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(54) **Building system and components thereof.**

(57) The invention relates to a building process and means for in situ casting of structures as houses, buildings, dikes, silos, piping, culverts and the like. It is especially suited for building in series a given structure. More in particular, it refers to a mold formed by a number of parts to be assembled at the construction site and the use thereof. The mold is assembled on site and a castable material capable of hardening to a load-bearing structure, such as concrete, is poured into the mold. The thus cast structure than becomes a solid monolith. Once the structure is dry, the mold is completely or partially disassembled, taken to the next construction site and the process repeated. Particular mold elements and devices and techniques for use in conjunction with the molds are also described.

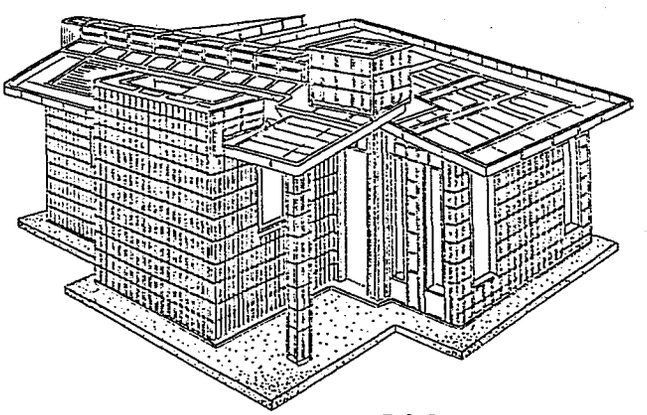

FIG. 7

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BUILDING SYSTEM FOR CASTING SINGLE-PIECE SOLID STRUCTURES

In the last two decades, changes in the construction techniques have been observed all over the world. The traditional construction systems used since the latter part of the 19th Century up to the commencement of the decade of the fifties, have been surpassed by the great construction demand, generated by two decisive factors: the population increase in a worldwide level and the improvement of the acquisition power of the family nucleus. These factors, reflected in the increasing demand of housing, schools, hospital and commercial constructions, have exceeded any type of programmed projection and have brought as a consequence the continuous rising of construction costs. These costs being subject to increases in skilled labor, high interests on financing and a great incidence on the material used, etc.

The system of the present invention fills a vacuum in the construction. It fulfills a series of purposes which simplify the construction process of any type of structure, and also substantially reduces the cost of the process.

The use of panels or plates to provide a surface to receive concrete has been known for a long time. More or less complicated systems have been used for pourings of walls and slabs and partially to join one to the other. This invention allows the integral pouring of walls and roofs which can, if desired, be used to produce a complete structure. It also permits the inclusion of any type of additions that have not previously been able to be produced in this way.

U.S. 485,901 etc.

The pouring concrete for buildings into metal molds which are assembled on site is also known. Such prior art procedures do, however, have problems in assembly and disassembly of the mold forms, particularly if one wishes to pour concrete for walls and roofs at the same time.

It is an objective of the invention to provide a complete system for in-situ casting of structures which can be used to great advantage when a series of similar constructions is to be built, but which may be used for a single-structure project. Thus provision is made for all the parts and assorted equipment to be used in this new type of construction process trying to keep as many standard parts as possible.

It is another object that of providing a construction process resulting in a trouble-free operation when all stages of the operation are followed as directed.

Another object is that of providing monolithic structures which require less material and provide more endurance.

Still another object is that of providing an extraordinary rapid construction system for enabling building of houses and the like at a favorable rate of at least three to one when compared to current building systems.

Another object is that of providing the means for a low cost wholly predictable building operation to be implemented from conception to commissioning in a short time by a disciplined crew.

Still another object is to provide a system which may be partially implemented for construction jobs involving minor additions or changes to existing structures or for providing partial structions to be finished with different materials such as for example, glass walls or thatched roofs, etc.

Another objective is the provision of a building system capable of incorporating a great diversity of building materials, a wide selection of architectural designs and any desired combination of building foundations, supports

for vaults or additional stories for housing heavy machinery, bearing walls in combination with non-bearing walls, etc.

SUMMARY OF THE INVENTION

The system of the present invention relates to a mold formed by a multiplicity of panels to be assembled into which a castable material capable of setting to produce a load bearing structure may be poured.

From a first aspect, the present invention provides a system for monolithic construction of a structure which comprises an assembly of metal mold elements into which a castable material, hardenable to produce a load bearing structure may be poured, said mold assembly comprising at least one mold disassembly facilitating element selected from the following:

a) an L-shaped member placed beneath the lowest layer of metal mold elements with the upright portion of the L-shaped member disposed outwardly from the surfaces between which said castable and hardenable material is to be poured and

b) at least some mold elements having a face portion which will constitute part of the mold surface which will abut the poured structural material and flanges along each edge of said face portion by which the element can be affixed to adjacent mold elements wherein at least one of said flanges is disposed at an angle which is other than perpendicular to the face portion.

From other aspects, the invention provides particularly shaped mold elements, particular arrangements of mold elements and particular devices of use in conjunction with the mold system.

The system of the present invention further provides panels which can withstand the pressure excerted by cement or concrete in the fluid state. The elements of the system are also capable of being coupled together in a fluid-tight manner as a result of their method of construction and the particular type of novel nut and bolt system used.

The invention further provides a ground pattern which permits un- or simi-skilled workers to lay out utility conduits and position walls with a minimum of supervision.

The invention will be described with reference to the accompanying drawings in which like parts are given the same numbers. Figures 1 through 10 show various stages in the use of the system. The remaining figures show items used in employing the system and some specific features relating to their use.

Figure 1 is a perspective view of the outline pattern.

Figure 2 is an inset detailing manner in which the ground pattern is secured to the floor.

Figure 3 shows further a floor pattern suspended from said ground pattern.

Figure 4 shows plumbing distribution in floor.

Figure 5 and inset show the ground pattern replaced in position after the pouring of concrete in order to mark the position of walls etc.

Figure 6 is a similar perspective showing the steel structure being set up and of the mold being assembled about said structure.

Figure 7 shows the mold completely assembled.

Figure 8 is a similar perspective of the already cast construction after the mold has been disassembled and retrieved.

Figure 9 shows perspective views of standard planks or panels.

Figure 10 is a partial side elevation of a flange shown in Figure 9.

Figure 11 shows how mold elements for opposite faces of a wall are spaced using a spacer tie.

Figure 12 shows a spacer tie.

Figure 13 shows a nut for use in conjunction with said spacer tie.

Figure 14 is a cross section of a wall with the mold elements still in place showing the use of a spacer tie

and its associated nut.

Figures 15 and 16 show mold elements forming caroner pieces of mold assemblies.

Figure 17 shows the use of mold element of a type specially designed to facilitate disassembly of the mold form after hardening of concrete or other hardenable material in the mold.

Figure 18 shows a mold in the form of a Greek cross which is of particular use in connection with roof mold assemblies.

Figure 19 shows a particularly useful organization of molds for a roof assembly in conjunction with a Greek cross mold element as shown in Figure 18.

Figure 20 shows the final steps of disassembly of a mold arrangement as shown in Figure 19.

Figure 21 is a side perspective of two oppositely disposed mold form elements and of a bridging member spanning both, of use to "surround" door posts.

Figure 22 is a perspective view of the hoister.

Figure 23 is a side view of the self-centering bolt.

Figure 24 is a side view of a self-centering nut.

Figure 25 shows the use of a self-centering bolt and nut unit.

Figure 26 is a mold form element mounted on an L-shaped member.

Figure 27 shows a ground pattern member.

DESCRIPTION OF THE INVENTION

A) GENERAL DESCRIPTION OF THE SYSTEM

A particular feature of the system of the present invention is the ease with which the forms into which concrete or cement is to be poured may be assembled and disassembled. Particular elements which facilitate the assembly and disassembly of the forms are described below. It will, however, be useful to provide a more general description of how these operations may be carried out.

After a suitable location has been defined for

building a series of dwellings and the site for each dwelling has been marked; plumbing, lighting and other fixtures for facilities have been defined for the complex and for each individual dwelling the process of the invention is initiated.

The first site of the first dwelling having been located, a mold 100 defining the periphery of the foundation slab is assembled using mold elements. These have walls 200 and base portions 201. They are secured to the ground (as shown - Fig. 1) by driving metal stakes 203 through holes 202 and corresponding holes (not shown) in the base 200. Thereafter any rough patches in the ground encompassed by the mold wall may be levelled and a steel wire netting 101 laid (this is shown in position in Fig. 4 - but for convenience is not shown in Fig. 3). This netting acts as reinforcement for the concrete of the floor slab. A ground distribution pattern 108 made at a scale of 1:1 with regard to the dwelling is laid on the ground to provide for a marking of the confines of each room as shown in Fig. 3. An element of the type used to construct the ground distribution pattern is shown in Fig. 27. This shows members 204 and 205 which mark the faces of the walls and a brace 206 to prevent distortion of the pattern in use. Also shown are hooks 207 whereby the member can be suspended from the walls 200 of the base mold element as shown in Fig. 3. After thorough marking has taken place, a upright metal rods 102 may be attached to the netting 101 along the lines of the walls.

The plumbing network 104 as well as the electricity, air conditioning, gas supply and other networks are laid in their final desired locations, so as to have them embedded when concrete is poured. This is shown in Figure 4.

The next step of the process is that of pouring concrete or cement to define a floor and the secure a base for the construction. The rods 102 naturally become embedded in this floor layer. Thereafter the ground pattern is replaced in position as shown in Figure 5 and the positions of rods 102 and the conduits for utilities 104 are checked. This repositioning of the pattern also enables one to provide

for spacer and positioning means to be attached to the concrete base so as to ensure the correct assembly of the metal mold forms into which concrete for the walls will be poured. Typically such spacer/positions means will be in the form of a simple U-shaped member which can be affixed to the concrete base between the pattern pieces for the inner and outer walls.

If the repositioning of the pattern is done before the concrete has set sufficiently to be load bearing, the pattern may be suspended from the walls of the mold used to pour the concrete base.

Once the positioning of the conduits and internal walls has been checked and the spacer/positioning means have been affixed in position, the pattern is removed from the concrete base. Desirably, metal reinforcing netting 103 is attached to the uprights 102 to reinforce the walls as shown in Figure 6.

Once set, the mold form elements 106 are assembled at both sides of the wirenetting 103 previously set up. The mold form assembly includes the lower surface of the roof and provision is made for frames for doors and windows or a corresponding space for then is allowed.

First, however, there are positioned L-shaped members as shown in Figure 26 along the lines which constitute the internal and external faces of all internal and external walls. These L-shaped members comprise "back" pieces 127 and bases 125 having holes 124 therein and are positioned with their bases 125 pointing inwards. The dimensions of the bases of the L-shaped members are such that they fit with the edge flanges of the elements of the mold forms. The mold forms used for the walls are typically of the type shown in Figure 9. Such mold forms have a metal base 126, the side of which that is not visible in these figures being the side which forms the surface abutting the concrete once this has been poured. Welded to the base 126 are flanges 131 in which are set holes 128. The elements may also be provided with holes 130 through which spacer

ties may be passed to maintain the vertical separation between the mold element assemblies for each of the faces of the wall.

The arrangement of a mold form element on an L-piece is shown in Figure 26. The holes 128 in the mold element form are aligned with the holes 126 in the L-shaped member and screws or some other withdrawable object may be dropped there through to maintain the alignment. The L-shaped members are, however, not secured to the concrete floor nor are the mold elements attached in any permanent way to the L-shaped members.

Each mold form element is attached to adjacent mold form elements by screws which are passed through holes 128 and secured by nuts behind the flange 131 of an adjacent mold form element. In this way, a mold assembly for one face of the wall is constructed. A similar assembly is contracted for the other face of each wall. Molds for both internal and external walls are constructed at the same time. Desirably, frames for doors and windows are put into position while the mold is being constructed. It is normally desirable that a spacer bar be placed across the base of each door area and attached to the mold forms so as to ensure that the doors spacing is maintained when the concrete is poured. Window frames may conveniently be "hung" in the correct position from the upper part of the mold form assembly. A typical arrangment of mold pieces and a spanning member which can be used to "surround" the post of a door frame is shown in Figure 21. A similar arrangement may be used for a window frame is shown.

Although in most mold form elements the flange 131 is disposed at 90° to the base plate 126, it is desirable that at least one pair of adjacent vertical rows of elements in the assembly which constitutes each face of each wall has elements wherein the flange is set at an angle which is other than perpendicular to the base plate. As will be discussed later, the use of elements with such angled flanges substantially eases the problem of disassem-

bly of the mold after concrete has been poured. The arrangement of mold form elements having angled flanges is shown in Figure 17. Four mold elements 135, 136, 137 and 138 are held together by nuts and bolts 139 typically of the type shown in Figure 25. While the abutting flanges of the pairs of elements 135 and 138 and 136 and 137 are perpendicular to the face of the mold, the flanges between the elements 135 and 136 and between elements 137 and 138 are at an angle to the perpendicular.

It is, of course, possible for mold form elements to be of any desired shape. Particular shaped forms may be used for corners or for the junction of the walls and the roof or for construction of stair cases and the like. Suitable mold form elements for the production of corners and the manner of use are shown in Figs. 15 and 16. The general principle of construction and assembly of such forms will, however, be the same as has been described thereto.

The two sets of mold elements constituting the opposite faces of a wall have a number of holes therein in the various mold elements, as shown for example, as shown as hole 130 in Figure 9. Through these holes spacing ties are inserted to ensure that proper separation between the mold form elements for each of the faces of the wall is maintained during the pouring of the concrete. It is often convenient to apply a little grease or oil to the spacer tie before pulling it into position. A typical spacing tie is shown in Figure 12 wherein the taper of the tie is somewhat exaggerated for the convenience of the viewer. A nut suitable for use with the ties is shown in Figure 14. It will be noted that the spacing tie is tapered for ease of removal from the concrete after it has been poured into the mold shape formed by the oppositely facing assemblies of mold form elements. The correct spacing of the assemblies is assure by the guard 140 and the positions of the thread 141 which determines the final position which the nut 142 may adopt when tightened or to the spacing tie. The spacing tie is provided with a handle 143 for ease of

tightening. The nut 142 is provided with a flange 144 which can "catch" on the strengthening 129 of the mold form elements. This then enable the spacing tie and nut to be tightened by a single workman on the "handle" side of the wall assemblies without the need for an additional workman to hold the nut while the spacing tie is being screwed into it. A typical arrangement showing the use of a spacer ties is shown in Fig. 11 and Fig. 14 shows a cross section of the vicinity of a space tie through the mold elements after concrete has been poured.

