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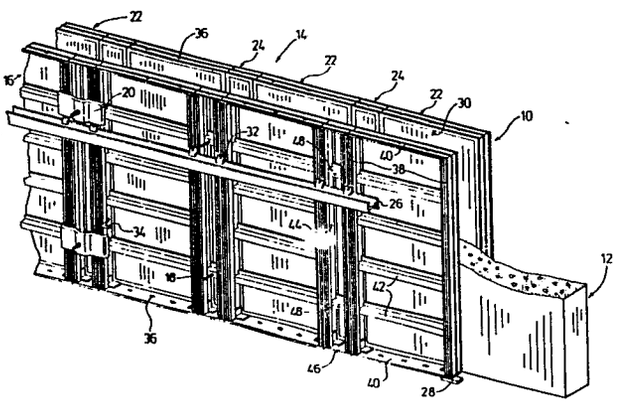
## (54) Concrete forming structures.

(57) Panel framework for supporting panel sheeting used in concrete forming structures (10), such as structures for supporting poured concrete in forming floors and walls. The framework comprises a perimeter frame of spaced parallel siderails (38) and endcap rails (40) with a plurality of spaced rigid cross-members (42) within the frame. The endcap rails (40) and cross-members (42) are mechanically secured to the siderails (38) to provide for replacement of components of the framework. The cross-members (42), as mechanically secured to the siderails (38), support the panel sheeting when affixed to the framework and used in forming concrete. In assembling panels for forming walls, tie member panels may be used where the wall form panels (22) are connectable to one another and to the tie member panels. The panels (22) are all of the same depth and have uninterrupted abutting edges, thus when interconnected, provide a substantially planar continuous frontwall face against which concrete may be poured without concrete leaking through the connections. The rear edges of the panel rails also all lie in substantially the same plane. Tie members (18) span the opposing tie member panels and are arranged and so connected to the opposing wall arrangements to hold them in their predetermined spaced-apart relationship after concrete is poured between the wall arrangements. Reinforcing members may be used with the tie members and clamped against the panel rear edges to reinforce the wall arrangements.

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# Concrete Forming Structures

This invention relates to concrete forming structures and panels used in such structures.

In the field of concrete forming, many advances have been made in replacing and improving the use of wooden structures in forming concrete walls and floors. One improvement has been realized in the use of prefabricated panels which are interconnectable to provide a surface onto or against which concrete may be poured. Examples of such form work are disclosed in United States patents 3,130,470, 3,399,859, 3,862,737 and Canadian patents 605,806 and 798,239. These patents disclose the use of various types of metals used in making the components, which are welded together to form the individual panel framework to which plywood sheeting may be affixed. For example, United States patent 3,130,470 and Canadian patent 605,806 disclose the use of steel members in forming the framework, whereas United States patent 3,862,737 discloses the use of aluminum in forming the structural components of the frame. Aluminum is advantageous, because its lightweight usually provides a more readily manageable wall forming panel. However, due to the lesser strength characteristics of aluminum, adaptations are required in forming the prefabricated panel frames.

The preformed panels are fabricated in a manner such that they are interconnectable and in situations where the panels are used in forming walls, well known tie members may be used to maintain the desired spacing between opposing wall panels when a wall is being poured. Such an arrangement is shown in Canadian patent 605,806, where

prefabricated panels of various shapes are interconnected to provide opposing wall arrangements and between which concrete is poured. The tie members, as normally connected to an open cage device, extend between wall arrangement inserts to which horizontally laid panels are connected. A similar approach to a forming wall arrangement is provided by many companies, such as, Peri-Werk Artur Schworer KG of WeiBenhorn, West Germany. This company supplies prefabricated panels where inserts, which are connectable to the panels, provide the wall arrangements. These may oppose one another and the ties, as connected to the inserts, maintain the desired spacing while concrete is poured between the forms. The inserts are supported by the use of reinforcing members (walers), whereby the insert arrangement spaces the walers from the interconnected panels. This results in a system which provides limited flexibility in shortwall constructions, because the walers are spaced from the panels, thus requiring inserts at every panel interconnection.

Regarding the panels used in the wall arrangements, the framework components are commonly welded together to provide a resultant integral structure. Should any components of the framework become damaged or fractured, it is usually necessary to scrap the entire panel, particularly if made of aluminum, because welding or repair of the aluminum components is very difficult.

It is, therefore, desirable to provide panel framework where the components are interconnected in a manner to provide for assembly and disassembly. Such an arrangement is disclosed in Canadian patent 844,509. A complicated

arrangement is provided for pretensionsing devices in the crossbars of the panel. In using such pretensioning devices, the results of panel frame disassembly is realized. In providing for the pretensioning of the cross-members, a complex siderail and endrail shape is required, thus complicating the interconnection of the corners of the siderails and endrails. Detailed consideration has been given in this patent disclosure to a device for pretensioning the cross-bar. The pretensioning arrangement provides for an interconnection of one siderail member to the other, where the cross-bars are clamped between the siderails as the pretensioning devices are tightened to apply an outward biased pressure on the cross-members to reinforce the cross-members against the load applied to the panel when used in concrete wall forming arrangements. Such an arrangement, however, is difficult to implement in the field, because the workmen do not usually have devices which could determine the necesary torque to be provided on each end of the pretensioning device to provide the correct tension on each cross-member. Further the use of such pretensioning devices substantially hinder the assembly of the panel, because all pretensioning devices, as located in the respective cross-bars, must be simultaneously placed through the holes of the siderails which is very difficult to achieve manually. Because of the complex shape required in the siderails to accommodate the pretensioning device, a further problem is encountered, where the connectors for interconnecting panel siderails are rearwardly of the pretensioning device location which, when used to interconnect panels, can cause a spreading apart of the face portions of the panels resulting in cracks in the wall

form arrangement to produce a concrete wall having spaced apart ridges at the interconnection of the panels. The aspect of interconnecting the siderails and clamping therebetween the cross-bars results in the cross-bar end portions being free; that is unconnected to the siderails. With the cross-bar having its ends free, the pretensioning device becomes critical in that the cross-bar with free member ends has a significantly higher degree of flexibility, as compared to a cross-bar which is fixed to the siderails such as in the past by welding of the cross-member end portions to the siderails. Thus if the proper tension is not provided in the pretensioning device, the panel can bow, due to the greater deflection in the cross-bars, during the pouring operation and result in a poor wall configuration for the set concrete. Therefore, this pretensioned cross-bar arrangement for panels, even though it permits disassembly, does not provide a panel arrangement which may be readily reassembled and which may be consistently relied upon from a load supporting standpoint when used in the field.

Canadian patent 759,872 and United States patent 3,399,859 disclose the mechanical fastening of endcap portions to the otherwise permanently welded frame structure to permit the insertion into the open end of the framework a plywood panel facing which mates with the specially formed edges of the siderails. However, with this mechanically fastened arrangement for the endcap, because the remainder of the structure is being welded, replacement of any components thereof aside from the particular endcap is not provided for.

The panel framework and wall arrangements, according to this invention, overcome a number of the above problems in the panels and may be used in a way to provide greater flexibility in making concrete forming structures in pouring concrete floors and walls.

The panel metal framework for supporting panel sheeting used in concrete forming structures comprises, according to this invention, a perimeter frame of spaced parallel siderails and endcap rails with a plurality of spaced rigid cross-members within the frame. The endcap rails and cross-members are mechanically secured to the siderails. The cross-members having their end portions fixedly mechanically secured to the opposing siderails, are of sufficient number and each of sufficient structural strength and stiffness to support concrete loads exerted on panel sheeting when affixed to the framework and when used in forming concrete. The mechanical connection of the cross-members to the siderails is such that, upon removal of fasteners used in making the connection, the connection is not destroyed. Thus in situations where complete disassembly of the panel arrangement is required, the reused components may be readily refastened into the framework.

The mechanical connection is accomplished by means providing for a fixed mechanical connection of an end portion of each cross-member to the corresponding siderail. The means may be provided on either the siderail or the cross-member. In arrangements where the connection means is provided on the cross-member end portion, individual damaged cross-members may be removed from the

framework and replaced without disassembly of the framework, or cross-members may be simply removed from the framework when the additional support is not required, or cross-members may be added in situations where additional support in the panel is required for a particular use in concrete forming. According to an aspect of the invention, the connection means may be provided internally of the cross-members, so as to protect the fasteners from concrete which may be splashed on the panels during the pouring and also eliminate recesses and the like on the cross-members which may fill with the concrete and when set, add additional weight to the panels. In so providing the connection means internally of the cross-members, mechanical fasteners are used which extend through the siderails and, as received by the internal connection means, draw the end portions of the cross-members against the siderails to provide for a secure fixed connection of the framework components. Preferably, the cross-members may be formed from extruded aluminum, where the section for the aluminum cross-members is such to provide the necessary strength in supporting the panel sheeting when used in confining poured concrete.

In concrete wall forming systems, according to this invention, each wall arrangement has a plurality of wall form panels and tie member panels. The wall form panels are connectable to one another and to the tie member panels. Each of the wall form panels and strong back panels has a perimeter framework of siderails and interconnecting endcap rails, all of which are of the same depth to define, when the panels are interconnected, a substantially planar frontwall face with the rear edges of

the perimeter rails all lying in substantially the same plane, which is parallel to the planar front face. The thus formed opposing wall arrangements are held in a predetermined spaced apart relationship by tie members when concrete is poured between the wall arrangements. Each tie member spans the opposing tie member panels and extends through and outwardly of each panel. The tie members are located along at least one level of the wall arrangement.

Horizontal load gathering means may be used where the tie members extend through the load gathering means. Means is provided for engaging the outwardly extending tie member portions and is adapted to clamp the load gathering means at every tie member on the same level against the coplanar panel rear edges to reinforce the wall arrangement and maintain substantially planar frontwall face.

In situations where a tie member panel is interconnected between wall form panels, a tie plate may be used through which the tie member extends and means is provided for engaging the tie member portions extending outwardly beyong the tie plates to maintain a desired spacing between the tie plates as they contact the exterior of the wall arrangements. Such tie plates each comprise a base portion for spanning the outer panel edges adjacent the tie member panel edges and has means for restraining the outer panel edges from lateral movement relative to panel edge length to enhance structural integrity of the interconnection of the panels.

In situations where the load gathering means is used in

association with ties for supporting the panels, a significant reduction in the number of ties needed is realized. Depending upon the wall being poured and the size of the ties, it is not necessary to place a tie panel at every panel interconnection. Because the ties extend through the tie panels, the interconnection of the panel edges is uninterrupted along the length of the interconnection. There is no need to modify panel edges to permit tie members to pass through the interconnected areas of the panels. This provides an essentially continuous wall form face with abutting joints to virtually eliminate any leakage of concrete through the panel joints.

To provide for the mechanical fastening of elements to the rear edges of panel rails used in modular concrete forming structures, the rear portions of the rail edges may be adapted to have fastening devices securable thereto. In a panel framework having the perimeter frame of siderails and endcap rails and a plurality of cross-members all interconnected to provide a rigid framework, the front face of the framework is adapted to have a panel sheeting affixed thereto. The rear edges of the panel rails are adapted to provide in an assembled form structure of a plurality of interconnected panels, a plurality of opposing spaced ledge portions which define an elongate slot. Fastener means is insertable through the slot and is adapted to seat on the opposing ledge portions to provide for the mechanical fastening of elements to the rear edges of the panel rails.

Preferred embodiments of the invention are shown in the drawings, wherein:

Figure 1 is an isometric view of individual panels assembled in spaced-apart tied wall arrangements for forming a concrete wall;

Figure 2 is an isometric view of a panel separated from a strong back of the assembly of Figure 1;

Figure 3 is an exploded view of sections of the panel siderail, endcap rail and cross-member;

Figure 4 is an isometric view of the strong back panel of Figure 1 showing the relationship and interconnection of siderail to endcap rail and cross-member;

Figure 5 is a partial view of a panel siderail abutting a strong back side rail, or other panel siderail to be interconnected by a swivel clamping device;

Figure 6 is a side elevation of the panel portions of Figure 5 as interconnected by the swivel clamping device;

Figure 7 is an isometric view showing a corner assembly for the wall arrangement of Figure 1;

Figure 8 is a section of the wall assembly of Figure 1 showing the relationship of a tie member to the opposing wall arrangements and a tie plate device used to clamp the walls in their spaced relation;

Figure 9 is a section through a wall arrangement showing the tie plate device in position;

Figure 10 is a side elevation of an alternative form of wall arrangement for Figure 1;

Figure 11 is a section through another alternative to the wall arrangement of Figure 1;

Figure 12 is a perspective view for an alternative wall arrangement;

Figure 13 is a partial view showing the construction of the panel of Figure 12 with mechanical fastening of panel siderail, endcap rail and cross-members;

Figure 14 is a section through adjacent interconnected panel siderail and strong back siderail showing an alternative arrangement for their abutting interfit; Figures 15 through 25 show various alternatives to the manner of mechanical interconnection of cross-member to siderail of a wall form panel frame, according to this invention.

Referring to Figure 1, a concrete forming structure for use in forming a wall is shown. It is appreciated, however, that the panels, according to this invention as used in this arrangement for forming the wall, may also be readily used in forming concrete floors, as supported by appropriate shoring structure. The concrete forming structure 10 of Figure 1 for forming a concrete wall 12 is made up of spaced-apart opposing wall arrangements 14 and 16. The opposing wall arrangements are tied together in their spaced-apart arrangement with tie rods 18, which are commonly used in the trade and tied into the walls by way of a tie plate clamping device 20. Each wall arrangement 14 and 16 consists of a plurality of wall form panels 22 which are interconnected by interposed tie member panels, or what could be considered as strong back panels 24. The wall arrangements are ordered so that the panels 22 oppose one another and tie member panels 24 oppose one another. This enables the use of ties 18 to bridge opposing tie member panels 24 and, with panels 22 interconnected to the tie member panels 24, the load exerted on the panels by concrete poured into the cavity between the panel arrangements is transferred to the ties by way of the tie plate clamps 20. Depending upon the size of the wall arrangement and its particular use, aligners in the form of

a beam 26 and a base plate 28 may be used to align the interconnected panels and strong backs so as to provide parallel face portions as generally designated at 30 to define the desired cavity into which concrete may be poured to provide smooth parallel wall exterior surfaces. The aligner beams 26 may be bolted to the rear faces of the rails of the panels and strong backs by use of plates 32 bolted to panel rails, which grip the ledge of the beam to clamp the beam against the rear edges of the rails so that the panels become aligned, due to the tie member panels or strong backs and wall form panels all being of the same depth as shown.

By way of using strong back panel 24 which in turn has the panel siderails releasably connected thereto, an arrangement is provided whereby less wall forming ties 18 are required to tie the wall arrangements together to retain the desired spacing between wall arrangements when concrete is poured into the defined cavity. By way of adapting the strong backs 24 to receive the ties 18, such ties may be large rod, as compared to the more commonly used thin tie plates. The rods by way of tie plate clamps 20 are secured to the panels so that the outward forces on the panels, by way of wet concrete poured therein, has their load transferred to these stronger tie members 18. Thus in the arrangement shown, there are only two ties per tie member panel at panel interconnection which is by far a lesser number compared to the number of required thin tie plate members, where four or five of such ties may be required per panel interconnection.

