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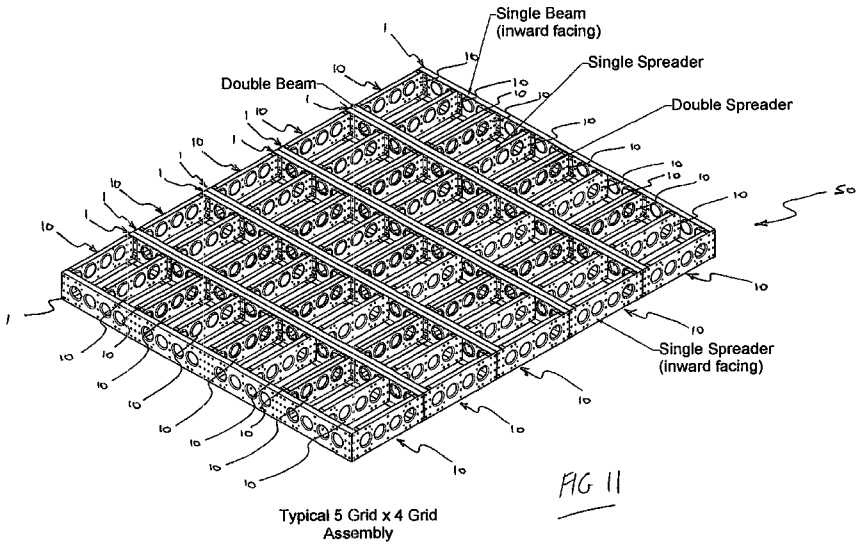


FIG 11

(57) Abstract: A frame system for a building structure includes beam members. Each beam member comprises two opposed, parallel flanges. A web is interposed between the flanges. Spreader members comprise two opposed, parallel side flanges, a web interposed between the side flanges and two opposed end flanges bridging the side flanges at respective terminal ends of the web. The beam members and the spreader members are configured to be fastened to each other to form a frame assembly.

FRAME SYSTEMS FOR BUILDING STRUCTURES

TECHNICAL FIELD

[00001] Various embodiments of frame systems suitable for building structures such as housing and commercial buildings are described. Various embodiments of forming machines for forming structural members for the frame systems and methods of forming the frame systems are described.

RELATED APPLICATIONS

[00002] This application claims the benefit of Australian provisional patent application numbers 2014902604 and 2014902687 filed on 7 July 2014 and 11 July 2014, respectively. The subject matter, including the specifications and drawings, of Australian provisional patent application numbers 2014902604 and 2014902687 are hereby incorporated by reference.

SUMMARY

[00003] Various exemplary embodiments of a frame system for a building structure comprise

beam members, each beam member comprising

two opposed, parallel flanges; and

a web interposed between the flanges; and

spreader members, each spreader member comprising

two opposed, parallel side flanges;

a web interposed between the side flanges; and

two opposed end flanges bridging the side flanges at respective terminal ends of the web, wherein the beam members and the spreader members are configured to be fastened to each other to form a frame assembly.

[00004] At least one end portion of each spreader member may have a length that is greater than a depth of the flanges of the beam members and may be of a reduced width to permit the end portion to fit and to extend between the flanges of the beam members.

[00005] The at least one end portion of each spreader member may have a reduced width such that the at least one end portion can fit between the flanges of the beam members with the flanges of the beam members and the spreader members being substantially co-planar so that the frame system can define a planar support surface.

[00006] The at least one end portion may be of a reduced width to an extent that is substantially equivalent to twice a thickness of a material of the beam members.

[00007] The beam member and the spreader member may be the products of at least a punching and folding operation carried out on lengths of sheet steel.

[00008] The side flanges of the spreader member may be bent to define the at least one end portion.

[00009] The end flanges of the spreader member may be bent to define inwardly extending zones that accommodate tabs extending from the side flanges, such that the end flanges and the tabs present a substantially flat surface so that the end flanges can be fastened directly to the webs of the beam members without the use of washers or packing.

[00010] The webs of the beam and spreader members may define apertures or openings for accommodating services for a building.

[00011] The frame system may include pairs of beam members arranged with abutting webs, wherein the beam pairs are arranged into a spaced apart, parallel array, and wherein adjacent beam pairs are bridged by an array of spaced apart, parallel spreader members.

[00012] The spreader members may include at least one pair of spreader members arranged with abutting webs.

[00013] Various exemplary embodiments of a method of building comprise fastening the beam and spreader members together to form the frame system.

[00014] The method may comprise:

forming two or more of the frame systems on a substrate, one on top of the other, such that a lowermost frame system defines a ground floor assembly and an uppermost frame system defines a roof assembly;

erecting a roof structure on the uppermost frame system while the uppermost frame system remains on one of the ground floor assembly and an intermediate floor assembly; and

lifting at least the uppermost frame system to define at least one floor level of the building structure.

[00015] The method may comprise forming the beam and spreader members by carrying out reciprocal forming and shaping operations on metal sheet.

[00016] Each spreader member may be formed by carrying out the following operations on a length of metal sheet:

punching the sheet to form apertures and notches or cuts in the sheet;

folding sides of the sheet to form side flanges;

folding ends of the sheet to form opposed end flanges; and

folding tabs extending from the side flanges over the end flanges.

[00017] The above operation could also be carried out so that the opposed end flanges are folded over to cover the tabs.

[00018] The step of folding the sides of the sheet may be carried out so that at least one end portion of the resultant spreader member has a length that is greater than a depth of the flanges of the beam members and is of a reduced width to permit the end portion to fit and to extend between the flanges of the beam members.

[00019] The step of folding the sides of the sheet may be carried out so that the at least one end portion can fit between the flanges of the beam members with the flanges of the beam members and the spreader members being substantially co-planar.

[00020] The reciprocal forming and shaping operations may be carried out by a forming machine that is located at a building site at which the building structure is to be built.

[00021] Various exemplary embodiments of a building structure comprise:

at least two frame systems as described above.

[00022] One of the frame systems may be a ground floor assembly supported on a base and another of the frame systems may be a roof assembly supported above the ground floor assembly, such that at least one floor level is defined between the ground floor assembly and the roof assembly.

[00023] Various exemplary embodiments of a forming machine for forming a spreader member of a frame system for a building structure comprise

a base;

a platform positioned above the base;

a top die arranged on the platform;

a bottom die supported by the base and operatively arranged with respect to the top die, the top and bottom dies being reciprocally displaceable relative to each other to punch apertures and notches or cuts in the sheet;

two side flange formers arranged on the base, one on each side of the bottom die, for forming parallel side flanges of the spreader member, the flange former being capable of horizontal and vertical actuation;

two end flange formers arranged on the base, one at each end of the bottom die, for forming parallel end flanges of the spreader member, the end flange formers incapable of horizontal and vertical actuation; and

actuators arranged on the base and the platform and operatively engaged with the flange formers, the actuators being configured for operation such that the side flange formers can fold sides of the metal sheet to form the side flanges and the end flange formers can fold ends of the metal sheet to form the end flanges.

[00024] The side flange formers may incorporate a die former that is shaped so that, upon operation of the side flange formers, the die formers can carry out an operation on the sides of the

metal sheet retained between the top and bottom dies to bend the side flanges so that at least one end portion of the spreader member has a reduced width.

[00025] The end flange formers may incorporate a die former that is shaped so that, upon operation of the end flange formers, the die formers can carry out an operation on the ends of the metal sheet so that a resultant end flange of the spreader member has inwardly extending zones to accommodate tabs that extend from the side flanges such that, when the tabs are folded inwardly, the end flanges and the tabs present a substantially flat surface.

BRIEF DESCRIPTION OF DRAWINGS

[00026] Figures 1 and 2 are isometric views of a beam member for an exemplary embodiment of a frame system for a building structure.

[00027] Figures 3 and 4 are isometric views of a spreader member for an exemplary embodiment of a frame system for use with the building structure.

[00028] Figures 5 and 6 are isometric views of a column member for an exemplary embodiment of a frame system for use with a building structure.

[00029] Figure 7 is a front view of a cleat or splice member.

[00030] Figure 8 is an isometric view of the splice member of Figure 7.

[00031] Figure 9 is an isometric view of the spreader member from one side.

[00032] Figure 10 is an isometric view of the spreader member from another side.

[00033] Figure 11 is an isometric view of the frame system comprised of the beam and spreader members.

[00034] Figure 12 is an isometric view of a building frame assembly comprised of the beam, spreader, column and cleat members of Figures 1 through 10.

[00035] Figure 13 is a detail view of a corner of a building frame assembly.

[00036] Figure 14 is an external view of a corner of a base of the building frame assembly of Figure 13.

[00037] Figure 15 is an internal view of the corner of Figure 13.

[00038] Figure 16 is a plan view of the corner of Figure 13.

[00039] Figure 17 is a plan view of an internal corner of the base of the building frame assembly of Figure 12.

[00040] Figure 18 is an isometric view of the internal corner of Figure 15.

[00041] Figure 19 is a plan view of a further internal corner of the base of the building frame of Figure 10.

[00042] Figure 20 is an external view of an attachment point between the base and a column.

[00043] Figure 21 is an internal view of the attachment point of Figure 20.

[00044] Figure 22 is an isometric view of a concrete footing of a building structure.

[00045] Figure 23 is an isometric view of the concrete footing of Figure 22 including thermal masses.

[00046] Figure 24 is an isometric view of a first floor assembly supported on the footing of figure 23.

[00047] Figure 25 is an isometric view of a first floor resting on the first floor assembly of Figure 24.

[00048] Figure 26 is an isometric view of jacks supported by the first floor assembly of Figure 24.

[00049] Figure 27 is an isometric view of a second floor assembly supported on the first floor of Figure 26.

[00050] Figure 28 is an isometric view of a second floor resting on the second floor assembly of Figure 27.

[00051] Figure 29 is an isometric view of jacks supported by the second floor assembly of Figure 27.

[00052] Figure 30 is an isometric view of a roof frame assembly supported on the second floor of Figure 28.

[00053] Figure 31 is an isometric view of a part of roof structure supported by the roof frame assembly of Figure 30.

[00054] Figure 32 is an isometric view of the completed roof structure of Figure 31.

[00055] Figure 33 is an isometric view of the roof structure of Figure 32 including gutters.

[00056] Figures 34 and 35 are isometric views of the roof structure of Figure 33 including roof panels and solar panels.

[00057] Figure 36 is an isometric view of a building structure wherein a second floor assembly and a roof frame are partially raised using jacks.

[00058] Figure 37 is a side view of the building structure of Figure 36 with the second floor assembly and roof frame raised using jacks.

[00059] Figure 38 is an isometric view of the building structure of Figure 37 with the second floor assembly raised using jacks and columns extending between the first floor assembly and the second floor assembly.

[00060] Figure 39 is an isometric view of the building structure of Figure 38 wherein the roof frame assembly is partially raised relative to the second floor assembly using jacks.

[00061] Figure 40 is an isometric view of the building structure of Figure 38 wherein the roof frame assembly is fully raised.

[00062] Figure 41 is an isometric view of the building structure of Figure 40 including column members extending between the roof frame and the second floor assembly.

[00063] Figure 42 is an isometric view of the building structure of Figure 41 with the jacks removed.

[00064] Figure 43 is an isometric view of the building structure of Figure 42 being clad.

[00065] Figure 44 is an isometric view of the building structure of Figure 43 including windows.

[00066] Figure 45 is an isometric part sectional view of the building structure of Figure 44.

[00067] Figure 46 is an isometric view of the concrete footing showing a first assembly stage of the floor assembly.

[00068] Figure 47 is an isometric view of the concrete footing showing a second assembly stage of the floor assembly.

[00069] Figure 48 is an isometric view of the concrete footing showing a third assembly stage of the floor assembly.

[00070] Figures 49 to 53 show different positions for a column fastened to the floor assembly.

[00071] Figure 54 shows a partly exploded view of a fastening arrangement for fastening a floor assembly between floors of a building.

[00072] Figure 55 shows the partly exploded view of figure 54 from a different angle.

[00073] Figures 56 to 58 show, consecutively, three stages in the construction of a floor assembly between floors of a building.

[00074] Figure 59 is a side view of an exemplary embodiment of a jack suitable for use with the building system.

[00075] Figure 60 is a three dimensional view of the jack of figure 59.

[00076] Figure 61 is a three dimensional view of a mounting head 348 of the jack engaged with a floor assembly.

[00077] Figure 62 is a three dimensional view of the jack in a closed condition mounted on a floor assembly.

[00078] Figure 63 is an isometric view of a forming machine for forming the spreader member of figures 3 and 4.

[00079] Figure 64 is an isometric view of the forming machine of figure 63 prior to operation.

[00080] Figure 65 is an isometric view of the forming machine of figure 63 during a first stage of operation thereof.

[00081] Figure 66 is a view taken at detail A of figure 65.

[00082] Figure 67 is a detail view of the forming machine during a second stage of operation thereof.

[00083] Figure 68 is a detail view of the forming machine during a third stage of operation thereof.

[00084] Figure 69 is a detail view of the forming machine during a fourth stage of operation thereof.

[00085] Figure 70 is a detail view of the forming machine during a fifth stage of operation thereof.

[00086] Figure 71 is a detail view of the forming machine during a sixth stage of operation thereof.

[00087] Figure 72 is a detail view of the forming machine during a seventh stage of operation thereof.

[00088] Figure 73 is a detail view of the forming machine during an eighth stage of operation thereof.

[00089] Figure 74 is a detail view of the forming machine during a ninth stage of operation thereof.

[00090] Figure 75 is a detail view of the forming machine during a tenth stage of operation thereof.

[00091] Figure 76 is a cross-sectional view taken through the forming machine of Figure 63.

[00092] Figure 77 is a view taken at detail B of Figure 76.

[00093] Figure 78 is an isometric view of a forming machine for forming the beam member of Figures 1 and 2.

[00094] Figure 79 is a flow chart illustrating a control sequence for a forming machine for forming beam members.

[00095] Figure 80 is a flow chart illustrating a control sequence for a forming machine for forming spreader members.

[00096] Figure 81 is a three-dimensional view, from one side, of a column member of figure 5.

[00097] Figure 82 is a three-dimensional view, from another side, of the column member.

[00098] Figure 83 is an end view of the column member.

[00099] Figures 84 and 85 are isometric views of a forming machine for forming the column member of Figure 81.

[00100] Figure 85 is an end view of the forming machine of Figure 84 during a first stage of operation thereof.

[00101] Figure 87 is a view taken at detail C of Figure 86.

[00102] Figure 88 is a detail view of the forming machine during a second stage of operation thereof.

[00103] Figure 89 is a detail view of the forming machine during a third stage of operation thereof.

[00104] Figure 90 is a detail view of the forming machine during a fourth stage of operation thereof.

[00105] Figure 91 is an end view of the forming machine after completion of the fourth stage of operation thereof.

[00106] Figures 92 to 94 show different views of a punching station for punching holes or openings into a blank that is to be formed into the column member.

[00107] Figure 95 shows a first stage in the operation of part of the forming machine that forms a side flange of the spreader.

[00108] Figure 96 shows a second stage in the operation of part of the forming machine that forms the side flange of the spreader.

[00109] Figure 97 shows a schematic view of a first stage in an operation to form a side flange of a spreader.

[00110] Figure 98 shows a schematic view of a second stage in the operation of figure 88.

[00111] Figure 99 shows a schematic of a draw tool used in the operation to form the side flange of the spreader.

DESCRIPTION OF EMBODIMENTS

[00112] In the following description, like reference characters designate like or corresponding parts throughout the figures. However, use of common reference characters is for convenience only and is not to be construed as identifying a component of one embodiment as being essential to any other embodiment. Furthermore, it is to be understood that, where practical, the following description describes further embodiments comprising combinations of components drawn from different embodiments.

[00113] Referring to figures 1 and 2, reference numeral 1 generally indicates an exemplary embodiment of a beam member 1 of a frame system for a building structure. The beam member 1 comprises a parallel flange channel section comprising a web 2 bridging two parallel flanges 4, and an array of through-apertures or openings in the form of service openings or holes 6 spaced lengthwise along the web 2. The holes 6 are dimensioned so that, in use in the frame system, for example as a floor or roof assembly, wiring and pipework can be passed through the holes 6. The beam member 1 is open between the parallel flanges 4 to define a C-channel 8.

[00114] Referring to figures 3 and 4, reference numeral 10 generally indicates an exemplary embodiment of a spreader member or spreader 10. The spreader 10 comprises a parallel flange channel section comprising a web 12 bridging two parallel side flanges 14, and an array of through-apertures in the form of service openings or holes 16 spaced lengthwise along the web 12. The holes 16 are dimensioned so that, in use in a base or floor assembly, wiring and pipework can be passed through the holes 16.

[00115] The spreader member 10 is shorter than the beam member 1. The spreader member 10 has a parallel end flanges 18 extending between or bridging the side flanges 14 at each terminal end 17 of the member 10. Opposed end portions 20 of the spreader 10 are sized to fit snugly between the parallel flanges 4 of the beam member 1. In other words, a width of the spreader 10 is reduced at the portions 20 so that the portions 20 can fit snugly between the parallel flanges 4 without the use of packing to take up any play. The width of the spreader 10 measured between the external sides of the parallel flanges 14 is substantially the same as the width of the channel 8 measured between facing sides of the parallel flanges 4. An extent of reduction of the spreader 10 at the portions 20 corresponds with twice the thickness of the material used for the beam member 1. Thus, when the portions 20 fit between the flanges 4, external faces of the remaining portions of the spreader 10 are flush with external faces of the flanges 4. Further detail of the spreader 10 can be seen in figures 9 and 10. As a result, a structure, for example a floor made up of planar floorboards or members can be positioned on

the spreader and beam members without the need for packing to take up any space between the floorboards or members and the spreader and beam members.

[00116] The end flanges 18 also define portions 21 that are folded or bent inwardly to define inwardly extending zones or recesses that accommodate tabs 23 that extend from the side flanges and are folded over when the spreader is formed. The extent of the inward folding of the portions 21 is such that external faces of the tabs 23 are flush with an external surface of a remaining portion of the end flange 18. Thus, when the portions 20 are positioned between the flanges 4, the end flange 18 can butt against an internal surface of the web 2 of the beam member 1. This allows the web 2 to be fastened to the end flange 18 without the use of packing or washers.

[00117] It follows that the length of the portions 20 is such that the flange 18 can butt or be brought to bear against the web 2.

