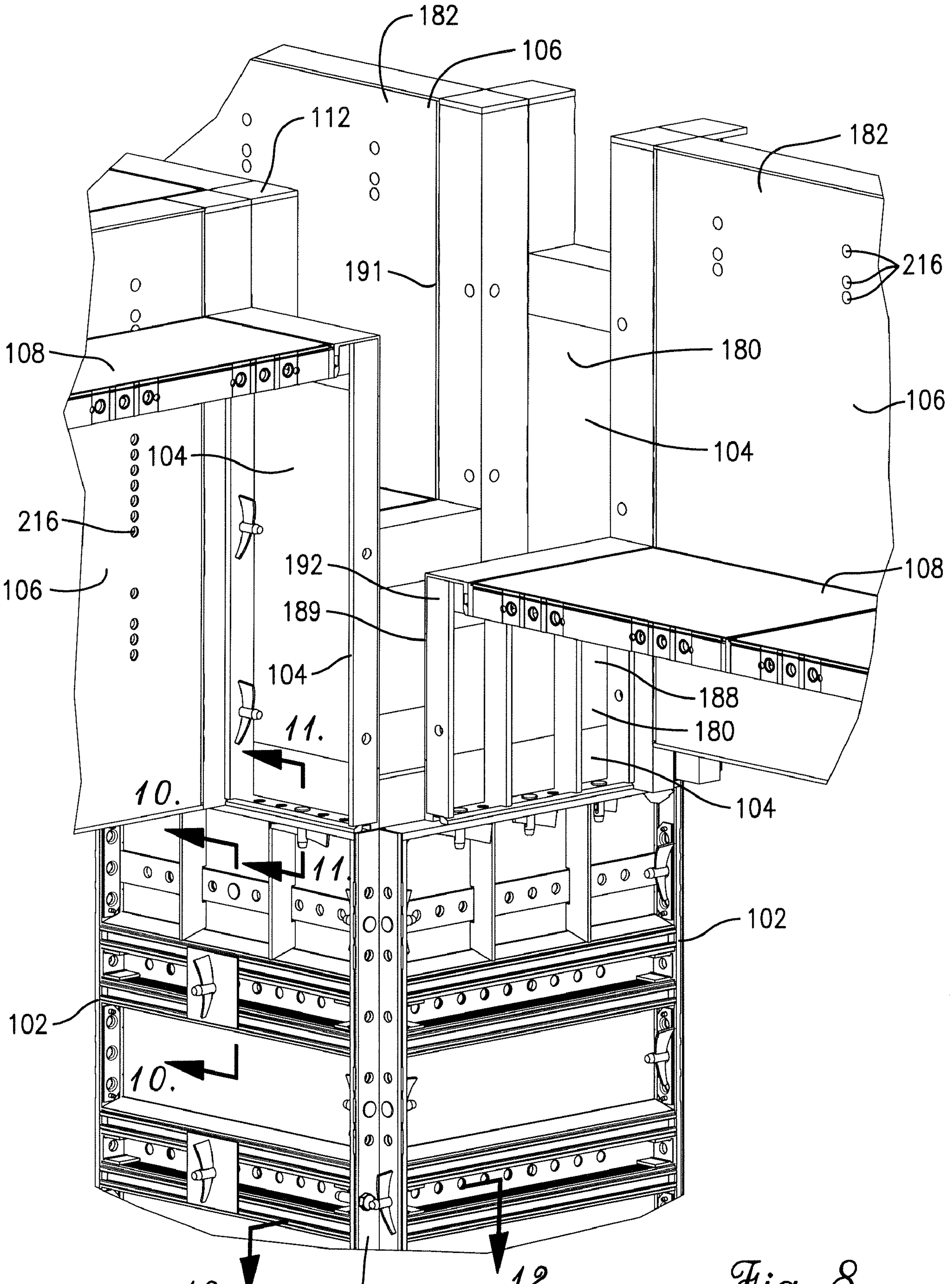
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Fig. 8.