The manner in which the panel siderails and the strong

back siderails are interconnected is more clearly shown in Figures 5 and 6; however, to demonstrate the relationship of the connectors to the panels, connectors 34 are shown. Similarly, connectors 34 may be used to interconnect the panels, as stacked one upon the other, by use of the apertures 36 as shown in the top and bottom portions of each panel.

Each panel 22 consists of spaced-apart siderails 38 which are interconnected at their ends by endcap rails 40 and a plurality of cross-members intermediate the endcap rails 40 are spaced apart as shown at 42. The endcaps 40 and the cross-members 42 are all mechanically fastened to the siderails 38. Thus the panel framework may be shipped in its "knockdown" form. The components can be assembled in the field by use of appropriate mechanical fasteners. During use of the panels, any damage to individual cross-members 42, siderails 38 or endcaps 40 may be repaired by simply disassembling partially or totally the panel framework to permit replacement. The arrangement may also be adapted to permit addition or removal of cross-members 42 from the frame in situations when it is desired to either strengthen the panel or, in view of a subsequent use, remove appropriate cross-members when less strength in the panel is required. In disassembling the panel, cross-members, which will be reused, may remain on the plywood facing when it is necessary to remove the plywood facing to repair the panel. On reassembly, the reused cross-members and replaced cross-members may be refastened to the siderails. The framework is such that the interconnection of the cross-members to siderails with endcaps provides a supporting surface against which a panel

sheeting, forming the face 30, may be affixed. Such panel sheeting may be in the form of commonly used plywood, or steel, aluminum, or fibreglass sheet to mention only a few.

The tie member panels strong backs 24 are constructed in a similar manner, where the framework for the strong back comprises siderails 44 and endcap rails 46 with interconnecting cross-members 48. The cross-members 48 are adapted so as to permit the ties 18 to pass therethrough, which is shown and described in more detail with respect to Figure 4.

Referring to Figure 2, the panel 22 and strong back 24 are shown in more detail. The siderails 38 of panel 22 include apertures 36 which are also provided in the endcaps 40. Similarly, with the siderails 44 and endcaps 46 of the strong back 24, apertures 36 are provided. The apertures in the siderails of the strong back and wall panels are positioned so as to be in register when a strong back 24 is abutted against a panel 22. Thus the connectors 34 may be positioned through the apertures 36 and moved into position to clamp the siderails of the wall form panel and strong back tightly together.

According to the arrangement of Figure 2, to ensure that the strong back and wall form panels are of equal depth, the siderails for each panel are the same configuration and the endcap rails for each panel are the same configuration and all are of equal depth. Thus the mechanical interconnection of the cross-members 42 and 48 and the endcaps 40 and 46 to the siderails 38 or 44 are all done in the same manner.

Referring to Figures 3 and 4, such mechanical interconnection of the modular form panels and strong back panels is shown. In Figure 3, the wall form panel 22 has its siderail 38 connected to the endcap rail 40 by use of an angle bracket 50. The endcap rail 40 is different in cross-section to the siderail 38 with regard to the provision of a complete bolt slot arrangement 52 on siderail 38 which is only partially provided on the endcap rail 40. A bolt 53, as adapted for use with the bolt slot 52, has a specially shaped head 55 which permits its insertion into the bolt slot and can then be rotated 90 degrees in the direction of arrow 57 to cause the innerface of the bolt head 59 to seat within the bolt slot 52. A square shaped shoulder 61 is provided on the specially shaped bolt 53 to abut the edges of the bolt slot to prevent turning of the bolt when a nut or other device is secured to the bolt in attaching elements to the rear face of the panels. The bolt slot 52 has outwardly extending opposing spaced ledges 63 and 65. Such ledges define along their edge portions 67 the elongate bolt slot generally designated 69. The innerface 59 of the bolt head rest on the abutments 71 of the ledges 63 and 65 to retain the bolt in the slot when elements are fastened to the bolt. The shape for the bolt slot 52 may be so dimensioned to receive a hexagon nut, such that ordinary bolts may be threaded into the hexagon nut as retained behind the abutment faces 71 of the ledges 63 and 65.

The bolt slot ledge portions on the rail rear edges also provide the additional material required to give the desired moment of inertia in the aluminum rails to withstand the loads to be supported by the rails.

This bolt slot arrangement is particularly useful when clamping alignment beams, such as alignment beam 26 shown in Figure 1, where the plate portions 32 clamp an edge of the alignment beam 26 against the planar rear face of the wall arrangement. In addition to the alignment beams, other elements may be secured to the rear portions of the panel rails, such as wall brace arrangements, wind brace arrangements, catwalk brackets, devices for ensuring a vertical orientation for the wall arrangements, tie plates to the rear panel edges, reinforcing members or load gathering members, namely walers, and other elements which may be desirably connected to the rear faces of the panels. As to the endcap rails 40, which include only a portion of the bolt slot, it can be seen that endcap rail 40 has a ledge portion 41 with an abutment 43. When panels are interconnected by abutting the endcap rails of the panels, then the opposing endcap rails define between the opposing ledges 41 a bolt slot along the abutment edges 43 of the joined endcap rails. Sufficiently large walers may be secured to the panel rear edges to reinforce the modular wall form arrangement to an extent which forms a gang wall form unit. This so formed gang wall form unit may be hoisted by a crane and moved to another location to pour another wall.

A butt type interconnection of endcap rail 40 to siderail 38 is provided. The endcap rail 40 overlaps the siderail 38, as shown in Figure 2, where interfering portions of siderail and endcap rail interior are cut away to provide for proper interfit. Such interfitting of siderail to end rail connection is completed by way of the angle bracket 50, where self-tapping screws 54 are used to extend through

apertures 56 in siderail and endcap rails and engage the bracket apertures 58 to form a tight fixed interconnection of siderail to endcap rail.

To complete the framework, cross-members 42 are provided intermediate the endcap rails of the thus formed perimeter frame. The cross-members 42 are directly fastened to the siderails 38 against its planar interior face portion 60. The cross-member 42 has an end portion 62 which presents a planar face generally designated 64, which mates and abuts the planar face 60 of the siderail 38. To accomplish a fixed mechanical fastening of the end portion 62 of the cross-member 42 to the corresponding siderail 38, a means is provided for making the mechanical connection in combination with the use of mechanical fasteners. According to the embodiment of Figure 3, such means is in the form of portions on the cross-member 42 which cooperate with the mechanical fasteners 66 in the form of self-tapping screws to mechanically connect and tightly draw the planar face portion 64 of the cross-member 42 against the planar face 60 of siderail 38. Such means for cooperating with the fastener 66 is in the form of an arcuate channel 68 provided on the interior surfaces of the cross-member 42. The arcuate channels 68 are appropriately dimensioned so that the self-tapping screws 66 are firmly screwed into the openings defined at the ends of the arcuate channel 68.

The cooperation of the arcuate channel 68 with the fastener 66 is such that the fastener 66 may be removed from the channels to permit removal and replacement of one or more of the cross-members 42, which may have become damaged in

use. Alternatively, should it be required to replace a siderail 38 due to damage, the fasteners 66 are removed from each cross-member end 62 to permit replacement of a siderail 38. Because of the cooperation of the arcuate channel 68 with the fastener 66 and removal therefrom avoids damaging the arcuate channel 68, such cross-members 48 may be reused where new or the same fasteners 66 are used to reconnect the siderail 38 to the cross-member 42 which are reused in the reassembly.

The abutting faces of the cross-member end 62, with the planar face 60 of the siderail 38, are drawn tightly together by the fastener 66 in cooperation with the arcuate groove portions 68 provide for a secure, fixed mechanical interconnection of cross-member ends with opposing siderails. Such arrangement prevents relative movements of the cross-member end portion relative to the siderail to provide a strong interconnection which assures panel frame structural integrity in use and significantly reduces the deflection in each cross-member when supporting the loads of poured concrete compared to an arrangement where the cross-member ends are free of the siderails.

The siderail 38 and endcap rails 40 include on their interior surface, ledges 70. Such ledges are spaced from the outer face portion 72 and 74 of the endcap rail 40 and siderail 38 to accommodate the thickness of the panel sheeting material 76. In this instance, the panel sheeting material is plywood and is placed against the ledges 70, where the face of the plywood panel 76 is coplanar with the faces defined by portions 72 and 74 of the endcap and siderails. The panel 76 is secured to the frame ledges by

fasteners, such as woodscrews 78 which extend through apertures 80 in the ledges. The woodscrews 78 are of a depth less than the combined thickness of the ledge 70 and the plywood 76, so that the screw does not project through the plywood face.

Various forces are exerted on the panel in use. The primary force is against the face of the plywood panel 76 as it confines wet concrete poured against the face. Such force on the panel is taken up by the perimeter frame and the cross-members 42. The cross-members 42 are provided with flanges 80, which are integral with the sides 82 and 84 of the cross-member. The sides 82 and 84 converge towards one another and are interconnected at their narrowest spacing by transverse wall 86. The height dimension of the cross-member 42 from the underside of its flange 80 to the upper surface of transverse wall 86 is such to fit within the spacing between the upper surface of ledge 70 and the underside 88 of bolt slot arrangement 52. The cross-members 42 have fasteners 90 which are woodscrews and which extend through apertures 92 and flanges 80 and are screwed into the plywood facing 76. This secures the relationship of the cross-member flanges 80 to the plywood face to take up the load when the panel is in use. The force on the panel 76 attempts to push the cross-members 42 away from the ledge area 70 of the perimeter frame. This places the fasteners 66 in shear which is the most effective use of the fasteners in resisting such forces. To assist the fasteners in resisting this force, the wall portion 86, as it fits snugly beneath the bolt slot arrangement 52 and contacts its underside 88, enhances the resistance to the cross-member being pushed transversely

from the siderail. Another force, which is exerted on the panel frame particularly when the panels are connected to structures for forming corners, the relationship of which is shown in Figure 7. These forces tend to pull the siderails 38 in a direction outwardly away from the cross-member ends 42. Such forces place the fasteners 78 in the siderails 38, which connect the panel 76 to the ledges 70, in shear. However, this force also applies a direct pullout force on fastener 66. To compensate for this, additional fasteners 94 are passed through apertures (not shown) in the base portion of the bolt slot arrangement 52 and are screwed into apertures 96 of the transverse endwall portion 86. Thus these fasteners 94 are also placed under shear when the panel is used, particularly, in attachment to corner arrangement structures.

The cross-members 42 and the frames may be made of various metals, such as steel which has high strength properties, or may be made of aluminum or magnesium alloys. For the preferred embodiment of Figure 3, the siderails and cross-members 42 are formed of aluminum alloy, thus the structures may be extruded. The trapazoidal shape, defined in part by the cross-member section 42, has converging sidewalls 82 and 84 which provides a strong load supporting member. The connection of the spaced-apart sidewalls 82, 84 to the siderails 38 by way of fasteners 66, enhances resistance to torsion when the panel is placed under load and provides flanges 80 which are readily fastened to the panel 76. On the underside of the flanges 80, ridges 98 may be extruded which bite into the panel face 76. The purpose of these ridges 98 is to prevent concrete, which

has just been poured, from running under the flanges and gathering in the interior of the cross-member 42 as the panel abuts the flanges 80.

Figure 4 shows the assembly of the tie member or strong back panel 24. The strong back panel has endcap rails 46 with siderails 44. The corners of the frame for the strong back 44 are mechanically interconnected in a manner similar to that of the wall form panel of Figure 3. Mechanical fasteners, in the form of self-tapping screws 100, are screwed through the siderail and endcap rails and into the bracket shown in dot at 102. The abutting relationship of the ends of the siderails 44 to the underside of the endcaps 46 is shown in Figure 4 as they are mechanically fastened to one another. The cross-member 48 of the strong back panel is mechanically secured to the siderails 44 in the same manner as with the siderail interconnection of Figure 3 of the wall form panel. The cross-member 48 has on its converging sidewalls 104 and 106 the arcuate channel portions 108 into which the mechanical fasteners 110 are screwed. This draws the planar face 112 of the cross-member 48 against the planar face 114 of the siderail 44. The interfitting relationship of the transverse wall portion 116 to the underside 118 of the bolt slot arrangement 120 is shown. With this embodiment, as with the arrangement of Figure 3, the ledge portions 122 of the siderails are cut away as at 124 to receive the width of the cross member 48 at its flange extremities 126. To secure the flanges 128 to the panel 130 which, according to this embodiment, is plywood, fasteners in the form of woodscrews 132 extend through apertures 134 and the flanges 128 and are screwed into the plywood.

To provide for the same relationship as with the wall form panel of Figure 3, in addition to the fasteners 110 being placed in shear, fasteners 136 are used and are screwed into the transverse wall 116 of the cross-member 48, so as to be placed in shear against forces tending to pull the siderail 44 away from the cross-member 48 end portion.

To adapt the strong back tie member panel 24 to its use in combination with ties, the panel 130 has an aperture 140 provided therein to receive in this instance a circular tie. In addition, the transverse wall portions 116 of the cross-member 49 has an aperture, as shown in part, at 142 to thereby allow the tie which spans opposing strong backs of the wall arrangement to extend through the strong back 24 and outwardly thereof. Tie plates or walers are connected to the ties in the manner discussed in Figures 8, 9 and 11. Using this type of tie member panel with the wall form panels avoids the need to slot or kerf the siderails of the panels to receive at their interconnection, the standard flat thin bar tie member. As a result, a leakproof face is presented to the poured concrete.

To provide for the interconnection of panels, whether they be wall form panels or strong back panels to other wall form panels, connectors of the releasable type are used. According to the embodiment of Figure 5, a swivel-type clamping device is used which, in a first position, may be inserted through adjacent contacting panel rails and, when swung to a second position, clamp the siderails of adjacent panels together. This connector, as generally designated at 34 in Figure 5, is inserted through a type of key slot

36 which has a circular central opening at 144 with outwardly extending wing slot portions 146. This arrangement is such to receive the circular end 148 of the swivel clamp 34 which has outwardly extending toggle portions 150. The swivel clamp 34 has an annular base plate 152 which is secured to end 148. Between the toggles 150 and the base plate 152 is a type of lock washer 154 which operates in a manner so as to cause the distance between its face and the toggles 150 to decrease as the clamp 34 is swung downwardly in the direction of arrow 156 to draw the opposing faces of the panel rails 38 and, in this embodiment, strong back rail 44 together. The handle portion 158 abuts the faces of the bolt slot arrangement 52 of the wall form panel. This relationship is shown more clearly in Figure 6. The abutting contacting relationship of the siderails is generally designated at 160, as the siderails are clamped together by clamping device 34. To provide for appropriate clamping action, both siderails 38 and 44 are provided with ridge portions 162 and 164 which oppose and abut one another. Intermediate ridges 166 oppose one another; however, the ridges 166 are of a lesser height than ridges 162 and 164 to provide a slight spacing therebetween. This permits the faces of the siderails 38 and 44 to move slightly towards one another in providing a spring action as the swivel clamp 34 is swung downwardly in the direction of arrow 56 to provide a secure clamping of the panel siderail faces.

Alternative forms of devices for clamping the siderails of the adjoining panels together are generally shown in Figure 12, where the flat bar ties are used. Such an arrangement is commonly referred to as the key and wedge arrangement.