[00118] Both the spreader member 10 and the beam member 1 share the same sectional depth. In use, end flanges 18 of the spreader member 10 enter the channel 8 of the beam member 1 between the flanges 4 of the beam member 1 to span the web 2 or to bridge or extend between the flanges 4.

[00119] The web 12 of the spreader member 10 defines a plurality of openings 9. These can be used for fastening the beam members 1 to the spreaders 10 and for other purposes which are described below.

[00120] Referring to Figures 5 and 6, reference numeral 30 generally indicates an exemplary embodiment of a column member 30. The column member 30 is generally truncated-"A"-shaped in transverse cross section. The column member 30 comprises a pair of converging walls 32 converging at a flat strip or cap 33 interposed between the walls 32. Each of the walls 32 terminates at an edge from which there extends a foot or flange 34. The flanges 34 are substantially parallel with angled outturns 35 (figure 83). The column member 30 has an array of bolt holes 31 in the cap 33, walls 32 and flanges 34. See for example figures 54 and 55 where these bolt holes are used.

[00121] A building frame arrangement or system 62 (figure 12) consists of three main elements, a 'C' formed member with open ends (i.e. the beam member 1), a 'C' formed member with integral cleats or closed ends (i.e. the spreader 10) and a substantially truncated 'A' formed member with open ends (i.e. the column member 30). All of these components can be formed from a sheet of steel fed from a roll of stock or coil. Alternatively, the components can be formed from sheet stock. For example, the components can use pre-sheeted steel coil or can be enabled to run from slit coil according to a required width of the respective component. Furthermore, widths of the material used for the components can either be the same or can vary with respect to each other depending on structural requirements.

[00122] Referring to Figure 11, reference numeral 50 generally indicates an exemplary embodiment of a frame assembly of the building frame system 62. The frame assembly 50 comprises

pairs of beam members 1 arranged with webs 2 abutting in a back-to-back arrangement and end beam members 1 with webs 2 facing inwardly. The beam member 1 pairings are arranged into a spaced apart parallel array. Adjacent beam member pairings are bridged by an array of spaced apart parallel spreaders 10 to form a grid arrangement. The beam members 1 and spreaders 10 are bolted together via the bolt holes 9 provided in the beam member 1 and the spreader 10. At select locations of the frame assembly 50, the spreaders 10 are arranged into pairs with abutting webs 12 in a back-to-back arrangement. End flanges 18 of each spreader 10 fit into respective channels 8 of facing beam members 1 to butt or bear against the webs 12 of the beam members 1 as described above. The spreaders 10 are fixed to the beam members 1 by bolts that extend through the bolt holes in the webs 12 of the beam members 1 and the end flanges 18 of the spreader members 10.

[00123] The spreaders 10 as well as the beam members 1 are placed back to back to form a double 'C' or 'I' shape in order to improve their load bearing capacity. To better explain and understand the co-operation of the spreaders 10, beam members 1 and column members 30, it may be taken that the spreader 10 is one grid-length and the beam member is (but is not restricted to) four grid-lengths. A length of the column member 30, although not restricted, is set to comply with the most commonly available materials for panelling and walling. In every respect other than those already stated, the features (hole sets) for fasteners and general access holes within each grid of each member are substantially the same. This allows for the spreader member 10 to be positioned in a 'C' or double 'C' (or 'I' shape) arrangement along the length of the beam member 1 at regular repeating grid-length intervals and fixedly located with bolts or other methods as deemed suitable or appropriate.

[00124] In some cases, it may be necessary to comply with jurisdictional building codes. Thus, as shown in figure 11, further single spreaders 10 can be interposed between the beam members 1 to reduce grid size.

[00125] Referring to Figure 12, a floor assembly 60 for a first floor of a building or dwelling includes a plurality of the frame assemblies 50 arranged side by side and bolted together. The floor assembly 60 sits on top of, and is bolted to a substrate such as a building foundation, footing or plinth 64. A plurality of equi-spaced column members 30 is bolted to a periphery of the floor assembly 60, and extends vertically upwards from the floor assembly 60.

[00126] With reference to Figure 13, it can be seen that a plurality (in this case three) of the floor assemblies 60 are horizontally disposed and vertically spaced by a plurality of column members 30. In this way, a lowermost floor assembly 60.1 can support a ground floor of a building, an intermediate floor assembly 60.2 can support a first floor of the building, and an uppermost floor assembly or roof frame assembly 60.3 can support a ceiling and/or a roof of the building.

[00127] Figures 14 to 16 illustrate the formation of an external corner of a frame assembly 50 for a floor assembly 60 by bolting together a beam member 1 and a spreader member 10. Respective column members 30 are bolted through the holes 31 in the flanges 34 thereof to the beam member 1 and the spreader member 10 via a matching pattern of the holes in each.

[00128] Figures 17 and 18 illustrate the formation of an internal corner of a frame assembly 50 for a floor assembly 60. Beam members 1 are bolted to spreader members 10. A column member 30 is bolted through flanges 34 thereof to one of the spreader members 10, via a matching pattern of holes in each.

[00129] Figure 19 illustrates the formation of an internal corner of a frame assembly 50 for a floor assembly 60 by bolting together beam members 1 and spreader members 10. Column members 30 are then bolted through flanges 34 thereof to the beam member 1 and the spreader member 10 via a matching pattern of holes in each.

[00130] Figures 20 and 21 illustrate the formation of an external edge of a frame assembly 50 for a floor assembly 60 by bolting together a beam member 1 and a spreader member 10. Column members 30 are then bolted through flanges 34 thereof to two spreader members 10 via a matching pattern of holes in each. Figure 19 further illustrates a cleat or gusset plate 40 stiffening an internal corner between a beam member 1 and a spreader member 10.

[00131] The facility of the single or double 'C' arrangement for both spreader members 10 and beam members 1 allows any platform of any size to terminate at its perimeter with an inward facing 'C'. This in turn allows a column member 30 to be attached at or around the junction of any grid interval. It also permits a column member 30 to be placed anywhere within a platform that has or is provided with a single 'C' form for attachment. Moreover, as previously noted, the commonality of the holes set out within the grids of the spreader members 10, beam members 1, and the column members 30, also provides the facility to fix grids at ninety degrees to each other as well as laterally and even vertically displace them to provide upper levels (such as upper floors and roof structures).

[00132] The attributes common to the spreader member 10 and the beam member 1 mean that, however they are configured, they provide access for ducting to convey air from the air handler throughout the structure.

Constructing a building structure

[00133] Figures 22 to 45 show the steps of constructing a double story building structure 300 including three floor assemblies 60 and column members 30.

[00134] Figure 22 shows a concrete footing 302 of the building structure 300. The footing 302 may include heated thermal masses 304, shown in figure 21, for climate control of the building

structure 300. The footing 302 also includes a passage formation 305 for the distribution of treated air from the thermal masses 304 throughout the structure 300.

[00135] Referring to figure 24, a number of frame assemblies 50 are assembled on the footing 302 to form a first floor assembly 60.1. The first floor assembly 60.1 may be bolted or otherwise fixed to the footing 302. Floor panels 310 are placed on top of the first floor assembly 60.1 to form a first floor 308 as shown in figure 25. Four gaps or openings 312 are left in the floor 308 to provide access to jacks to rest directly on the footing 302 or to be bolted to the first floor assembly 60.1, as described below. A central gap or opening 314 is provided in the floor 308 for a staircase.

[00136] Figure 26 shows the jacks 316 supported by the footing 302 and extending through the openings 312 in the first floor 308. The foot of each jack 316 rests on the footing 302 or is bolted to the first floor assembly 60.1.

[00137] In the drawings, there are shown four jacks for each floor level. However, it will readily be appreciated that any number of jacks could be used, depending on the area of each floor level. For example, in some cases three jacks could be used and in other cases more than four could be used.

[00138] Referring to figure 27, a number of frame assemblies 50 are assembled on the first floor 308 to form a second floor assembly 60.2.

[00139] Floor panels 310 are placed on top of the second floor assembly 60.2 to form a second floor 320 as shown in figure 28. Four gaps or openings 312 are left in the floor 320 to provide access for jacks 322 to be bolted to the second floor assembly 60.2. A central gap or opening 314 is provided in the floor 320 for the staircase (figure 29).

[00140] Figure 29 shows the jacks 322 fixed to the second floor assembly 60.2 and extending through the openings 312 in the second floor 320. The foot of each jack 322 is bolted or otherwise fixed to the second floor assembly 60.2.

[00141] Referring to figure 30, a number of frame assemblies 50 are assembled on the second floor 320 to form a third floor assembly 60.3.

[00142] Figure 31 shows part of a roof framework 330 assembled using beam members 1 and spreader members 10 bolted together. The roof framework 330 is fixed to and supported by the roof frame assembly 60.3. Figure 32 shows the completed roof framework 330. Figure 33 shows the roof framework 330 with barge boards and gutters 332 fixed to the framework 330. Assembling the roof structure 330 is made easier and safer by the roof frame assembly 60.3 being close to the ground rather than in a conventional raised position.

[00143] The roof structure 330 is covered by roof sheets 334 and solar panels 336 as shown in figures 34 and 35. Once again, fixing the roof sheets 334 and solar panels 336 to the roof structure is made easier and safer by the roof structure 330 being close to the ground.

[00144] After the roof is completed, the second floor assembly 60.2 and the roof frame assembly 60.3 can be lifted or raised using the jacks 322. Figure 38 shows the second floor assembly 60.2 and the roof frame assembly 60.3 partially raised relative to the first floor 308 by the jacks 316.

[00145] The second floor assembly 60.2 is raised by the jacks to the position shown in figure 39. Column members 30 are then fixed to the first floor assembly 60.1 and the second floor assembly 60.2 and extend between the floor assemblies 60.1, 60.2. The column members 30 are spaced along the periphery of the floor assemblies 60.1 and 60.2. The column members 30 support the second floor assembly 60.2 in the raised position shown in figure 40.

[00146] The roof frame assembly 60.3 is lifted or raised using the jacks 322. Figure 39 shows the roof frame assembly 60.3 partially raised relative to the second floor 320 by the jacks 322. The roof frame assembly 60.3 is raised to the position shown in figure 40. Column members 30 are then fixed to the second floor assembly 60.2 and the roof frame assembly 60.3 to extend between the second floor assembly 60.2 and the roof frame assembly 60.3. The column members 30 support the roof frame assembly 60.3 in the raised position shown in figure 41.

[00147] With the second floor assembly 60.2 and the roof frame assembly 60.3 supported by the column members 30, the jacks 316, 322 can be removed. The first floor 308 and the second floor 320 can then be finished by placing floor panels in the openings 312 where the jacks 316, 322 stood.

[00148] It has been found that the use of the grid structure comprising the beam members 1 and the spreaders 10, bolted together, results in a frame system that has sufficient rigidity to limit the extent of deformation of the frame system during jacking to an adequate extent.

[00149] The building structure 300 is clad by cladding as shown in figure 43. Window cavities are formed in the building structure and window frames inserted into the window cavities as shown in figure 44.

[00150] Figure 45 shows a partially sectioned view of the building structure. The holes 6, 16 in the beam members 1 and spreader members 10 provide paths for routing services such as wires, piping and ducting under the floors 308, 320 and in the roof.

[00151] Figures 46 to 48 are illustrative of an example of a method for conveniently forming the floor assembly 60.1.

[00152] Initially, a row of beam members 1 are connected together to span the footing 302. A row of the spreaders 10 is fastened on each side of the row of beam members 1. This initial assembly is formed towards one side of the footing 302.

[00153] Further rows of beam members 1 and spreaders 10 are fastened to one side of the footing 302 (figure 47). At this point, the assembly can be shifted about on the footing to allow the footing to support the terminal row of beam members 1 and spreaders 10 on the one side of the floor assembly 60.1.

[00154] Remaining rows of beam members 1 and spreaders 10 are fastened to the other side of the footing 302 to form the floor assembly 60.1 as shown in figure 48.

[00155] Using the method described above, it is possible for the floor assembly 60 to be built on the plinth or footing 64 without the need for cranes and other lifting equipment to move the floor assembly about.

[00156] During the construction process described above, or after the structure 300 is complete, it may be necessary to move columns 30 or to insert further columns 30, depending on building requirements, such as the addition of further rooms or where further weight-bearing capability is required.

[00157] Figures 49 to 53 illustrate how the position of the columns 30 can be varied.

[00158] For example, in figure 49, a column 30 is fastened to a single spreader 10. In figure 50, two columns are fastened between two spreaders 10. In that case, the two spreaders 10 are transversely oriented relative to two other spreaders 10 positioned between paired beams 1. This illustrates the structure of a foot assembly 337 for the columns 30. This is made possible by the modular nature of the spreaders 10 allowing them to be positioned in a wide variety of locations within the floor assembly 60. For example, this would allow the foot assembly 337 to be positioned on any of such locations to support the columns 30.

[00159] In figure 51, a column 30 is fastened to a spreader 10 at a junction between that spreader 10 and a pair of spreaders 10 connected between consecutive paired beams 1.

[00160] In figure 52, a column 30 is fastened to a single spreader 10 extending between consecutive paired beams 1.

[00161] In figure 53, a column 30 is fastened to a single spreader 10 extending between consecutive paired spreaders 10.

[00162] Figures 54 and 55 show two different views of a manner in which a floor assembly 60 is fastened to consecutive columns 30 at a junction between two floors of a building or structure.

[00163] The gusset plate 40 has a web 41 interposed between a pair of flanges 43. The flanges 43 and web 41 are oriented at about 45° relative to each other. A height or width of the plate 40 allows one of the flanges 43 to be fastened to the web 12 of the spreader 10 with fasteners 44 received through openings 45 in the flanges 43 and a corresponding set of openings 9 in the web 12.

[00164] The opposed flange 43 is fastened to an internal surface of the web 2 of the beam 1 with the fasteners 44. The pair of spreaders 10 can thus be fastened to the internal surface of the beam 1 with two of the gusset plates 40. The end flange 18 of the spreaders 10 can also be fastened to the internal surface of the beam 1, as explained above.

[00165] A lower column 30 is connected to an upper column 30 with splice members or plates 37. Each splice plate 37 has a profile that corresponds with a profile of one side of the column 30. Thus, the splice plate 37 has a faceplate 38 that can span adjacent upper and lower portions of consecutive columns 30. Similarly, the faceplate 38 has a flange 39 that can span adjacent upper and lower portions of the flanges 34 of the consecutive columns 30. The faceplate 38 can be fastened or bolted to the converging walls 32 of the consecutive columns 30 via openings in the faceplate 38 and the bolt holes 31 in the columns 30. Likewise, the flange 39 can be fastened or bolted to the flanges 34 of the consecutive columns 30.

[00166] The openings in the flange 39, a corresponding set of holes 9 in the web 2 and the holes or openings in the flange 43 can be brought into register with each other allowing the splice plates 37, the columns 30, the beams 1 and the gusset plates 40 to be fastened together with a common set of the fasteners 44.

[00167] Figures 56 to 58 show stages in the fastening of a floor assembly 62 column 30.

[00168] In figure 56, two spreaders 10, already fastened together, are fastened to a beam 1 with the fasteners 44 engaging the web 2 and the flange 18. In figure 57, gusset plates 40 are fastened to the web 12, the web 2, the flange 34 and the flange 39, with the fasteners 44, as described above.

[00169] In figure 58, there is shown the use of a tool suitable for the fasteners 44.

[00170] Figures 59 to 62 show one of the jacks 316 (or the jacks 320) that can be used in the construction method or building system described herein.

[00171] The jack 316 is telescopic having a lower section 340, an intermediate section 342 and an upper section 344, telescopically arranged with respect to each other. In this example, the sections have a square or rectangular cross-section, in plan. However, it is envisaged that other suitable sectional shapes are possible.

[00172] A flange 346 is arranged on the lower section 340. The flange 346 can be bolted to faces of upper flanges 4 and upper flanges 14 of the beam members 1 and the spreader 10, respectively, of the lower or first floor assembly 60.1.

[00173] A mounting head 348 is arranged on the upper section 344. The mounting head 348 also has a flange 350. The flange 350 can be bolted to faces of lower flanges 4 and lower flanges 14 of the beam members 1 and the spreader 10, respectively.

[00174] Keeper members or keepers 352 are arranged on the mounting head 348. Each keeper 352 has a locating formation or foot 354 that is positioned so that a further floor assembly 60 can be constructed or positioned between the foot or feet 354 and the preceding floor assembly 60.

[00175] Thus, the further floor assembly 60, such as the second floor assembly 60.2, can be jacked upwardly while being secured between the flange 350 and the keepers 352.

[00176] It will readily be appreciated that the keepers 352 can have a variety of configurations that serve the purpose of securing the further floor assembly 60 against excessive movement relative to the mounting head 348 while being jacked upwardly.

[00177] The intermediate section 342 and the upper section 344 have sets of support pins or pegs 356 at the respective lower ends. The pegs 356 of each section are configured to project from walls 358 and to rest on upper ends of a preceding section once that section is extended. The pegs 356 can thus serve to support the jack 316 as it is extended in various stages.

[00178] The jack 316 is hydraulic or pneumatic. Thus, the pegs 356 serve to avoid the need for having fluid pressure support the jack 316 in its extended or partially extended condition.

[00179] The pegs 356 can be spring mounted to extend automatically. Alternatively, the pegs 356 can be manually or remotely operated.

Spreader Forming Machine

[00180] Figure 63 shows a forming machine 100 for forming a blank of material into the spreader member 10. The forming machine 100 is configured for carrying out reciprocal forming and shaping operations on metal sheeting to form the spreader 10. In particular, the forming machine 100 is suited for cutting, stamping and/or punching and pressing and/or folding lengths of steel stockfeed to form the spreader members 10.

[00181] The forming machine 100 comprises a base 102 supporting a bottom die 104, and columns 106 extending vertically from the base 102 and spaced around the bottom die 104. The columns 106 support a platform 108 in a suspended position above the bottom die 104.

[00182] Two top die actuators 110 are mounted on the platform 108. The actuators 110 drive a top die 112 between a home position and a forming position. When the top die 112 is in its home position sufficient space is provided between the top and bottom dies 112 and 104 to feed a blank 10A between the dies. When the top die 112 is in its forming position, the top and bottom dies 112 and 104 cooperatively carry out a forming operation.