Assembly of mold form elements for the roof of a single story building or the ceiling of the first floor and flooring for the second floor of a multi story building is effected in substantially the same way as the assembly of forms for the walls. In this case, however, the "top" can be left open unless the roofing is on a slant. In the case, where an assembly of mold forms is used only for the underside of the roof, the top side of the concrete for the roof may be smoothed manually in the same manner as was done for the initial floor laid on the ground.

I have found that a particular arrangement of mold form elements is particularly useful for the roof assembly. The arrangement I have devised particularly facilitates the disassembly of most of the elements for the roof assembly while leaving certain elements in position where they may be supplied by struts. This enables one to disassemble the roof mold assembly before the concrete of the roof has fully set since the remains elements supported by the struts provide sufficient support for the particularly set room concrete. They key to my inventive assembly for a roof mold is the use of a mold piece having angled flanges. The flanges are directed "inwardly". The mold form assembly element of this design need not be any larger than is needed to be mounted on the top of a support strut and provide local support for the roof. Use of an element of this type enable adjacent elements to be removed easily when the time comes to disassemble the roof mold while leaving the element itself in

position mounted on a supporting strut.

I have, however, found that it is particularly useful to use as the element which is to be supported by a strut, an element in the shape of a Greek cross and to use a particular arrangement of particularly shaped mold form elements in conjunction therewith. A suitable element in the form of a Greek cross is shown in Figure 18 and an arrangement of molds to be used in conjunction therewith in Figure 19 which shows the underside of such an arrangement. The arrangement has an element 146 in the form of a Greek cross of the type shown in Figure 18. Abutting therewith are further elements 147, 148, 149, 150 each of which has an "outwardly" angled flange at the end which abuts element 144 and "inwardly" angled flanges on the sides adjacent thereto. Also abutting element 146 are elements 151, 152, 153 and 154 each of which has two "outwardly" angled flanges on the sides which abut element 146 but has a flange perpendicular to the base plate on its other two sides. Abutting elements 147 and 152 is element 153, abutting elements 149 and 153 is element 158 and abutting elements 149 and 154 is element 155 and abutting element 151 and 147 is element 156. Each of elements 153, 156, 155 and 156 has only a single flange which is angled (in each case "outwardly") the remaining flanges being perpendicular to the base plate.

I have found that with this arrangement if a strut is used to support element 146, the remaining elements shown can be disassembled without difficulty after the concrete has been poured and particularly set and element 146 can be left attached to a suitable strut to provide support for the partially set concrete of the roof until it has set sufficiently for the roof to be able to bear its own weight.

Most conveniently mold form elements for the under face of the roof can be raised to roof level using a hoister of the type shown in Figure 22. If additional bracing for the walls during the pouring of the concrete is required, as is often the case when no roof is present, this can be provided by the use of a brace.

Once the form elements for the walls, both internal and external and for the underside of the roof (the assembly for the outside face of the external walls extending up to the level of the upperside of the roof) have been assembled concrete is poured into the mold by gravity feed. If necessary, vibrators may be used to obviate the risk of cavities in the walls. Any type of material which can be cast and which will subsequently set to form a load-bearing structure may be used. Typically, materials are cement and concrete for example a cellular concrete such as those described in the article by Rudolph C. Valore in Journal of the American Concrete Society May and June 1954 (page 773-796 and 817-832) which article is incorporated herein by reference.

Once the concrete of the walls has set sufficiently for it to bear the weight of the walls and part of the weight of the roof (the remainder of the weight of the roof being borne by struts as described above) the assembly of mold elements may be substantially disassembled. Mold form elements for the underside of the roof are removed with the exeption of those mold elements which are supported by a strut. The angled flanges of the mold elements enable one to effect a partial sliding of the flanges over each other to break the seal of the mold with the concrete rather than requiring a direct pull perpendicular to the face of an element and thus substantially simplified the removal of the first pieces. Such movement of the pieces is achieved by use of hand operated levers. Once some of the pieces having such angled flanges have been removed, removal of the remaining elements is easier.

For removal of the assembly for the walls, first the spacer ties which have kept the forms for the two faces of the wall properly spaced are removed. The L-shaped pieces are then knocked or levered out of their position beneath the mold assembly thereby allowing the force of gravity to encourage the mold elements to drop and break their seal with the concrete. The mold is then disassembled starting with those mold pieces which have angled flanges.

The mold may then be reassembled at the next site where the prior preparations have already taken place.

The process may then be repeated in similar manner until the series of buildings is terminated.

PARTS AND EQUIPMENT

A) Element or Panels

The elements are the surfaces which make contact with the concrete or other material used. Are totally metallic and comprise a smooth contact surface surrounded by metal flanges 131, and can be a metal sheet reinforced by a strengthening frame 129. This frame, placed in its posterior part, allows the contact surface to endure the pressures of the product poured in the mold, as well as the overlying joints with other panels. The frame can best be described as reinforcement ribs.

By its function and shape, the panels can be classified in the following groups:

- Standardized Panels.
- Special Panels.
- Interior Cornering Panels.
- Exterior Cornering Panels.
- Retrieval Panels.
- Retrieval Panels, cross type.

Standard Panels

As described with reference to Figure 9 of the standardized panels the present invention have a series of characteristics that give a great functionality and great universality in use; such characteristics are:

a) Existance of flanges 131 around the perimeter of the panel, perfectly welded braised or soldered to the edge of the concrete contact surface, forming a right angle in relation to the face 126. The perimetric flanges have circular perforations 128 generally with identical diameters in all of them. These circular perforations 128 are uniformly separated as shown in Figure 10 as a distance 1, there is only one distance 1 that is not constant in the panels and is referred as to the one existing between the centre of the

perforations which go along the edges of the corner and the corner itself, this distance 1 is identified on sheet number 1 as distance l_2 and l'_2. These distances l_2 and l'_2 are always equal and their sum is always equivalent to the distance l_1; this is:

$$l_1 = l_2 + l'_2$$

$$l_2 = l'_2$$

$$2\, l_2 = 2\, l'_2 = 11$$

In addition, the mentioned perforations are a uniform distance face taking into consideration the thickness of the contact surface this, as shown on Figure 10, where it is observed that the distance a_2 is equal to the sum of the distance a_1 and the thickness of the frontal surface.

The characteristics previously described allow the universality in combinations of the different panels among them, since:

besides the distance $l'_2 = l_2 - a_1 + 1 = a_2$

1) The elements can be adjacently joined vertically or horizontally.

2) The joint of two adjacent element and in horizontal manner the joint of a third panel in vertical manner is also possible.

3) Any type of elements can be joint in a universal manner, and at the same time, allow the union of third panels, since the circular perforations will always coincide.

4) The elements can be joined in a perpendicular manner among them, thus composing tridimensional and adjustable molds which can be reduced or enlarged in equal lengths or multiples of "1" distance existing between the centres of the circular perforations.

In this case, metal strips having holes aligned with the holes of the flanges may be placed above the tops of the flanges and a further assembly of mold elements placed on top thereof. The metal strip when bolted to the flanges serves to hold the elements in the correct position at right

angles to each other.

b) Existance in some of these standardized elements of some perpendicular transversal circular perforations 130 from the concrete contact surface to its posterior part, on which the mentioned perforations are joined to the reinforcements by welding.

The mentioned circular perforations, all with the same diameter, and as shown in Figure 9 maintain the following relations in connection with their position.

1) Equidistance between lateral ends of the standardized panel:

2) Symmetry in positioning of holes where more than one hole is provided in any one element, for example, as shown in Figure 14.

3) Therefore, the placing of the perforations comply with the following characteristics:

$$b_1 = b_2$$
$$g_1 = g_2$$
$$h = g_1 + 2\,g_1 = 2\,g_2$$

having to comply with the condition that g_1 and g_2 must be in length a multiple of l_1; therefore:

The characteristics previously described allow the universality in combination of elements for the pouring of vertical structures, as well as some specific uses in the pouring of horizontal structures.

1) The circular perforations have as an object to allow the passing of the parts or accessories that allow the joint of two opposed panels, with the purpose of supporting the horizontal pressures excerted by the poured material. Such thickness ("E") will be determined by the length of the joint element between opposed panels.

2) Due to the placing of the mentioned perforations, complying with the characteristics $h=g_1 + g_2 = 2g_1 = 2g_2$ and $b_1 = b_2$, the equilibrium of the panels is perfect, for which no deformations will exist in the pouring of the structure due

to the distribution of the vertical loads.

3) Due to the circular feature of these perforations, as well as the equidistance of such perforations in relation to the lateral ends, the metal sheets may be joint in a frontal manner, irrespective of their horizontal or vertical position.

SPECIAL ELEMENTS

Special elements are available for the assembly of molds for use where concrete or like material is to be poured for a structure which is not of regular shape.

Such special elements do, however, have many of the features of standardized elements:

a) A metal face position and perimetric flanges welded thereto. Such perimetric flanges generally have two types of perforations, being these perforations of two types:

- Circular perforations with identical diameters in the case of flanges that form right angles in the corners, and only the ones which form such right angles.
- Elliptical perforations with their inferior diameter equal to the circular perforations. In every case, the distance between the centres of the circular perforations or elliptical perforations must be the same as for standardized panels. In the case that by the needs in a pouring, the surfaces of contact are not straight, the lengths must be measured according to the shape adopted by the edge line of the element.

In every case, the length "l" existing between the centre of the perforations, must correspond to the width of the perimetric platen, plus the thickness of the contact surface, this is a_3.

1) The circular perforations allow the joining of special elements with standardized elements in perfect unions, offerring in such joined surfaces completely smooth.

2) The elliptic perforations allow the joining of special plain elements with standardized elements, when offerring possibilities of lateral tolerance but not frontal, for which the concrete contact surfaces (by products or other products to be poured) will be completely smooth.

b) The existance in some of these elements of more transversal circular perforations from the concrete contact surface to their posterior part, in which such perforations are joined to the reinforcements by welding. The mentioned perforation is perpendicular to the surface of contact in the zone where it is produced.

These mentioned circular perforations, all with the same diameter, as described in Figure 9 only keep relation of placing with the intersections of the panel reinforcements, and in proportion of one perforation per every two intersections of reinforcement in any direction.

These perforations, as described in reference to the standardized panels, have as an object the passing of parts or accessories which allow the joint of two opposed panels, with the purpose of supporting the horizontal pressures excerted by the product to be poured, as well as to define the thickness of the structure to be poured. Such thickness will be determined by the length of the spacer tie between opposed panels.

Interior Cornering Elements

Elements for use in constructing corners of mold assemblies are shown in Figure 15. They have the following characteristics:

a) Two frontal parts to contact the concrete are joined at an angle with dimensions in length and width in relation to one multiple of the length l_2

of the standardized elements.

Perpendicular to the two frontal surfaces, these will have on the opposed sides the joint between them, joined two perimetric flanges 131 forming right angle with the mentioned frontal surfaces. The mentioned flanges platens, similar to the ones described in Figure 14, have circular perforations generally with identical diameters on all of them.

On the ends of such corner pieces are placed two steel end pieces 133 perpendicularly welded to the frontal parts which serve as a contact with the concrete, as well as to the perforated platens described in the previous paragraph.

If desired one end of such a corner piece may be set at an angle to the perpendicular.

The end pieces 133 have circular perforations 128 with diameters identical to the ones existing in the perforated flanges keeping also the same relations of length a_1, e, l_1 and l_2, though not necessarily a_2 width.

The characteristics previously described allow their universality in combination with other interior cornering elements, as well as other elements of the system described herein since the interior being joined together by their ends or their sides.

In addition, the cornerings may be joined with any type of element already described, for example, as shown in Figure 15.

Exterior Cornering Parts

Exterior cornering parts as shown in Figure 16 can be joined tightly with other elements.

The exterior cornering panels have no contact surface with the concrete or product to be poured and their characteristics are:

a) Two platens, 170, 172 joint among each other in their length, with reinforcements 172 in their posterior part joined in a perpendicular manner, as well as in their ends. The mentioned platens

generally have perforations 126 with identical diameters on all of them.

The perforations are circular and correspond in their dimensions with the ones described with respect to Figures 14, 15 and 16 of the standardized elements, complying also in dimensions the proportions already described in the mentioned drawings:

$$l_1 = l_n$$
$$d_1 = d_2 = d_n$$
$$l_2 = 1/2\ l_1$$
$$a_3 = l_1 = l_n$$

In this manner, the joint between panels will be completely adjusted and with no possibility of leaks.

Retrieval Panels

Are surfaces of contact with the concrete or other material for which the mold assembly has been used to obtain a structure, designed to facilitate the labor of retrieval of the system, once the structure has been poured and dried.

I have observed in the development of the system, the difficulty presented in reality for the disassembly of the mold assembly and elements once the structure is finished. This is due to the tension existing between the different panels in their joint, and the only body that forms with the structure poured. The critical problem is the removal of the first element, when in the pouring there are two or more that join with each other, which renders difficult the retrieval of the panels located at the cornering of walls.

When the pouring is performed covering panels and roofs in one operation, the difficulty is doubled, since the retrieval of the panels corresponding to the roof without causing damage is impossible.

Three types of pieces are specifically designed to facilitate disassembly of the mold.

a) The retrieval panels with an angled flange as shown in Figure 17 are similar to the elements described as standardized elements herein, but

one or several of the perimetral flanges do not conform a right in their length.

The elements shown in Figure 17 are complementary and capable of being joined in their union conform a standardized panel since the sums of their angles are 180°, therefore offer a completely smooth surface and with no possibility for leaks.

The retrieval panels are used in complementary pairs and in replacement of the standardized elements for example as shown in Figure 17.

The retrieval panels with flanges in non-right angle in two laterals are used to replace standardized panels in the molding for the roofs, since they allow an easy retrieval as well as the propping to support the weight of the product poured for a certain period of time after the panels of the mold have been removed.

b) The retrieval panels, cross type, described in drawings numbers 18, 19 and 20 consist in a surface of contact with the concrete or product to be poured shaped as a cross with twelve sides 180 which perimetrically have joint a perforated flange 181 in a non-perpendicular shape.

The perforated flanges 181, similar to the one existing in the retrieval panels of wedge type, generally have circular perforations 128, and comply the relations in corresponding dimensions with the standardized panels.