Figure 7 shows a corner assembly for spaced-apart wall arrangements. The corner assembly includes on its outer wall portion standard panels designated at 22 of their usual construction having the siderails 38, which support the plywood facing panels 76 at a 90 degree angle relative to one another. The ridges 162 of the panels abut one another to define the outer corner of the wall. To define the interior corner of the wall, specially shaped siderails for corner panels are used. The corner panels are generally designated at 168 and 170. Each panel has a siderail 172 having an outwardly extending flange portion at 174 and an angular transversely extending flange porion 176; the obtuse angle between which being approximately 135 degrees. The siderail 172 has at its rear portion a flange arrangement 180 which, when it opposes the corresponding flange arrangement of the other siderail 182, forms a bolt slot arrangement. The corner panels 168 and 170 may be interconnected in various manners and since an interior corner is defined, preferably bolts as at 184 are used. The bolts cause the outwardly extending face portions 174 of the panels to contact one another and define the interior corner of the wall to be poured.

To secure the intersection of the outer panels 22, which define the outer corner area, a connector plate 186 is used. The connector plate has two rail portions 188 and 190 which are at 90 degrees relative to one another. Each rail has ridges 192 which abut the ridges 166 of the panels 22. At the intersection of the rails 188 and 190, a ridge 194 is provided to define an apex which abuts the faces 162 of the panels. Rails 188 and 190 also include groove portions at 196 which capture the ridges 164 of the

siderails to hold them in position. To clamp the bracket 186 to the siderails, key slots 36 are provided and which additionally include square slotted portions 198 to permit use of either the swivel clamp 34 of Figure 5 or the use of key and wedges.

Turning to Figure 8, the relationship of the ties 18 to the strong back panels 24 is shown. The tie 18 extends through the apertures 140 in the plywood faces 130 of the strong backs and through apertures 142 of the cross-members 48 of opposing strong back panels. The tie rod 18 is circular and has provided on its surface spiral-shape ridges 200 to provide a coarse thread. The tie rod 18 is of sufficient length to extend outwardly beyond the bolt slot arrangements 120 of each strong back and thus extend outwardly beyond in essence the rear edge or rear face of the wall arrangement.

To provide for removal of the wall form ties 18 from a poured set concrete wall, plastic tubular inserts 202 are used and which are located between the opposing panel portions 130 by insert sealers 204 which have an annular flange at 206 for abutting the faces of the panels 130. After the concrete wall has set and the strong back panels are removed from the walls, the ties 18 may be simply slid out of the tube insert 202. The tube insert sealers 204 may be removed from the concrete wall and the resulting holes in the wall may be patched with appropriate patching materials to provide a smooth wall finish to which finishing material may be applied.

To gather the load from the panels and apply it to the tie

members 18, a tie plate 20 is used. The tie plate has an aperture 208 provided therein through which the tie rod 18 extends. The aperture 208 is provided with bearing material 210 which is swedged into position to provide a bearing surface against which the connical bearing surface 212 abuts, as the winged nut 214 having wing portions 216 is threaded onto the tie 18 and tightened against the plate. To facilitate this tightening and engagement of the wing nut 214 with the rod 18, it has internally thereof a coarse threaded portion 218 which appropriately engages the coarse thread 200 on the tie rod. The tie plate has an interior surface portion at 220 which abuts the exterior surfaces 222 of the siderails. Surfaces 222 all lie in the same plane due to the equal depth of the siderails of the strong back and wall panels. So as to capture and thereby restrain the panel siderails from moving laterally relative to the length of the panel edges, the tie plate is provided with ridges or flanges 224 which extend from the face 220 and abut the edges 226 of the bolt slot arrangements 52 of the wall form panels. Thus when the panels are under load, the outwardly extending ridges 224, as they capture the edges 226 of panels which are secured to both sides of the strong back, prevent those edges from separating as the load of freshly poured concrete is applied.

Turning to Figure 9, this interfitting relationship of the tie plate to the panel edges is more clearly shown. The panel siderails at 38 are shown as interconnected to the strong back panel siderails 44. The bolt slot arrangements 120 of the strong backs are retained against the blot slots 52 by ledges 228 as they contact the faces 230.. By tightening the wing nut 214 on the tie rod 18, and with a

similar wing nut 214 tightened onto the tie plate used on the opposing strong back, the innerface 220 firmly abuts the rear face portions 222 of the rails. With the bolt slot arrangement 120 of the strong backs confined by the ledges 228 against the bolt slot arrangements 52 of the panels 38 by ledges 224, the interconnected panel rails with rail ridge portions 162, 164 firmly abutting are prevented from opening, particularly between ridges 164.

As can be seen from Figure 9, upon removal of the tie plates 20 after the concrete of wall has set, the panels 22 may be removed from the strong backs 24, because the ridges 162 and 164 of the siderails simply abut one another. This is particularly useful in situations where it may be desired to remove a panel from the wall while the strong back remains against the wall, which may be supported by other angular bracing (not shown). Thus the panels may be stripped from the set wall independently of the strong backs. This approach may also be useful in situations where it is desired to provide a support arrangement for pouring concrete floors. Jack posts or shoring posts may contact the strong backs connected thereto. After the poured floor is set, the panels may be stripped from the strong backs where the strong backs with jack posts remain to support the poured set concrete floors, as it continues to cure.

Various combinations of panels and strong backs may be used in forming a wall arrangement. In Figure 10, strong backs 24 are used at every other connection of wall form panels 22. Thus a pair of adjacent wall form panels are connected at 234 by use of the swing clamps of the type shown in

Figure 5. At the siderails of panels 22, opposite joint 234, strong backs 24 are inserted into the wall arrangement and appropriately connected to the panels 22. Ties 18 are provided in the strong backs to provide two levels, one at an upper level of 18a and the other at a lower level of 18b. Because all of the panels are of the same depth, the rear face of the panel arrangement 222, as discussed with respect to Figure 9, permits the use of walers or load gathering members 236. These walers, through which the ties extend, are connected to the ties at the respective levels by way of plates 238 and wing nuts, such as 214. The plates 238 are different from the tie plates 20, because they must cooperate with the external portions of the walers 236 in the manner shown. The bolt slots in the panel rails provide for interconnection of intermediate panels between ties to the walers to ensure a reinforced straight modular wall form system.

With the arrangement of Figure 10, a significantly less number of ties may be used. In the past where strong backs were used, ties were located at each strong back and the panels were of a normal spacing of approximately two foot centres. With the arrangement of Figure 10, the ties are now placed at approximate four foot centres, thereby eliminating half of the ties per length of normal poured wall section. This, therefore, reduces the number of holes in the set concrete which may be patched after the panels are removed therefrom. This arrangement also provides greater flexibility in forming the wall, since smaller panels may be connected to one another to form odd length walls. The interconnected smaller panels, as provided between spaced strong backs, are supported by the walers 236.

A further alternative to the arrangement of Figure 10 is that shown in Figure 11, where the relationship of the walers 236 to the rear face 222 of the wall form arrangement is shown. Ties 18 extend through strong backs 24 where an intermediate strong back 24, as interconnected to panels 22, does not have a tie extending therethrough. Due to the planar rear face presented by the equal depth rails of the various panels, the waler 236 contacts all of the panel rail rear edges to support the intermediate waler 24 and interconnected panels 22 to provide an arrangement with a reduced number of ties for a given span of poured wall.

The use of strong backs in combination with panels permits the use of stronger ties at less frequent intervals in the wall. However, the system remains to be made up of the individual lightweight panels which are readily carried by a workman. Thus the walers in combination with the strong backs provide a great advantage in the field, because various configurations for wall arrangements may be made which may be easily disassembled once the poured wall has set, where the individual components of the wall arrangement may be easily carried and a minimum number of ties used in forming the wall arrangements.

An alternative wall arrangement is shown in Figure 12 which is adapted for use with flat plate ties at panel joints. The concrete forming structure comprises opposing wall arrangements 240 and 242. The opposing wall arrangements are interconnected by flat plate ties 244 which fit into slot kerfed portions 246 provided in the opposing side rails. Not all of the tie members are shown; however, the

arrangement is such that the ties 244 may be connected to the wall form panel siderails by key and wedge arrangements as generally shown at 248. Up to six ties per panel joint may be used in a wall arrangement of Figure 12, depending upon the forces developed within the forming structure as wet concrete is poured thereinto to form a wall as represented at 250. Each wall arrangement is made up of opposing wall form panels 252. Each opposing wall form panel has siderails 254 with interconnecting endcap rails 256 which are mechanically connected to the siderails to define a panel perimeter frame. A plurality of cross-members intermediate the endcaps are provided at 258. A variation of cross-member 258 is shown at 260 which is shown in more detail in Figure 13. The cross-members 258 and 260 are mechanically secured to the siderails 254 for the reasons previously discussed in providing a panel, which is readily disassembled in the field to replace damaged components of the panel framework. With the panel arrangement of Figure 12, where each panel is interconnected to an adjacent panel by a key and wedge arrangement at 248, ties are required at each panel intersection. In Figure 12, only some of the ties are shown where it is understood, as previously mentioned, that ties are provided at each panel joint, the number depending upon the type of wall being poured.

Figure 13 shows an alternative arrangement for the siderails and cross-members. In this embodiment, the panel 252 has siderails 254 of the same cross-section as the endcaps 256. Because the siderail and endcap rail are identical in cross-section, a mitre joint may be formed for interconnecting the corners of the endcap rails to the

siderails. To provide for mechanically fastened interconnection, angle bracket 262 may be used where self-tapping screws 264, as they extend through apertures 266, are threaded into appropriately sized apertures 268 in the corner brackets 262. The siderail and end rail have an internal flange 270 which provides a support against which plywood panel facing 272 is secured. Such securement may be by way of woodscrews which extend through apertures in the flanges 270 and are screwed into the wooden panel 272 in the same manner as is done with the system shown in Figure 3. The siderail and endcap rails are provided on their external surfaces with ridges 274, 276 and 278. These ridges abut one another of the siderails when adjacent panels are interconnected in the manner shown in Figure 12. To provide for such interconnection of the siderails, a quadrant shaped slot 280 is used. Slot 280 has laterally extending square shaped notches 282 extending outwardly from the circular central portion 284. These square notches receive the standard key and wedge devices for forming panel interconnection. In addition, transversely extending notches 286 are formed to accept the type of swivel clamp shown in Figure 5.

Regarding the cross-members used to support the plywood panel 272 between the siderails and endcap rails, two different forms of extrusions 258 and 260 are shown. Cross-member 258 is an aluminum extrusion having converging sidewalls 288 and 290. The converging sidewalls are interconnected at their narrower spacing by transverse wall 292. This section, insofar as the walls and the member flanges 294 are concerned, is similar to the section of the cross-member of Figure 3. Provided above the transverse

wall 292 are longitudinally extending ledges 296 which oppose one another to define an opening between edges 298, thus forming the bolt slot arrangement with all attendant uses, such as described with respect to the arrangement of Figure 3. On the interior surfaces of the cross-member 258 are provided two arcuate channels 300. These arcuate channels are so formed to receive and cooperate with mechanical fasteners in the form of self-tapping screws 302 which extend through apertures 304 in the siderail 274 to draw the planar edges at 306 of the cross-member end portion, generally designated 308 against the planar interior face 310 of the siderail 274 to provide a fixed connection. A portion of the end of the cross-member is notched at 312 to fit under the ledge portion 314 of the siderail, such that the edge 316 thus formed abuts the intersection 318 of the leg 314 with the interior face 310 of the siderail. The base of the end portion 308 is notched at 320 to overlap the ledge 270 of the siderail, so that the cross-member 258 has its end portion 308 snugly received between the ledge 270 and the corner portion 318. This enhances the support of the cross-member against forces exerted on the face 272 of the plywood panel. To complete the interconnection of the cross-member to the siderail, a fastener in the form of a self-tapping screw extends through aperture 322, which interconnects the flange 294 to the siderail. Thus these fasteners are placed in shear when forces push the siderail outwardly away from the cross-member end 308.

An alternative section for the cross-member is shown at 260, which is essentialy of I-beam shape and is of a solid aluminum extrusion. The end portion 324 is adapted to fit

between the ledge 270 and the intersection 318 in a similar manner as with cross-member 258. The extrusion includes in the intermediate web portion two thickened areas 326. The ends of the thickened areas are bored to provide holes 328 which receive the self-tapping screws 330 which draw the planar end portions 324 of the cross-member 226 tightly against the interior face 310 of the siderail 254. Thus the end of the cross-member has been adapted, by providing interior of its end portion 324, holes or bores 328 which cooperate with the self-tapping screws in providing for mechanical interconnection, where the fasteners may be removed from the bores without damaging same, so that reuse of the cross-members is facilitated.

In completing the connection of the plywood panel 272 to the panel frame work, woodscrews 332 extend through apertures 334 in the flanges 294 of cross-member 258 and apertures 336 of cross-member 260. The apertures 334 and 336 are provided along their length to facilitate affixing of the panel to the cross-members at several locations.

To accommodate the tie members, the siderail 254 is slotted at 246 by removing or milling ridges 274, 276 and 278 in the manner shown. The connector aperture 280 is provided at this slotted area 246, so that corresponding holes 338 in the tie member, as shown in Figure 12, are aligned with the aperture 280 to permit the use of the swivel connector or the standard key and wedge connectors in securing the ties to the siderails.

The system of Figure 12 may be modified to incorporate the use of strong backs, as in Figure 1, where the rail section

of Figure 13 is used. Referring to Figure 14, the siderail 254 of panel 252 has its ridge 278 removed from the extrusion where remaining ridges 274 and 276 are provided. The rail 338 of the strong back panel 340 has ledge 342 to which strong back panel facing 344 may be secured in the same manner as panel 272 is secured ledge 270 of rail 254. The strong back rail 338 includes a ridge 346 which abuts ridge 274 and also has ridge 348 which abuts ridge 276 of rail 254. The rail 338 has special provision to overlap a portion of rail 254 interior of their abutting faces to assist in holding the rail of the panel against the poured concrete. This is accomplished with rail 338 by providing a ledge at 350 which overlaps ridge 276. This arrangement transfers the load from the panels directly to the strong back rails 338 which, in turn, are supported by a tie plate in the previously discussed manner. On the rear edge of the strong back rail 338, a bolt slot arrangement may be provided at 352.

The provision of the arrangement of Figure 14, in providing the overlap of interior sections of the siderails of the strong back and panel, also provide an arrangement which substantially reduces the shear forces exerted on the cross-members as connected to the panel facing.

The use of cross-members, or reinforcing members, in the panel framework, having a trapazoidal shape in cross-section substantially enhances the overall structural strength of the panel. The converging legs of the cross-member, as secured to the panel facing, reduces the effective span between support areas for the panel.

The mechanical connection of the cross-member ends to the siderails, due to the planar end provided by the cross-member and the interior of the side rail, makes for a very simple fixed connection where the faces abut, as drawn together by the use of appropriate mechanical fastener. Such mechanical fastening permits removal and replacement of individual cross-members without disassembly of the entire frame and also allows addition or removal of cross-members without having to unfasten the siderails. This is permitted by removing the panel face of the frame, which allows the cross-members to be then, as disconnected, removed from the siderails and another unit inserted should a cross-rail or cross-member be damaged.