[00183] The machine 100 has a two parallel side flange formers 114 (hereinafter referred to as flippers 114) for forming the parallel flanges 14 of the spreader member 10. The flippers 114 are located at either side of the bottom die 104. For each flipper 114 there is a horizontal flipper actuator 116 for moving the flipper 114 horizontally, and a vertical flipper actuator 118 for moving the flipper

114 vertically. The horizontal and vertical flipper actuators 116 and 118 act cooperatively to move the flippers 114 between a home position and a forming position.

[00184] Figure 78 shows a machine 150 for forming the beam member 1. The machine 150 is configured for carrying out reciprocal forming and shaping operations on metal sheet to form the beam members 1. The machine 150 only requires the above described formers and former actuators. Operation of the machine 150 may be at least partially automated by use of a programmable logic controller (PLC) running a program such as that represented in the flow chart of Figure 79.

[00185] The machine 100 for forming the spreader 10 requires all of the above described formers 114 and former actuators 110, plus the additional parts described below with reference to Figures 63 to 77.

[00186] Two end flange formers 120 (hereinafter referred to as plungers 120) are mounted on the platform 108, with one plunger 120 at each end of the die 104. For each plunger 120 there are plunger actuators 122 and 124 for driving the plungers 120 between a home position and a forming position, and a plunger actuator 126 for returning the plunger 120 to its home position.

[00187] The base 102 further supports four tail arms 130 (the function of which will be explained below), two for each end of the die. For each tail arm 130 there is a tail arm actuator 132 for driving the tail arms 130 between a home position and a forming position.

[00188] The base 102 further supports two end punches 140, one for each end of the die, for punching holes in the end flanges 18. For each end punch 140 there is an end punch actuator 142 for driving the end punches 140 between a home position and a punching position.

[00189] In use, operation of the forming machine 100 for forming spreader members 10 may be at least partially automated by use of a programmable logic controller (PLC) running a program such as that represented in the flow chart of Figure 80.

[00190] A blank 10A is fed between the top and bottom dies 112 and 104. Where feeding of the blank 10A is automated, sensors may be employed to sense the presence of the blank 10A and commence operation of the machine 100. Where feeding of the blank 10A is performed manually, commencement of operation will likely be contingent upon the closing of a guard (not illustrated).

[00191] Operation of the machine 100 commences with the closure of the top die 112 onto the bottom die 104, as illustrated in figure 65. This forms the holes 9 and 16, and other features on the web 12 of the spreader 10. This also forms the cuts or notches that are required for carrying out the necessary folding or bending operations to achieve the spreader 10. In other words, the flanges 14, 18 and the tabs 28 are in the pre-bent or pre-folded conditions subsequent to operation of the closure of the top die 112 onto the bottom die 104.

[00192] The flippers 114 are then moved from their home positions to their forming positions, forming the parallel flanges 14.

[00193] As can be seen in Figures 76 and 77, when the top die 112 is seated upon the bottom die 104, a smooth transition for a die former or tool 114A carried by a flipper body 127 to pass downward over the bottom die 104 and take the material to be formed with it is presented. The bottom die 104 is set back one material thickness from the upper die 112 to allow the die former or tool 114A forced onto the side face of the bottom die 104 by the horizontal flipper actuator 116 and pulled downward by the vertical flipper actuator 118 to draw the material down to form the flange 14.

[00194] Next, the plungers 120 are actuated to fold the end flanges 18 in a similar process, and then the plungers 120 are returned to their home positions. Then the tail arms 130 are actuated, each tail arm 130 folding one tab 20 over the end flange 18. Each tail arm 130 is then returned to its home position.

[00195] The operation that is carried out to form the end flanges 18 is similar to that that is carried out to form the flanges 14. It follows that the plungers 120 incorporate a tool or die former 120A that is similar to the tools 114 A. For example, the actuator 122 drives the downward or vertical movement of the tool 120A while the actuator 124 drives the horizontal movement of the tool 120A.

[00196] The end punches 140 are actuated to punch bolt holes in the end flanges 18 and are then returned to their home positions.

[00197] Next, the top die 112 is returned to its home position, and then the flippers 114 are returned to their home positions. In this way, the flippers prevent the part (i.e. spreader member 10) being raised with the top die 112.

[00198] Finally, ejector pins are actuated to free the finished part from the bottom die 104.

[00199] The forming machine 100 performs a number of sequential functions in close order. For reasons of distribution and portability, the forming machine 10 could be mounted to a truck bed or tray, or to a trailer for towing behind a vehicle. In this way, spreader members 10 could be formed at a building site.

[00200] The forming machine 100 could also be used to form the beam members 1, by switching the PLC to run a program such as that represented in the flow chart of Figure 79, and by feeding a blank (a longer blank than blank 10A – not illustrated) lengthwise into the machine 100 in stages (and with a high degree of accuracy), so that a portion of the beam member 1 profile is formed at a time.

Beam Forming Machine

[00201] The forming machine 150 of figure 78 is configured specifically for forming beam members 1. The forming machine 150 comprises longer top and bottom dies 112 and 104, and flippers

114 than the forming machine 100. However, the machine 150 does not include the plungers 120, tail arms 130 or end punches 140 of the forming machine 100.

Column Member Forming Machine

[00202] Figures 81 to 83 show views of the column member 30. The column member 30 comprises a truncated "A" form section comprising sloping walls 32 which depend and diverge from a flat strip or cap 33. The column member 30 includes substantially parallel flanges 34 with angled outturns 35 and arrays of holes 31 in the cap 33, the walls 32 and the flanges 34.

[00203] Referring to Figures 84 and 85, there is shown a forming machine 200 for forming a blank of material into the column member 30.

[00204] The forming machine 200 comprises a material magazine 202 and a forming section 204. The forming section 204 comprises four spaced journals 206 mounted on a number of through beams, so as to feed material into the forming section 204. The magazine 202 butts directly onto the forming section 204 and forms a structural part of the whole base frame of the machine 200.

[00205] A punching station 203 is positioned at a feed end of the forming section 204 and is operable to punch openings or holes into stock to form the holes 31 of the column member 30.

[00206] The journals 206 support two outer fixed dies 208 that complete the outturns 35 on the completed "truncated - A" form. The journals 206 also support and house an upper die support beam 209. The upper die support beam 209 is aligned and supported by control elements 210 within the journals and rests on control stops 212 at each end of the machine. The support beam 209 is able to move upwards under the control of an actuator 214 placed in the head of each of the four journals 206. The actuators 214 allow for the controlled vertical movement of the upper die support beam 209. Within the support beam 209 is a longitudinal space 216 that houses an upper die 220. The die 220 is of a semi resilient material.

[00207] A lower beam 221 is supported by side control elements 222 where it passes through each journal and in turn rests on upward facing actuators 224. The lower beam 221 is comprised of an inner and outer members. The inner member is moveably supported within the outer member on a number of actuators 230. The inner member supports a lower die 234 which, together with the upper die 220, determines the angle of the truncated "A" form. By cooperating with the upper die 220, the lower inner and outer members of the lower beam form the column member 30 as described below.

[00208] At the start of the forming process the upper die 220 is constrained to its bottom home position, providing a material thickness between itself and the bottom die 234. The lower die actuators 224 drive the lower die 234 upwards into the resilient upper die 220 to form the bends at the lateral edges of the cap 33 of the column member 30. The constraint of the upper die 220 is then relaxed and the upper and lower dies 220, 234 move down together until a lower outer die 235 closes

onto the upper outer fixed die 208, so completing the second bend of the "A" form, forming the flanges 34. Lower die inner actuators 230 are now enabled to collapse which allows the outer lower dies 232 to close onto the upper fixed dies 208 to form the outturns 35 along each side of the "A" form.

[00209] Operation of a forming machine 200 for forming column members 30 may be at least partially automated by use of a programmable logic controller (PLC) running a program.

[00210] A blank 1A is fed between the top and bottom dies 208 and 234. Where feeding of the blank 1A is automated, sensors may be employed to sense the presence of the blank 1A and commence operation of the machine 200. Where feeding of the blank 1A is performed manually, commencement of operation will likely be contingent upon the closing of a guard (not illustrated).

[00211] The punching station 203 pre-forms the bolt holes in sheet 1A in stages as it passes from the magazine 204 into the "A" forming part of the machine 202 of the machine. This will result in the forming of the many holes 31, and other features on the web 33 of the part 30.

[00212] Detail of the punching station 203 can be seen in figures 92 to 94. The punching station 203 has a housing 227. The housing 227 defines an entry wall 229 and an exit wall 231. Both walls 229, 231 have openings 232 to permit the passage of the blank 1 A.

[00213] A bed 237 is mounted on a suitable support structure in the housing 203 for supporting the blank 1 A. A punching head 239 is mounted in the housing to be vertically reciprocally displaceable with respect to the bed 237. A series of punching dies 241 mounted on the head so that when the head 237 is driven reciprocally, the punching dies 241 can carry out a punching operation on the blank 1 A to form the holes 31 in the blank.

[00214] A pair of actuators 243 also mounted on the housing to drive the head 237.

[00215] The forming machine 200 performs a number of sequential functions in close order, but for reasons of distribution and portability the desired machine is as small and compact as possible. The forming machine 200 could be mounted to a truck bed or tray, or to a trailer for towing behind a vehicle. In this way, column members 30 could be formed at a building site.

[00216] All of the actuators referenced herein could be hydraulic cylinders. However, in cases where alternate actuator types (such as electric or pneumatic actuators) can deliver the required force to perform the relevant operation, then these may be employed.

Formation of flanges for spreader

[00217] As described earlier, the flanges 14 of the spreader 10 are bent or formed so that the portions 20 can be received between the flanges 4 of the beam members 1 without the need for packing or washers. In particular, the flanges 14 are formed so that an overall width of the portion 20 is reduced by an extent which is twice the width of the material used for the associated beam 1. Also,

flanges 18 of the spreader 10 are bent or formed to accommodate the tab 23 such that the flanges 18 present a flat surface for hearing or butting against the web 2 of the beam members 1.

[00218] Figures 95 to 99 indicate a principle of operation that is employed to generate or form the flanges 14, 18. With reference to the preceding drawings, like reference numerals refer to like parts, unless otherwise specified. The use of the common numerals is not intended to indicate that the parts or components referred to in the preceding drawings are somehow essential to the structures shown in figures 90 to 94.

[00219] The flipper 114 is mounted on the horizontal flipper actuator 116 with a spherical steel bearing 115. This facilitates pivotal movement of an arm 117 of the flipper 114. The vertical movement of the flipper actuator 118 is operated with a draw ram 119.

[00220] In figure 90, the flipper 114 is shown in in an up position prior to a drawing process to be performed on the blank. In figure 91, the flipper 114 is in a down position subsequent to the drawing process.

[00221] In the transition between the up and down positions, the tool 114A acts on the blank to form the flange 14. This process is indicated schematically in figures 92 and 93. The setback of the bottom die 104 relative to the upper die 102 can be seen in these drawings.

[00222] The tool 114A has enlarged end portions 121. A length of these end portions 121 corresponds generally with a length of the portions 20 of reduced width of the spreaders 10. It follows that operation of the flippers 114 results in fold lines 123, 125 of the spreader 10 (figures 9, 10).

[00223] It is relevant to note that the tool 114A does not rotate relative to the flipper body 127. Thus, the tool 114A carries out a drawing process on the blank to form the associated flange 14.

[00224] As indicated, schematically, the draw ram 119 provides the necessary pivotal movement of the tool 114A in a vertical plane. The horizontal flipper actuator 116 provides the necessary horizontal movement of the tool 114A to generate sufficient horizontal force such that the fold lines 123, 125 are formed in the drawing process.

[00225] As described above, the flanges 18 are formed in a similar manner using the plungers 120 and the actuators 122, 124 and 126, all of which drive the tools 120A in the same way as the tool 114A is driven. Thus, fold lines 129, 131 are formed in the flange 18 (figures 9, 10) to accommodate the tabs 23 so that the tabs 23 and the flange 18 present a flat surface for abutment against an inner surface of the web 2.

Application of building system

[00226] The inventor envisages that the method illustrated in figures 22 to 45 can readily be carried out without a level of skill usually required for building dwellings and other permanent structures. It is clear from the above description that the frame assemblies 50 are fabricated or

assembled from similar components. Furthermore, the forming machines described above have a relatively low width to length requirement since they are configured for forming strips of metal. As a result, the forming machines can be conveyed in a relatively compact manner, for example, by segmenting the machines in a modular fashion and placing modules side-by-side on a transport bed or in a container.

[00227] Thus, in a proposed application, the forming machines are conveyed to an area in which building structures are to be erected using the frame assemblies described above. During the process or method illustrated in figures 20 to 43, the forming machines can be used on site to fabricate the components required for the frame assemblies.

[00228] It is relevant to note that all the components, apart from fasteners, of the frame assembly can be fabricated from a sheet or strip of steel. It follows that, together with the forming machines and the steel, the provision of further equipment to a building site is limited. On the other hand, with conventional or existing building systems, a wide variety of different components are required to be provided to the building site. It follows that the logistics and sourcing of materials for conventional or existing building systems can be more complicated than as operations carried out in connection with the present building system.

[00229] The various components, particularly the beam and spreader members are modular in nature. It follows that they can be connected together using a common bolt and nut combination. A typical example of such a bolt and nut combination would be one in which a head and a nut both incorporate a flange such that the parts of the components can be sandwiched between the flanges. As described above, the components are assembled without the need for washers or flanges. It follows that it is not necessary to use washers with the bolt and nut combinations.

[00230] The inventor envisages that the forming machines described above can be used to punch and form the relevant components from standard sheet or coil stock. It is relevant that the forming machines are not roll formers. Roll formers cannot conveniently be conveyed as can reciprocating machines such as the forming machines described above. The forming machines can be configured to function in a range of conditions, such as in solar-powered container-based arrangements or, where possible, in a traditional factory arrangement. The possibility of using the forming machines in shipping containers enhances the ability to transport the shipping machines to locations where the building method described herein can be practised or carried out.

[00231] It is to be understood that a variety of different sheet metal sizes can be used, depending on requirements and on the ability to form the material. For example, a suitable thickness may be anywhere between 1 mm and 8 mm, for example, between about 1 mm and 6 mm. The dimensions of the beams 1 and spreaders 10 can vary depending on the required application and various structural requirements.

[00232] According to calculations and investigations carried out by the inventor, the spreader and beam members can be fabricated by forming machines with a power output of about 3 hp. This results in components being fabricated at about 1 to 2 minutes per part. At that rate, the inventor envisages that all the spreader and beam members required for the first floor of the structure of the building described above could be provided within five hours. As result, it is expected that an entire frame for the building described above could be erected within 3 to 4 days.

[00233] It follows that, broadly, an exemplary embodiment of a method of building would include transporting forming machines to a building site, forming a strip of steel into the various components required for the base assembly and erecting a building or structure using a number of the base assemblies.

[00234] It is also relevant to note that there is described herein a process for forming a spreader with uniformly flush end faces and side faces that are capable of cooperating with C-shaped beams in a frame assembly to present a uniformly flush or level surface for the assembly of a floor on the surface without the need for packing to accommodate discontinuities.

[00235] In this description, reference has been made to steel sheet. The inventor envisages that the operations described above can be carried out on other materials that are capable of being formed in a similar manner. These could include other metals.

[00236]

[00237] Throughout the specification, including the claims, where the context permits, the term “comprising” and variants thereof such as “comprise” or “comprises” are to be interpreted as including the stated integer or integers without necessarily excluding any other integers.

[00238] It is to be understood that the terminology employed above is for the purpose of description and should not be regarded as limiting. The described embodiments are intended to be illustrative of the invention, without limiting the scope thereof. The invention is capable of being practised with various modifications and additions as will readily occur to those skilled in the art.

[00239] Various substantially and specifically practical and useful exemplary embodiments of the claimed subject matter are described herein, textually and/or graphically, including the best mode, if any, known to the inventor for carrying out the claimed subject matter. Variations (e.g., modifications and/or enhancements) of one or more embodiments described herein might become apparent to those of ordinary skill in the art upon reading this application. The inventor expects skilled artisans to employ such variations as appropriate, and the inventor intends for the claimed subject matter to be practiced other than as specifically described herein. Accordingly, as permitted by law, the claimed subject matter includes and covers all equivalents of the claimed subject matter and all improvements to the claimed subject matter. Moreover, every combination of the above described elements, activities, and all possible variations thereof are encompassed by the claimed subject matter

unless otherwise clearly indicated herein, clearly and specifically disclaimed, or otherwise clearly contradicted by context.

[00240] The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate one or more embodiments and does not pose a limitation on the scope of any claimed subject matter unless otherwise stated. No language in the specification should be construed as indicating any non-claimed subject matter as essential to the practice of the claimed subject matter.

[00241] The use of words that indicate orientation or direction of travel is not to be considered limiting. Thus, words such as "front", "back", "rear", "side", "up", down", "upper", "lower", "top", "bottom", "forwards", "backwards", "towards", "distal", "proximal", "in", "out" and synonyms, antonyms and derivatives thereof have been selected for convenience only, unless the context indicates otherwise. The inventor envisages that various exemplary embodiments of the claimed subject matter can be supplied in any particular orientation and the claimed subject matter is intended to include such orientations.

[00242] Thus, regardless of the content of any portion (e.g., title, field, summary, description, abstract, drawing figure, etc.) of this application, unless clearly specified to the contrary, such as via explicit definition, assertion, or argument, or clearly contradicted by context, with respect to any claim, whether of this application and/or any claim of any application claiming priority hereto, and whether originally presented or otherwise:

a. there is no requirement for the inclusion of any particular described or illustrated characteristic, function, activity, or element, any particular sequence of activities, or any particular interrelationship of elements;

b. no characteristic, function, activity, or element is "essential";

c. any elements can be integrated, segregated, and/or duplicated;

d. any activity can be repeated, any activity can be performed by multiple entities, and/or any activity can be performed in multiple jurisdictions; and

e. any activity or element can be specifically excluded, the sequence of activities can vary, and/or the interrelationship of elements can vary.

[00243] The use of the terms "a", "an", "said", "the", and/or similar referents in the context of describing various embodiments (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted.

[00244] Moreover, when any number or range is described herein, unless clearly stated otherwise, that number or range is approximate. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value and each separate sub-range defined by such separate values is incorporated into the specification as if it were individually recited herein. For example, if a range of 1 to 10 is described, that range includes all values therebetween, such as for example, 1.1, 2.5, 3.335, 5, 6.179, 8.9999, etc., and includes all subranges therebetween, such as for example, 1 to 3.65, 2.8 to 8.14, 1.93 to 9, etc.