The element of cross type is used preferably for the conformation of molds for the roofs and joint in all its sides by retrieval panels of wedge type, serves as a support for the support beams. When the roof is removed, it is the last panel to be recovered and its placing divides the surrounding panels in four areas of mold removal.

The retrieval panels are strategically placed in the roofs, in such manner that allow the commencement of the panel removal in a easy way once the concrete or similar has set in several places as well as guarantee an exact support once the panels are removed, to support the

structure of the roof and avoid that it does not suffer deformations by lack of curing.

(c) L-shaped pieces as shown in Figure 26 consist of a metallic surface of irregular thickness foled in an angle shape.

Their end of least thickness, shown in Figure 26, as thickness "C" acts as a surface of contact with the concrete or product to be poured. They generally have circular perforations in their length, similar to the ones existing in the perforated flanges of the standardized elements.

Retrieval panels of the general type can also be used to conform corners. Their shape is of a platen, cut in a square form. Its thickness, not uniform, is less in two frontal faces.

I have observed that after pouring a structure of the type previously mentioned there is particular difficulty in disassembly the mold as a result of the lack of tolerance between the roof and the floor body conformed by the concrete or solid product, along with the joint panels, difficult their removal due to the absence of tolerance between the roof and floor to allow the retrieval.

By first removing the L-shaped members, the disassembly of the mold is greatly facilitated.

B) SELF CENTERING CONICAL SCREWS

I have developed as a unique element of joint and assemble of this system the self centering conical screws, as described in Figures 23 and 24.

Other systems of joint for the assemble of panels for the pouring of concrete or similars such as the combination of wedge-pin, fastening hook, etc. or even the conventional screw have been used before but I have observed that they lack of accuracy when offering tolerance in their fastening, with which the joint among panels is never perfect and is reflected in defective pourings with marks in the panels. These defects are accentuated with the continuous use of the elements of joint and the panels, since the tolerances

increase per wearing out, especially in those elements of joint on which the use of tools, like hammers or mallets have to be used for their placing.

My self centering screw obviates such problems.

Both the screw 185 and the bolt 186 have in their head ends the shape of truncated cones, 187, 188 and when screwing, these cones are encountered.

The screws pass through the circular or elliptic perforations of the panels with more than enough tolerance, and when screwing the panels, these slide through the cones of the screw and bolt, thus, forcing them to join exactly.

Due to the tolerances, the self centering conical screws like the panels of the mold do not loose accuracy with the usage, since even if there is wear off, the joint continues to be exact.

C. SEPARATING TIES

Figures 12 and 13 show a separating tie and a nut for use therewith. The tie consists of a metallic tapered bar that has a threading 141 in the thinnest and in the thickest end has a guard 140.

The separating tie is the element with which the inventor joins the faced panels, passing it through the circular perforations previously described in the box referred to panels.

Other systems used to join faced panels, such as steel bars with special fasteners on the ends; faced cones and hollow, by means of which the bars can be penetrated, as well as steel platens with perforations joint to the panels, etc. are known. The mentioned system, however, are faced with several problems: the majority of these leave the element absorbed in the concrete or product to be poured, giving up the recovery of these with the consequent loss, as well as the problem that it means as a point of corrosion the metallic piece that is exposed in the surface of the poured structure. The systems that incorporate faced cones run into the difficulty that bear the own placing of the cones, since the job must be un-

assembled in the interior of the two panels, etc.

The system offered by the inventor widely reduces this task since the conic gap keeper is introduced through the perforations existing in the metal sheets and the nut is placed on its end.

The length of the separator tie is the determinant of the thickness of the wall, adding to it the width "a_3" of the two panels and the length "r" of the thread. (screw)

After performing the pouring of concrete, the conic gap keeper is recuperated by making it turn slightly; its taper allows easy removal. The disposition of a tie after pouring of concrete and before disassembly of the mold is shown in Figure 14.

D. ADJUSTABLE TELESCOPIC STRUT

It is the system designed for the supporting panels placed to conform the molds of the roof.

The metallic bars are known to provide support to the structures or panels for the molds, but the strut of the present invention is provided with a thread over a cylindrical metal bar that confers the advantage of handling with milimetrical accuracy to obtain lengths with no error. In addition, it allows the mobility even if supporting high loads, since the rotation of the threaded axle is produced over a metallic screw fixed to the tube.

The bar is basically composed of two tubular bodies, placed in a telescopic manner and with regular perforations and coincedental, by which it is possible to penetrate a metallic pin that holds the two tubes in a fixed relationship.

On the opposed end of the mentioned of the thinner tube is a metallic threaded screw fixed on its interior part to which another cilindric element is also threaded and is provided of two or more arms to facilitate its manual rotation.

Joined to the tube of greater thickness is a base, the linkage being by means of an axle.

E. REINFORCEMENT BAR

A reinforcement bar which is a metallic profile of "U" shape provided of circular and regular perforations on both lateral ends as well as in the centre. The mentioned lateral perforations coincide in shape and dimensions with the ones pointed in our box dedicated to the standardized panels, to the perimetric platens, maintaining the same relation in diameters, as well as distances between centres and borders of metal sheet.

The referred reinforcement bar is used as an additional element of support in situations of critical load, as much in panels as in roofs.

In the case of walls of great thickness and great height, the reinforcement bar, is the part that directly receives the effort transmitted by the spacer ties since these pass through two of these profiles, placed contrarily joined to the panels of the mold.

The reinforcement bar is also subject to be used as an element of alignment and support in overhanging roofs as well as for the reinforcement of groups of panels with the object of giving greater solidity and facilitate their handling with mechanical means.

F. ALIGNMENT BAR

A metallic profile in "J" shape with perforations on its laterals, having dimensions of diameter, distances between centres and of similar edges to the ones described and existing in the perimetric flanges in the standardized panels.

The inventor has developed the mentioned profile to obtain a perfect alignment of the wall molds in which the mold for pouring roofs is not incorporated.

The profile is fixed to the superior perforations existing in the elements by means of screws, with which a perfect alignment is obtained.

G. HOISTERS

Hoisters are for the placing of the panels that conform the mold of roofs, or the ones assigned to walls

that due to their height the placing is difficult (for example, the walls of a two story housing).

The hoister shown in Figure 22 equipped in its front part of two fixed wheels 220 as well as handles 221 in the posterior part, in order to be able to handle it by one single person as a handtruck.

The frontal part incorporates a system of profiles 222 placed in a telescopic manner and a cable hoist 223 which is operable manually or by use of a molar. The hoist incorporates a system of lock to avoid sliding while in use.

In the end of the profile is pivot system 224 of fastening of panels tilting with a superior turn of 90°, which allow the rising of panels in a vertical form and then be subject to adopt a horizontal or inclinated position.

The hoister has reinforcements in the back part subject to be used as a ladder and as a work platform.

H. STABILIZERS FOR WALLS

This accessory, is an adjustable mechanism used to fix and maintain the verticality of the molds of the walls, when these are poured without molds for the roof.

Consists of a base-platform with a threaded axle joint in a vertical manner with a handle on the ends. The joint of the threaded axle and base platform are articulated in such a manner that allow the rotation of the threaded axle. Joined to a screwed bolt in the mentioned threaded axle is a metallic profile at which end is a platen with a circular perforation. To the same metallic profile is joint another profile by means of an articulated joint that also has a platen perforated on its end.

The stabilizers, by means of the perforated flanges, are joined to the panels of the mold, and driving the handle in a circular movement manner allows the placing of the mold of panel in any position desired.

I. FRAMECOVERS FOR DOORS AND WINDOWS

Figure 21 shows laminar profiles to hold the frames for doors, windows, etc. in the interior part of the mold.

In addition, they counteract the pressure excerted by the concrete or product to be poured in the interior of the mold, therefore avoiding the deformation of the frames.

The framecovers are shaped so as to have an area 118 deformed from the plane of their exterior ends and have circular or elliptic perforations 119 in their exterior ends, complying the same specification that the panels of the mold to which they are joined.

J. DOOR DIVIDERS

An accessory that is placed in the inferior part of the spaces assigned to the doors, joining the faced sides of the door trims. Its function is to guarantee the fidelity of the space assigned to the door, since its placing prevents that the space is not distorted, and avoids any possible displacement of the panels of the molds.

The divider has tubular element having an oblique cut in its middle section to facilitate the retrieval once the pouring is done. At ends are shaped profiles shaped to fit around door frame covers.

K. FOUNDATION SLAB PANEL

For the pouring of the bases of the structures where the molds are to be mounted, if these were needed, or for the pouring of concrete or similar, in the formation of floors and foundations, that do not imply high thicknesses, the inventor has designed a special panel.

The mentioned panel is formed by a metallic panel in "L" shape with platens perpendicularly joint in their ends and in each one of the internal angles. These platens have circular perforations that allow the union of the panels among each other. In order to be fixed to the foundation of the floor, the panels have circular perforations on one of its sides, and aligned to these platens with perforations.

L. GROUND PATTERNS

In the observance of the construction of structures in series, the inventor has developed a system that facilitates the preparation of the construction, as well as the accuracy; eliminating at the same time the needs for instru-

ments of measure.

The ground pattern, that must be prepared individually for every project to be performed, consists in a tubular structure 204, 205 joined by metallic elements 206, which exactly reproduces the ends of the horizontal projection of a construction.

Per each one of the lines of the end of vertical projection, a tubular structure is placed and reproduced exactly, and at 1:1 scale, the mentioned production; each one of the sides are joined to the other by means of laminar platens placed regularly at a certain distance.

All the ends of the tubular structure are provided hooks 207 that will serve to support the body of the pattern over the panels of the mold of the floor.

The ground pattern eliminates the need of taking measures for the exact placing of the structure to be performed. In addition, allows that when performing marks and signals over the pattern, indicate exactly the location of any type of service (electricity, plumbing, etc.). Of course, it points out the perfect placing of the walls and the structure to be construed, since it reproduces exactly the horizontal projection of the walls.

C L A I M S

1. A building system of use in the construction of monolithic structures which comprises an assembly of metal mold elements each mold element having a face portion and flanges around the periphery of said face portion, said assembly comprising at least one mold disassembly facilitating piece selected from:

a) an L-shaped member of such dimensions that the base of the L-shape can be placed beneath the flange of the lowest metal mold element when said mold elements are assembled to form a mold for one face a wall, the upright of the L-shaped member being disposed outwardly from the surface forming the face of the mold; and

b) at least one of said mold elements having at least one flange which is disposed at an angle which is other than perpendicular to the face portion.

2. A system according to claim 1, wherein at least one of said mold elements having a flange disposed at an angle other than perpendicular to the face portion is an element wherein the face portion is in the shape of a Greek cross and the angle between the flanges and the face portion is less than 90°.

3. A system according to claim 2, wherein said Greek cross shaped element is employed as part of the mold for the roof of a monolithic structure and is secured to other mold elements having at least one flange disposed at an angle which is other than perpendicular to said face portion, the arrangement of said mold elements being substantial, as shown in Fig. 19 hereof.

4. A system according to claim 1, 2 or 3, wherein there is provided for each door opening in the assembly a door spacer to maintain the correct spacing of the mold elements for the opposite sides of the door during the pouring of a castable material capable of hardening to form a load-bearing structure.

5. A system according to claim 4, wherein a door frame for the structure to be cast using the assembly is prepositioned in the mold assembly.

6. A system according to claim 1, 2 or 3, wherein a window frame for the structure to be cast using the assembly

is prepositioned in the mold assembly.

7. A system according to claim 6, wherein the window frame is suspended from spacer pieces which are attached to the mold elements constituting the mold assemblies for each of the faces of the wall within which the window frame is to be incorporated.

8. A system according to claim 1, 2 or 3, wherein mold assemblies for the opposite faces of a wall are held apart by spacer ties.

9. A system according to claim 8, wherein said spacer tie is tapered.

10. A system according to claim 8, wherein said spacer tie has a screw end and is used in conjunction with a nut on one face of which is provided with a projection extending in the direction parallel to the axis of the nut.

11. A kit of parts for use in the construction of monolithic structures which comprises metal mold elements, each mold element having a face portion and flanges around the periphery of said face panel said kit of parts comprising at least one mold disassembly facilitating piece selected from the following

a) an L-shaped member of such dimensions that the base of the L-shape can be placed beneath the flange of the lowest metal mold element when said mold pieces are assembled to form one face of a wall and

b) at least one of said metal mold elements having at least one flange disposed at an angle which is other than perpendicular to the face portion.

12. A kit of parts according to claim 10, wherein at least one of said metal mold elements has a face portion in the shape of a Greek cross and the angle between all of the flanges and the face portion of the mold is less than 90°.

13. A kit of parts according to either claim 11 or 12, which further comprises a door spacer element.

14. A kit of parts according to either claim 11 or 12, which further comprises a spacer tie.

15. A kit of parts according to claim 12, wherein said spacer tie is tapered and has a screw thread of the end thereof.

16. A kit of parts according to claim 15, wherein there

is provided for each spacer tie a nut having a flange on one face thereof, said flange extending in a direction parallel to the axis of said nut.

17. A kit of parts according to claim 14, wherein at least some of said metal mold elements being provided with at least one hole through the face portion through which a spacer tie may be inserted.

18. A metal mold element having a face portion in the shape of a Greek cross and having flanges around the edge thereof said flanges being provided with holes through which bolts or screws may be passed to secure said element in use to adjacent mold elements and being disposed at an angle of less than 90° to said face portion.

19. A spacer tie having a tapered cross section and a screw thread in combination with a nut screwable onto said screw thread, said nut being provided with a flange on one face thereof said flange extending in a direction parallel to the axis of said nut.

20. A kit of parts for use in construction of a mold for use in the production of monolithic structures comprising metal mold elements said elements having face portions and flanges welded to said face portion along each edge thereof, said flanges, in the case of mold elements when the flange is at 90° to the face portions being of uniform size and being provided with holes through which bolts or screws may be inserted in use to secure adjacent mold elements to each other said holes being disposed at the mid point of the external distance from the face of the mold element to the edge of the flange on all such mold pieces and being spaced equal distances apart on all mold elements, the distance for each corner of the mold the first hole on each flange being one half of the distance between adjacent holes the external dimension of each flange which is disposed at 90° to the base being one half of the distance between adjacent holes on a flange.

21. A kit of parts according to claim 20, wherein said holes are circular in the case where the angles at the corners of the periphery of the face portion are 90° and are elliptical

in the case where the side in question makes an angle other than 90° to its adjacent sides or where the face portion is not flat, the minor diameter of the minor being the same dimension as those of the circles and the mid point of said minor diameter being at the mid point of the external distance from the face of the mold element to the edge of the flange.