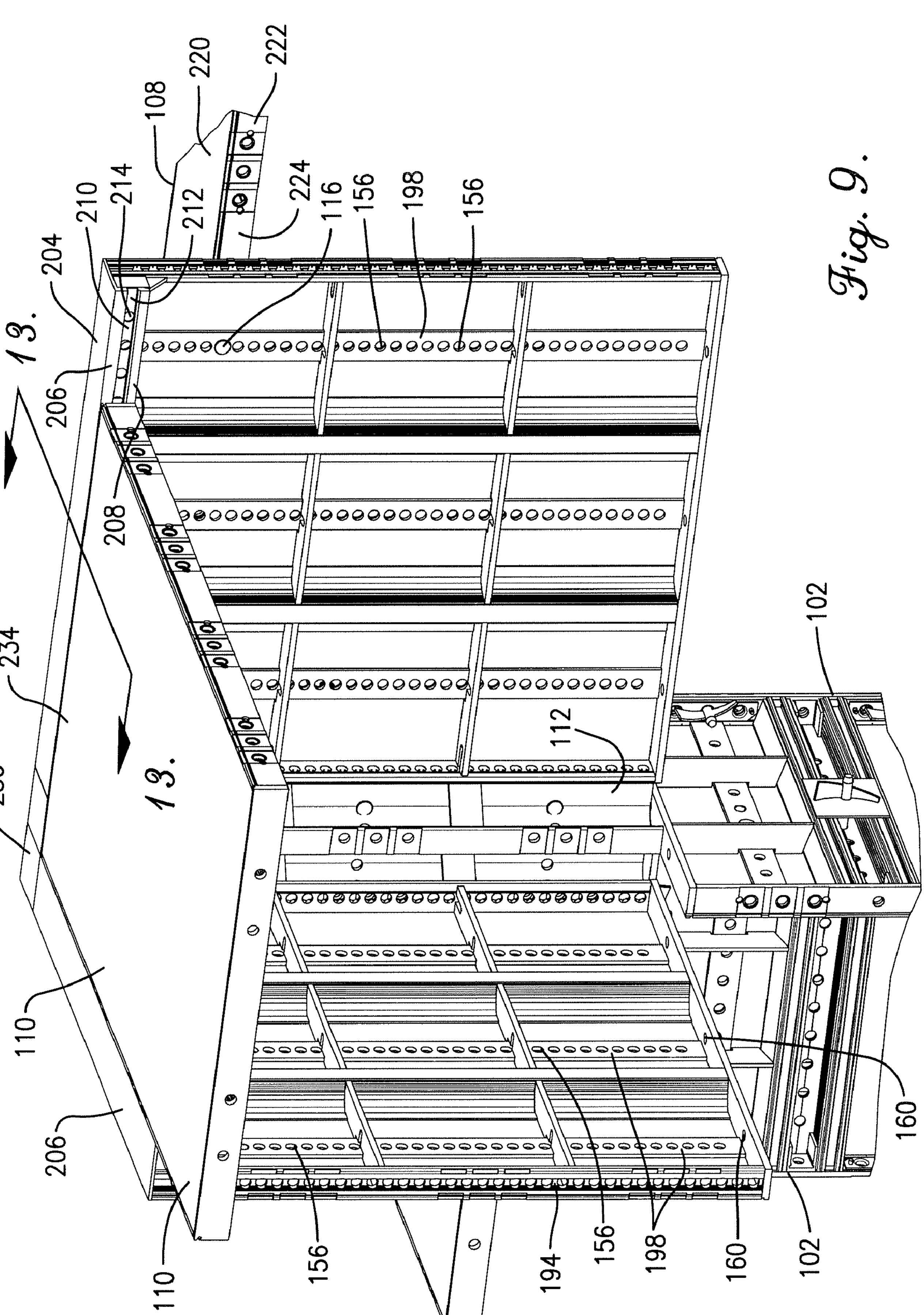
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Fig. 9.