[00245] Accordingly, every portion (e.g., title, field, background, summary, description, abstract, drawing figure, etc.) of this application, other than the claims themselves, is to be regarded as illustrative in nature, and not as restrictive, and the scope of subject matter protected by any patent that issues based on this application is defined only by the claims of that patent.

CLAIMS

1. A frame system for a building structure, the system comprising
beam members, each beam member comprising
two opposed, parallel flanges; and
a web interposed between the flanges; and
spreader members, each spreader member comprising
two opposed, parallel side flanges;
a web interposed between the side flanges; and
two opposed end flanges bridging the side flanges at respective terminal ends of the web, wherein the beam members and the spreader members are configured to be fastened to each other to form a frame assembly.

2. The frame system of claim 1, wherein at least one end portion of each spreader member has a length that is greater than a depth of the flanges of the beam members and is of a reduced width to permit the end portion to fit and to extend between the flanges of the beam members.

3. The frame system as claimed in claim 2, in which the at least one end portion of each spreader member has a reduced width such that the at least one end portion can fit between the flanges of the beam members with the flanges of the beam members and the spreader members being substantially co-planar so that the frame system can define a planar support surface.

4. The frame system as claimed in claim 3 in which the at least one end portion is of a reduced width to an extent that is substantially equivalent to twice a thickness of a material of the beam members.

5. The frame system as claimed in claim 2, in which the beam member and the spreader member are the products of at least a punching and folding operation carried out on lengths of sheet steel.

6. The frame system as claimed in claim 5, in which the side flanges of the spreader member are bent to define the at least one end portion.

7. The frame system as claimed in claim 5, in which the end flanges of the spreader member are bent to define inwardly extending zones that accommodate tabs extending from the side flanges, such that the end flanges and the tabs present a substantially flat surface so that the end flanges can be fastened directly to the webs of the beam members without the use of washers or packing.

8. The frame system as claimed in claim 1, in which the webs of the beam and spreader members define apertures for accommodating services for a building.

9. The frame system as claimed in claim 1, which includes pairs of beam members arranged with abutting webs, wherein the beam pairs are arranged into a spaced apart, parallel array, and wherein adjacent beam pairs are bridged by an array of spaced apart, parallel spreader members.

10. The frame system as claimed in claim 9, in which the spreader members include at least one pair of spreader members arranged with abutting webs.

11. A method of building, which comprises fastening the beam and spreader members of claim 1 together to form the frame system.

12. The method as claimed in claim 11, which comprises:

forming two or more of the frame systems on a substrate, one on top of the other, such that a lowermost frame system defines a ground floor assembly and an uppermost frame system defines a roof assembly;

erecting a roof structure on the uppermost frame system while the uppermost frame system remains on one of the ground floor assembly and an intermediate floor assembly; and

lifting at least the uppermost frame system to define at least one floor level of the building structure.

13. The method as claimed in claim 12, which comprises forming the beam and spreader members by carrying out reciprocal forming and shaping operations on metal sheet.

14. The method as claimed in claim 13, in which each spreader member is formed by carrying out the following operations on a length of metal sheet:

punching the sheet to form apertures and notches or cuts in the sheet;

folding sides of the sheet to form side flanges;

folding ends of the sheet to form opposed end flanges; and

folding tabs extending from the side flanges over the end flanges.

15. The method as claimed in claim 14, wherein the step of folding the sides of the sheet is carried out so that at least one end portion of the resultant spreader member has a length that is greater than a depth of the flanges of the beam members and is of a reduced width to permit the end portion to fit and to extend between the flanges of the beam members.

16. The method of claim 15, in which the step of folding the sides of the sheet is carried out so that the at least one end portion can fit between the flanges of the beam members with the flanges of the beam members and the spreader members being substantially co-planar.

17. The method of claim 13, in which the reciprocal forming and shaping operations are carried out by a forming machine that is located at a building site at which the building structure is to be built.

18. A building structure, which comprises:

at least two frame systems as claimed in claim 1.

19. The building structure as claimed in claim 18, in which one of the frame systems is a ground floor assembly supported on a base and another of the frame systems is a roof assembly supported above the ground floor assembly, such that at least one floor level is defined between the ground floor assembly and the roof assembly.

20. A forming machine for forming a spreader member of a frame system for a building structure, the forming machine comprising

a base;

a platform positioned above the base;

a top die arranged on the platform;

a bottom die supported by the base and operatively arranged with respect to the top die, the top and bottom dies being reciprocally displaceable relative to each other to punch apertures and notches or cuts in the sheet;

two side flange formers arranged on the base, one on each side of the bottom die, for forming parallel side flanges of the spreader member, the flange former being capable of horizontal and vertical actuation;

two end flange formers arranged on the base, one at each end of the bottom die, for forming parallel end flanges of the spreader member, the end flange formers incapable of horizontal and vertical actuation; and

actuators arranged on the base and the platform and operatively engaged with the flange formers, the actuators being configured for operation such that the side flange formers can fold sides of the metal sheet to form the side flanges and the end flange formers can fold ends of the metal sheet to form the end flanges.

21. The forming machine as claimed in claim 20, in which the side flange formers incorporate a die former that is shaped so that, upon operation of the side flange formers, the die former can carry

out an operation on the sides of the metal sheet retained between the top and bottom dies to bend the side flanges so that at least one end portion of the spreader member has a reduced width.

22. The forming machine as claimed in claim 20, in which the end flange formers incorporate a die former that is shaped so that, upon operation of the end flange formers, the die former can carry out an operation on the ends of the metal sheet so that a resultant end flange of the spreader member has inwardly extending zones to accommodate tabs that extend from the side flanges such that, when the terms are folded inwardly, the end flanges and the tabs present a substantially flat surface.

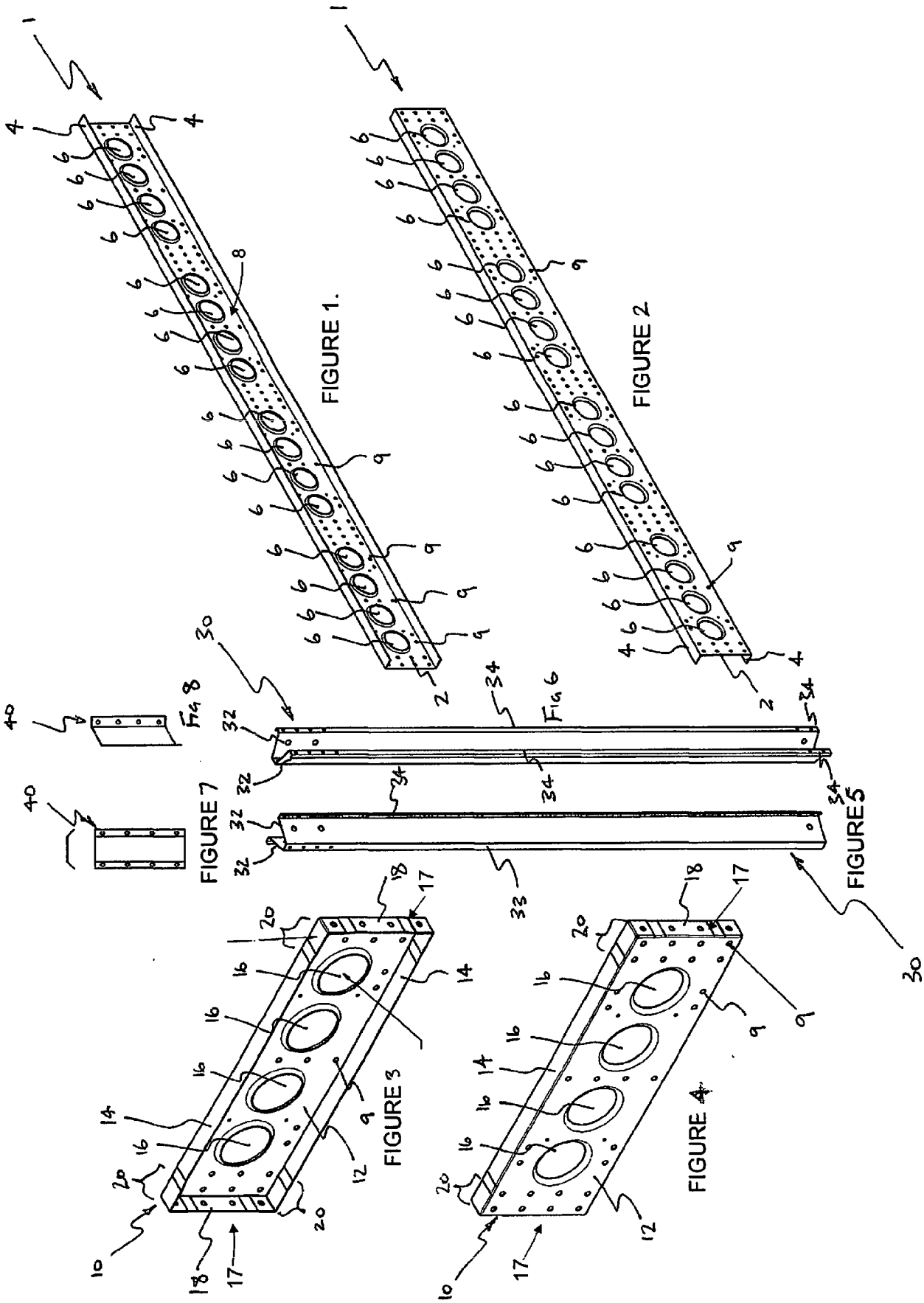
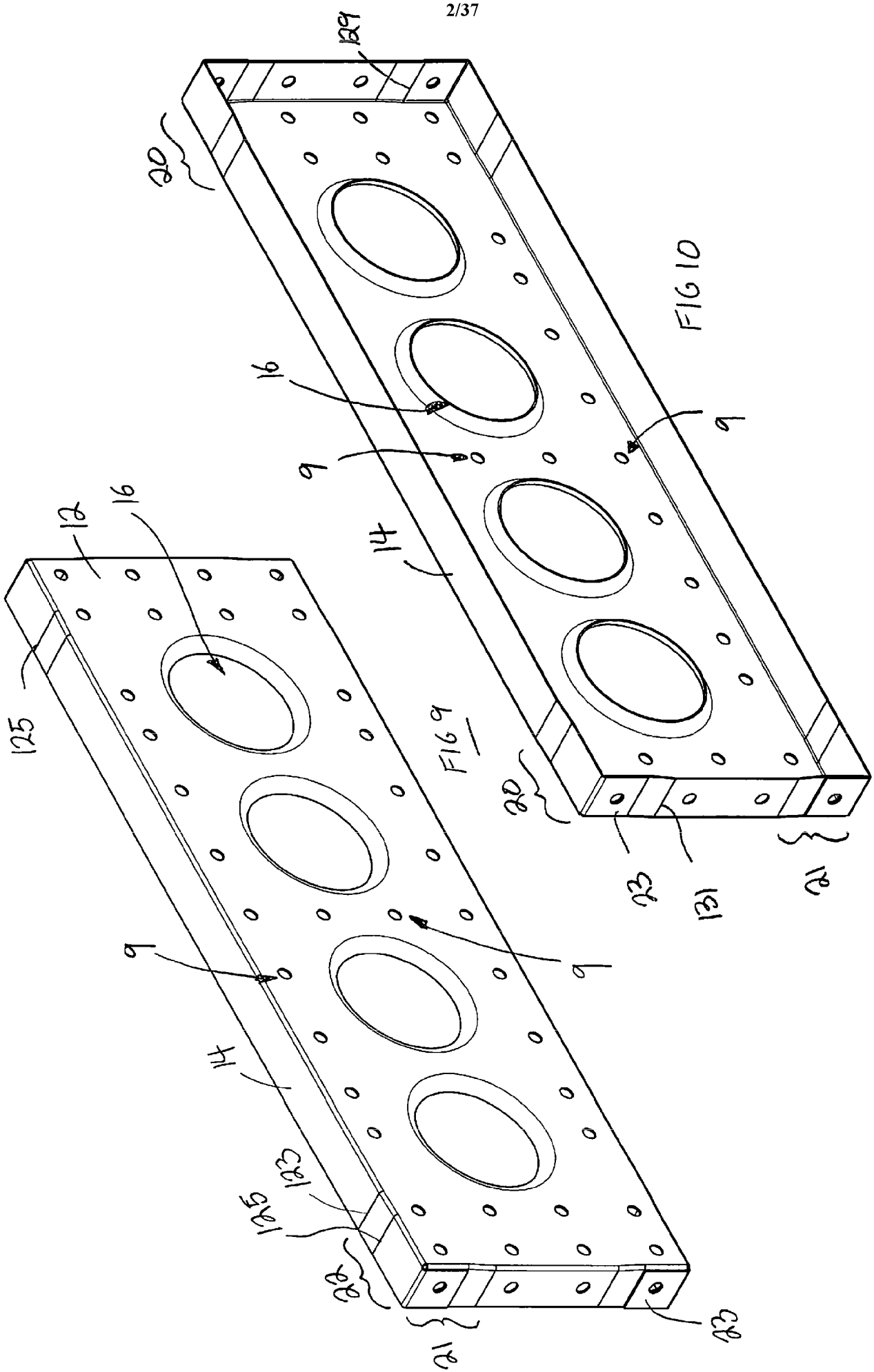