22. A ground pattern for use in the construction of monolithic structures which comprises a metal reproduction of the floor plan of said structure, including any internal walls on a 1:1 scale, the outer portions of said pattern being provided with hooks whereby said ground pattern may be suspended on mold elements used to pour a foundation slab for said structure.

23. A self centering screw and nut combination where the end of the screw and a projection or the nut surrounding the screw hole therein are both in the form of truncated cones.

24. A method for the construction of structures wherein a foundation slab is laid of castable material which is hardenable to form a load bearing structure and thereafter a metal ground pattern reproducing the floor plan of the structure on a 1:1 scale is suspended above the foundation slab and the positions of walls, utility conduits and the like is marked on to said foundation slab from the metal ground pattern.

25. A method of constructing a structure wherein building system according to claim 1 is assembled on a foundation slab and a castable material hardenable to form a load bearing structure is poured into mold assembly formed by said system and the mold assembly is thereafter disassembled.

26. A method of combination according to claim 25, wherein said foundation slab has been marked with the positions of walls utility conduits and the like by suspending thereabove a metal ground pattern which reproduces on a 1:1 scale the floor plan of the structure.

27. A method of constructing a structure according to claim 24, wherein the structure comprises a roof and the mold for the roof comprises a mold element in the shape of a Greek cross having flanges which are at an angle of less than 90° to the face portion of the element.

28. A method according to claim 27, wherein a strut is used to support such a Greek cross-shaped element and this element and the strut are left in place after rest of the mold is disassembled.

29. A method according to claim 28, wherein said strut is mounted on a screw base so as to permit rotation of the strut if required.

30. A method according to claim 25, 26, 27 or 28, wherein disassembly comprises removal of an L-shaped member form beneath the lowest mold element of a wall before removal of the elements constituting the mold assembly for that wall.

31. A method according to claim 25, 26, 27, 28 or 29, wherein disassembly comprises removal of mold elements having at least one flange disposed at an angle of greater than 90° to the face portion before removal of mold elements wherein the flanges are perpendicular to the face portion.

32. A hoister useful in the assembly of a mold comprising a frame which is extendible vertically and of which a carrier element adapted for the mounting of mold elements can be hauled, said carrier element being rotatable at the top of said frame so as to pivot the axis of said carrier element from a vertical to a horizontal position.