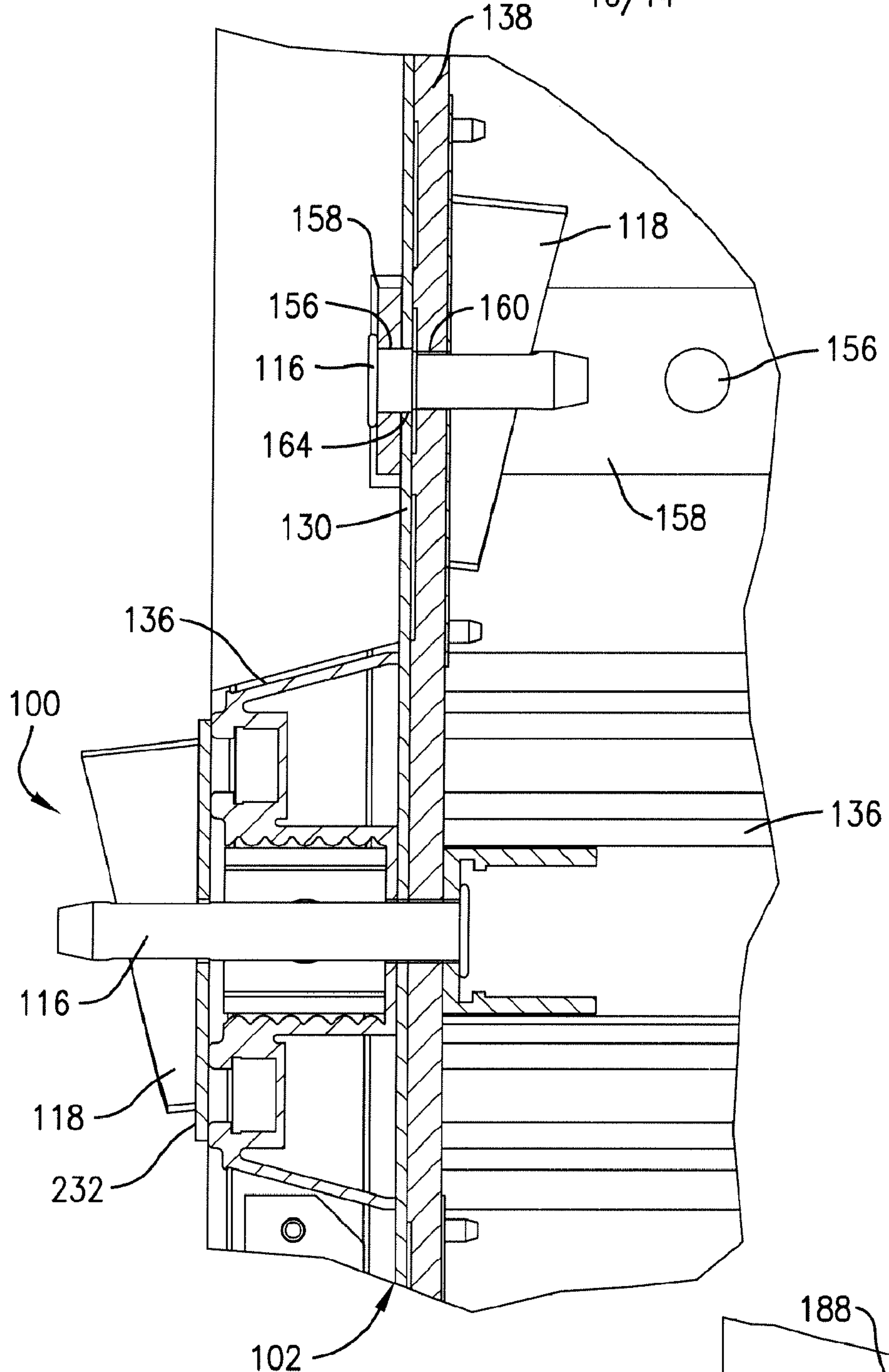
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Fig. 10.