FIGURE 1.
FIGURE 2
FIGURE 3
FIGURE 4
FIGURE 5
FIGURE 7
Fig 8
Fig 6


129
20
16
9
14
12
125
123
121
18
181
23
FIG 9
FIG 10

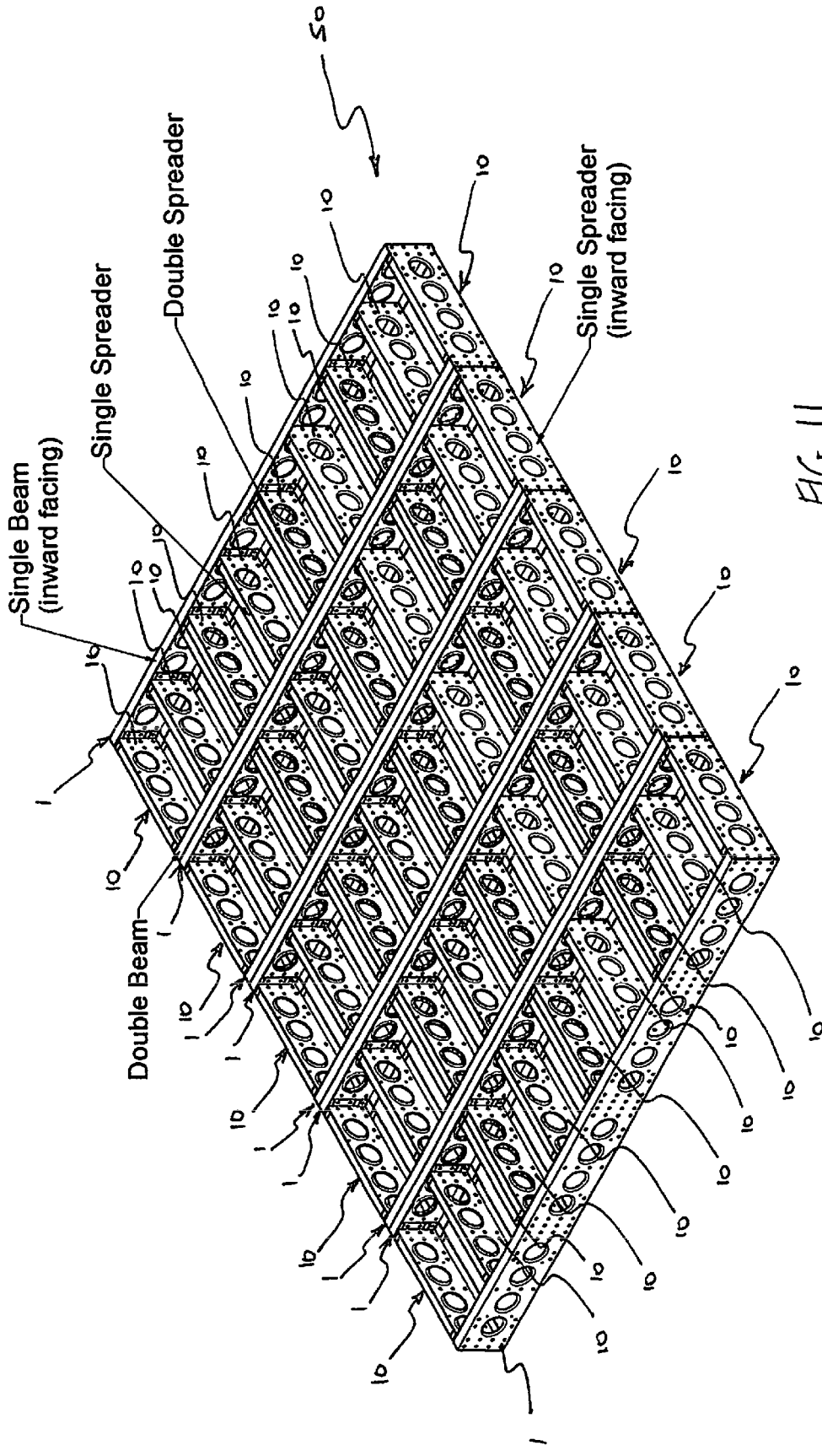
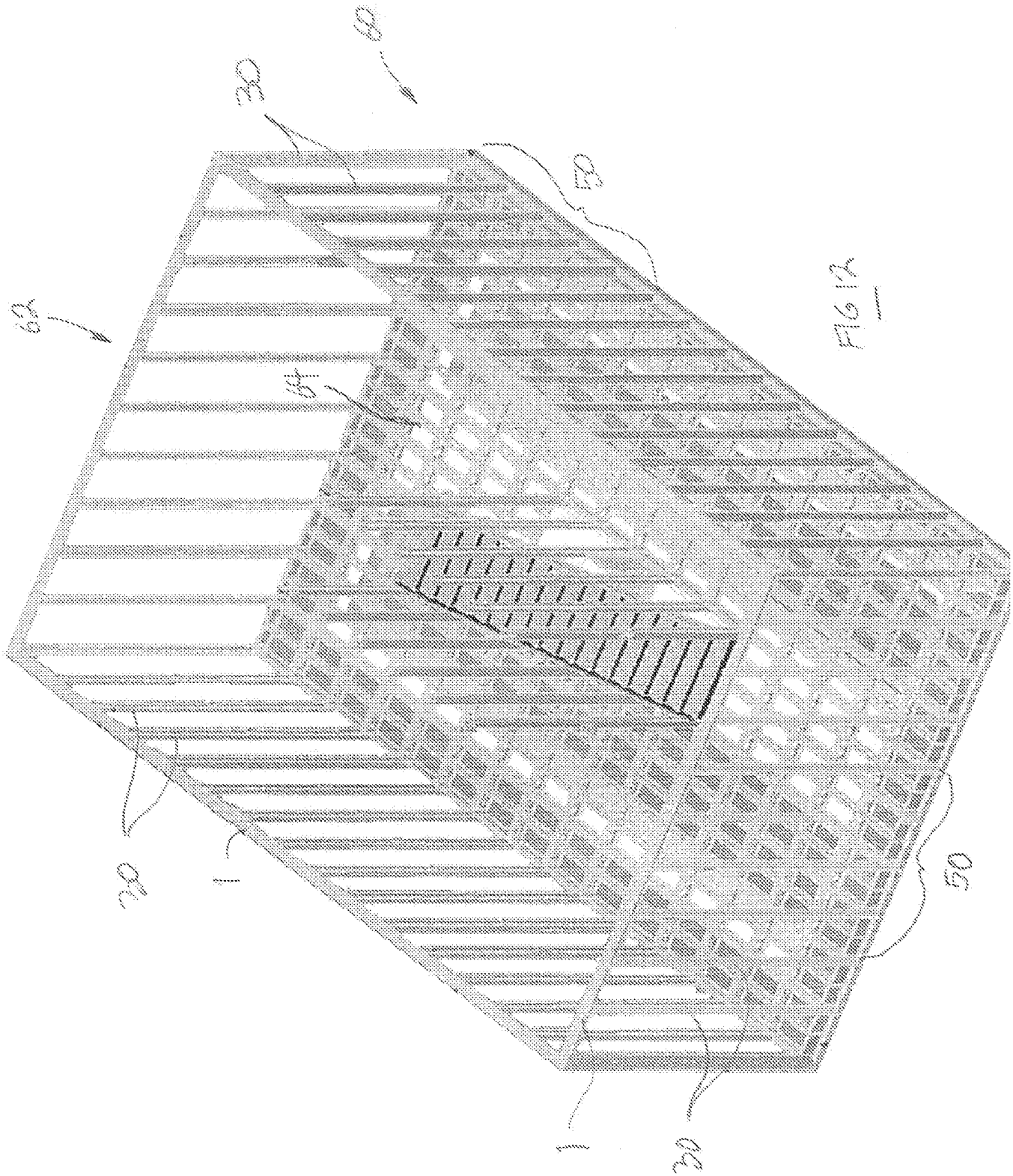
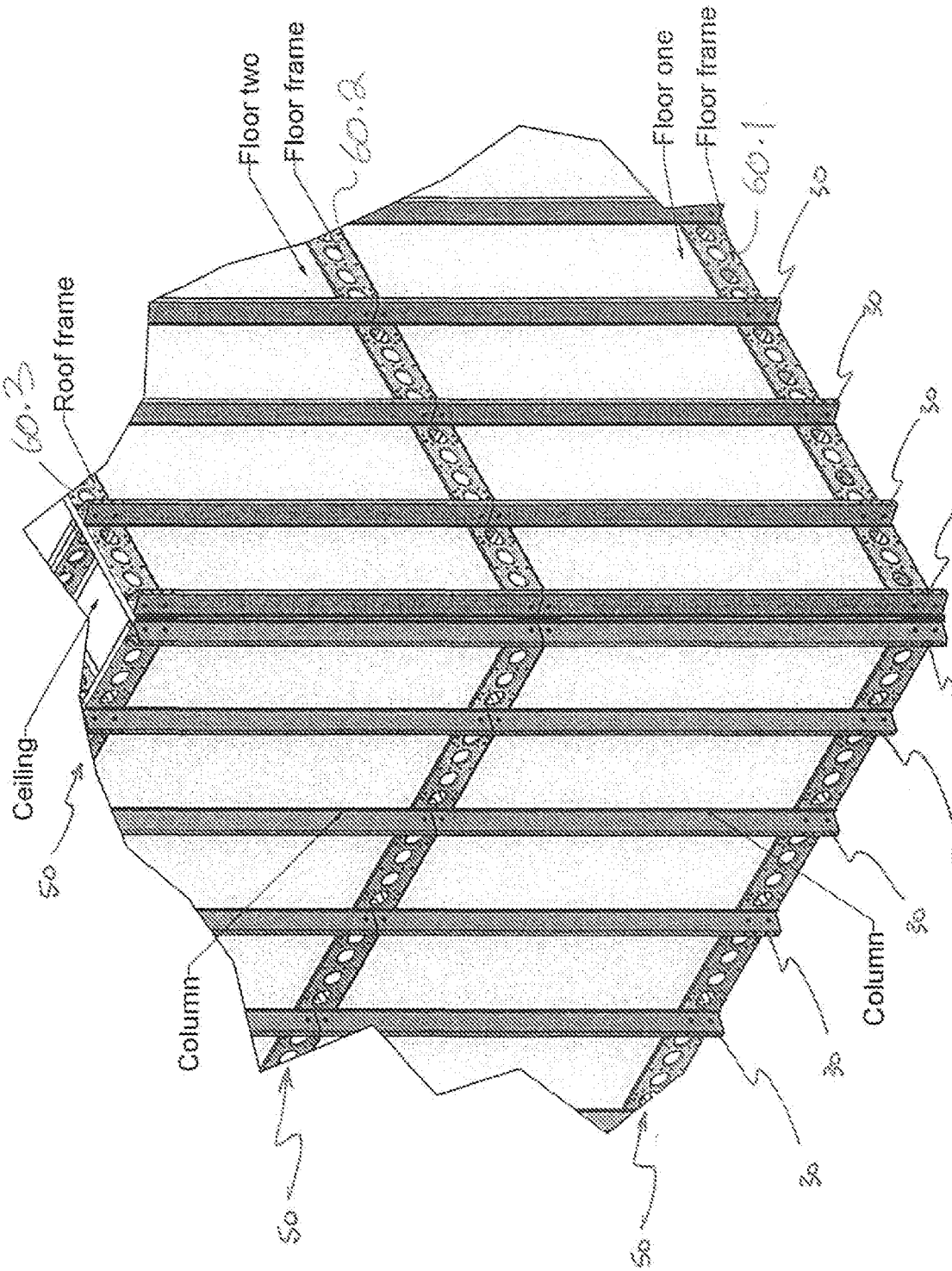

Single Beam
(inward facing)
Single Spreader
Double Spreader
Single Spreader
(inward facing)
Double Beam
Typical 5 Grid x 4 Grid
Assembly

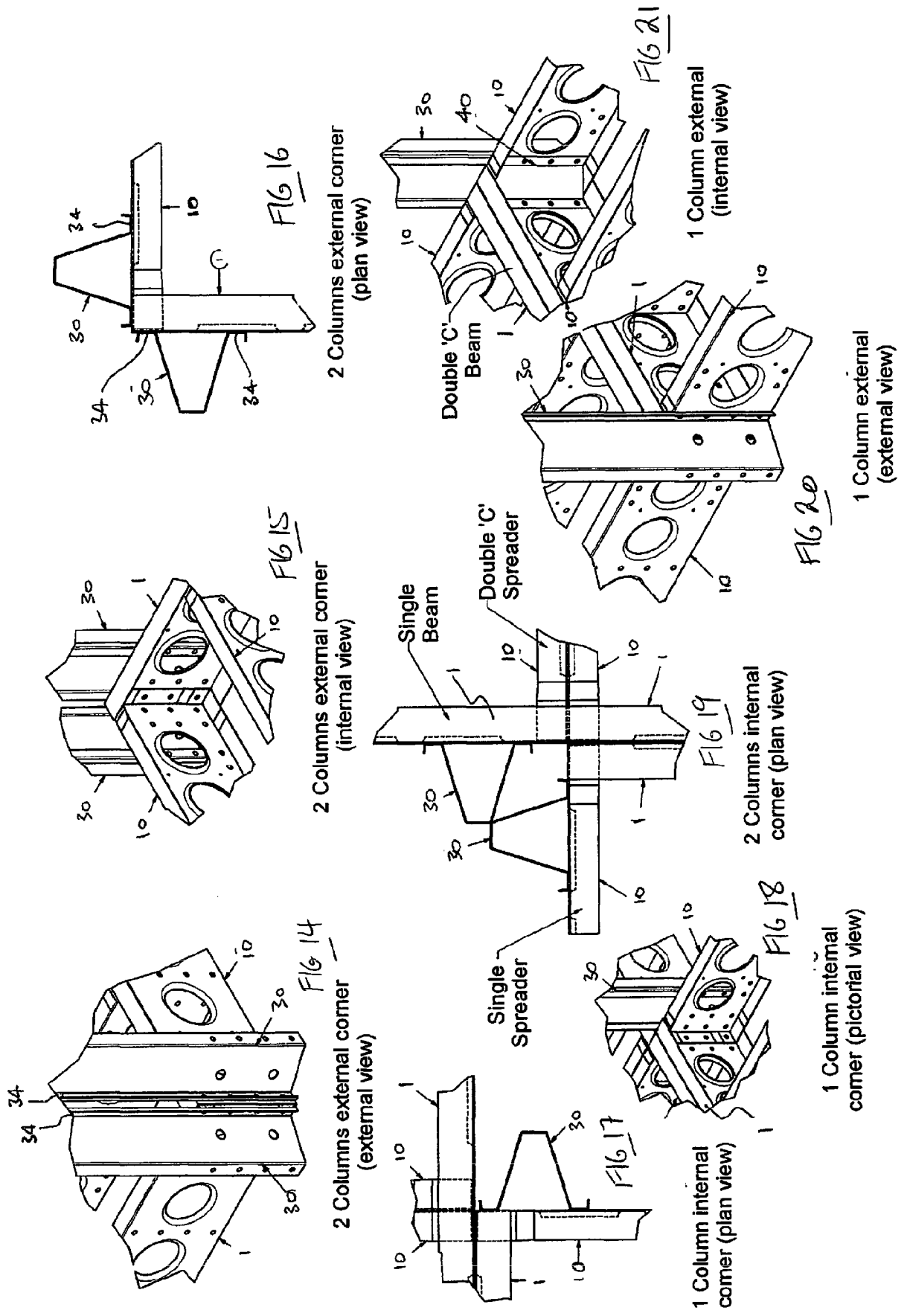
FIG 11


8
30
B
68
64
FIG 12
10
1
50
1
30



General arrangement of columns & frames

Fig 13


2 Columns external corner (external view)
2 Columns external corner (internal view)
2 Columns external corner (plan view)
1 Column internal corner (plan view)
1 Column internal corner (pictorial view)
2 Columns internal corner (plan view)
1 Column external (internal view)
1 Column external (external view)
Single Spreader
Single Beam
Double 'C' Spreader
Double 'C' Beam