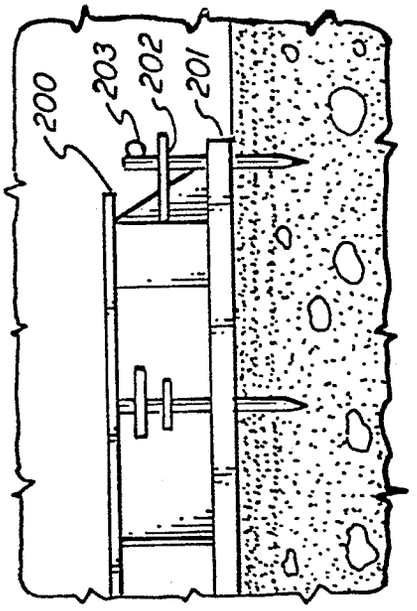


FIG. 2

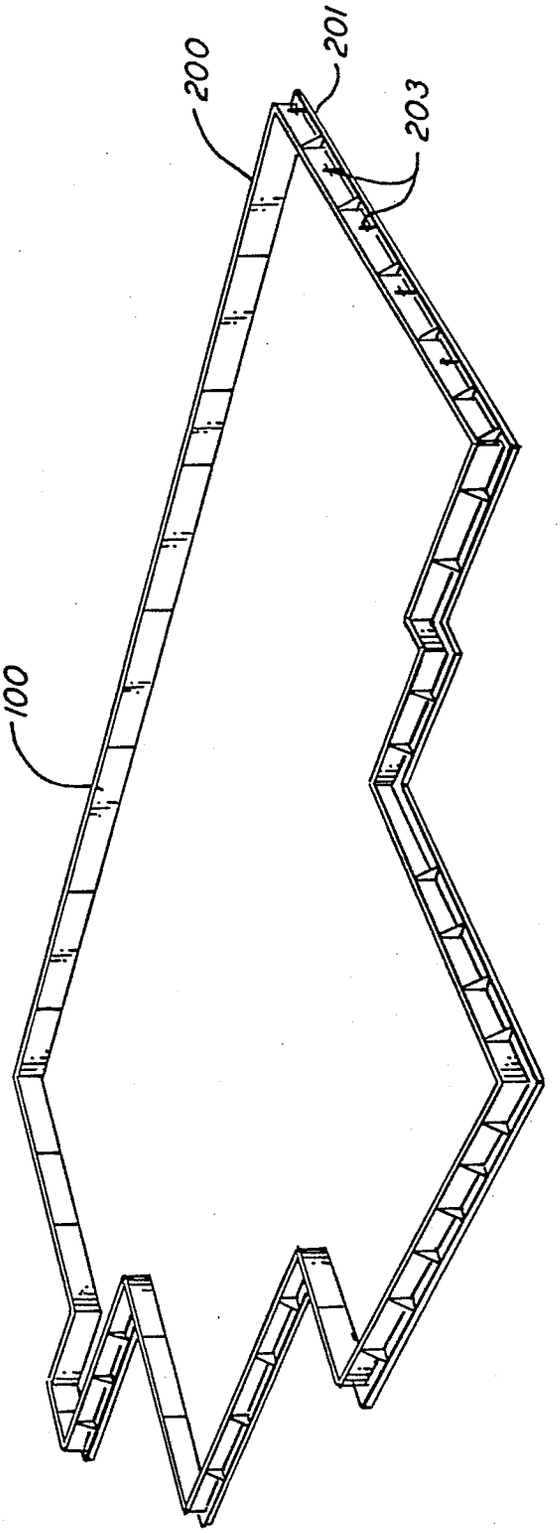


FIG. 1

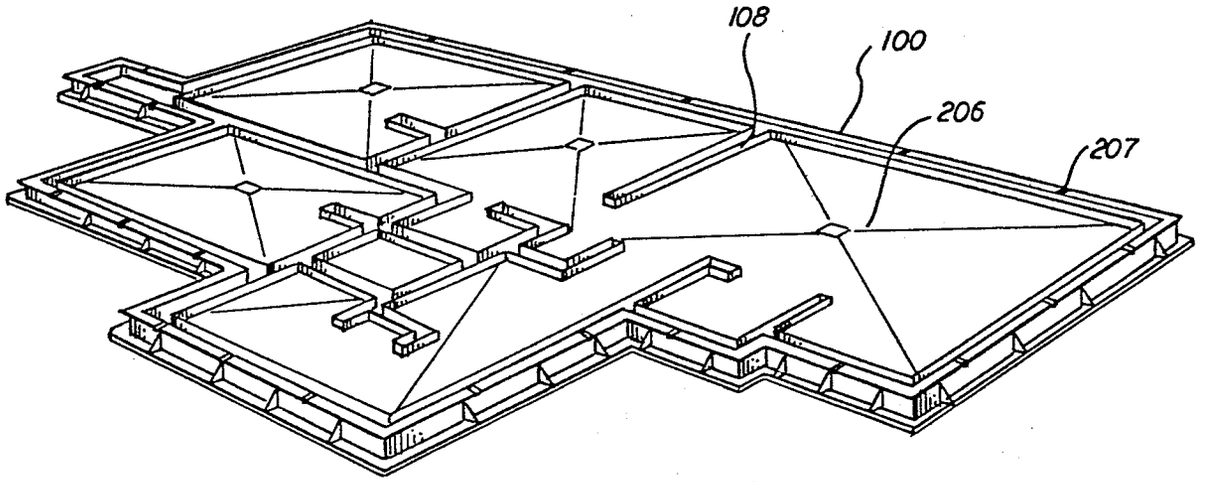


FIG. 3

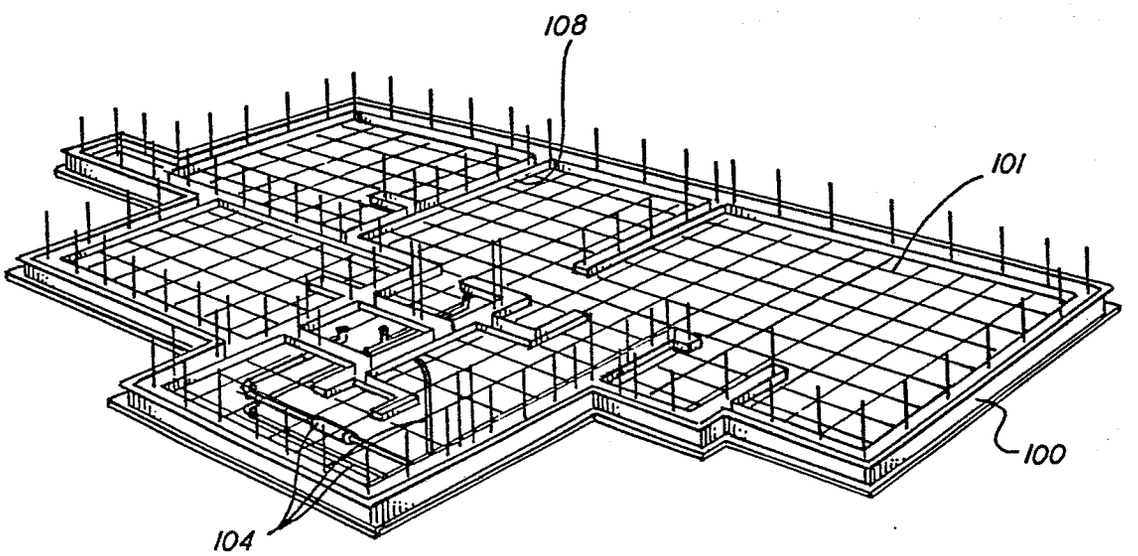


FIG. 4

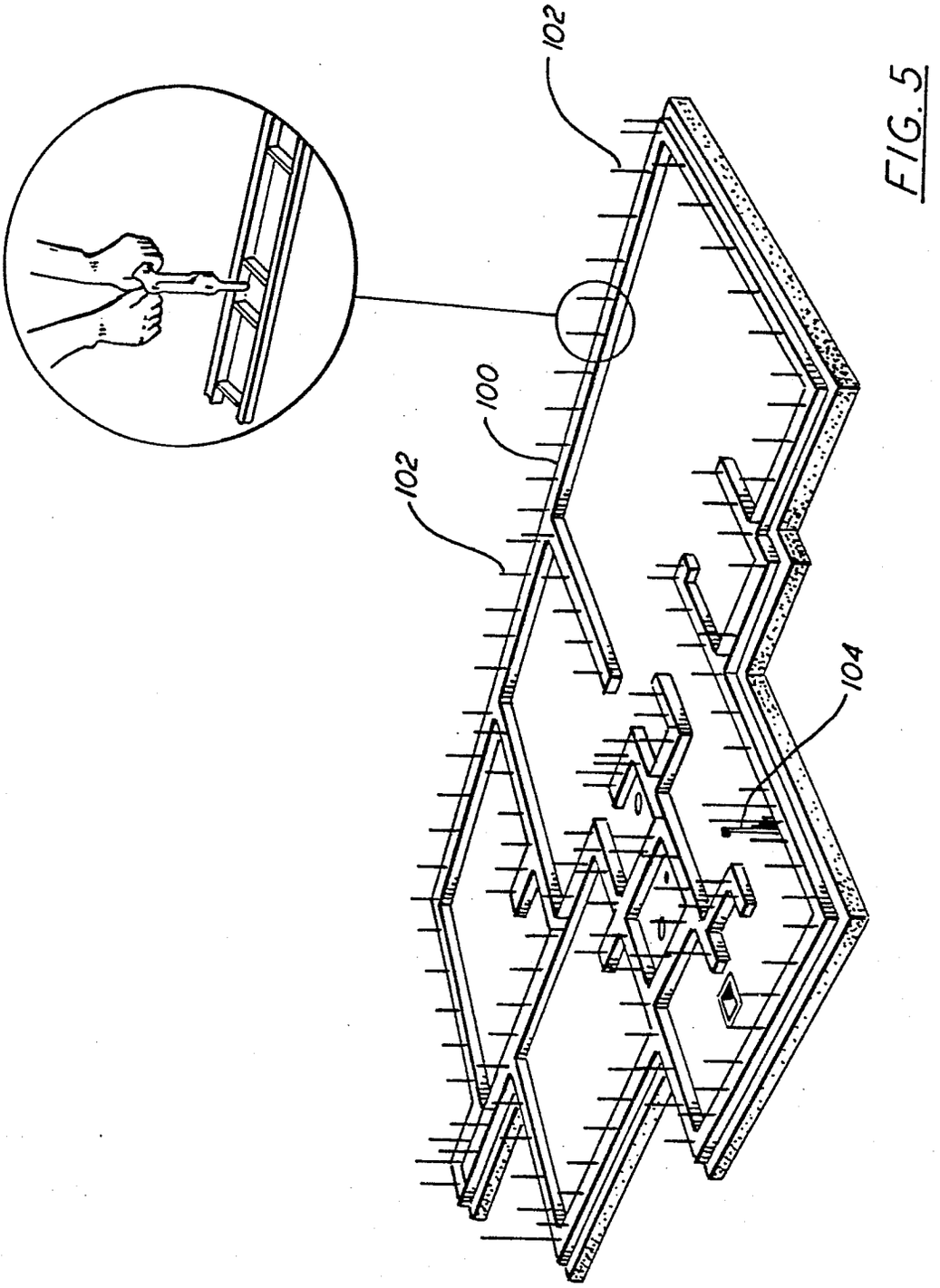


FIG. 5

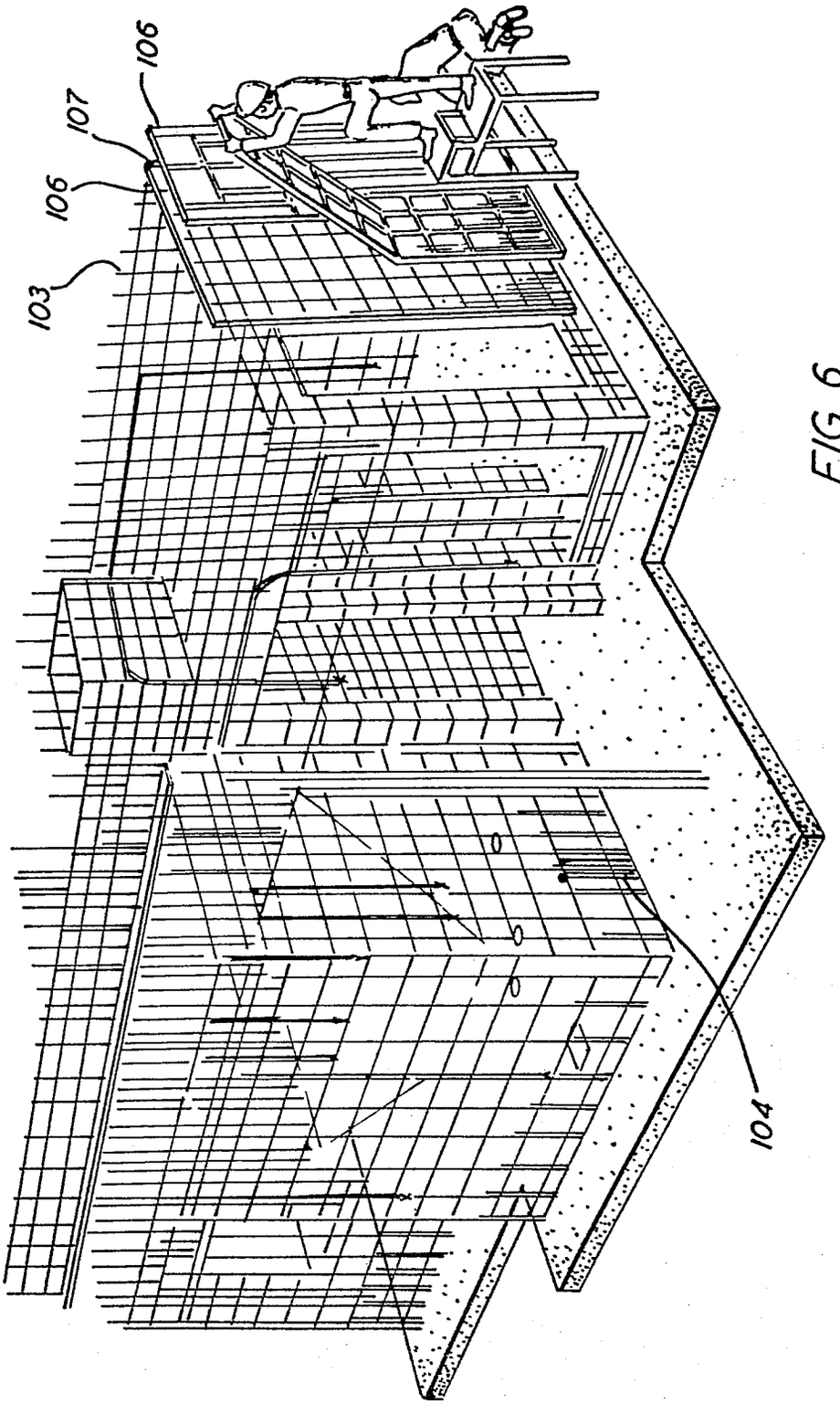


FIG. 6

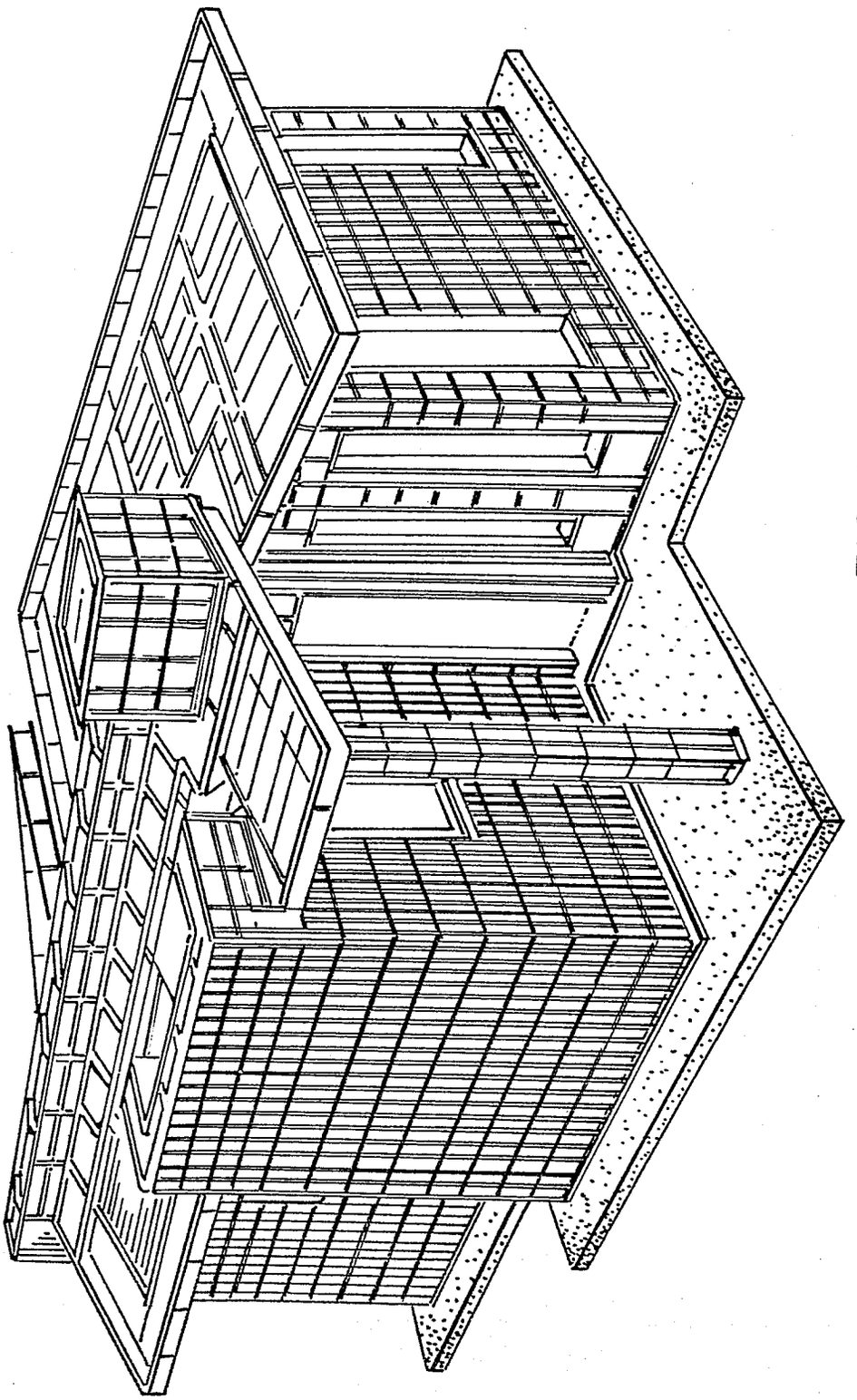


FIG. 7

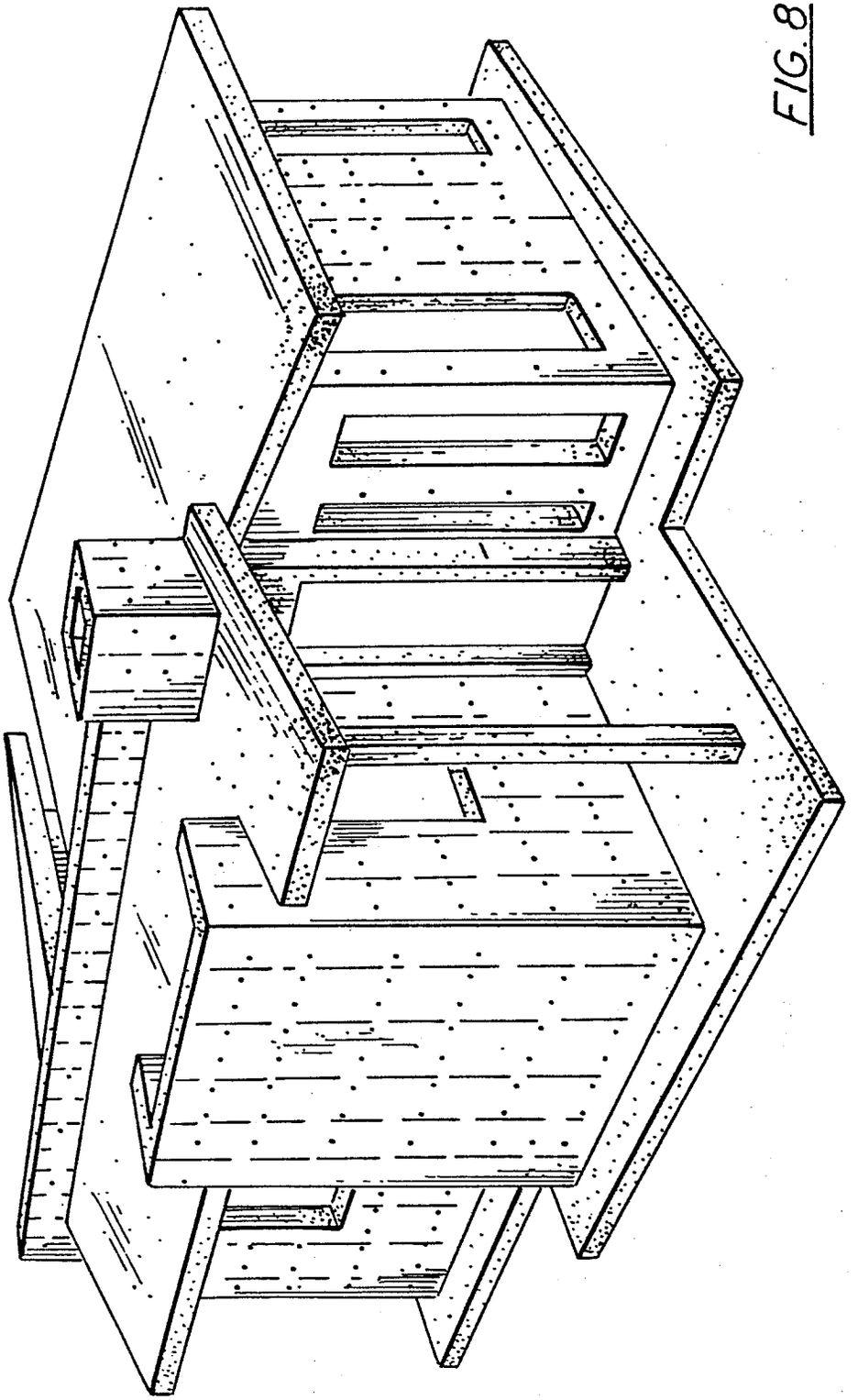