The siderails may be modified such that, in the areas where apertures are provided for mechanical fasteners to extend through the siderails and be screwed into arcuate channels interior of the cross-members, a countersunk arrangement may be provided such that the fastener heads are flush with the surface of the siderail. This arrangement facilitates cleaning of concrete which may have found its way in between panel interconnections and has set on the faces.

An advantageous aspect in providing for the connection of the fasteners internally of the cross-members is that clean sloped surfaces of the cross-members are provided, to thereby prevent collection of concrete on the surfaces or should concrete set on the surfaces, it may be readily chipped away with a hammer and chisel thereby maintaining the lightweight aspect of the form panels.

To realize the advantages of this invention in the fixed

mechanical connection of cross-member ends to panel frame perimeter, and supporting of panels, other sections for the cross-members and other mechanical connections may be provided as shown in the various embodiments illustrated in Figures 15 through 28. Only partial sections of the panel assemblies are shown to demonstrate generally the position of the siderail and the manner in which the various sections of the cross-members have their end portions connected to the interior face of the respective siderail. Referring to Figure 15, a siderail 354 has secured to its interior face a cross-member 356 which is essentially U-shaped in section, having opposing sidewalls 358 and 360 with a transverse wall portion 362. At the base of walls 358 and 360, out-turned flanges 364 are provided. To connect the end portion 366 of the cross-member, as shown in Figures 15 and 16, L-shaped angle brackets 368 are firstly secured to the sidewalls 358 and 360 by self-tapping screws 370 which extend through the apertures in the plates to the interior space of the cross-member 356. With the angle brackets secured to the end 366 of the cross-member, the brackets are then secured to the interior face of the siderail 354 by additional mechanical fasteners 372. They extend from the interior face of the siderail 354 and through the brackets, where the brackets are provided with appropriate apertures to receive the self-tapping screws 372. In tightening the self-tapping screws 372, the end portion 366 of the cross-member is drawn into abutting relationship with the siderail. The cooperation of the fasteners with the brackets is such that the fasteners may be removed without destroying the apertures in the brackets, so that the cross-members may be reused.

Referring to Figure 17, an arrangement is shown where a siderail 374 has an end portion of cross-member 376 secured thereto by way of a plate 378 which is welded to the end portion 380 of the cross-member at filet weld areas 382. The section of the cross-member 376 defines in part a trapazoidal shape, having converging sidewalls 384 and 386 with transverse interconnecting wall 388. At the base of sidewalls 382 and 384 are out-turned flanges 390 which serve the same purpose as those of the cross-members of Figure 3. The plate is secured to the siderail by use of mechanical fasteners in the form of self-tapping screws 392. Thus, the cross-members may be stripped from the siderail by removal of the self-tapping screws 392.

An alternate shape for the cross-section of the cross-member is shown in Figures 18 and 19. In Figure 19 it can be seen that the cross-member 394 is somewhat triangular in shape, having sidewalls 396 and 398 with out-turned flanges 400, to which plywood facing is secured. Interior of the cross-members 394 are three arcuate channels 402 which receive self-tapping screws 404 which are used to connect a plate 406 to the end of the cross-member 394. To provide for mechanical connection of the cross-member to the siderail 408, rivets 410 are used. Should it be necessary to replace a damaged cross-member or siderail, the rivets 410 are simply snipped off without damaging the plate 406. Should that particular cross-member to be reused, new rivets may be provided to draw the face of plate 406 against the siderail to form a fixed secure connection of cross-member to siderail.

Figure 20 shows an arrangement where portions are formed

integral with the cross-member and which cooperate with the fasteners used in mechanically connecting a cross-member end to the siderail. The cross-member 412 has sidewalls 414 and 416 with transverse wall 418. Out-turned flanges 420 are provided at the bottom of each sidewall 414 and 416. The end portion of the cross-member 412 is milled so as to provide tabs 422 and 424 which are extensions of the flanges 420 and tab 426 which is an extension of transverse wall 418. These tabs are bent in the manner shown in Figure 20 or may be strengthened by corner braces. Rivets 428 extend through the siderail 430 and through apertures 432 in the tabs to provide a secure connection of cross-member end 412 to the siderail. As with the embodiment of Figure 18, the rivets may be removed when partial or total disassembly of the frame is required.

Another use of rivets is shown in Figure 21, where the cross-member has a section similar to that of Figure 15. The cross-member 432 is secured to the siderail 434 by use of a U-shaped bracket 436 which is riveted at 438 to the sides of the U-shaped member 432. The base portion 440 of the bracket 436 is riveted at 442 to the siderail to complete the interconnection of the components. When it is desired to disassemble or remove a cross-member 432 from the siderail 434, the rivet 442 may be removed and the siderail or cross-member replaced.

An alternative approach to the use of a bracket in securing a cross-member to a siderail is shown in Figures 23 and 24. The siderail 444 of the panel frame has an end portion 446 of cross-member 448 secured thereto by the use of

U-shaped bracket 450. The U-shaped bracket extends through slots 452 and 454 in the siderail and has its base 456 riveted to the siderail 444 by rivet 458. The cross-member 448 has extruded on the interior thereof spaced-apart ridges 460 and 462 which slidably receive the outwardly extending legs of U-shaped member 452. The legs 464 are riveted to the interior walls or sidewalls 466 and 468 of the cross-member by rivets 470. Removal of the cross-member 448 from the siderails is accomplished by snipping off the rivets.

The arrangement of Figure 22 provides a similar connection to that of Figures 23 and 24, where the spaced-apart legs 472 and 474 are welded at 476 and 478 to the siderail 480. The cross-member 482 is of the same shape as the cross-member of Figure 23, where the outwardly extending leg portions 472 and 474 are riveted by rivets 484 to the sidewalls 486 and 488 of the channel-shaped cross-member 482.

The remaining alternative to the mechanical interconnection of cross-member to panel siderail is shown in Figure 25. The cross-member 490 has sidewalls 492 and 494 with interconnecting transverse wall 496 with a bolt slot arrangement 498 provided thereabove. At the base of the sidewalls 492 and 494, flange portions 500 are provided. A cleat member 502 has a head portion 504 for abutting the rail surface with its depending plate portion secured to the underside of transverse wall 296 by self-tapping screws 506. The assembly is provided by milling out a portion of the ridge 508 of the siderail 510 to accommodate the width of the head portion 504 of the cleat. The cleat is then

extended through a slot 512 in the rail sidewall. The cross-member has its transverse portion overlapping the cleat and is secured thereto by the self-tapping screws 506. Disassembly of this connection may be provided by removal of the self-tapping screws 506, should replacement or removal of a cross-member 490 be desired.

There is provided by this invention a panel framework which has mechanically interconnected components. The mechanical interconnection for the components provides for knockdown shipping of the frame and assembly at another location, such as the job site or by a regional dealer. The panel sheeting may be applied to the assembled framework at the site or by the dealer to also reduce shipping costs of the framework. To provide the desired sections for mechanical interconnection and a lightweight panel, the components may be extruded from lightweight aluminum or magnesium alloys. Fasteners of the type discussed with respect to Figure 3 and the cooperation with appropriate devices on the cross-members provide for a secure fixed mechanical connection of cross-member ends to the siderails of the frame. By providing the connection interior of the cross-members, this protects the fasteners and avoids corroding and binding the fasteners within the connecting areas on the cross-members. In addition, the interior location of the connection prevents concrete from building up on the members. As to the manner in which such panels are used in wall arrangements, various aspects are shown where advantageously strong backs may be judiciously used in combination with the wall form panels to provide greater flexibility in the panel forming arrangement and substantially reduce the number of ties required in forming

the spaced apart wall arrangements for the concrete pouring structure. With a proper exterior configuration for the siderails of the strong backs and panels, an arrangement may be provided which permits removal of the panel away from the strong backs after the concrete has set. Other situations involved pouring floors where jack posts or shoring frames may be placed under stringers and the panels supported by the stringers. When the floor has set, the panels may stripped from the set floor and shore posts used to support the floor until the concrete cured.

CLAIMS

1. A panel frame for use in concrete forming structures comprising spaced parallel siderails with interconnecting parallel endcap rails and spaced cross-members of equal length intermediate said endcap rails, said endcap rails and cross-members being mechanically secured to said siderails, characterized in that each cross-member end portion has means for cooperating with mechanical fasteners used in fixedly securing said siderails to said cross-member end portions, the cooperation of said fastener cooperating means with said mechanical fasteners being such that said mechanical fasteners are removable from said fastener cooperating means of each cross-member end portion without damage to said fastener cooperating means.

2. A panel frame according to claim 1, characterized in that said fastener cooperating means is mechanically connected to said siderail to secure said cross-member end portion to said siderail.

3. A panel frame according to claim 2, characterized in that said fastener cooperating means is a plate means, said plate means being mechanically connected to said siderail.

4. A panel frame according to claim 1, characterized in that said mechanical fastening of said endcap rails and cross-member rails to said siderails permits replacement of any frame component, the cooperation of said fastener cooperating means and said mechanical fasteners being such to permit removal of said mechanical fasteners for replacement of a siderail and subsequent reassembly using mechanical fasteners with the same fastener cooperating

means of reused cross-members.

5. A panel frame according to claim 1, characterized in that said cross-member end has wall portions, the interior surfaces of which define a space interior of said cross-member end, said fastener cooperating means being associated with said interior surfaces.

6. A panel frame according to claim 1, characterized in that said cross-member is an extruded aluminum alloy member adapted to be load bearing and having wall portions, the interior surfaces of which define a space, said fastener cooperating means being integrally formed on at least one of said wall portion interior surfaces.

7. A panel frame according to claim 6, characterized in that each of said cross-members includes sidewalls and interconnecting transverse wall, said fastener cooperating means being provided on at least one of and along the length of the interior surfaces of said wall portions, said siderail abutting the end of said cross-member with mechanical fasteners extending through said siderail and cooperating with said fastener cooperating means to secure said siderail to the corresponding end of said cross-member.

8. A panel frame according to claim 6 or 7, characterized in that said fastener cooperating means is an arcuate channel into which mechanical fasteners in the form of self-tapping screws are screwed to secure said siderail to the cross-member.

9. A panel frame according to anyone of claims 6 through 8, characterized in that there are two sets of mechanical fasteners used to fasten each cross-member end portion to the corresponding siderail, said first mechanical fastener set being in shear to a force exerted in a direction parallel to the side of said siderail, said at least one additional mechanical fastener being in shear to a force exerted in a direction perpendicular to the side of said siderail and outwardly away from said cross-member end portion.

10. A panel frame accorting to anyone of claims 6 through 9, characterized in that said cross-member has converging sidewalls with said transverse wall at the narrower spacing between said sidewalls, said siderail having means along its length to support an edge of a panel sheet affixed to said frame, said cross-member as fastened to said siderail providing a load carrying surface substantially coplanar with said support means for an affixed panel.

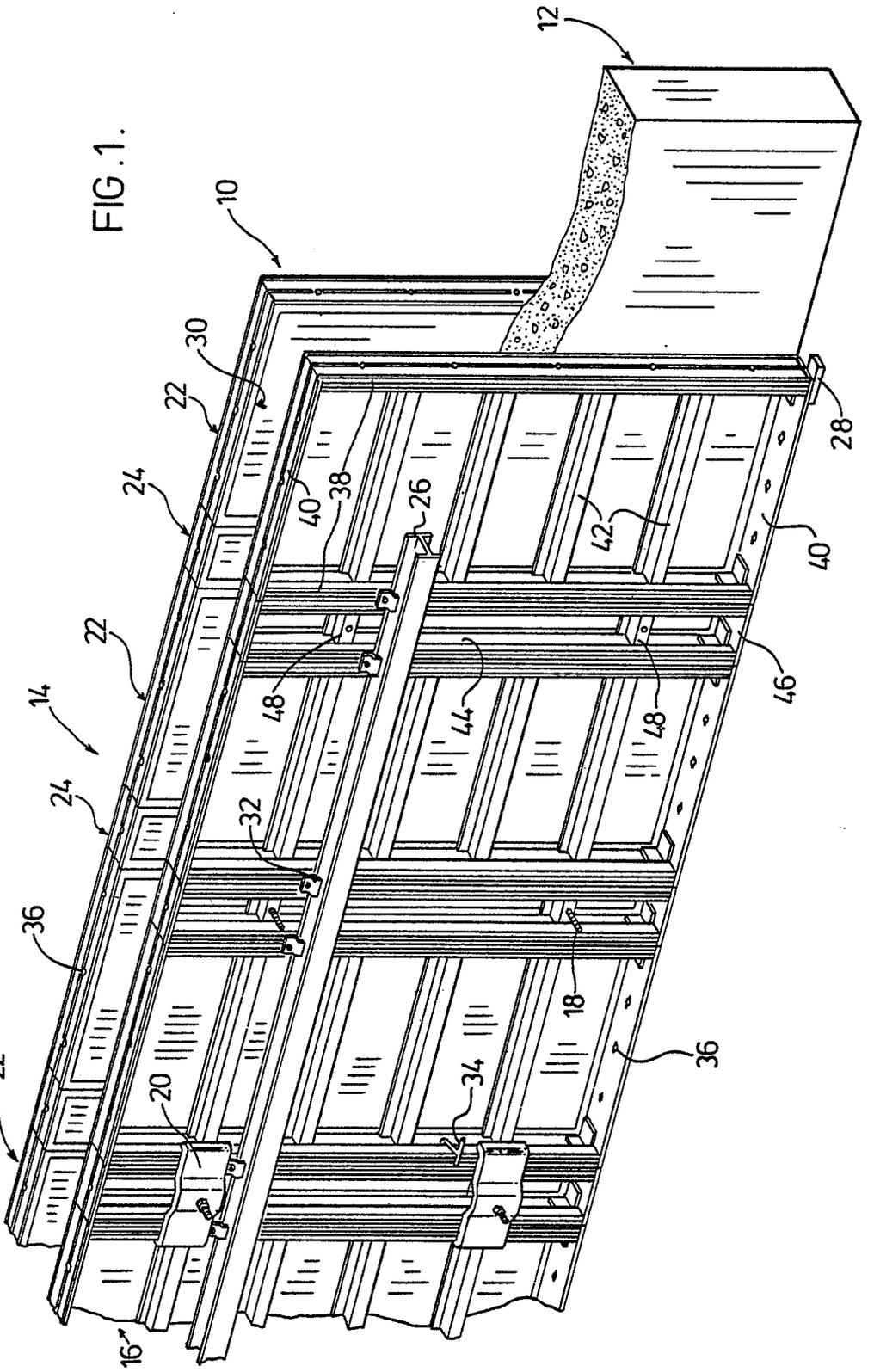
11. A panel frame according to anyone of claims 6 through 10, characterized in that said cross-member has an out-turned flange along each sidewall edge, said flanges of each cross-member being substantially coplanar with said siderail support means.

12. A panel frame according to anyone of claims 6 through 11, characterized in that said siderail has means for abutting a transverse mating porton of cross-member end, said abutting means being mechanically fastened to said mating transverse portion of said cross-member.

13. A panel according to anyone of claims 6 through 12, characterized in that the rear edges of said panel are adapted to provide in an assembled form structure of a plurality of interconnected panels opposing spaced ledge portions which define corresponding elongate slots, fastener means being insertable through said slot and adapted to seat on said opposing ledge portions to provide for the mechanical fastening of elements to the rear edges of said panel rails.

14. A panel frame according to anyone of the preceeding claims, characterized in that said siderails, cross-members and endcap rails are of aluminum or magnesium alloy.