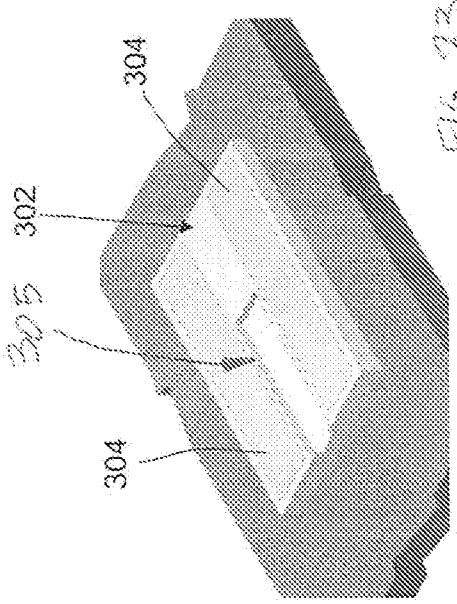


FIG 23

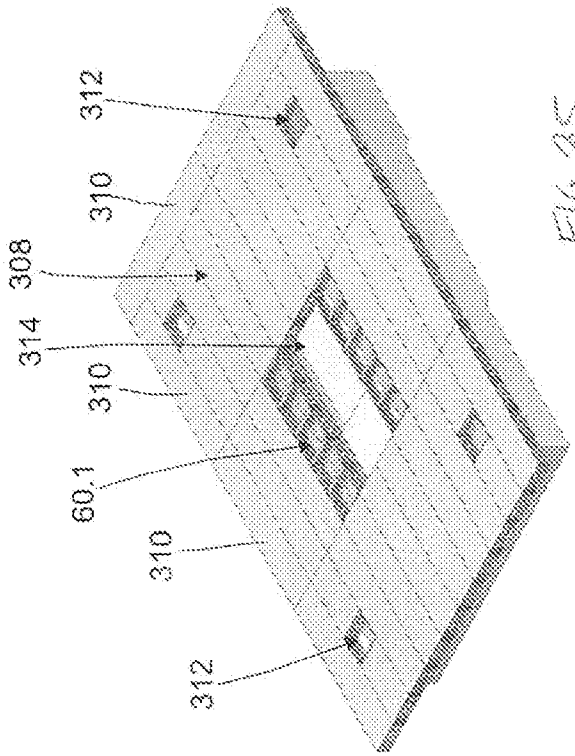


FIG 25

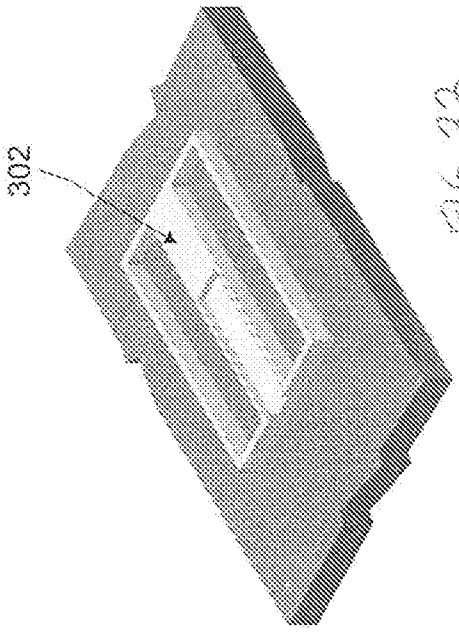


FIG 22

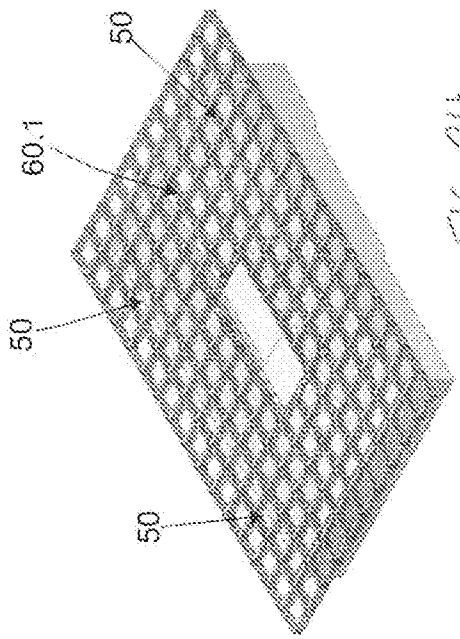


FIG 24

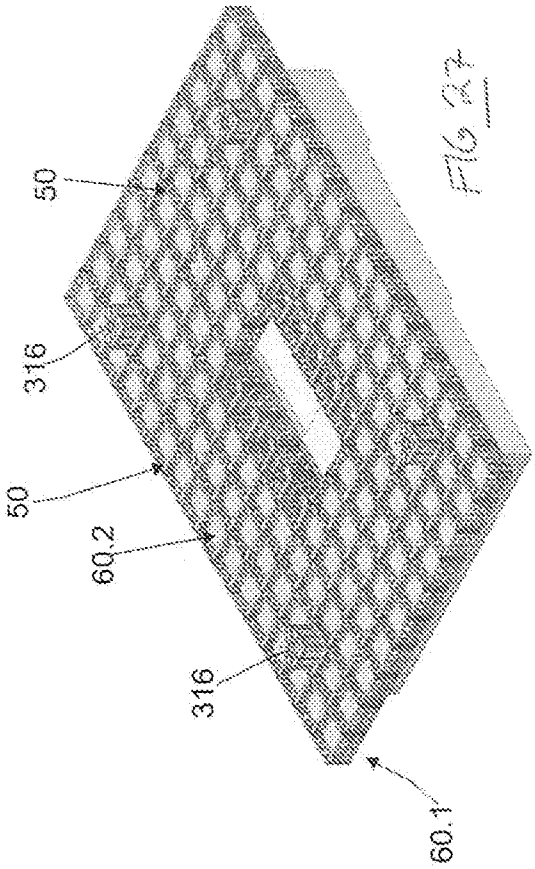


FIG 17

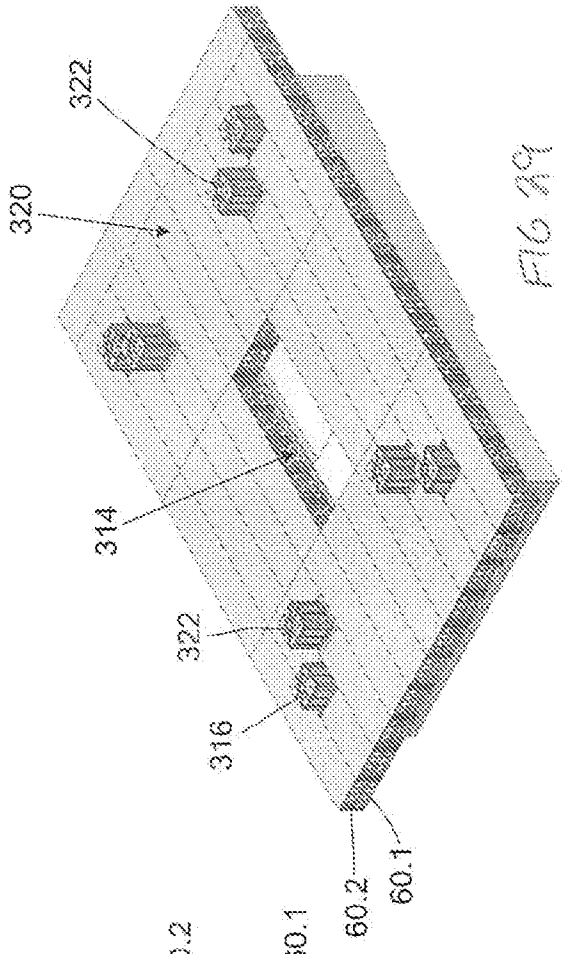


FIG 19

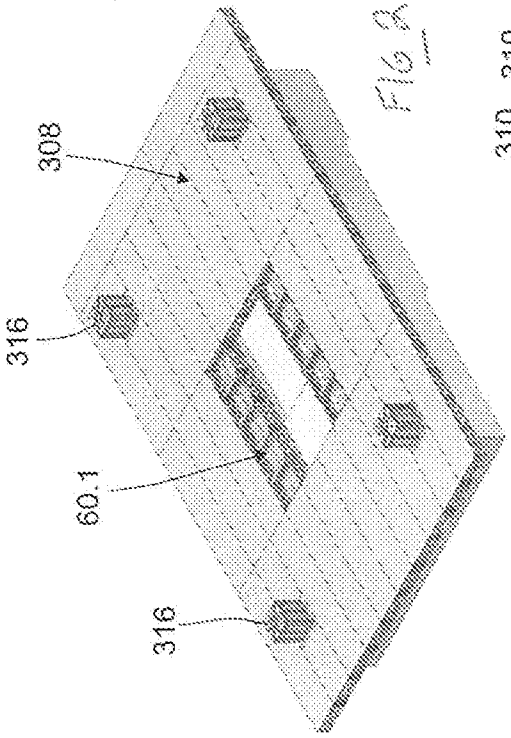


FIG 16

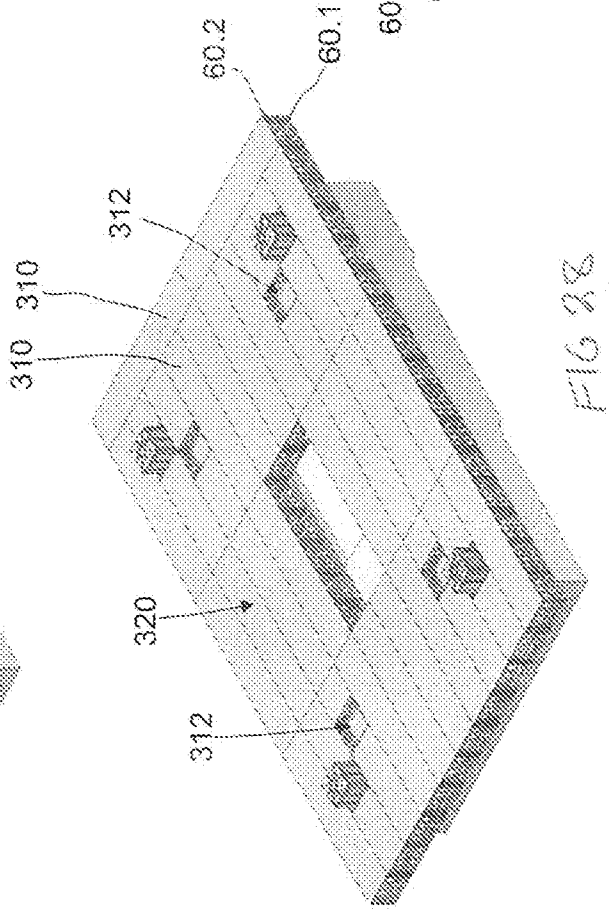


FIG 18

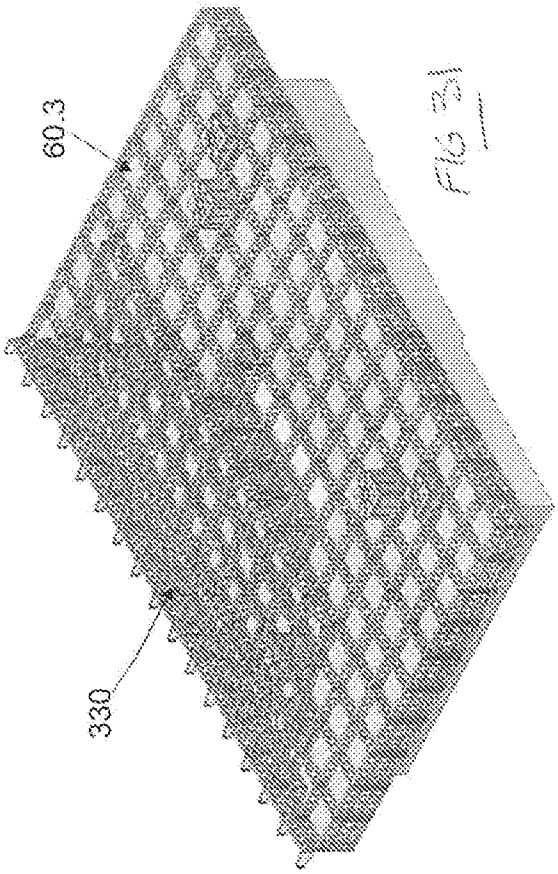


FIG 3I

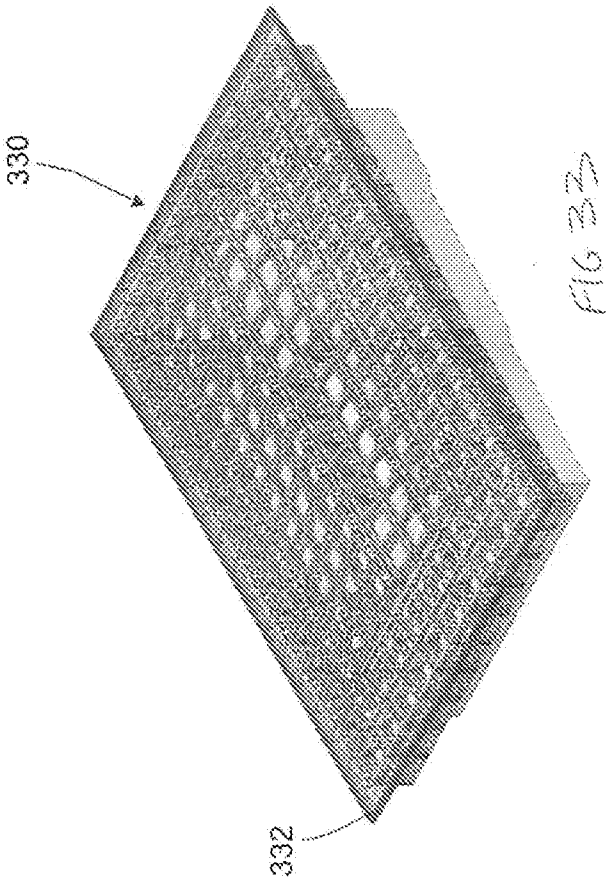


FIG 3J

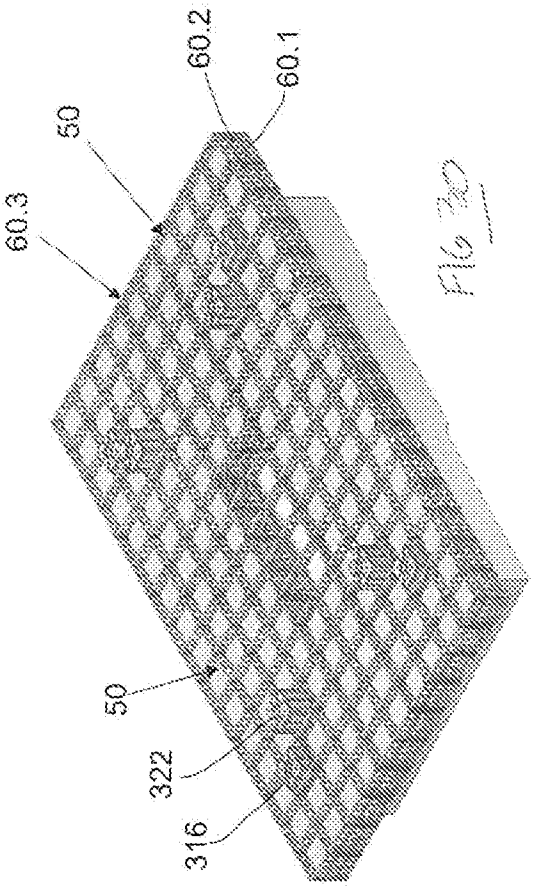


FIG 3G

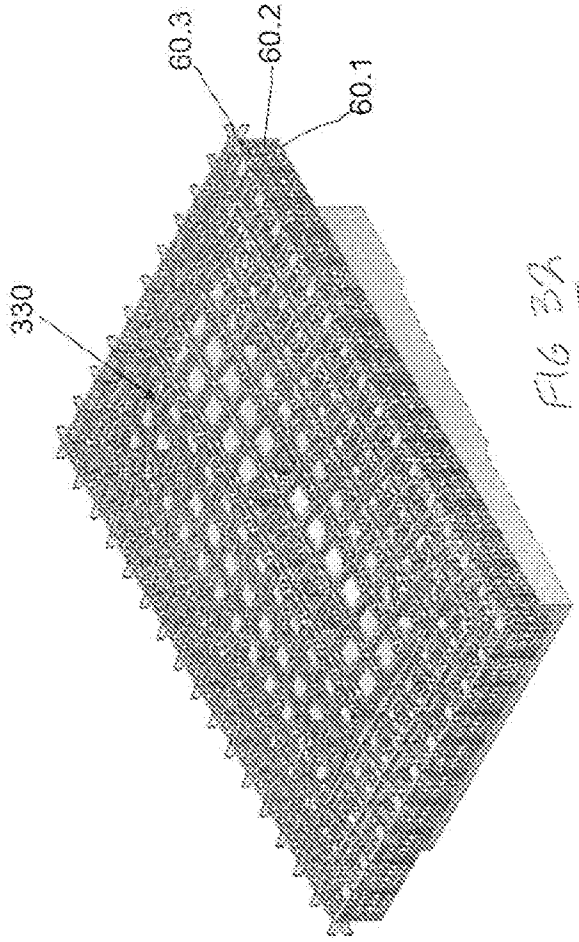


FIG 3H

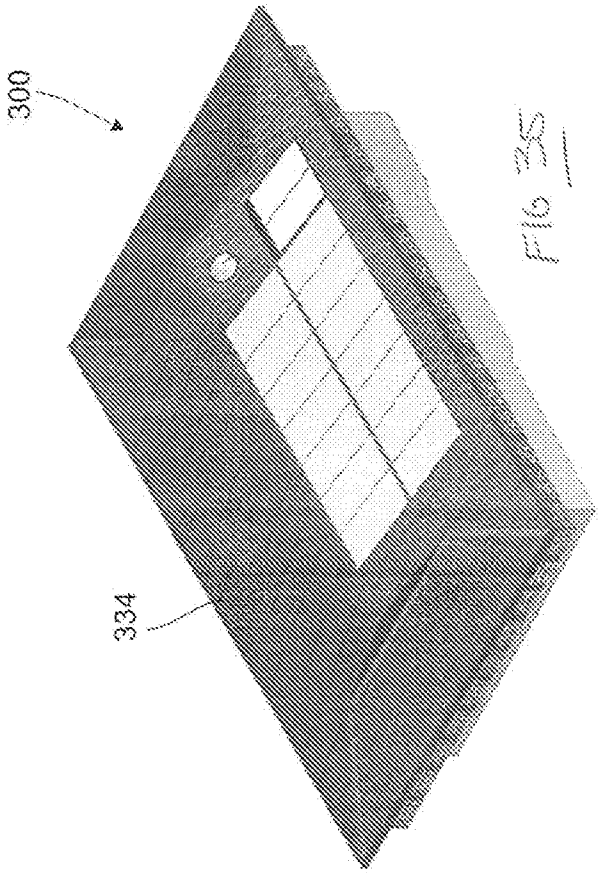


FIG 35

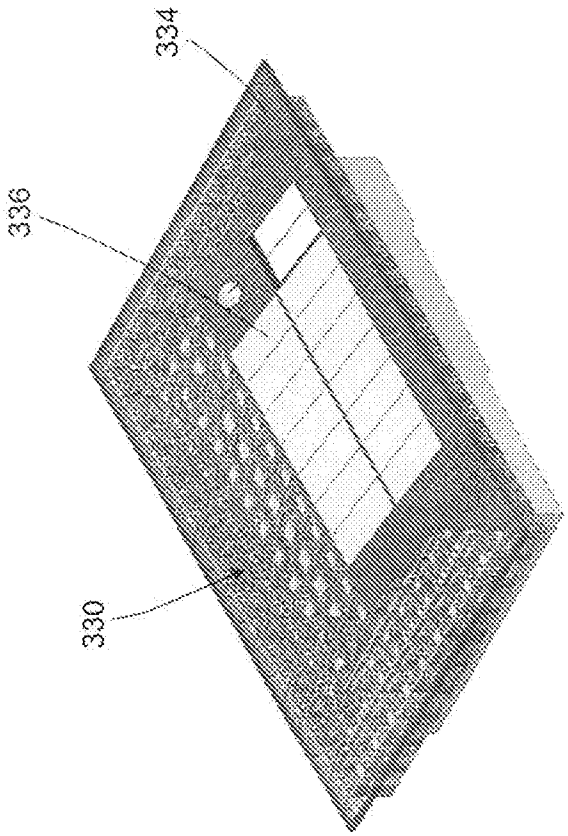