FIG.8

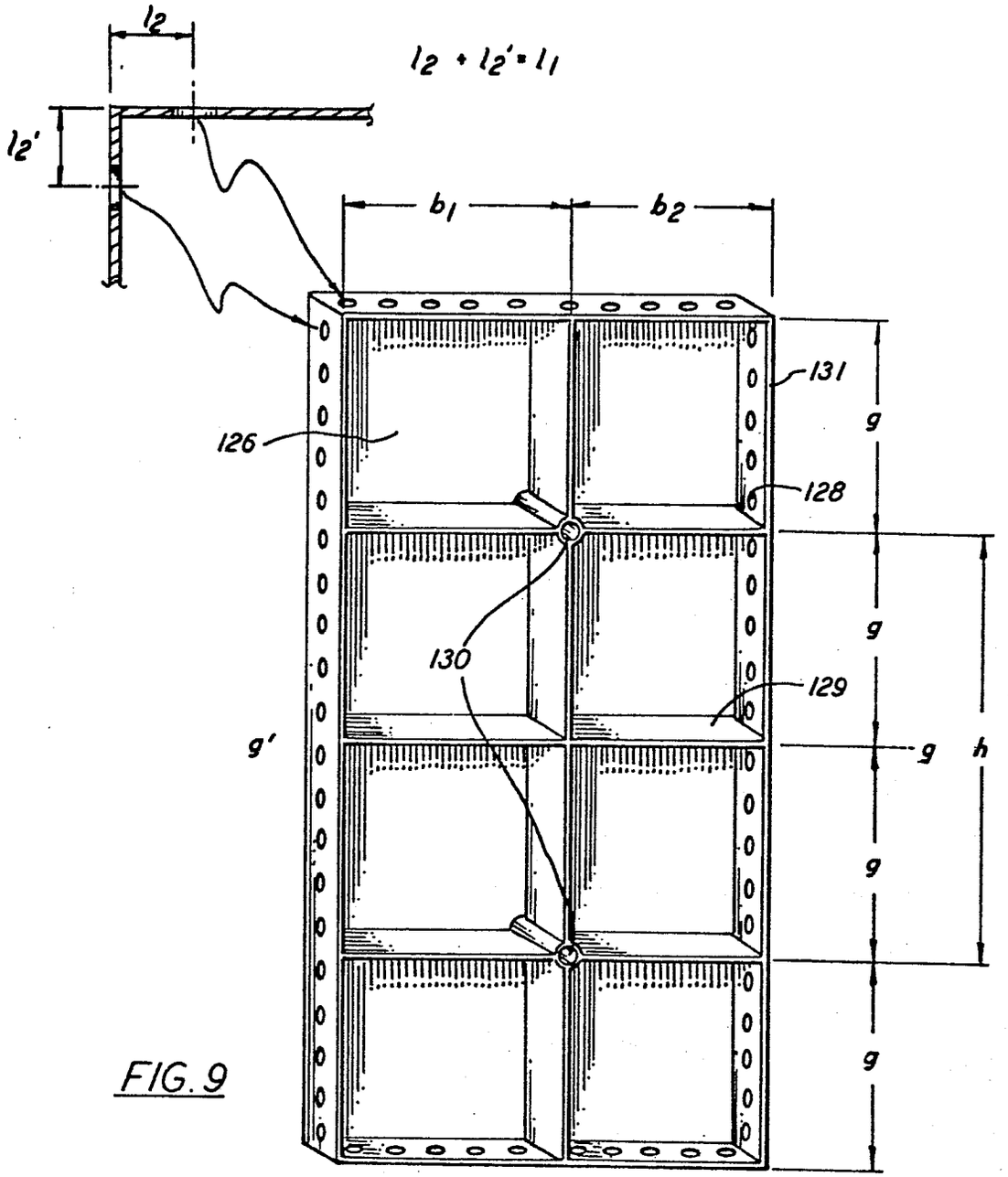

l2
l2 + l2' = l1
l2'
b1
b2
131
126
128
g
130
129
g'
h

FIG. 9

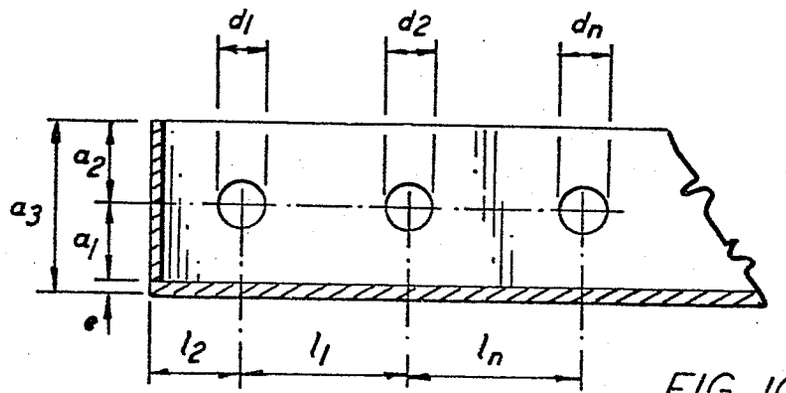

d1
d2
dn
a2
a3
a1
e
l2
l1
ln

FIG. 10

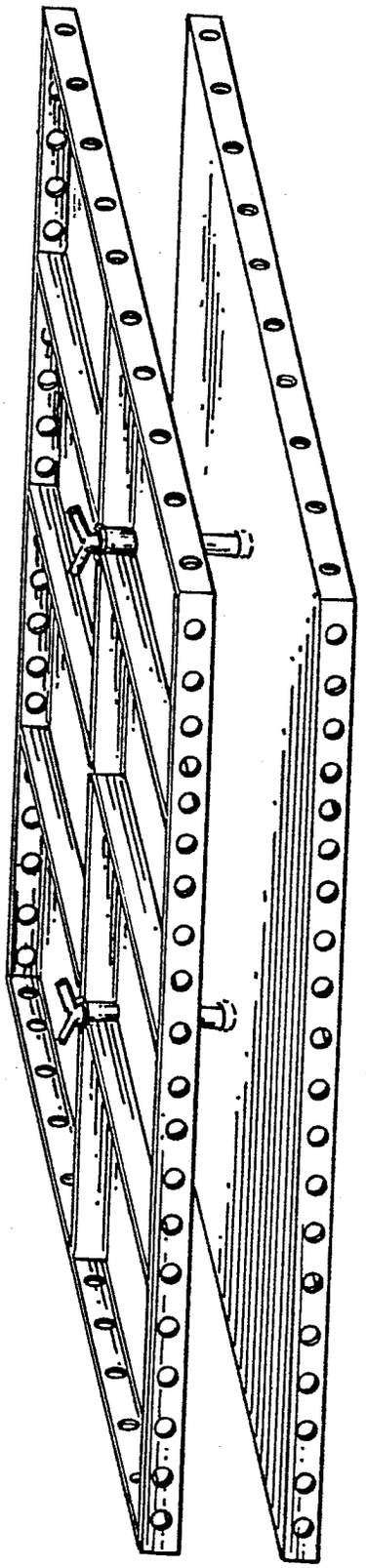


FIG. 11

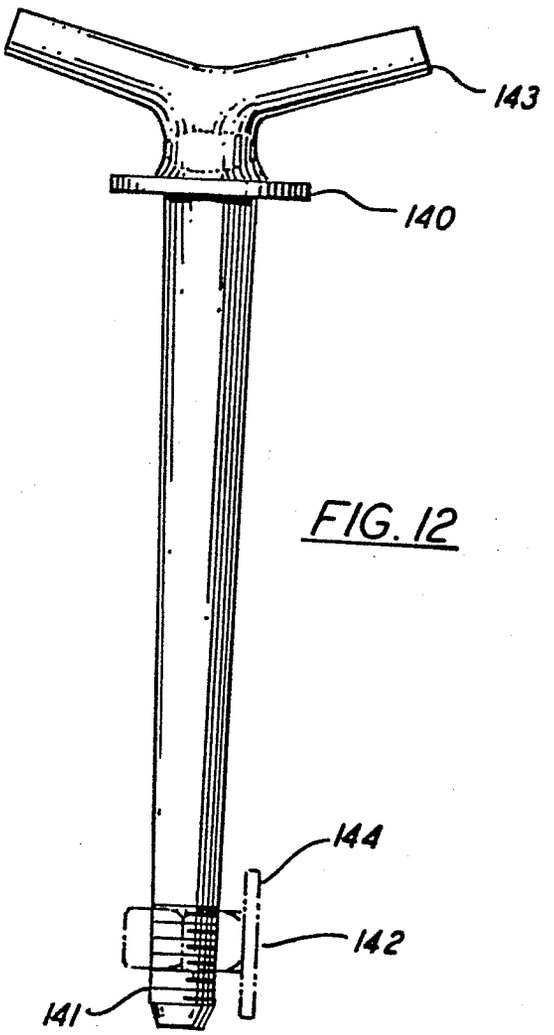


FIG. 12

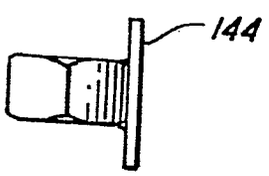
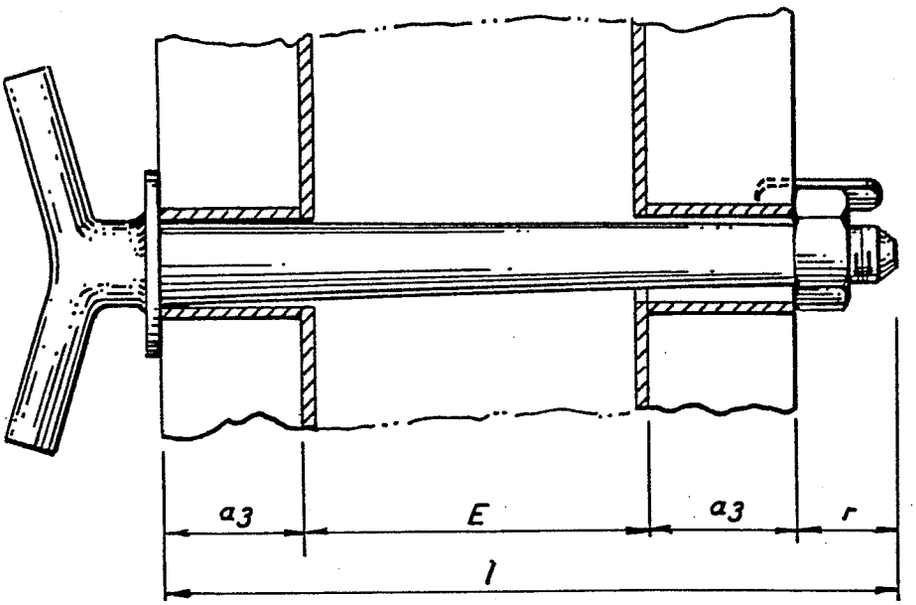