FIG. 1.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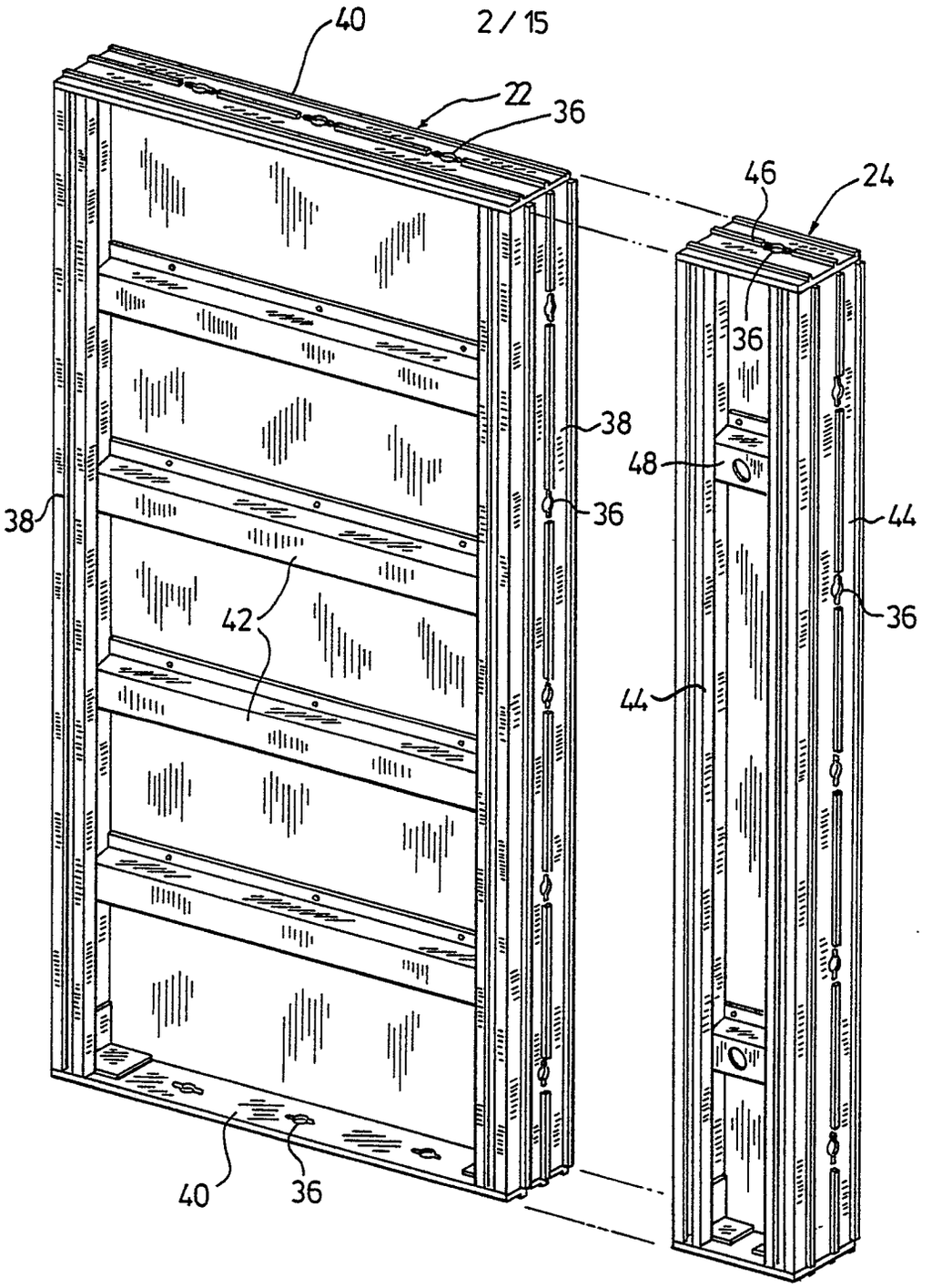


FIG.2.

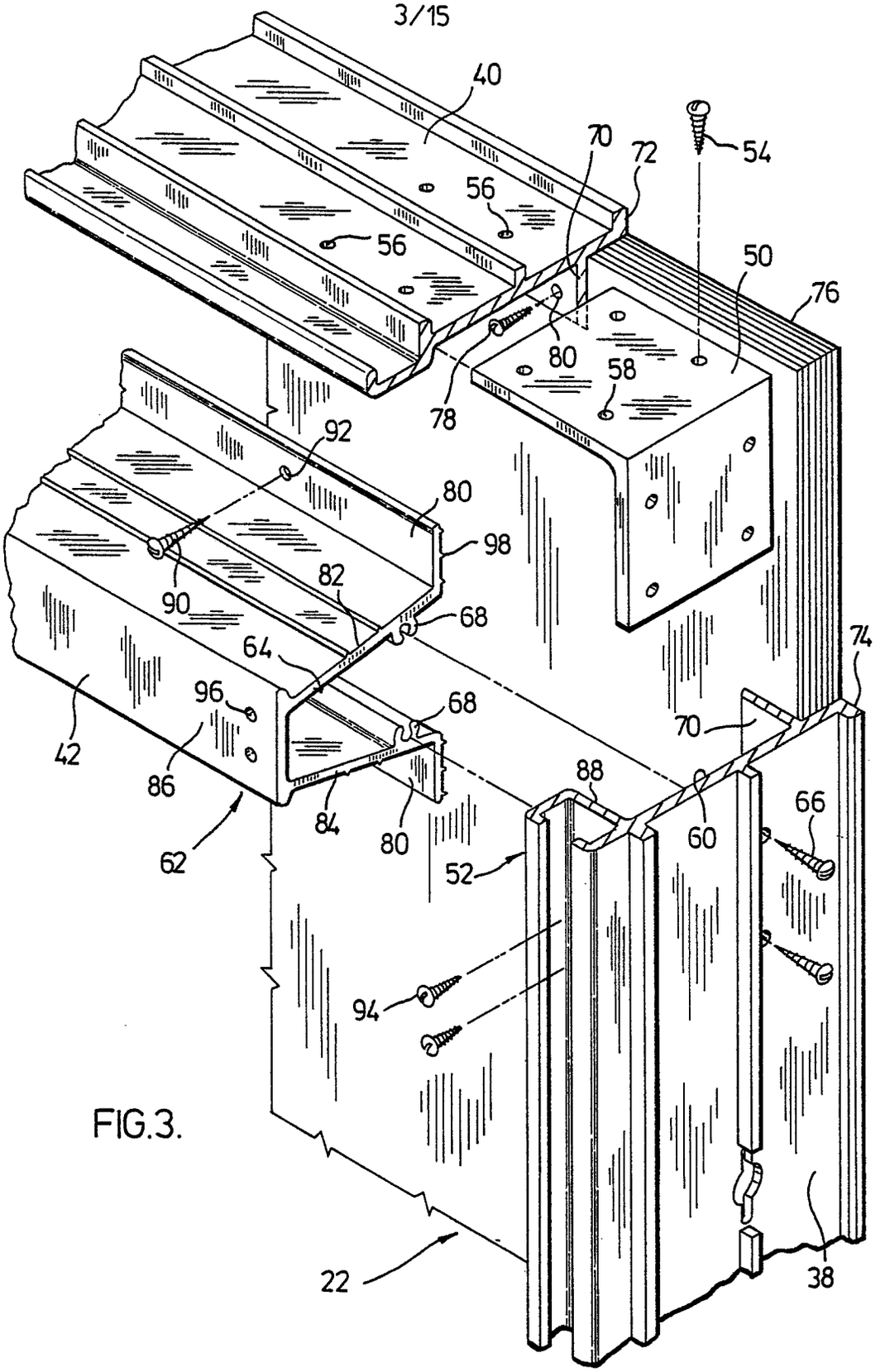
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FIG.3.

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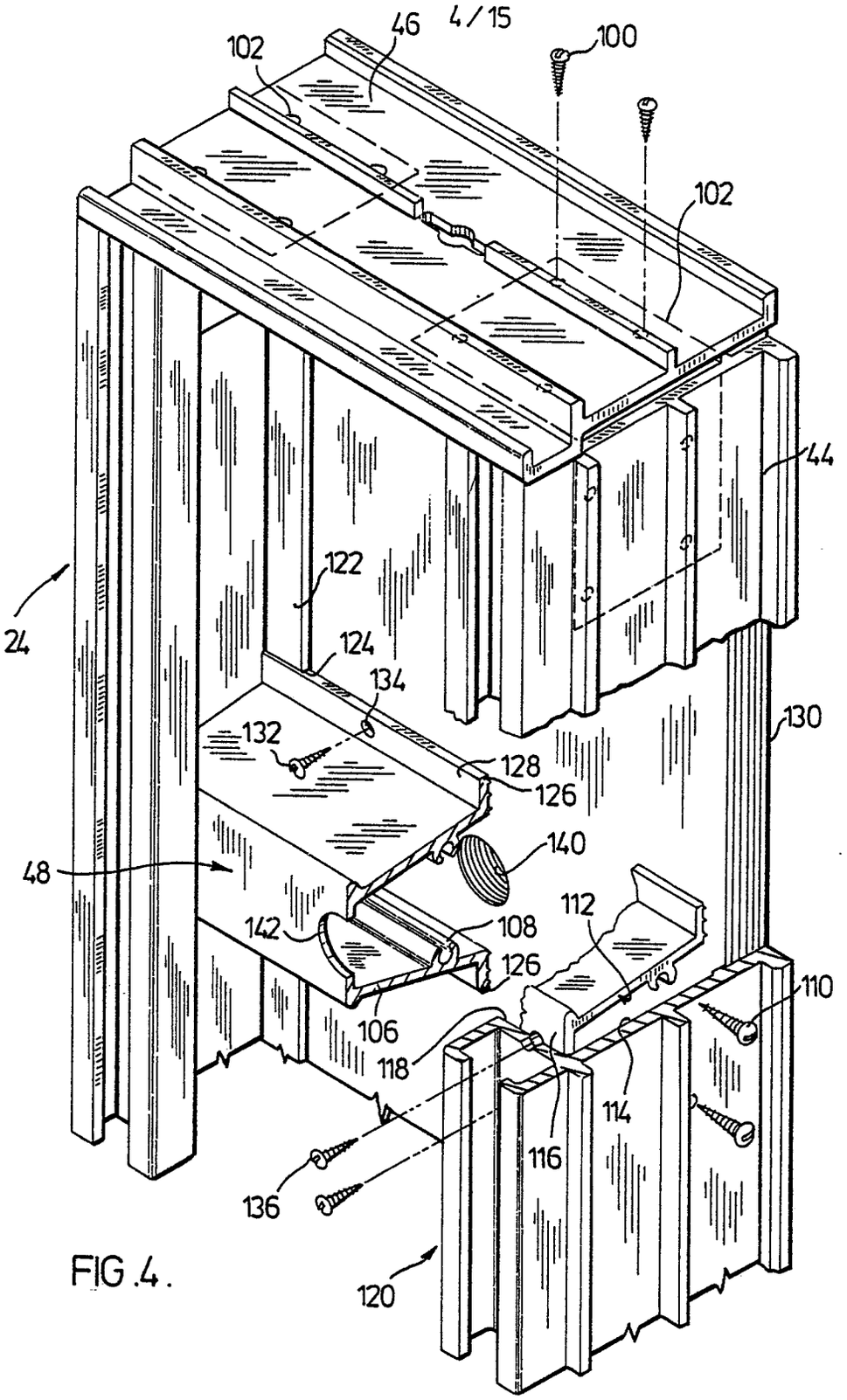
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FIG .4.

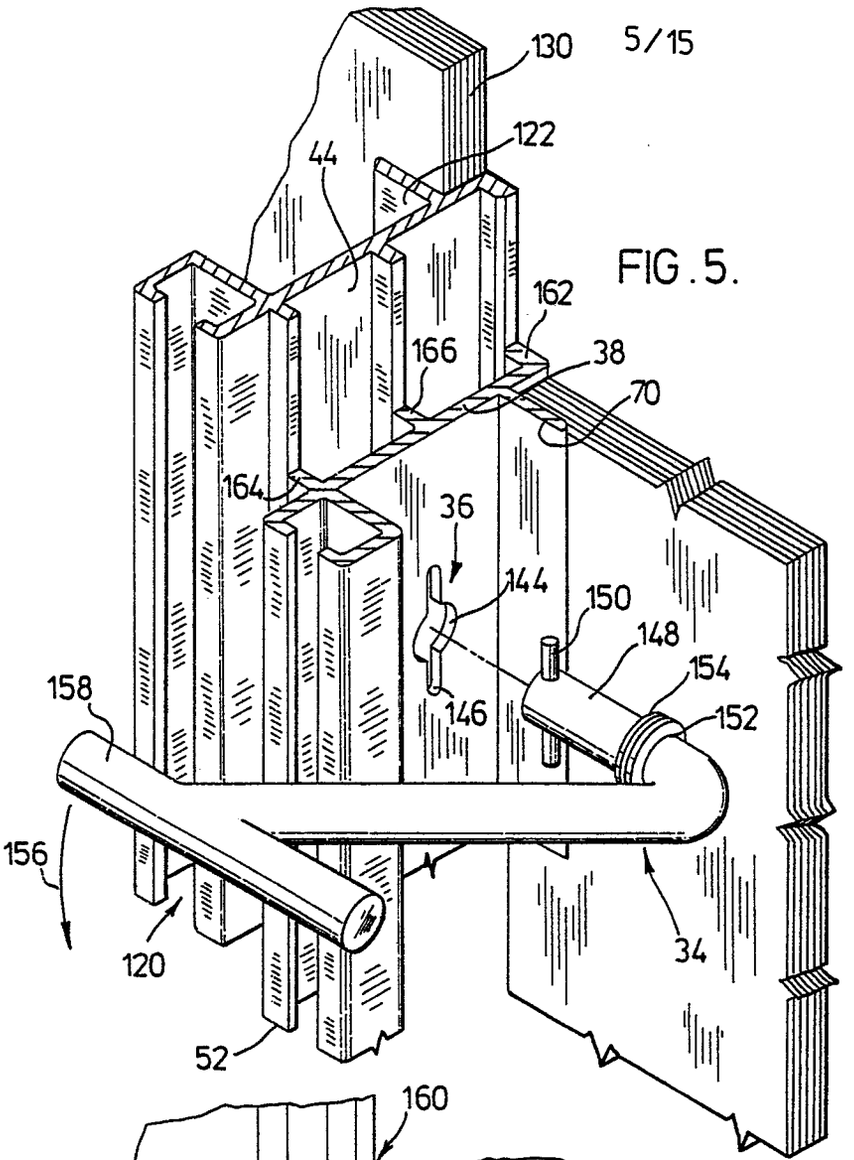
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FIG. 5.