FIG 34

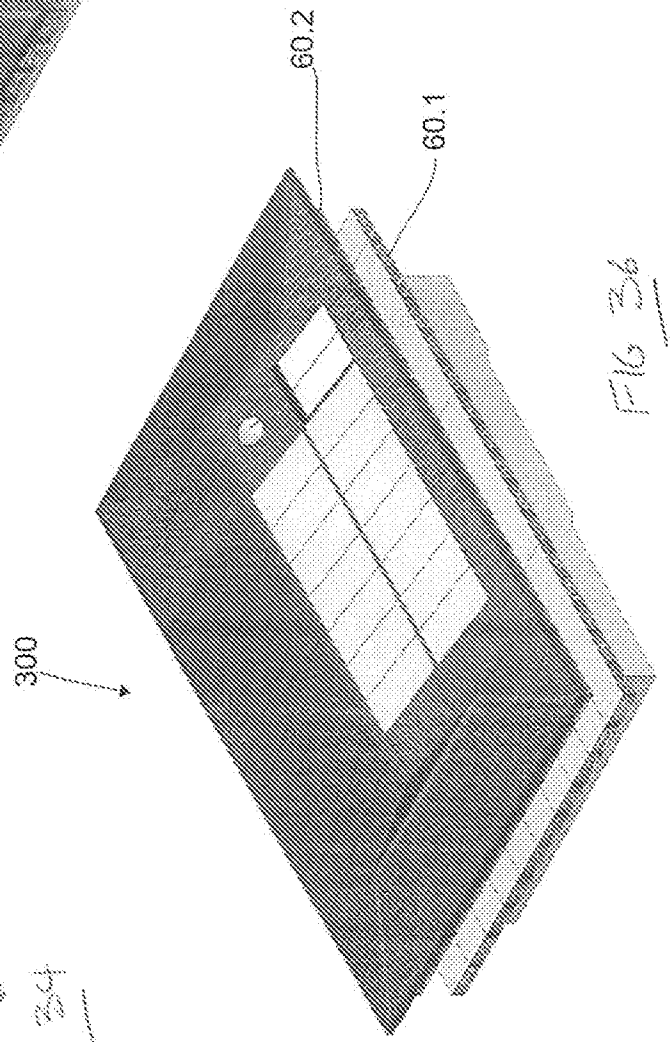


FIG 36

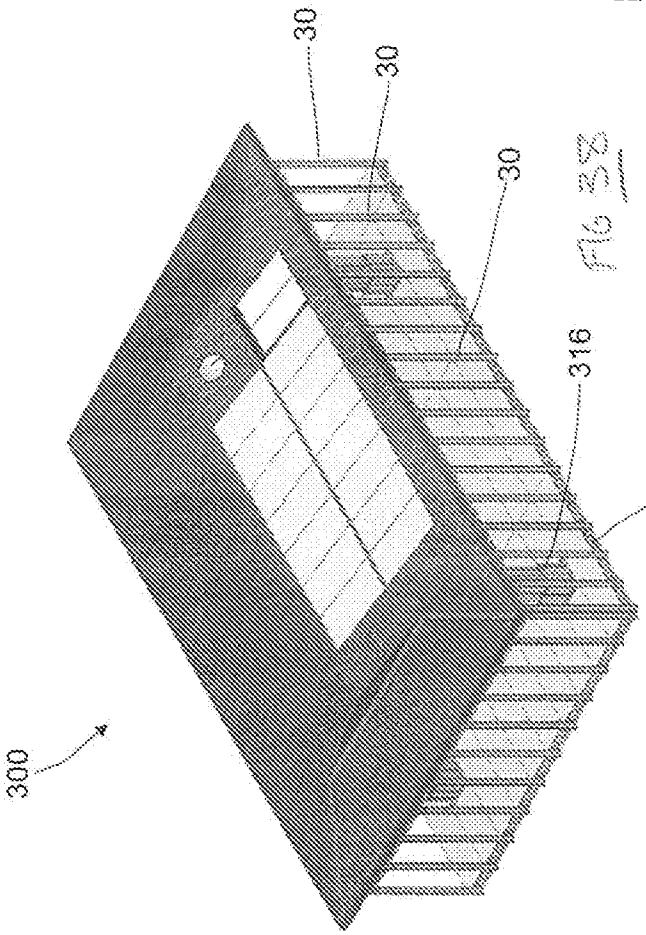


FIG 35B

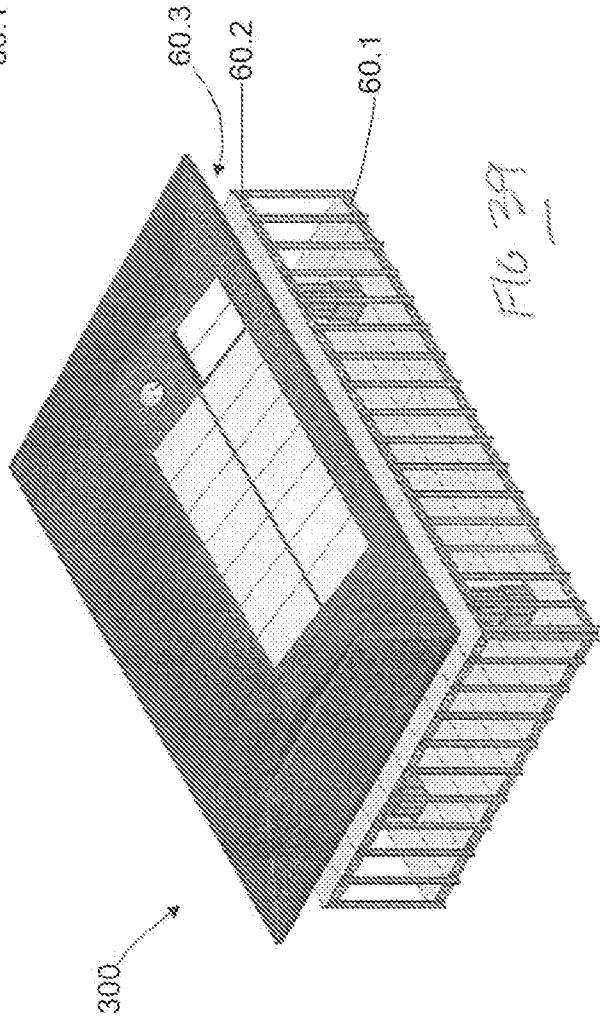


FIG 39

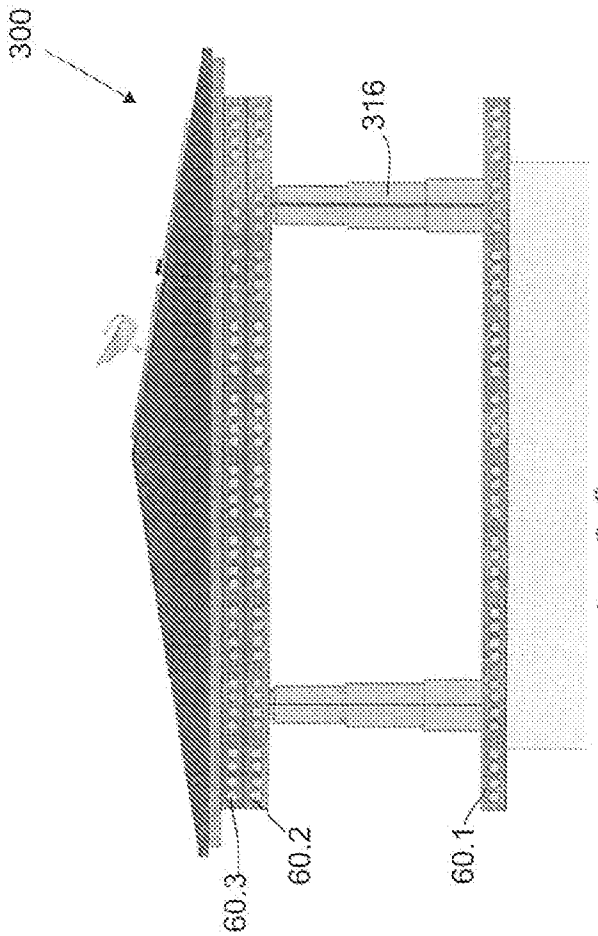


FIG 37

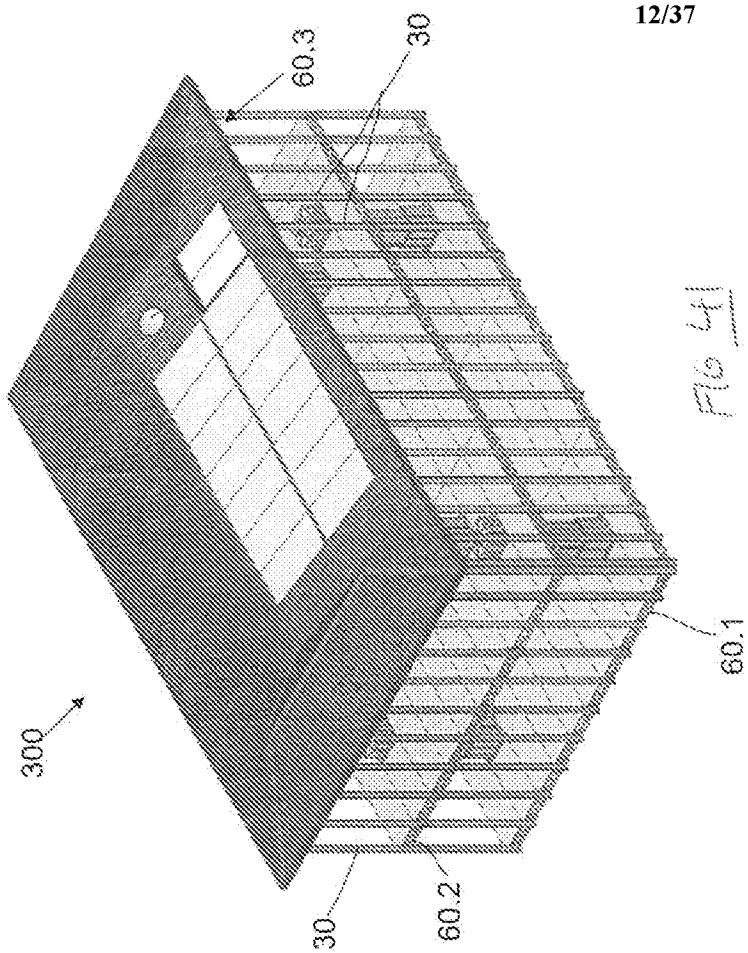


Fig 41

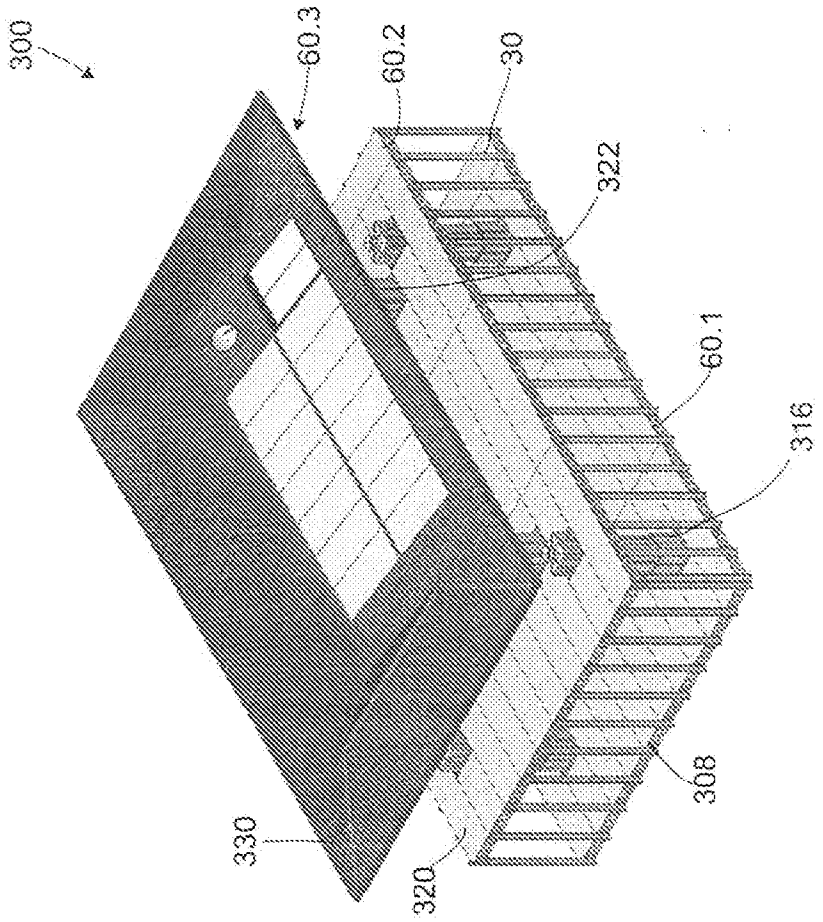


Fig 40

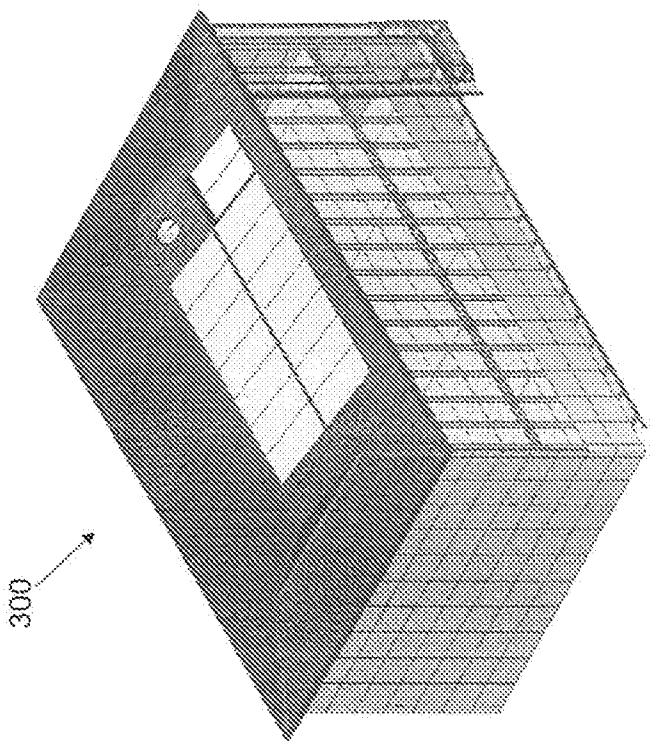


FIG 43

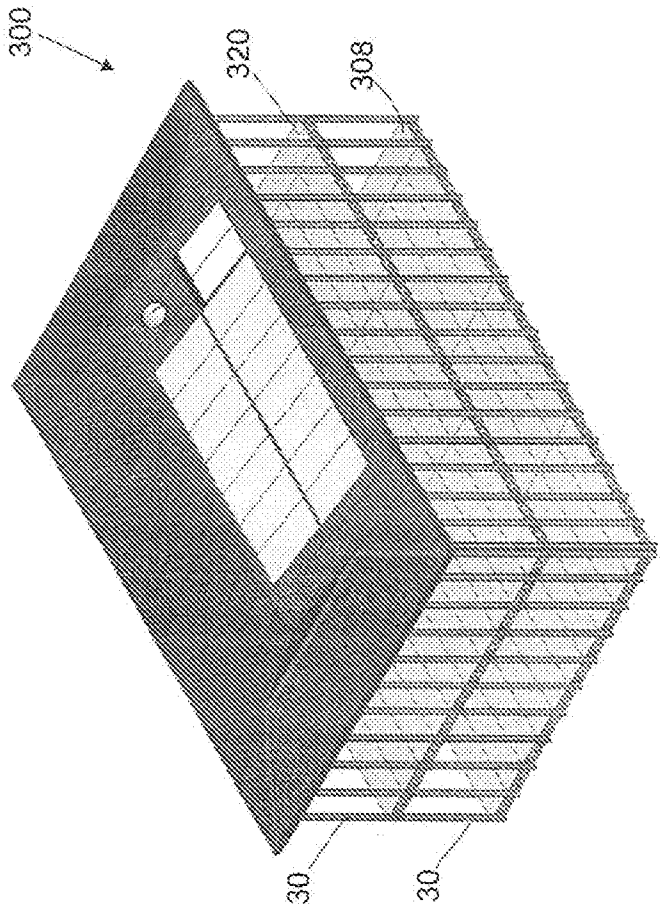


FIG 42

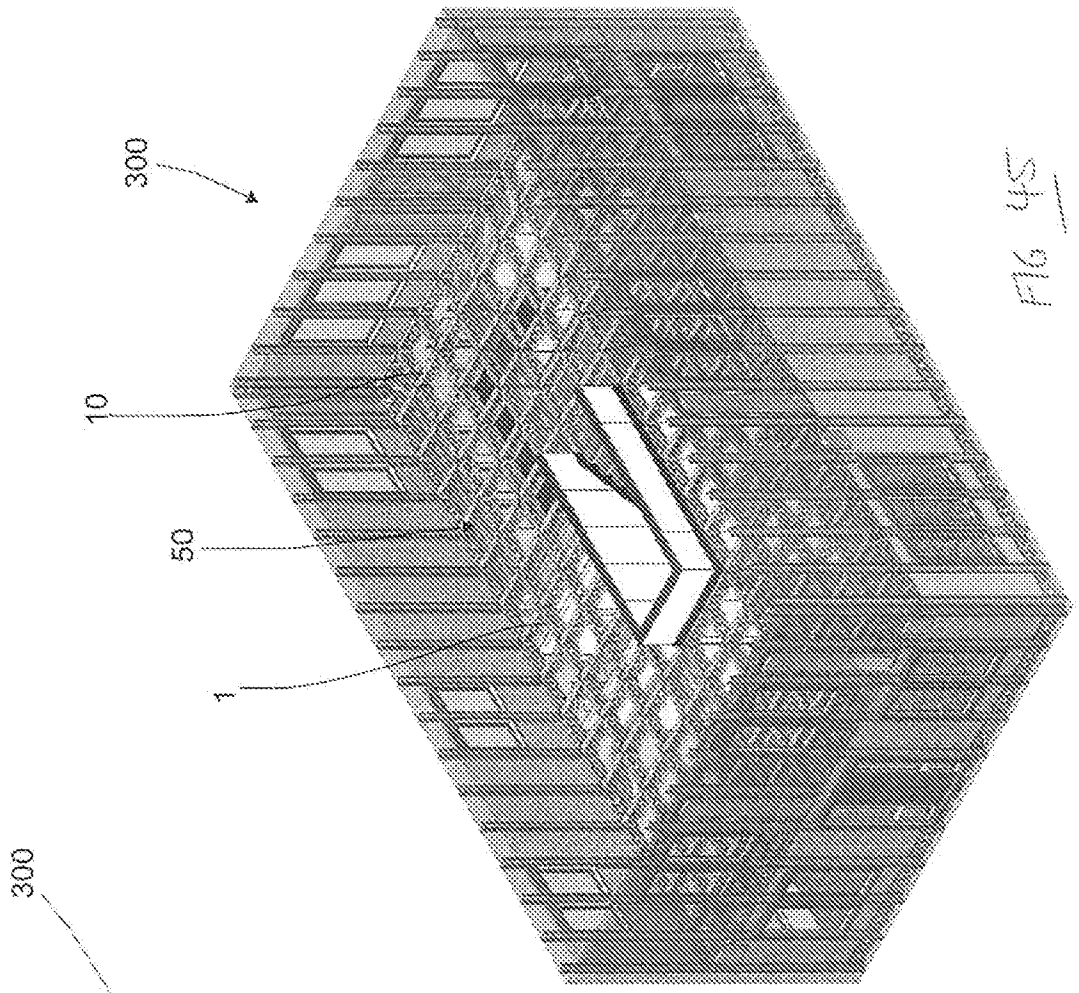


FIG 4S

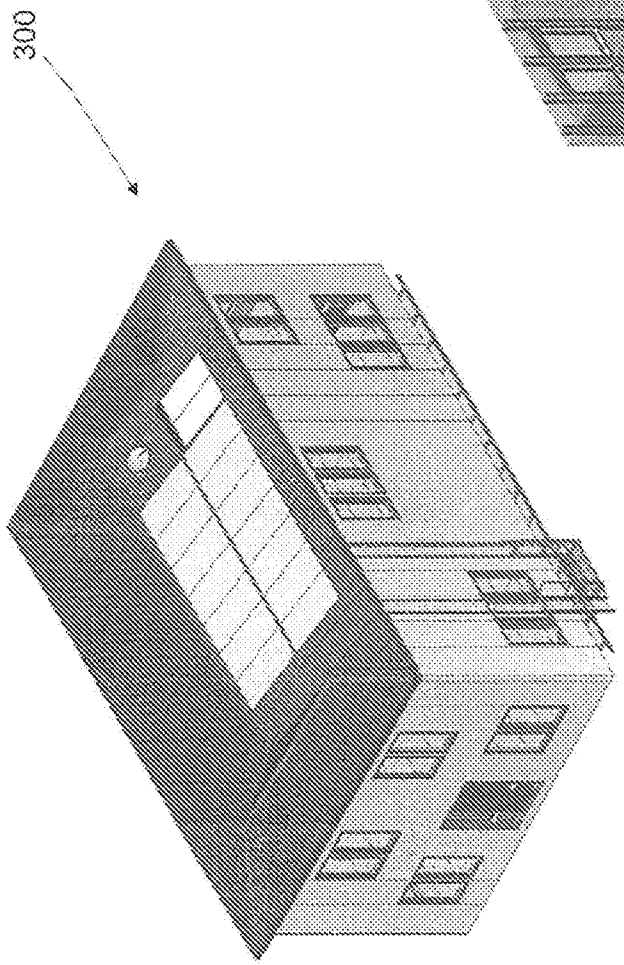


FIG 4A

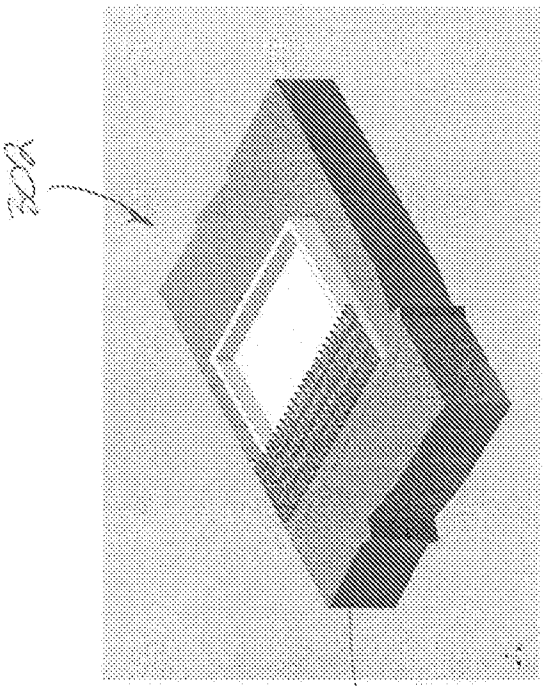


FIG 4A

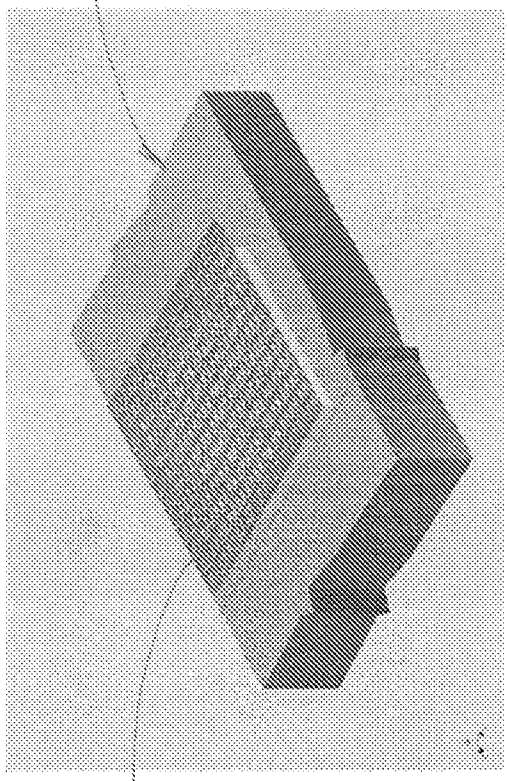


FIG 4B

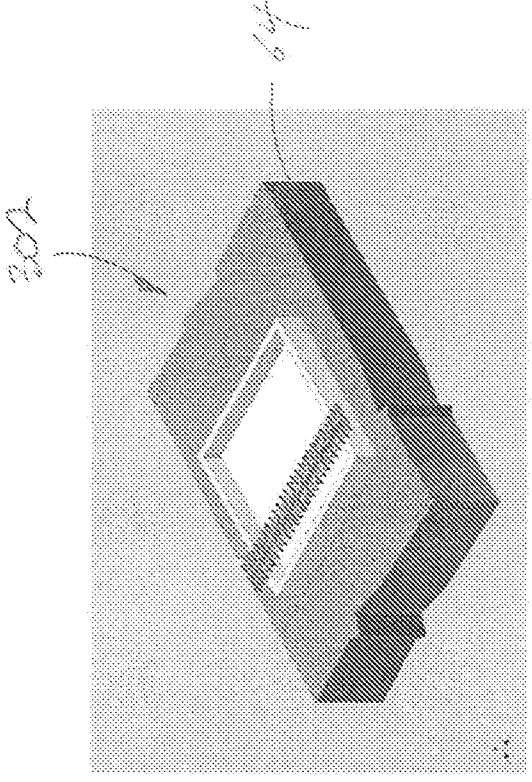


FIG 4C