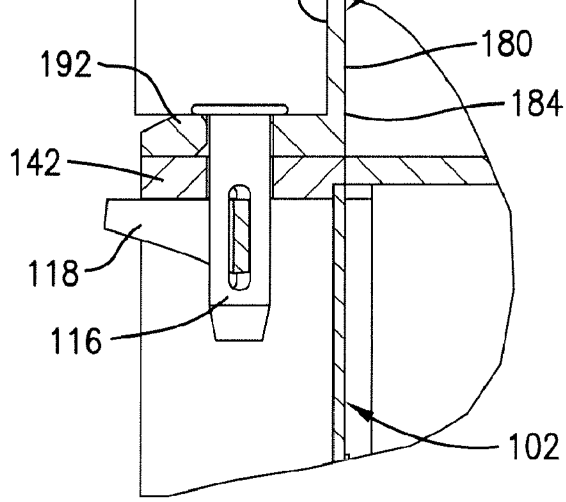
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Fig. 11.

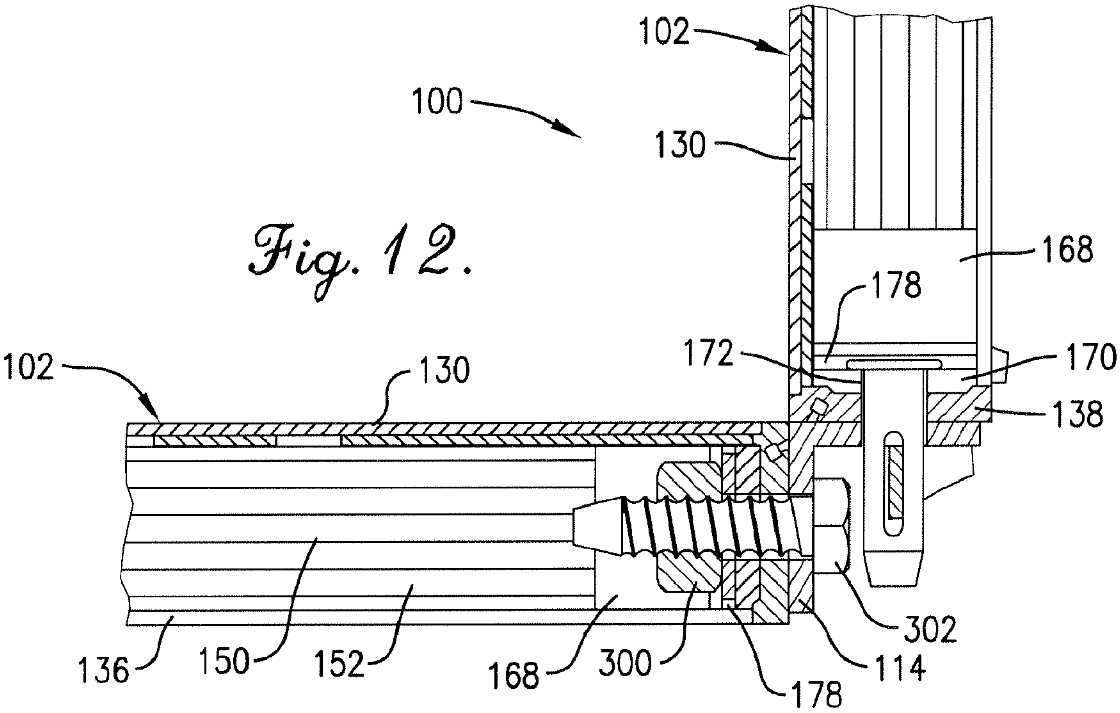
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Fig. 12.