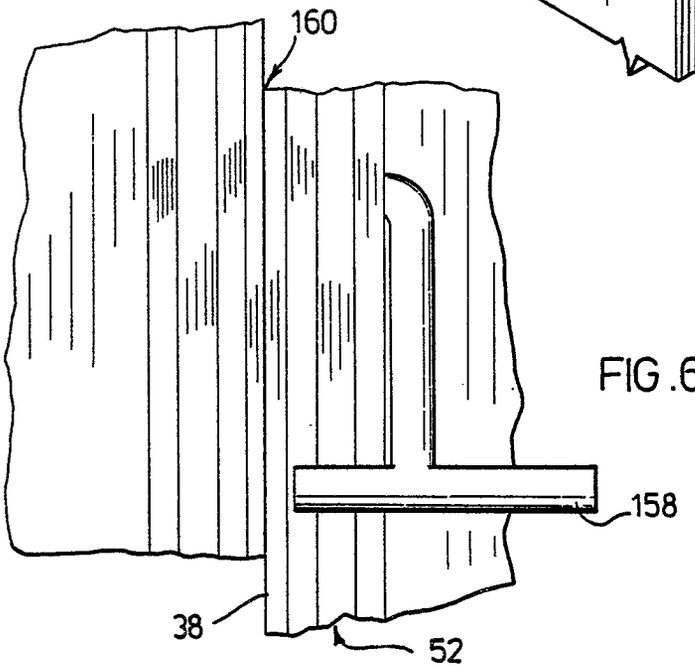
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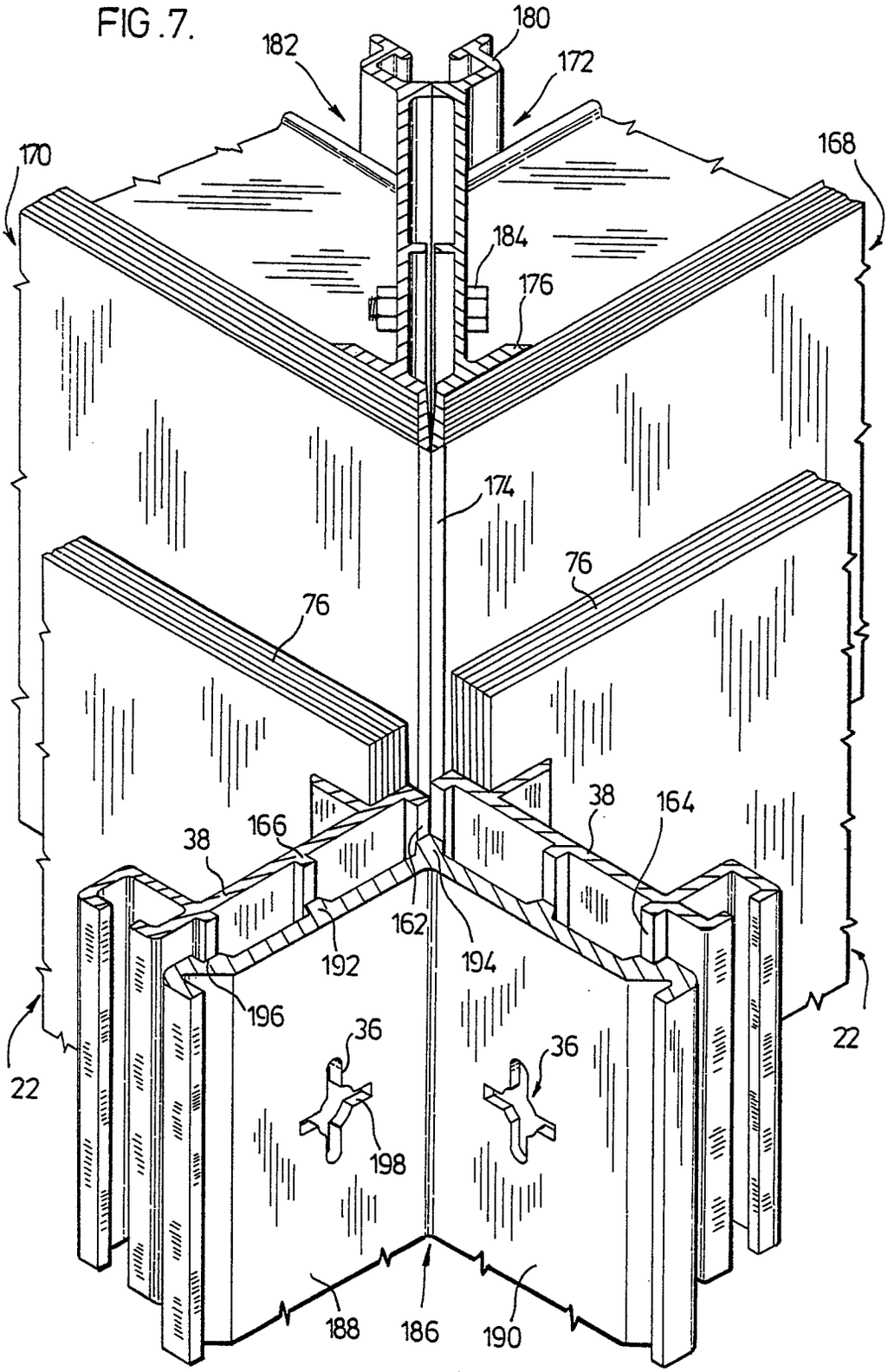
FIG. 6.

FIG. 7.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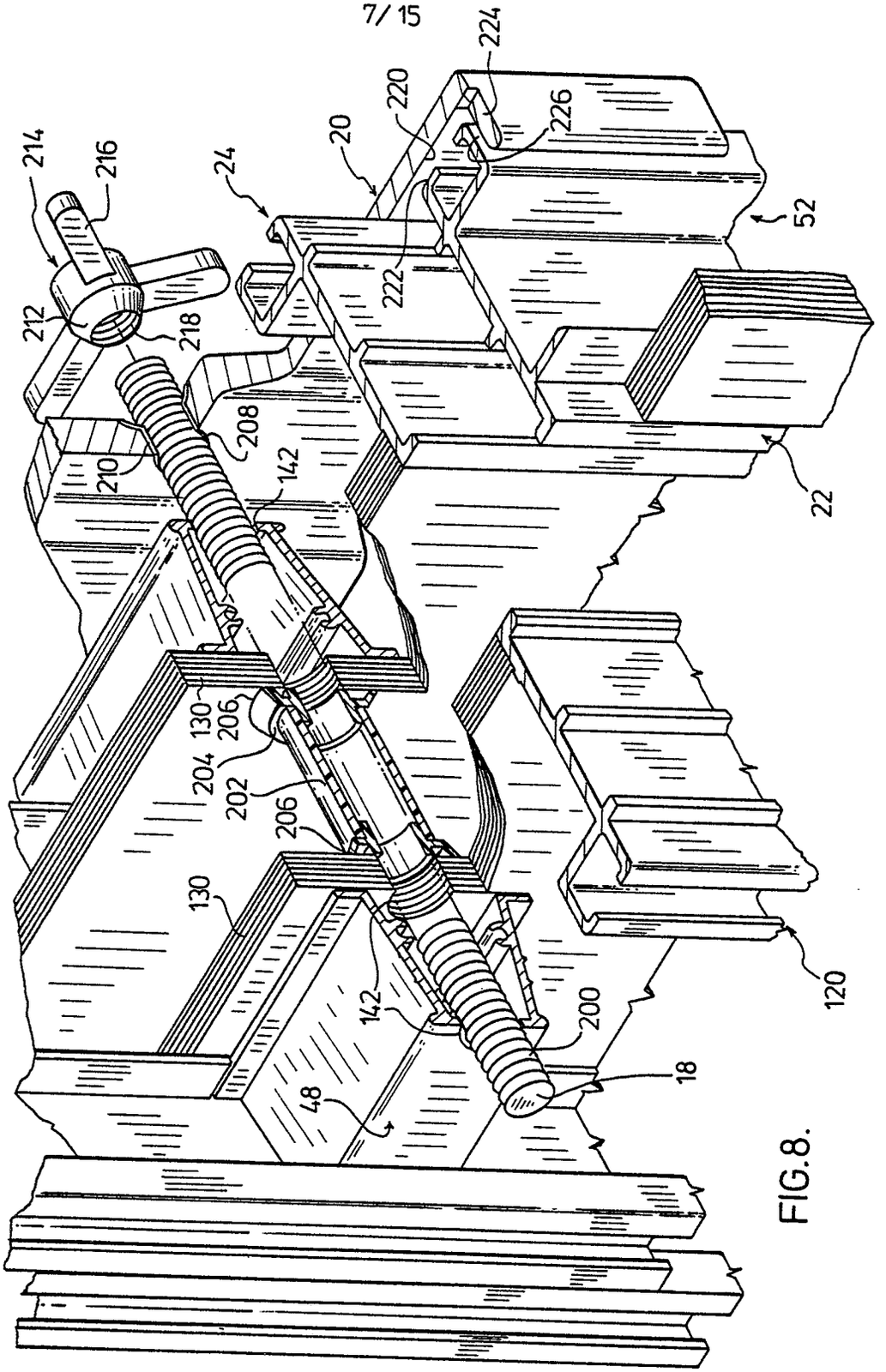
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FIG.8.

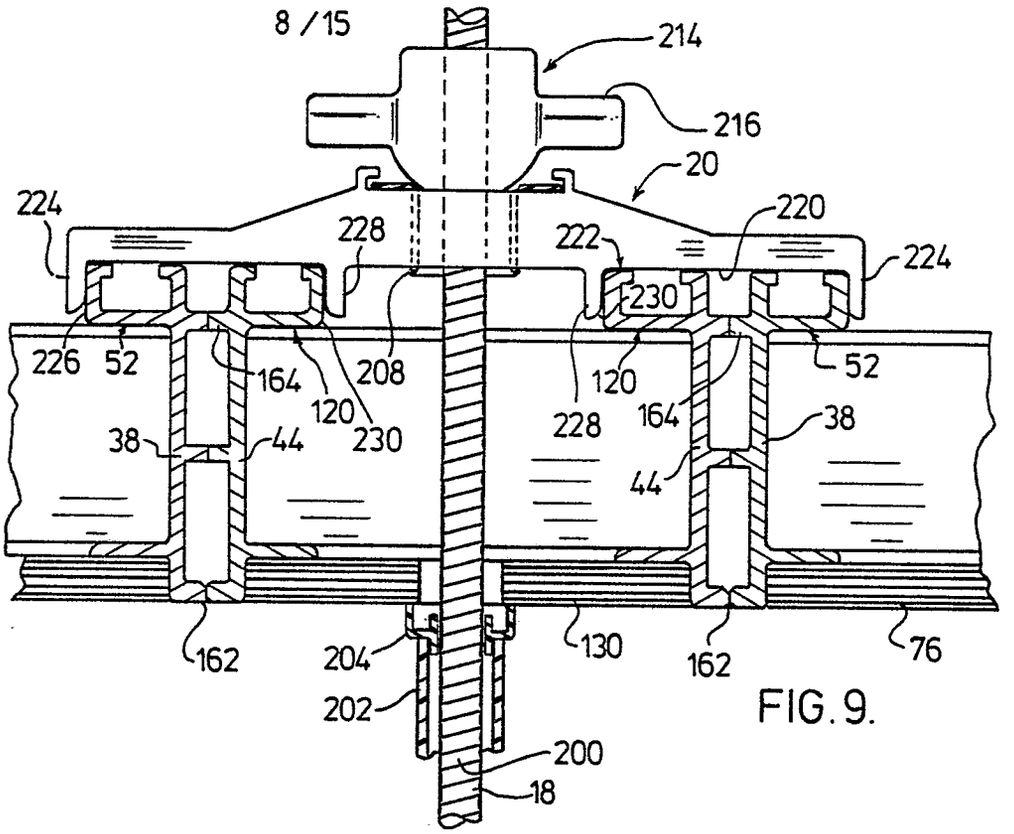
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FIG. 9.

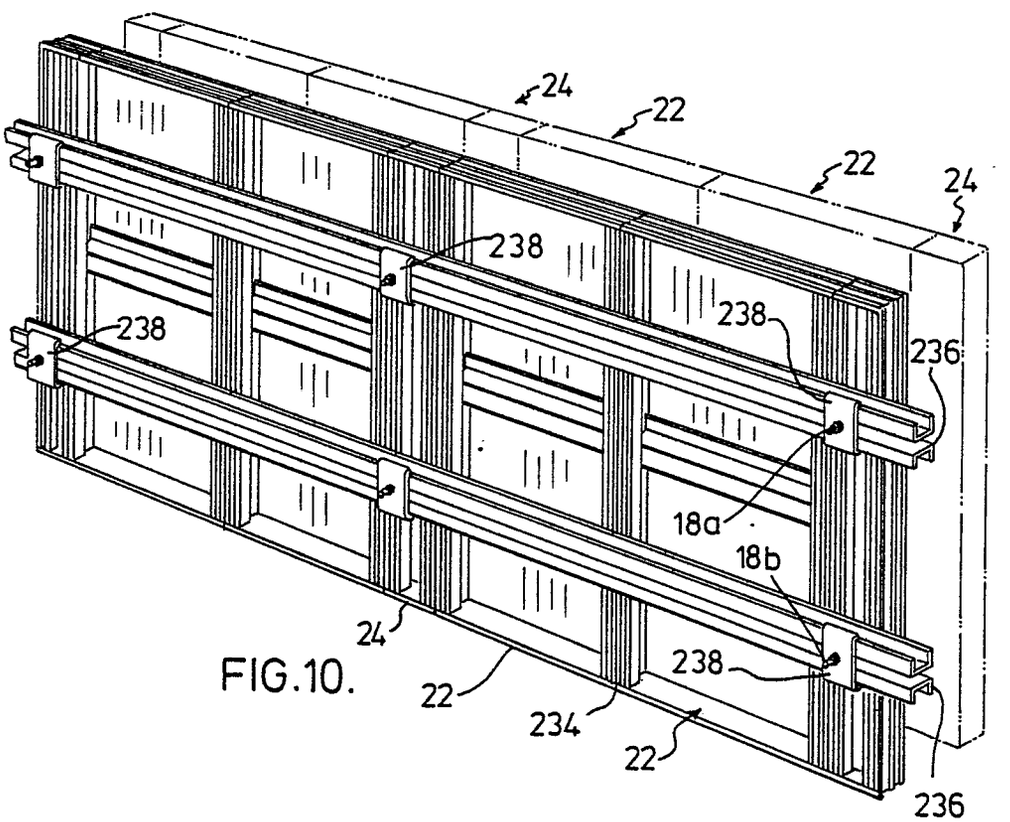
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FIG. 10.

FIG.12.