FIG. 13



$E = l - (2a_3 + r)$

FIG. 14

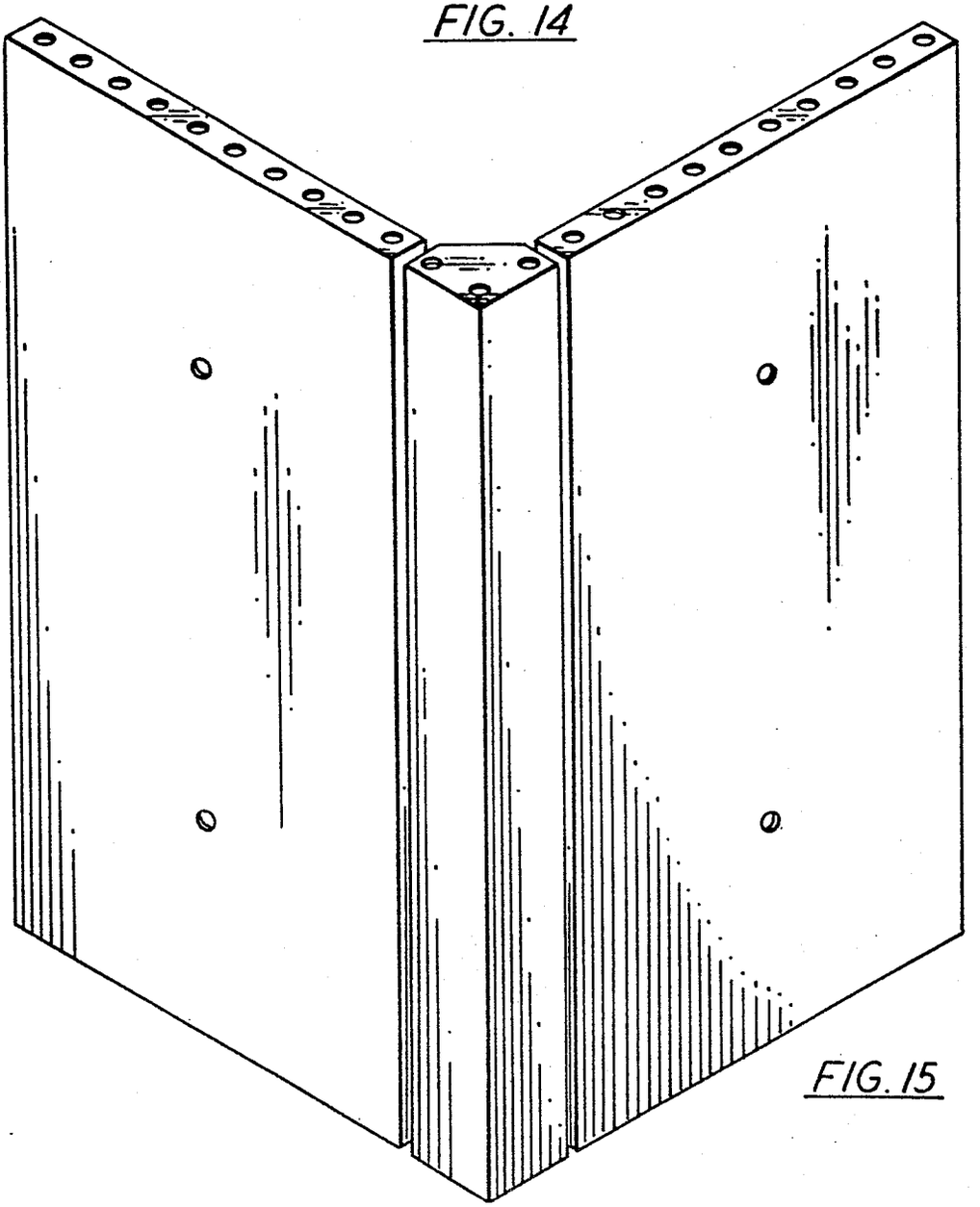


FIG. 15

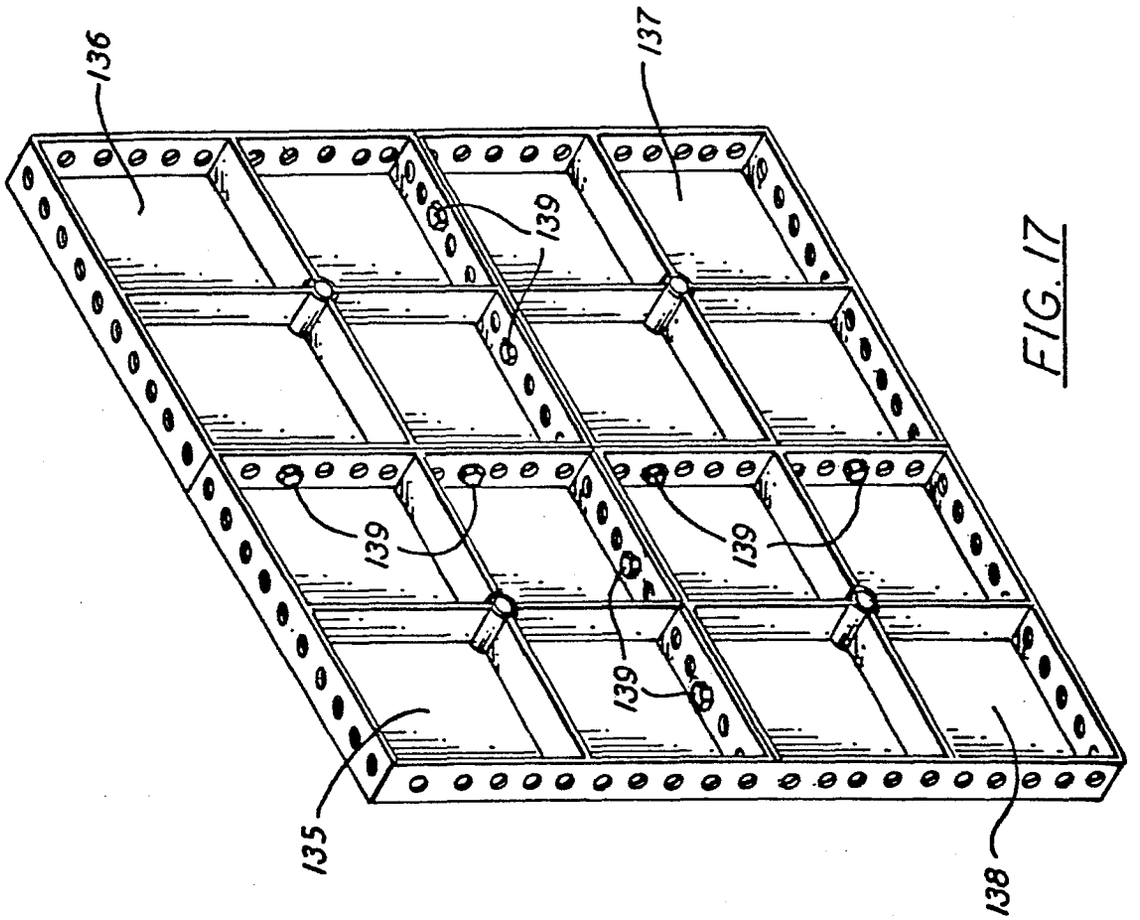


FIG. 17

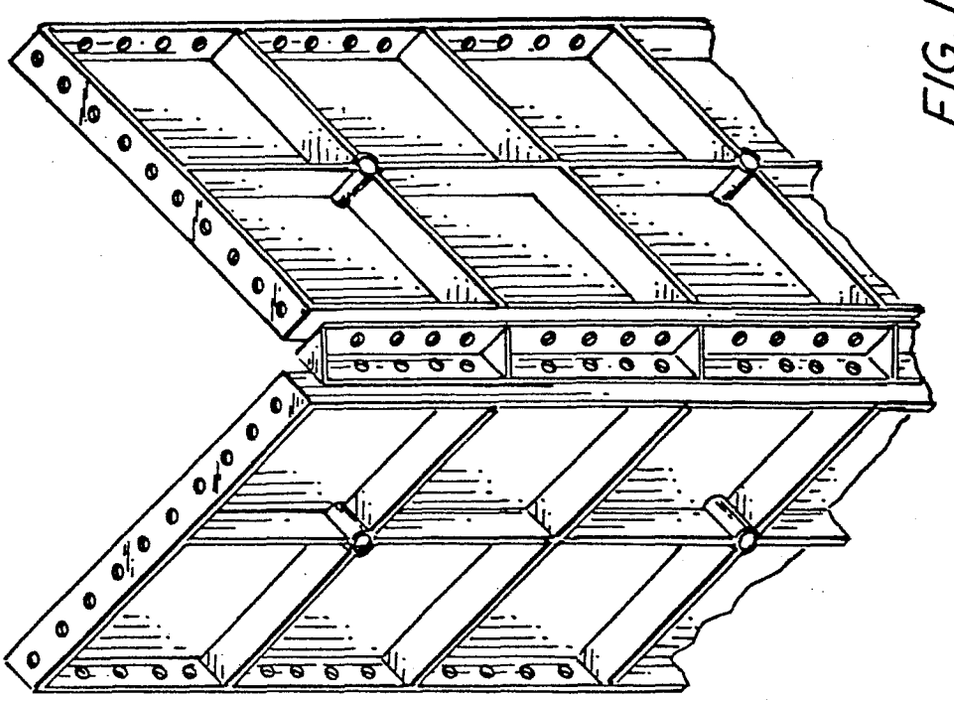


FIG. 16

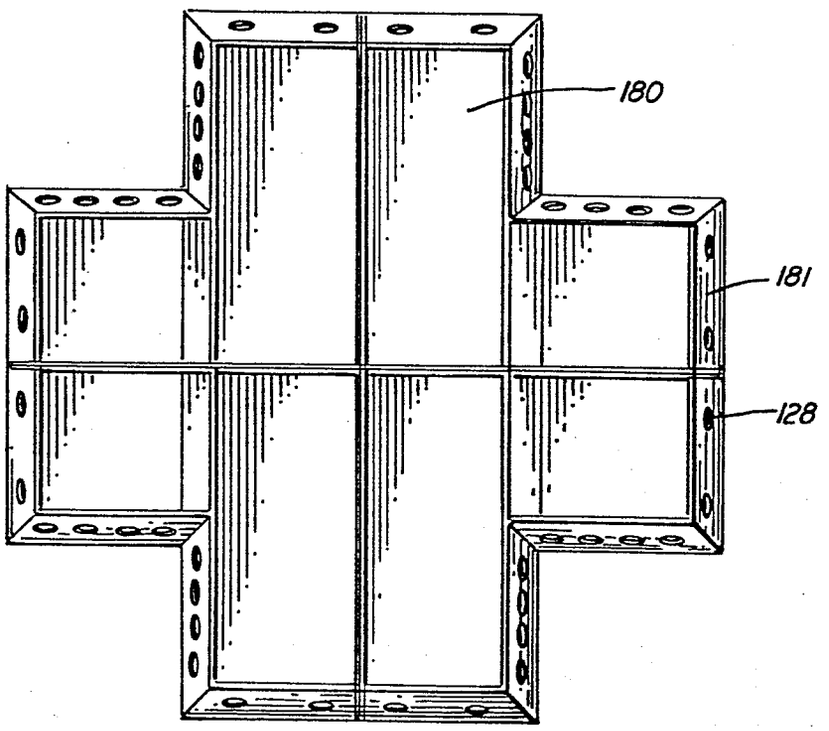
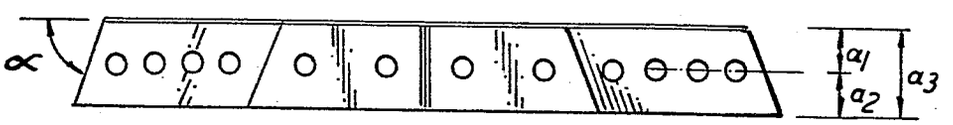


FIG. 18



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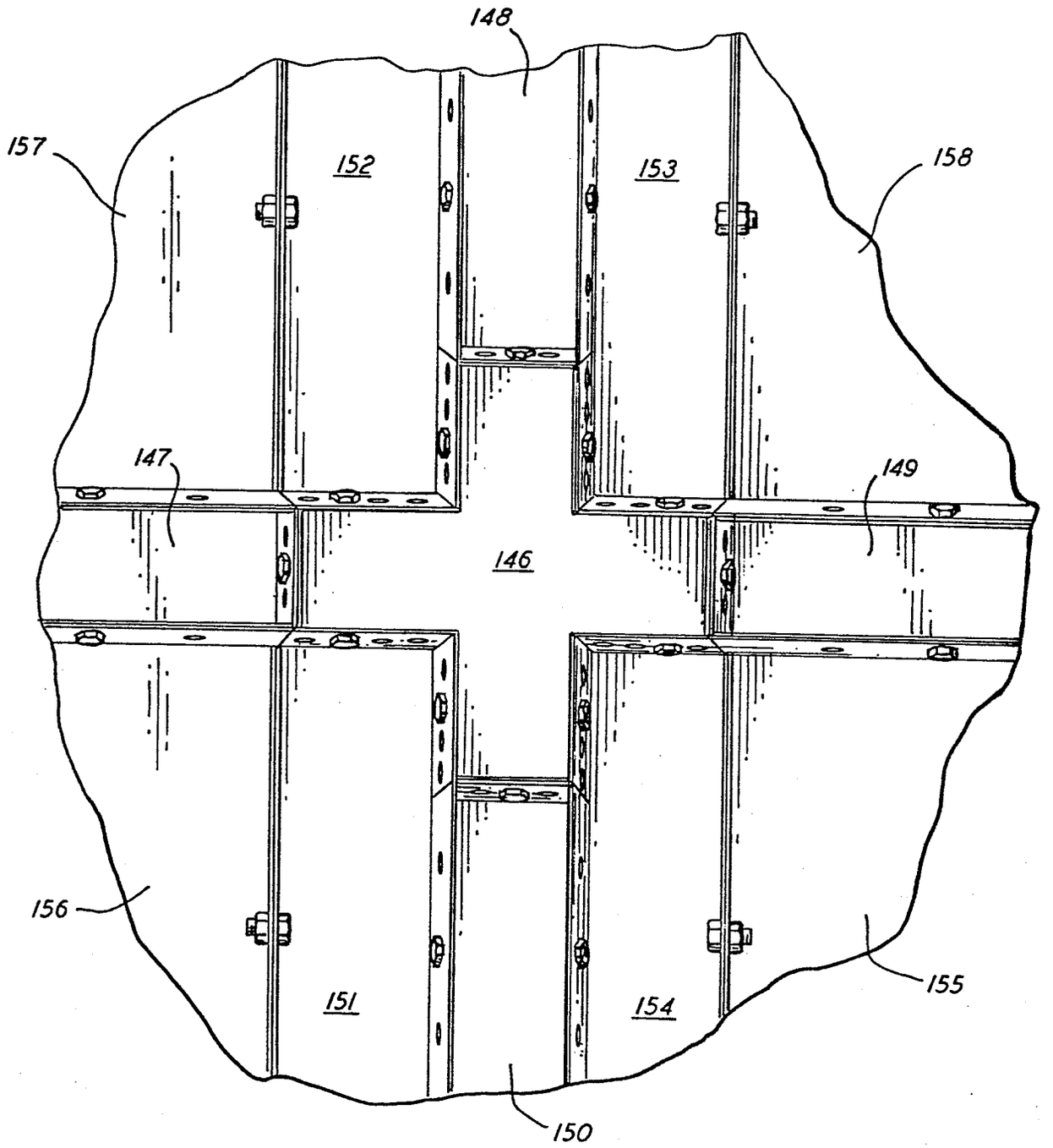

FIG. 19

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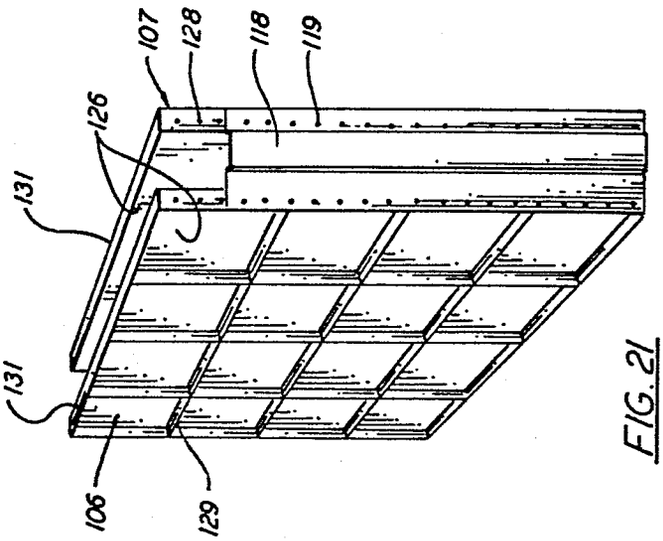