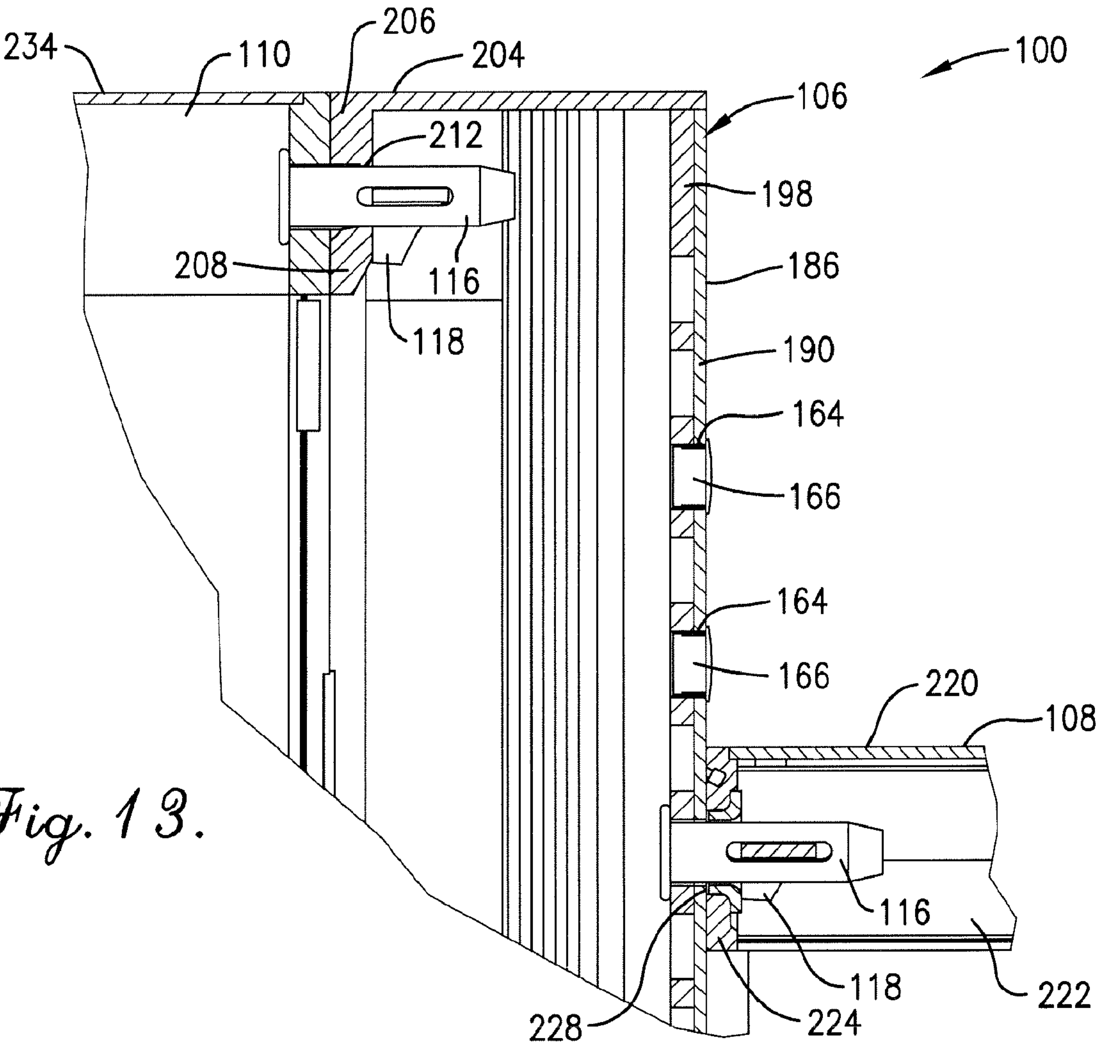
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Fig. 13.