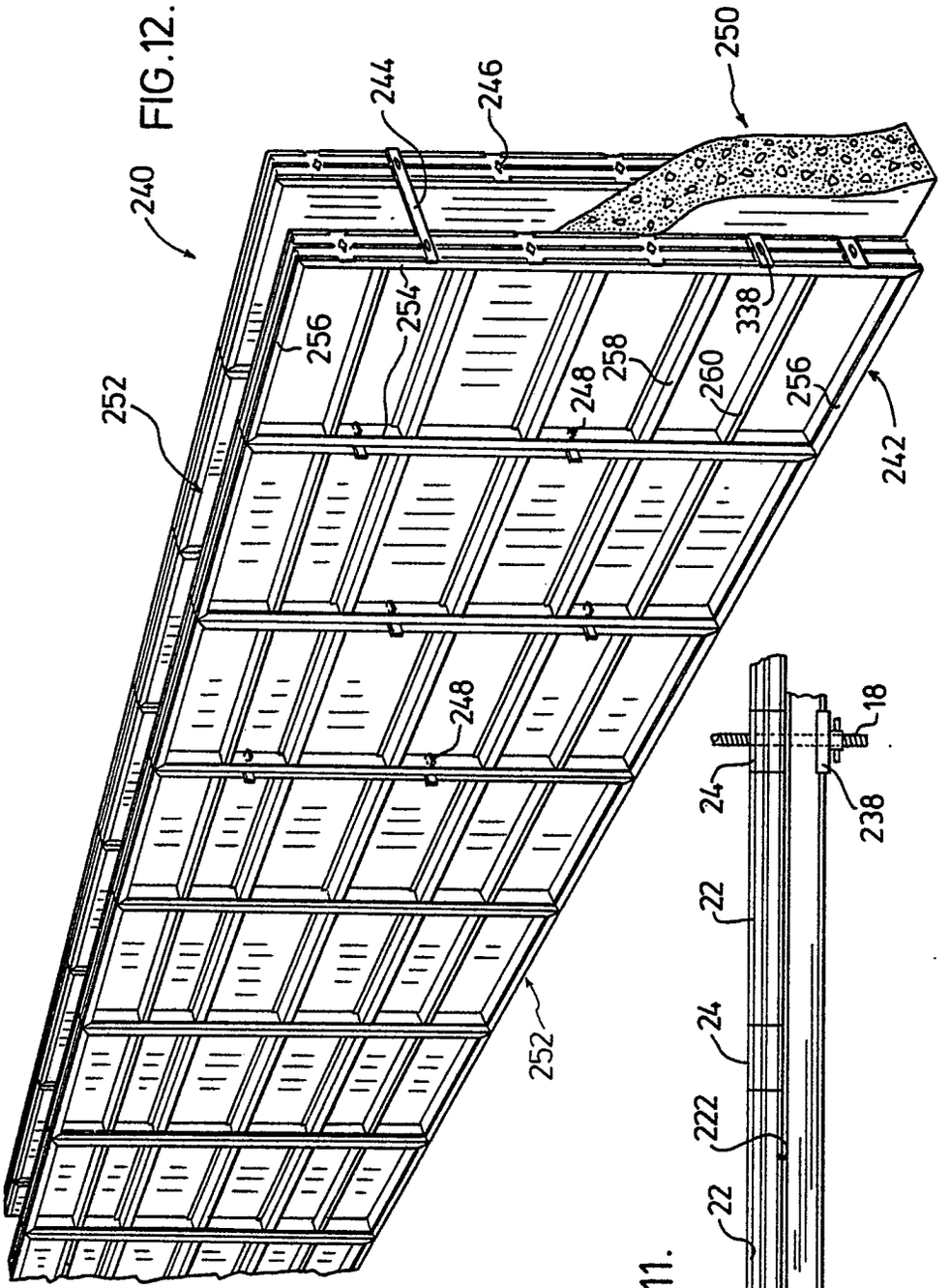
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FIG.11.


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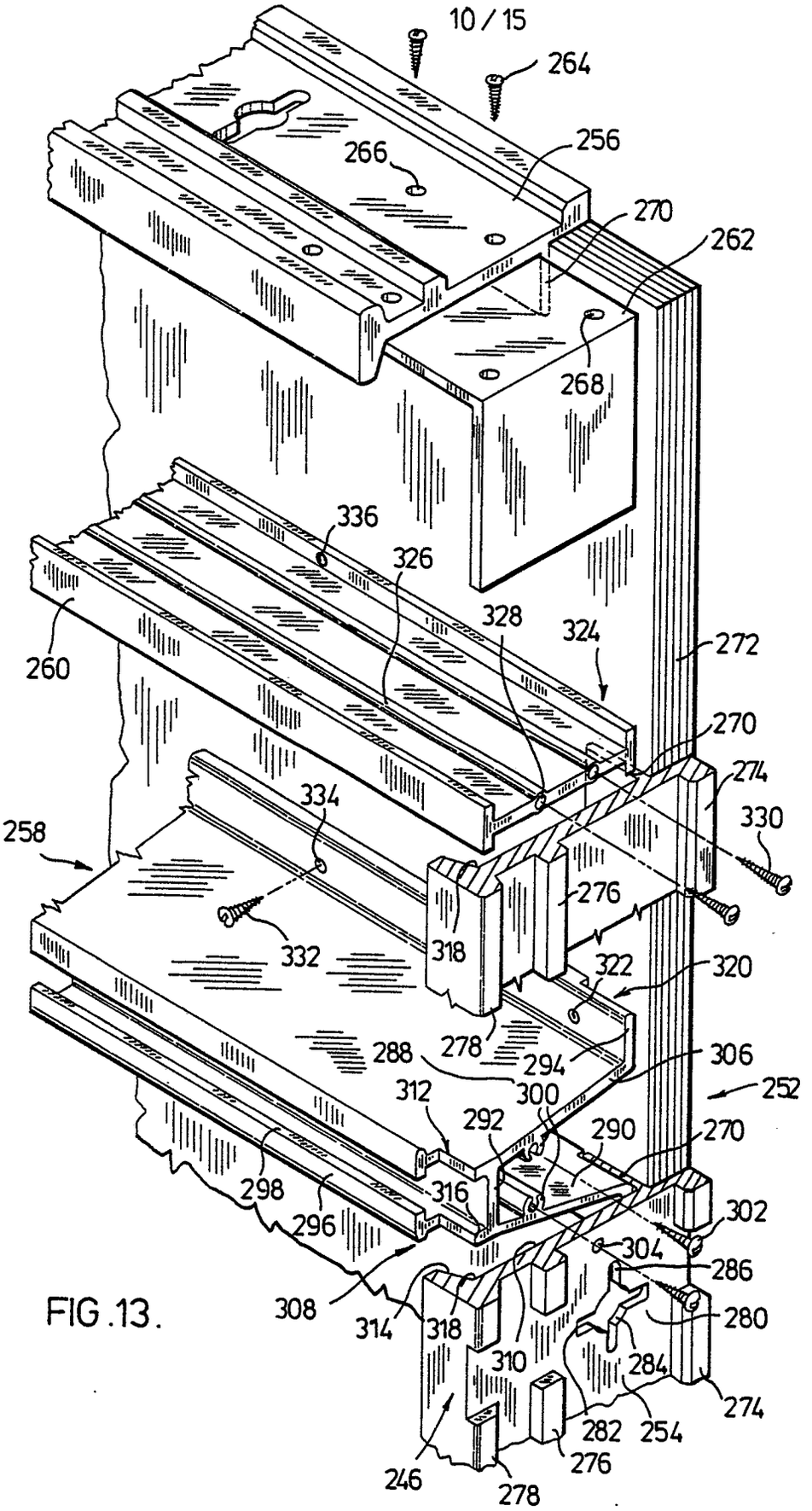
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FIG.13.

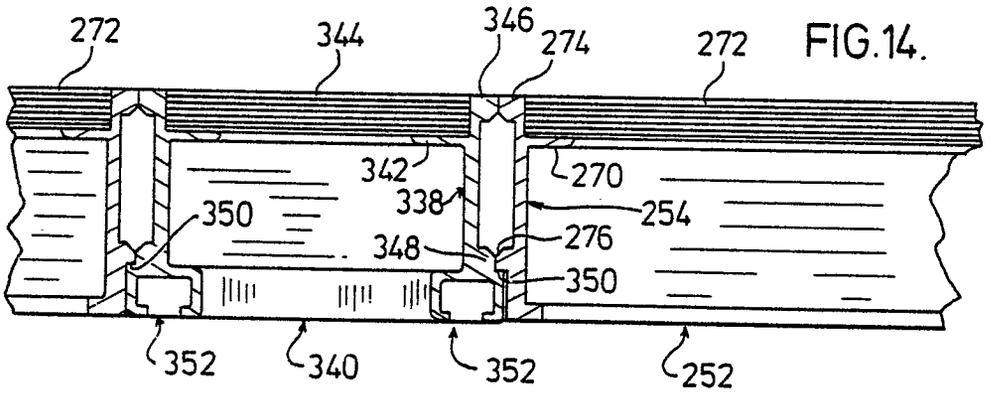


FIG.14.

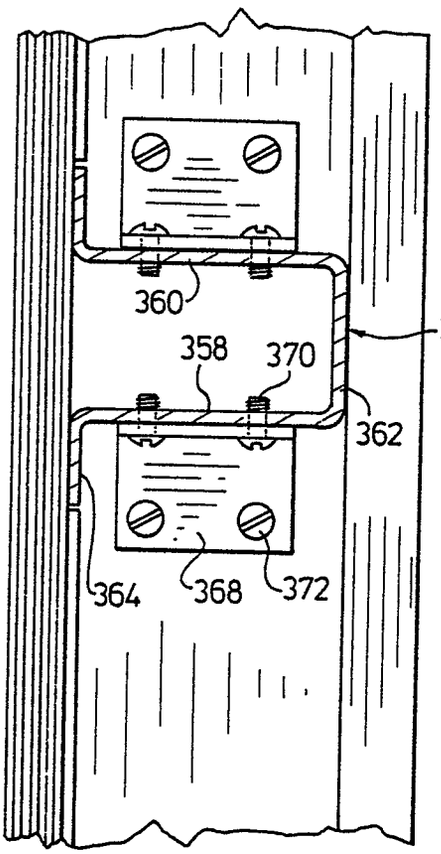


FIG.15.

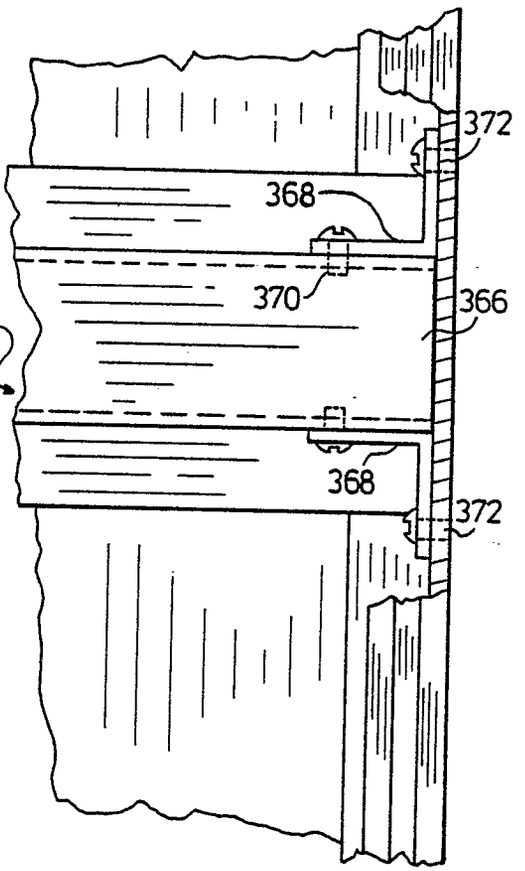


FIG.16.

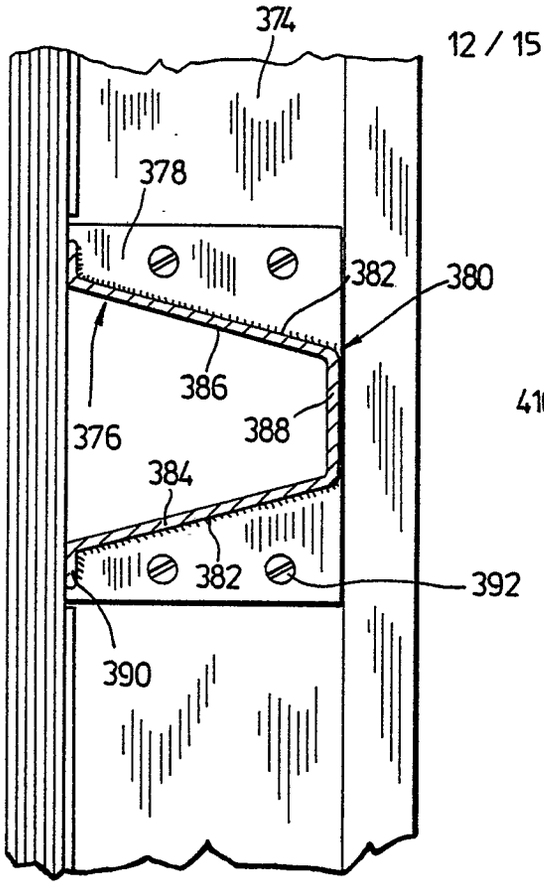


FIG .17.

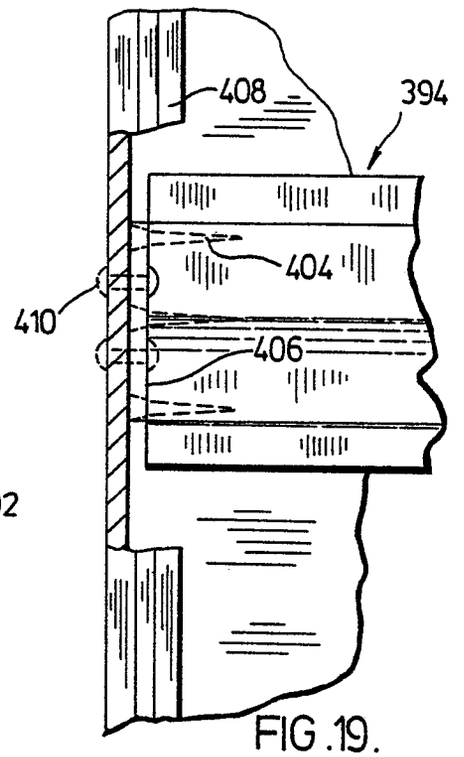


FIG .19.

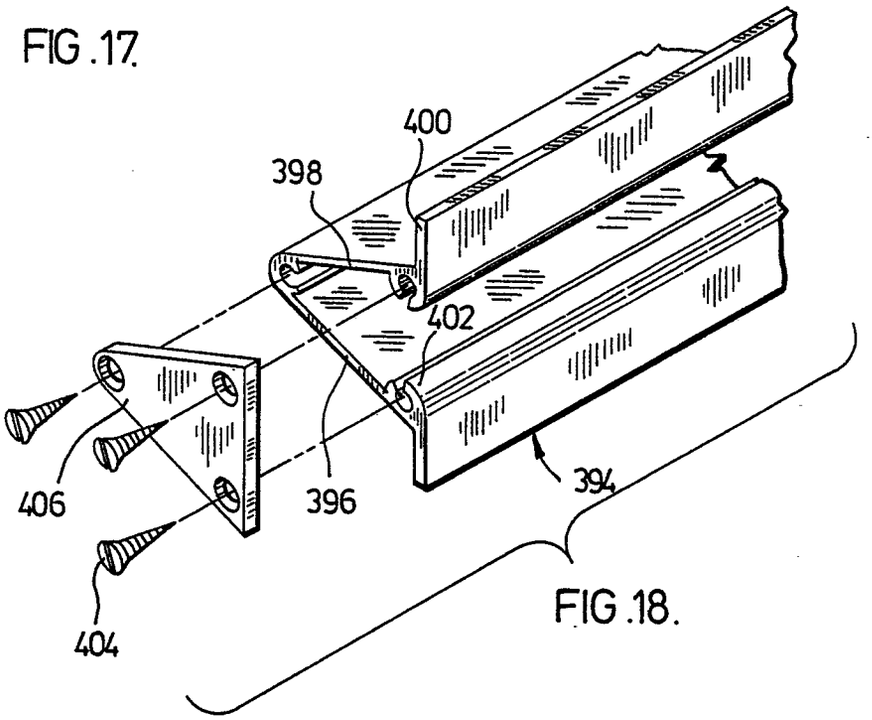


FIG .18.