FIG. 21

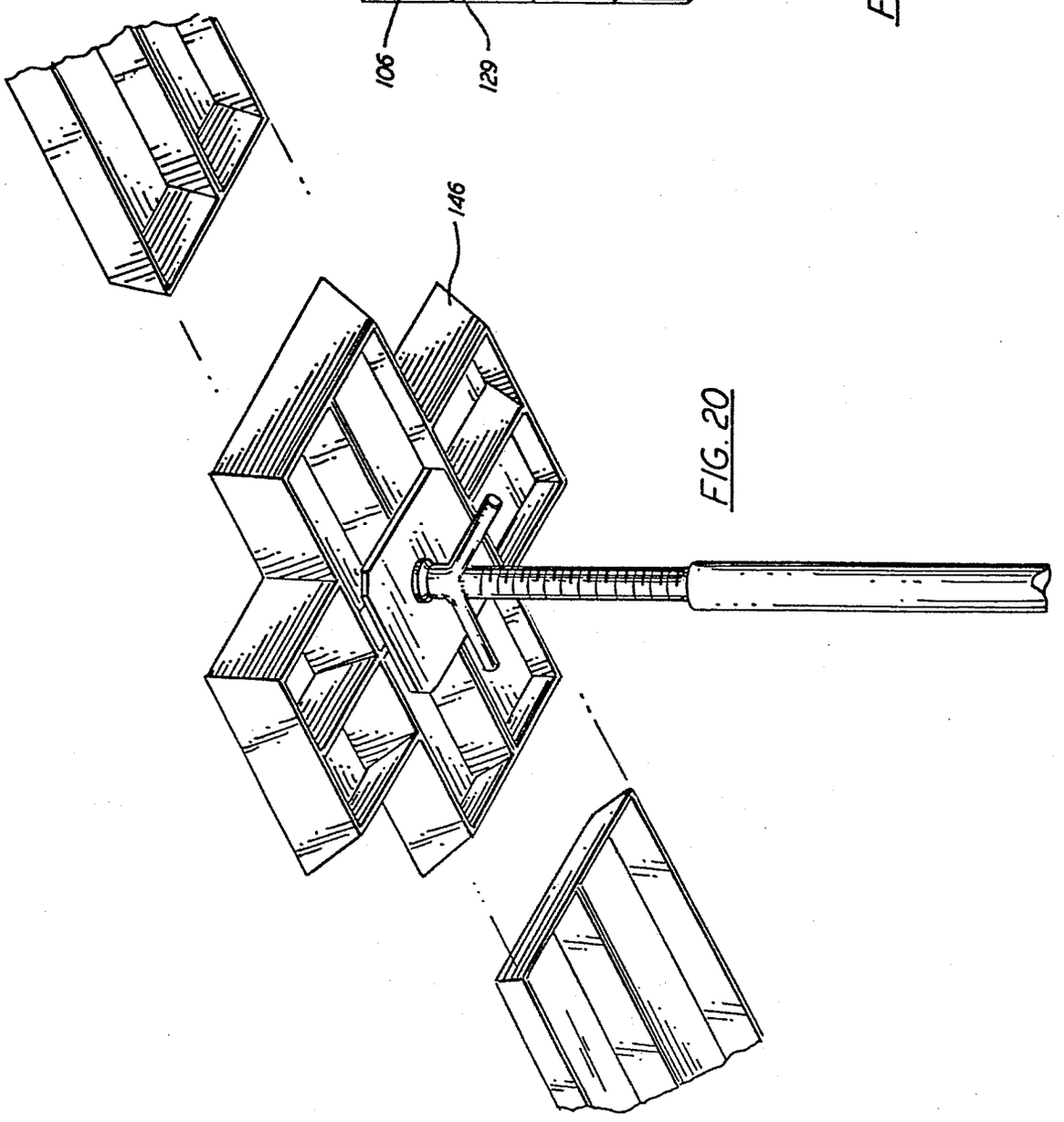

FIG. 20

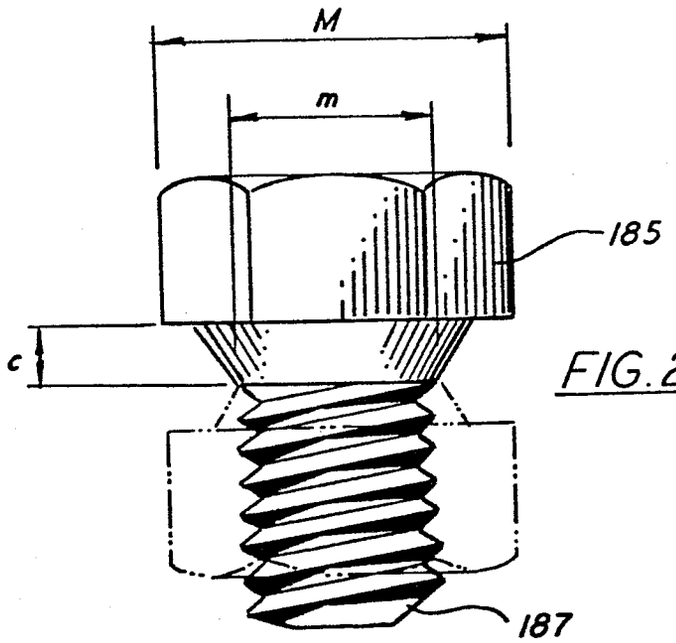

FIG. 23

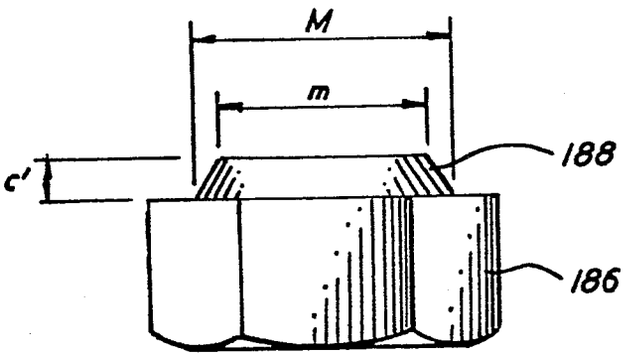

FIG. 24

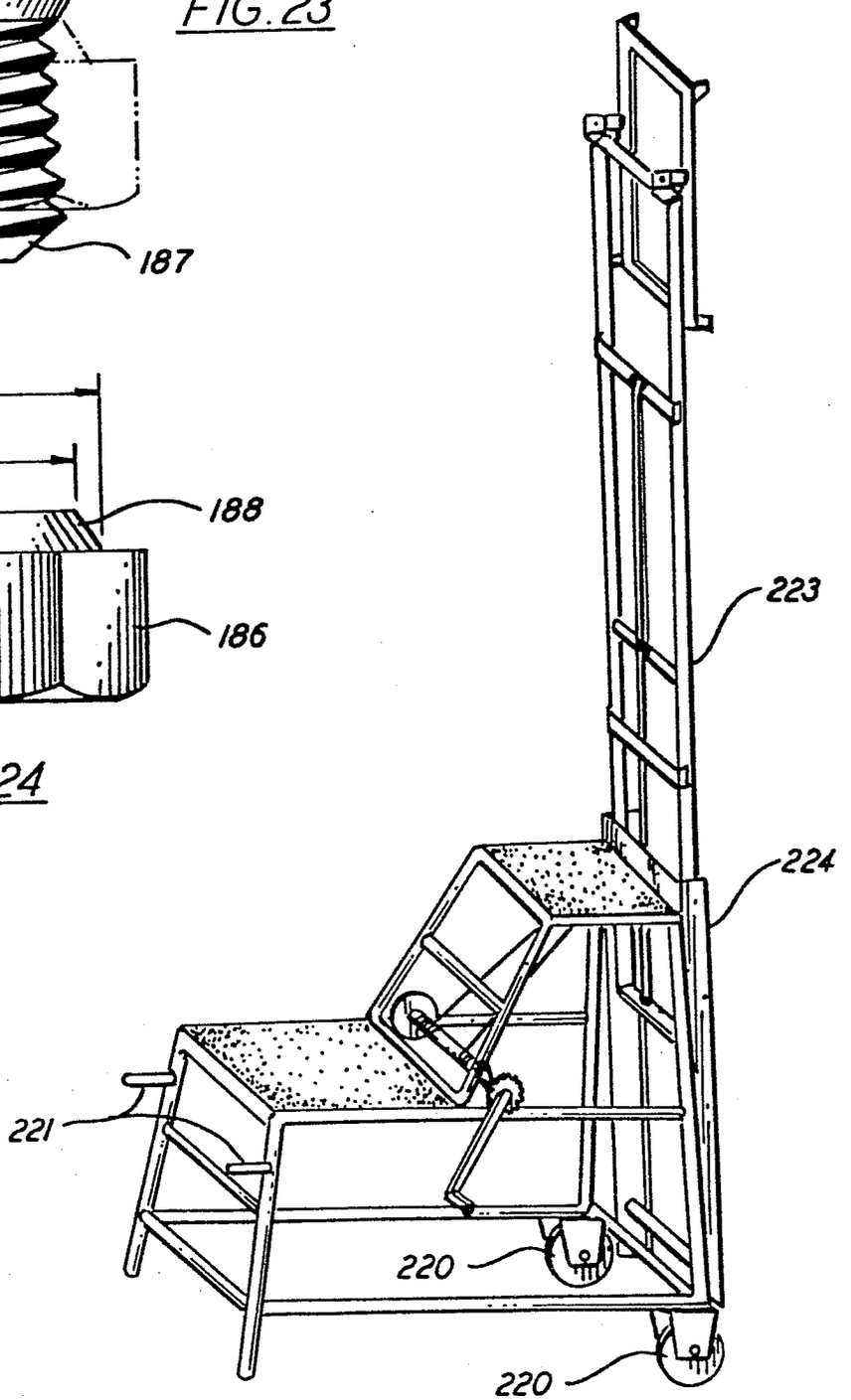

FIG. 22

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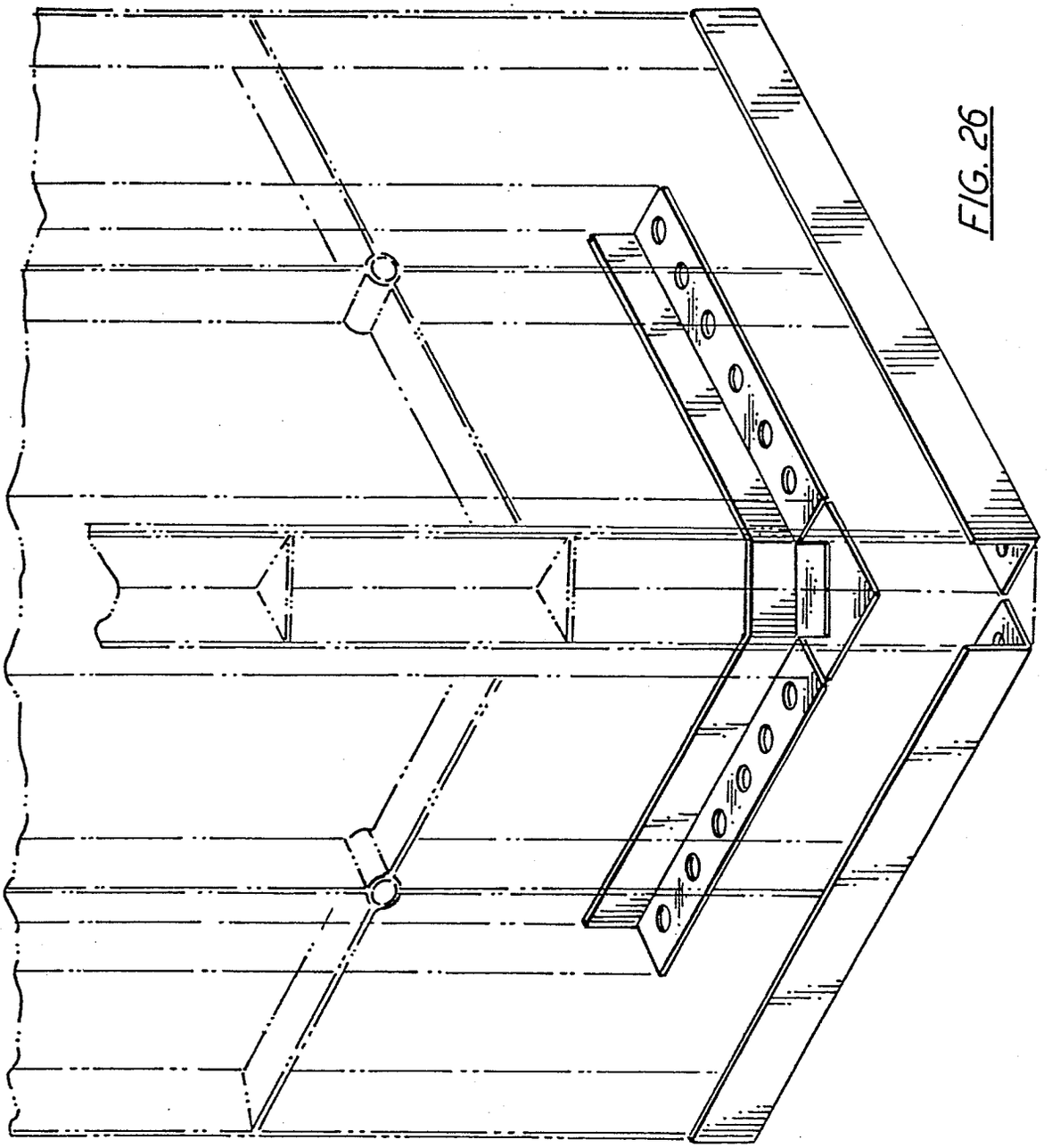

FIG. 26

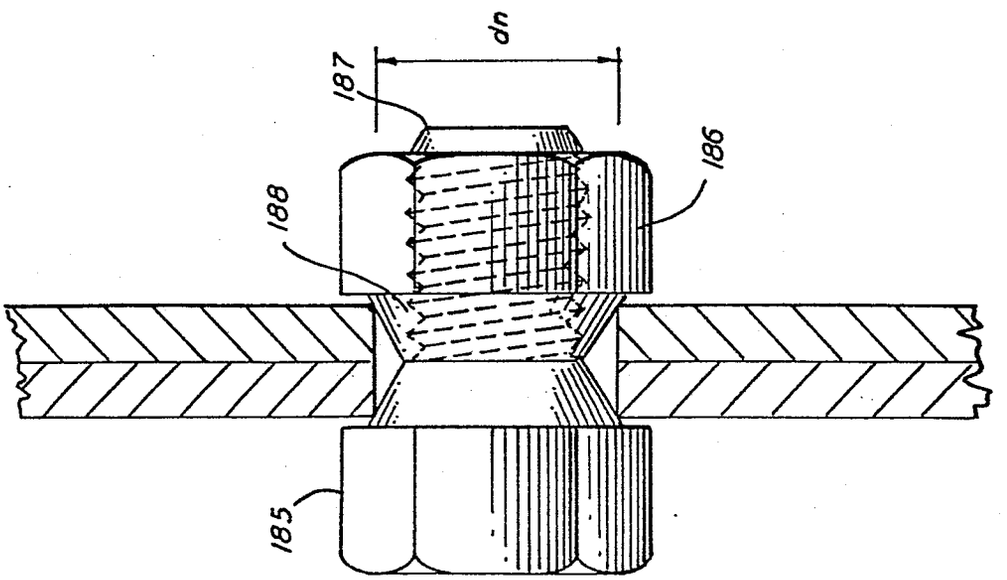

FIG. 25

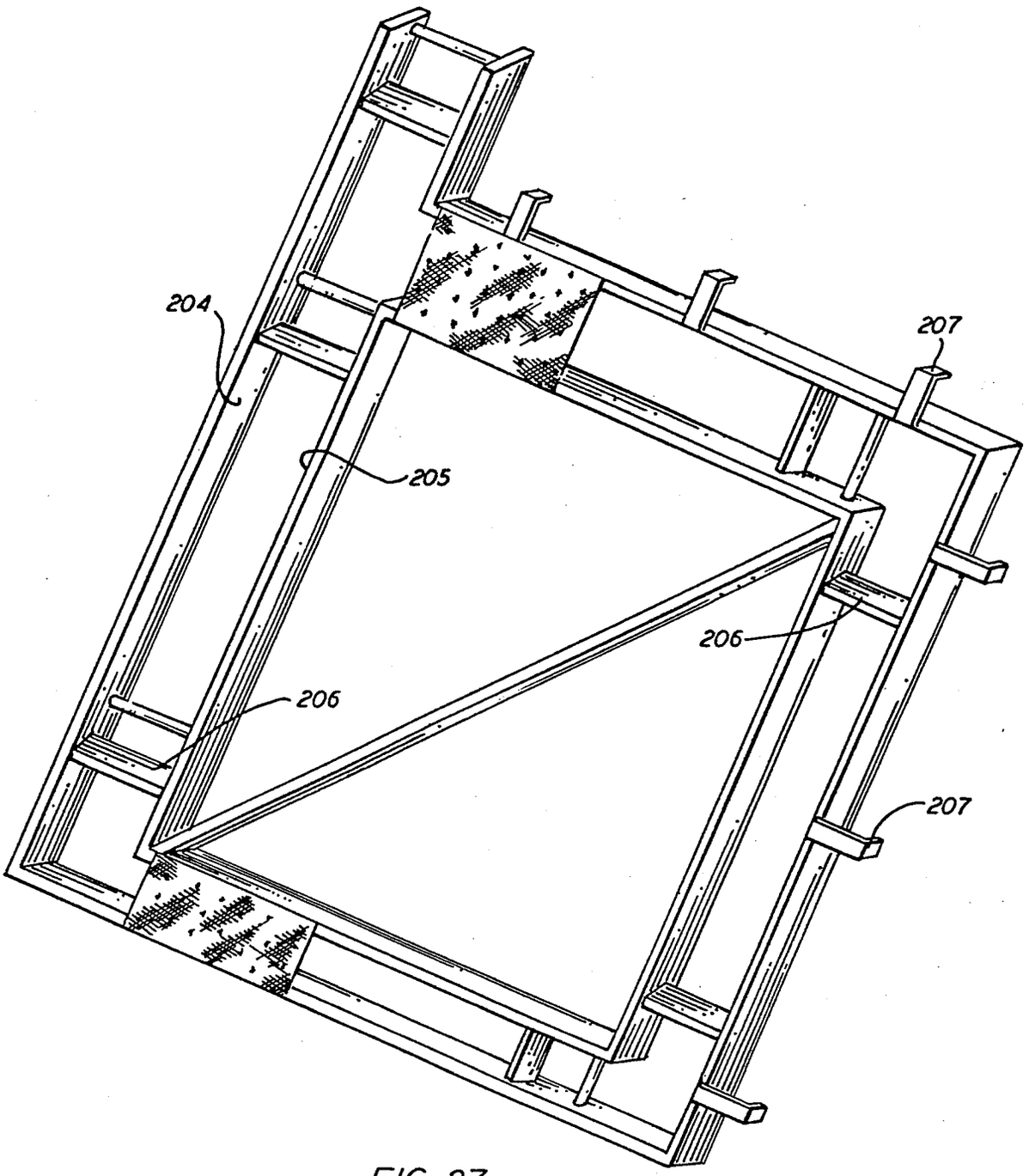

FIG. 27