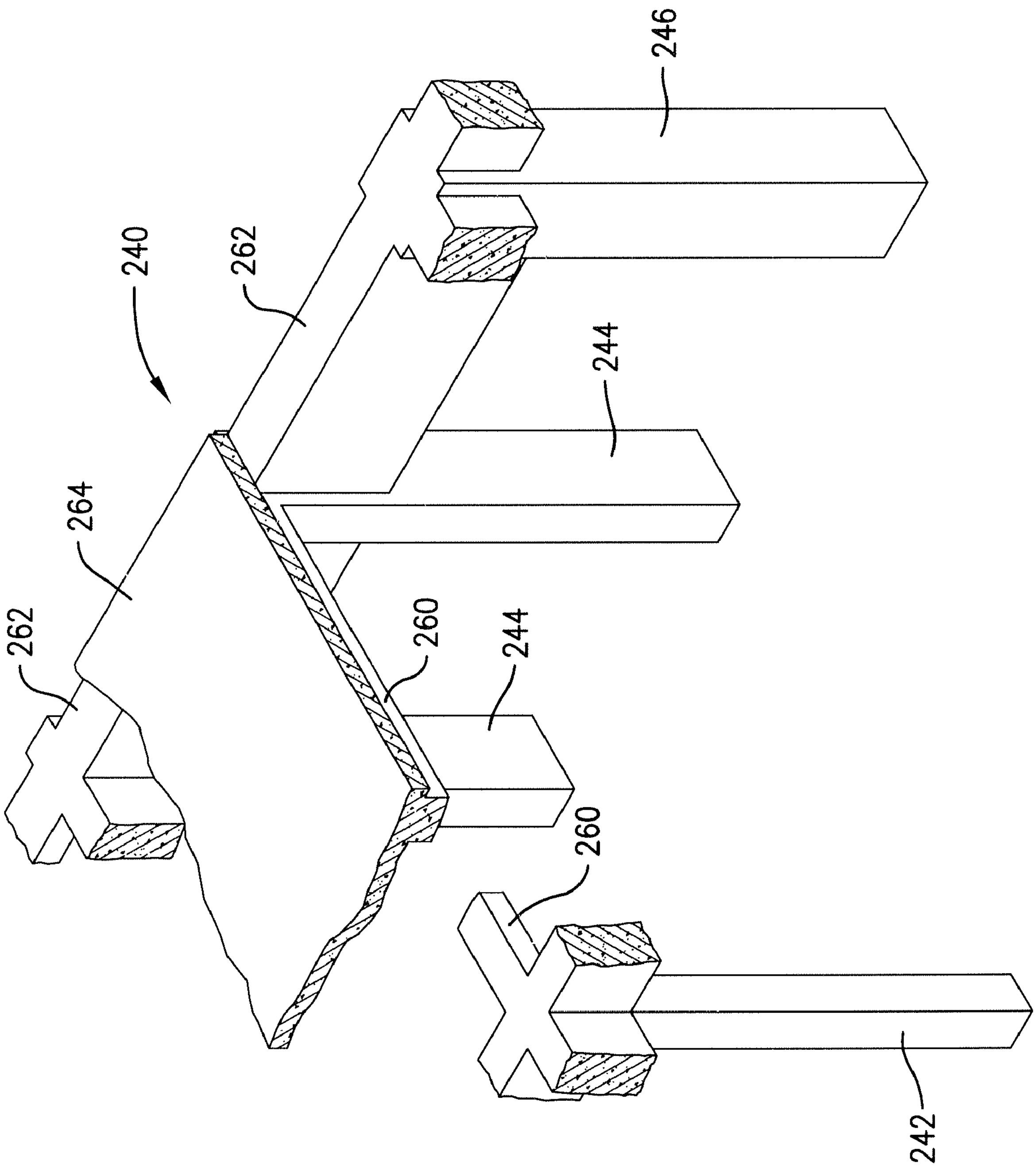

Fig. 14.