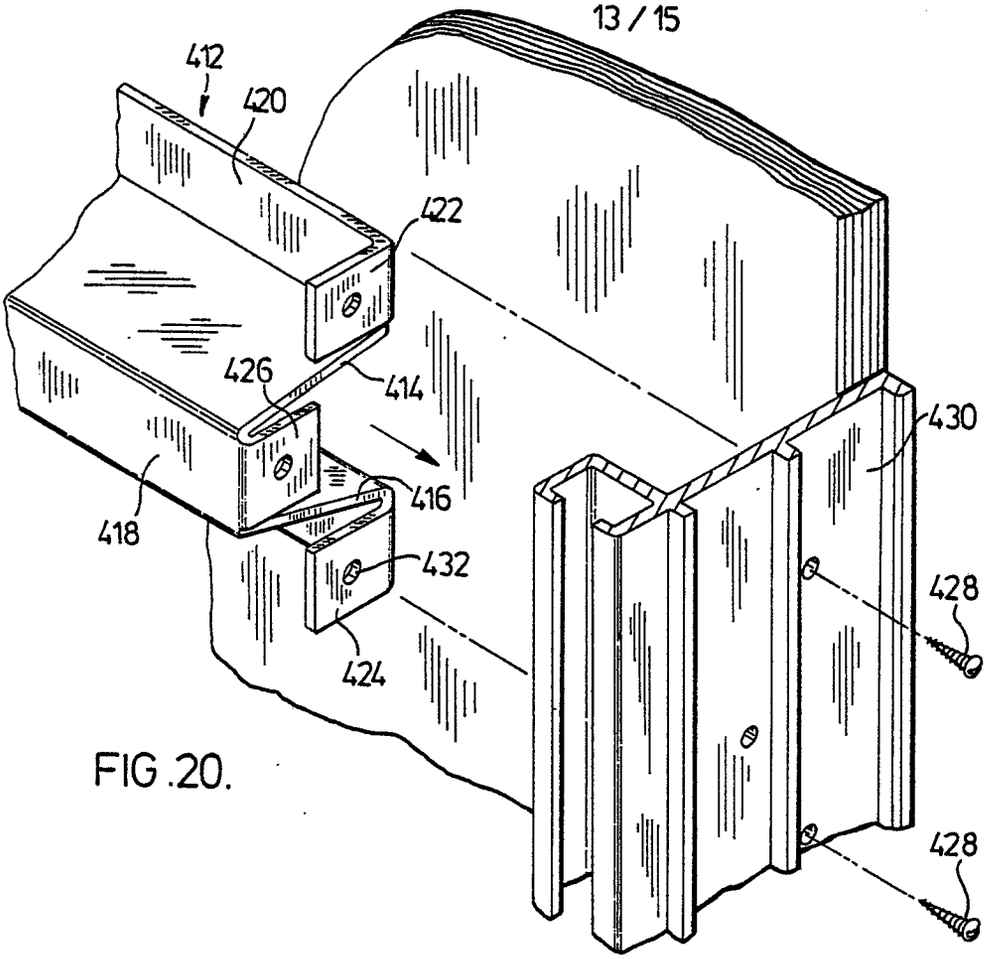
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FIG .20.

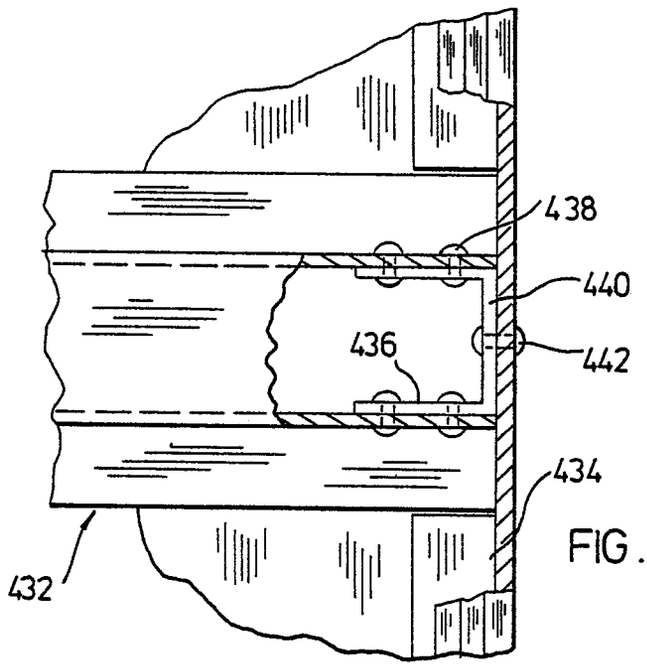
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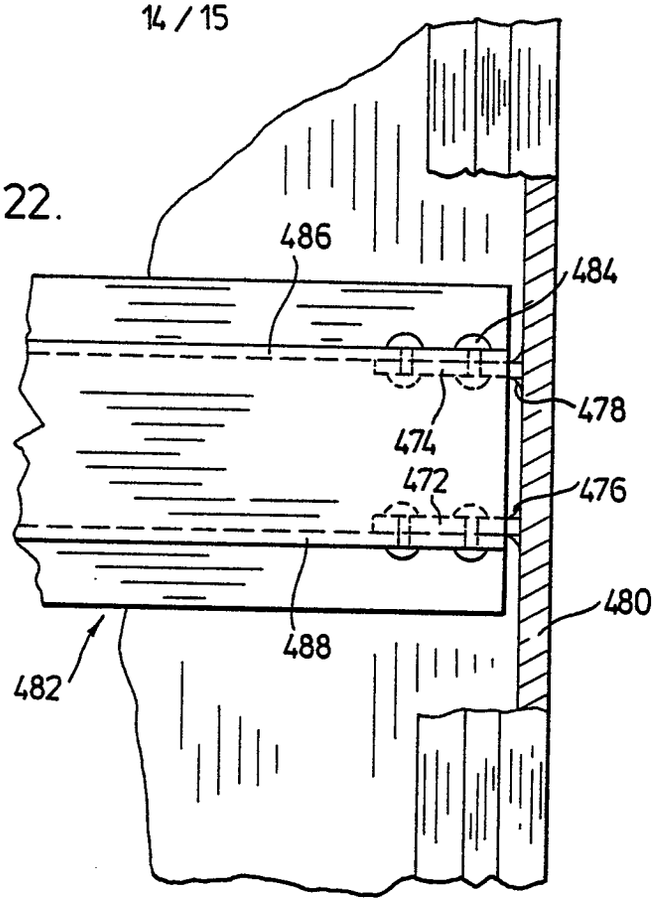
FIG .21.

FIG. 22.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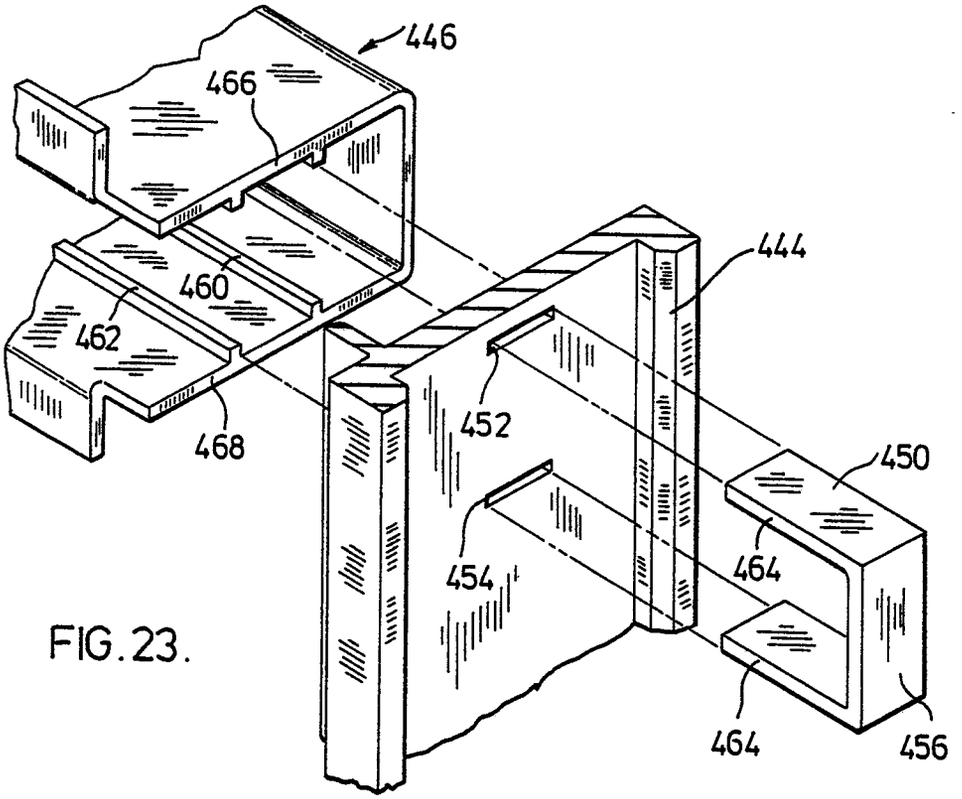
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FIG. 23.

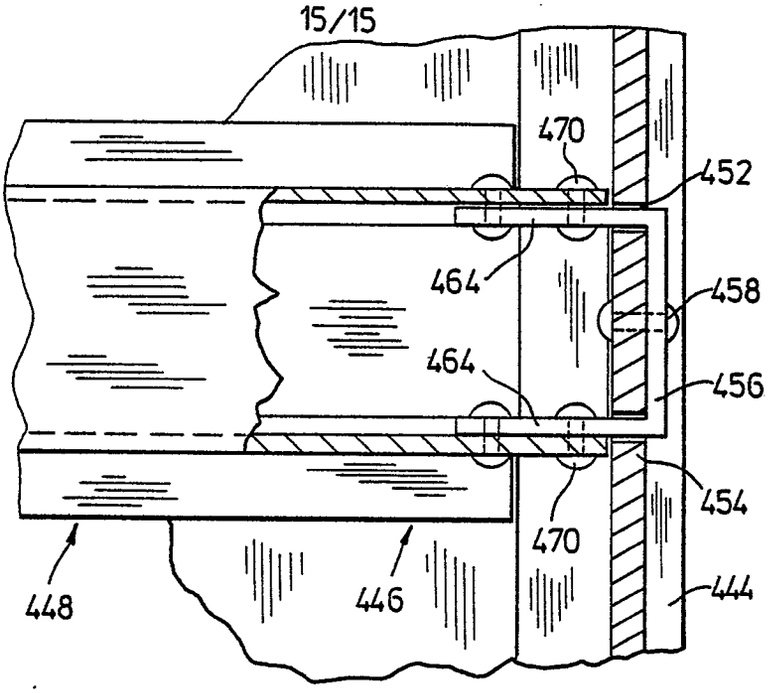
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FIG. 24.

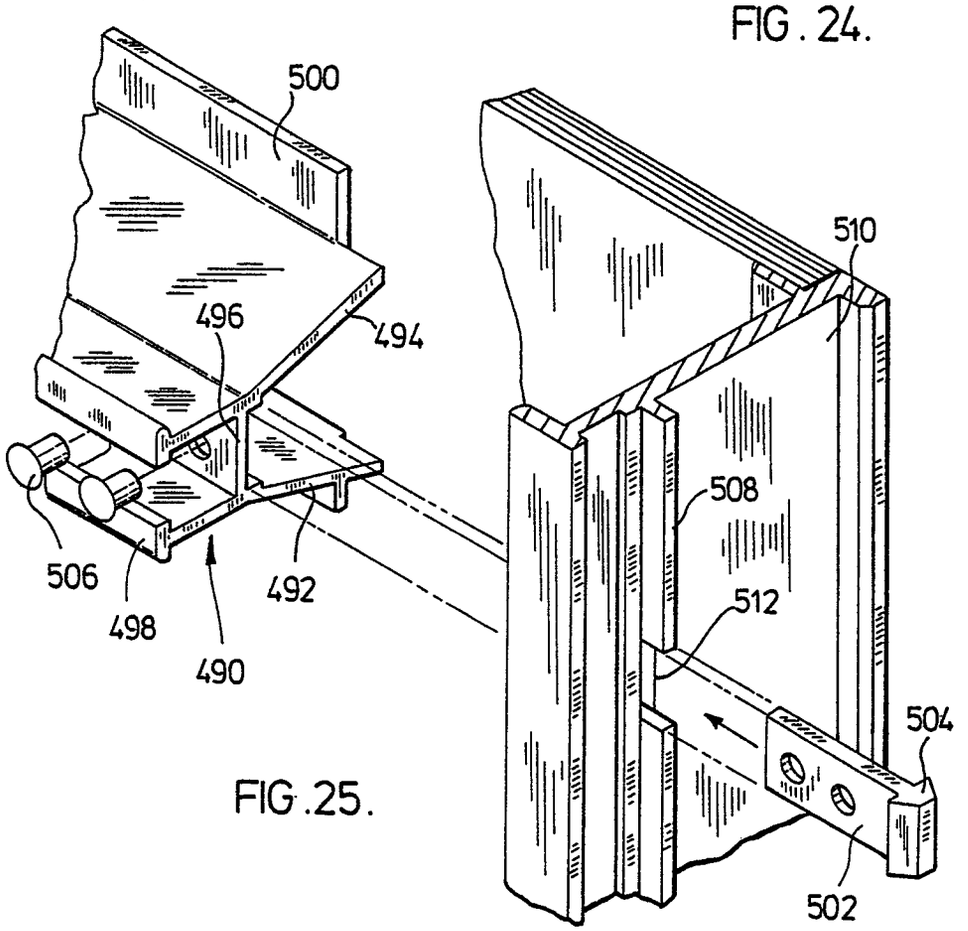
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FIG. 25.

0062420

Application number

EP 82 30 1301.6

European Patent Office

# EUROPEAN SEARCH REPORT

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim |
|---|---|---|
| A | US - A - 3 163 911 (W.H. KENNEY)<br>* column 2, lines 25 to 52; fig. 1 to 4 * | |
| A | GB - A - 1 343 051 (SYMONS CORP.)<br>* fig. 1, 3 *<br>& DE - A - 2 128 609 | |
| A | GB - A - 1 142 861 (RAPID METAL DEVELOPMENTS LTD.)<br>* fig. 1 * | |
| A | US - A - 3 362 676 (G.F. BOWDEN)<br>* fig. 1 to 3 * | |
| A | US - A - 3 171 186 (G.F. BOWDEN)<br>* fig. 1 to 4, 7 * | |
| A | US - A - 3 246 871 (G.F. BOWDEN)<br>* fig. 1 to 3 * | |

### CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)

E 04 G 11/08
E 04 G 17/04
E 04 G 9/08
E 04 G 11/48

### TECHNICAL FIELDS SEARCHED (Int.Cl. ³)

E 04 G 9/00
E 04 G 11/00
E 04 G 17/00

### CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same category
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Berlin | 16-06-1982 | v. WITTKEN |