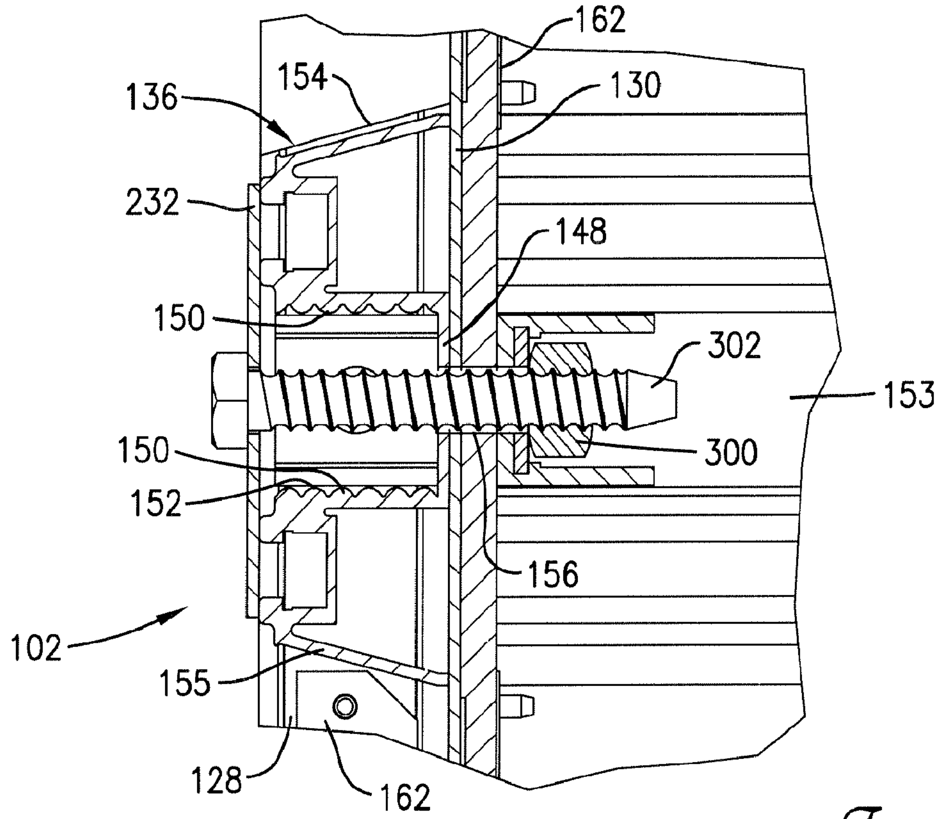
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Fig. 15.

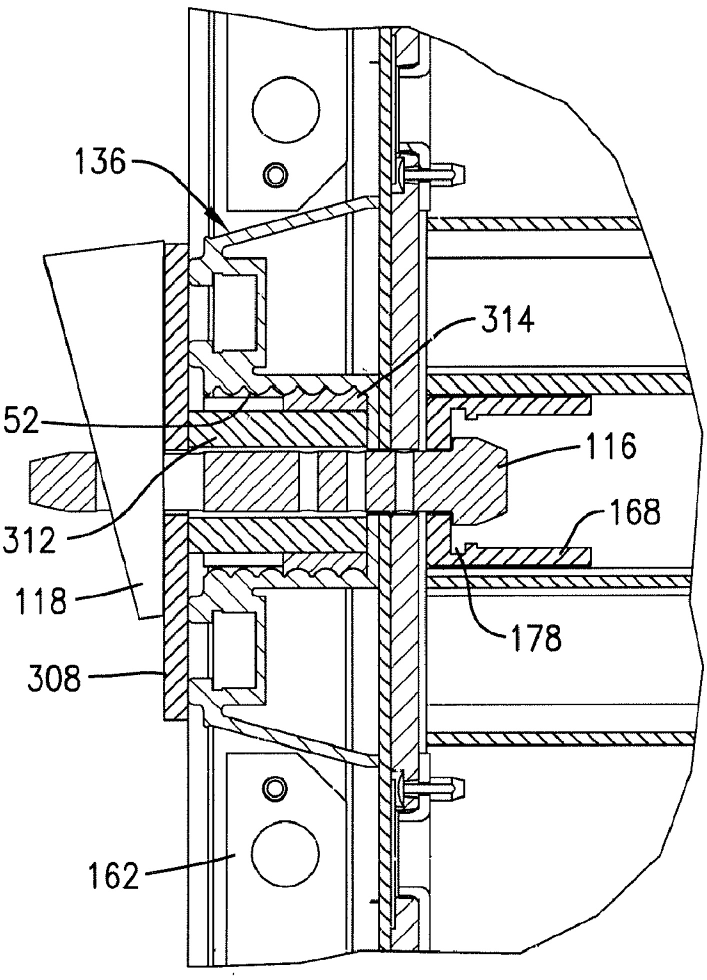
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Fig. 16.

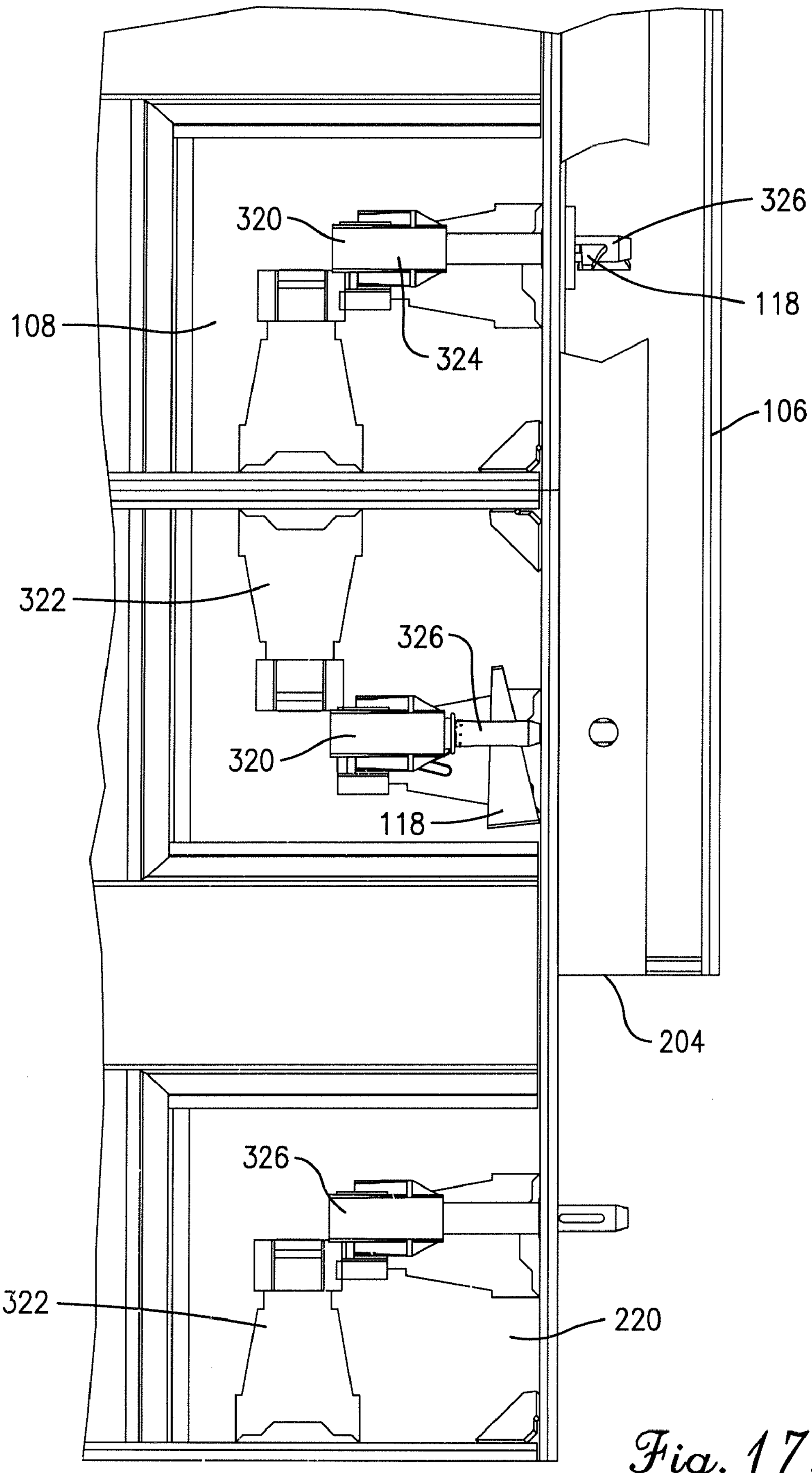

Fig. 17.