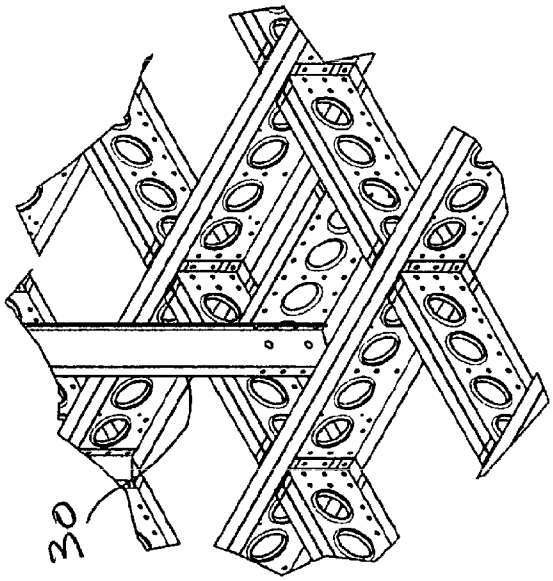


FIG 51

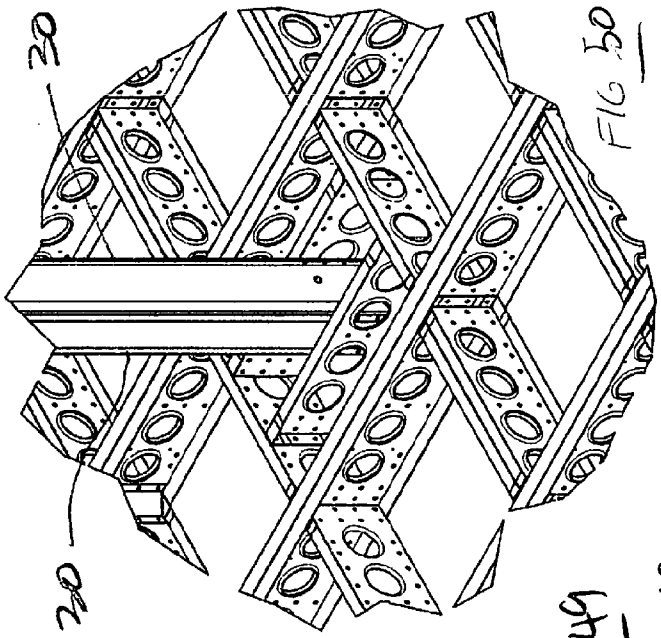


FIG 50

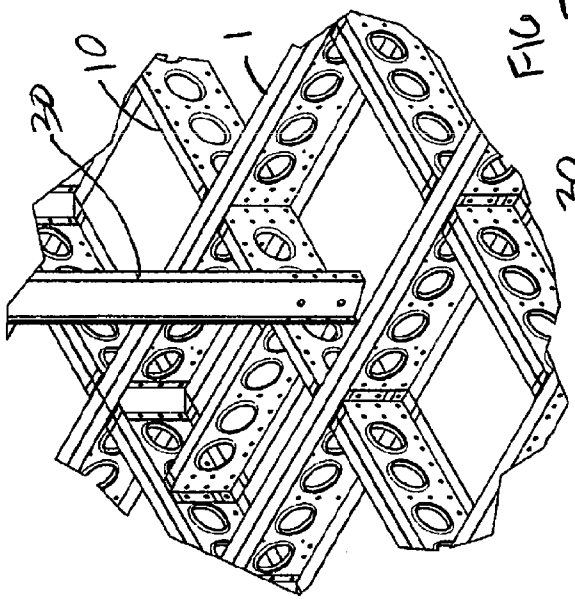


FIG 49

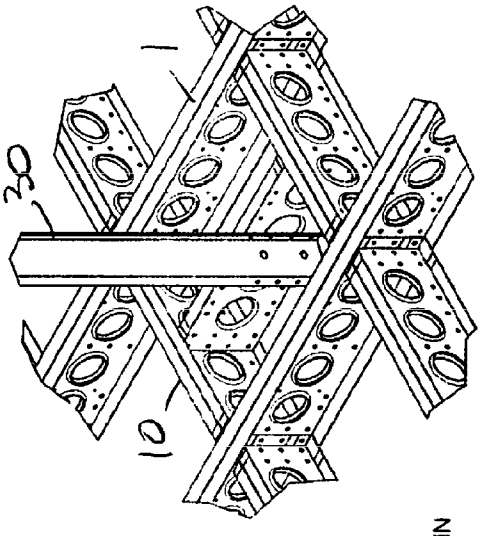


FIG 53

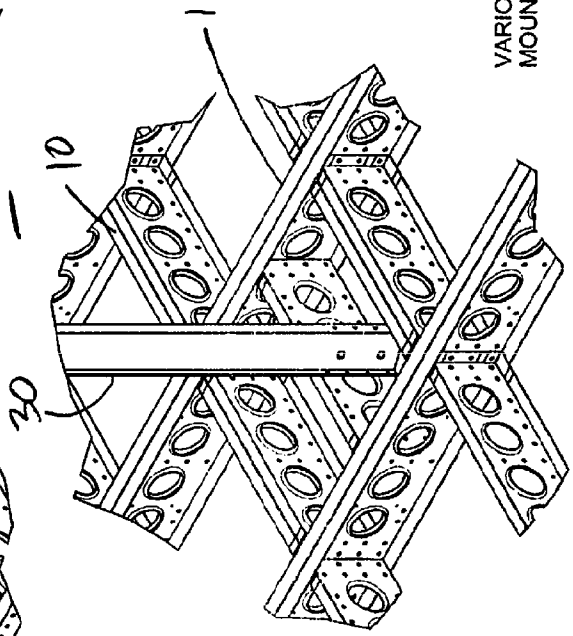


FIG 52

VARIOUS TYPES OF COLUMN MOUNTINGS

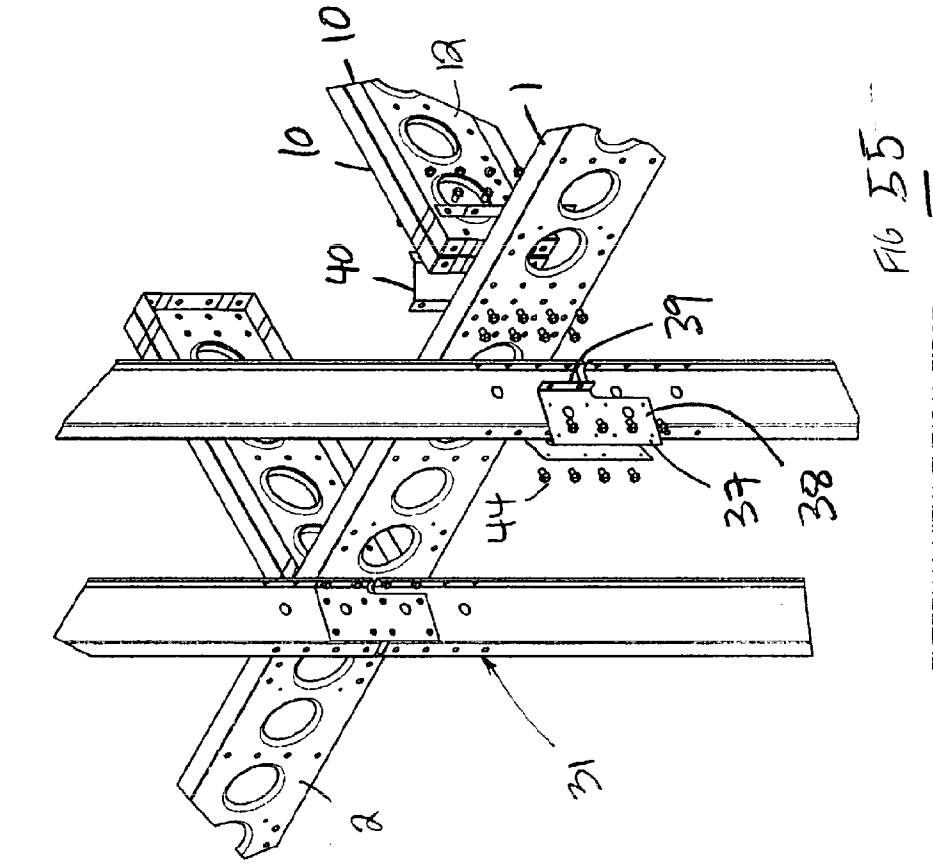


FIG 55

EXTERNAL VIEW: TYPICAL FIRST FLOOR COLUMN CONNECTION SHOWING THE SPLICE PLATES

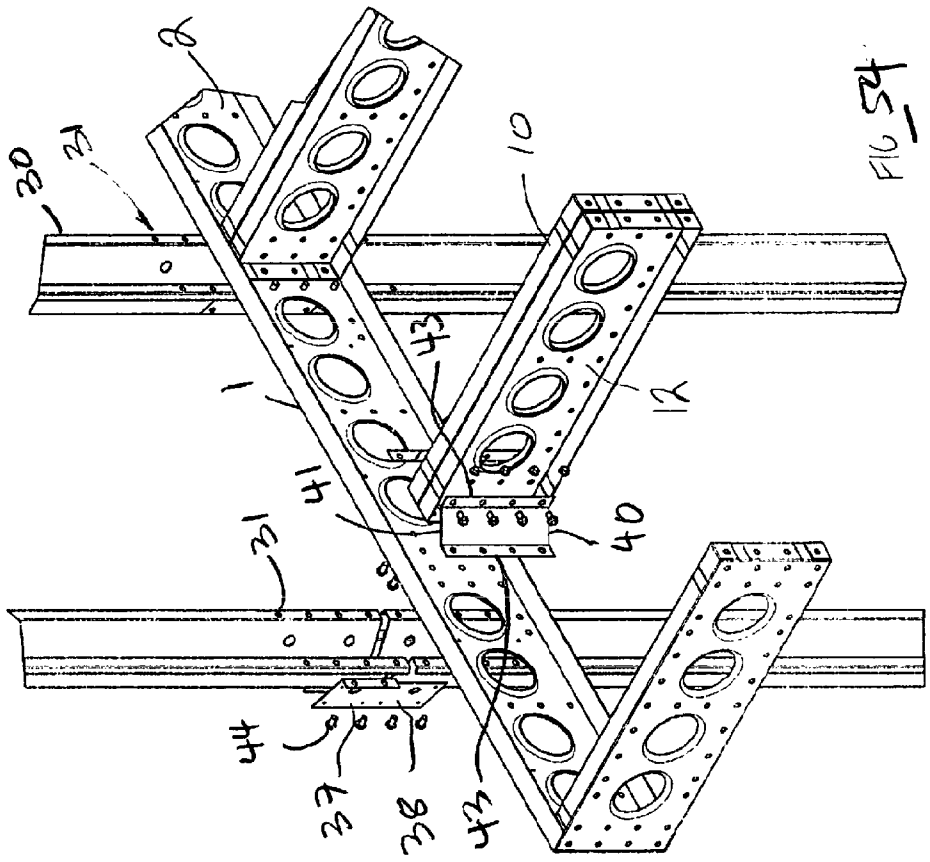


FIG 54

INTERNAL VIEW: TYPICAL FIRST FLOOR COLUMN CONNECTION SHOWING INTERNAL GUSSET

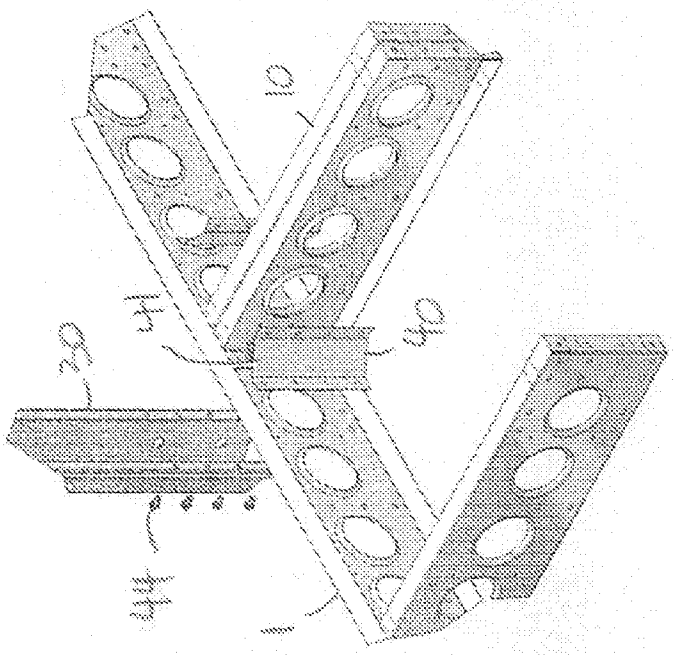


Fig 34

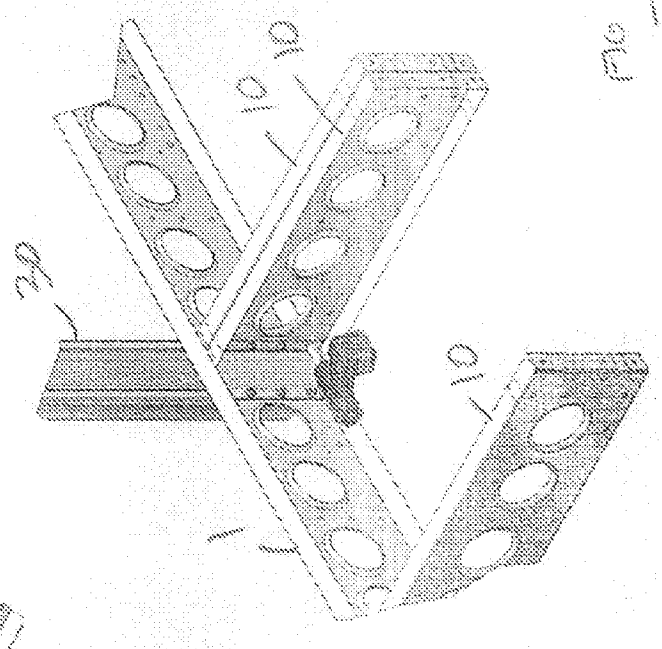


Fig 35

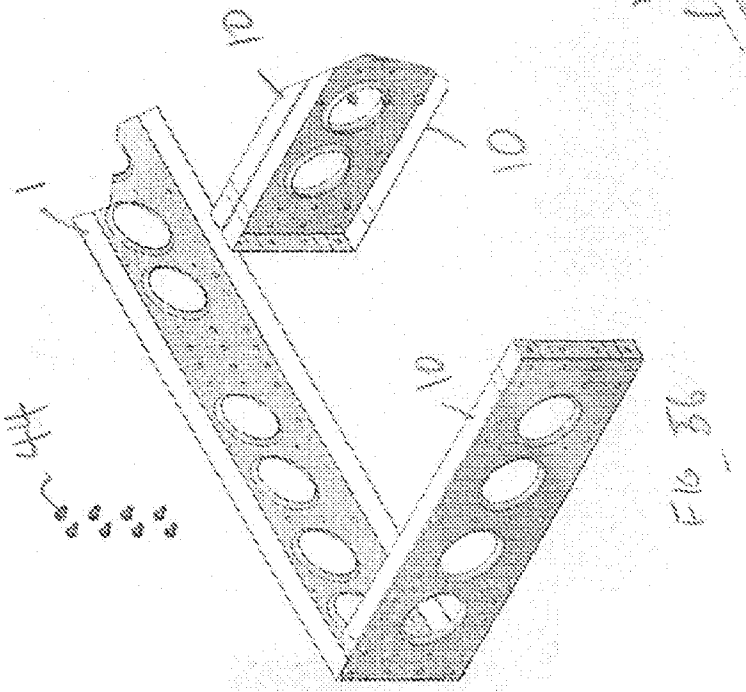


Fig 36

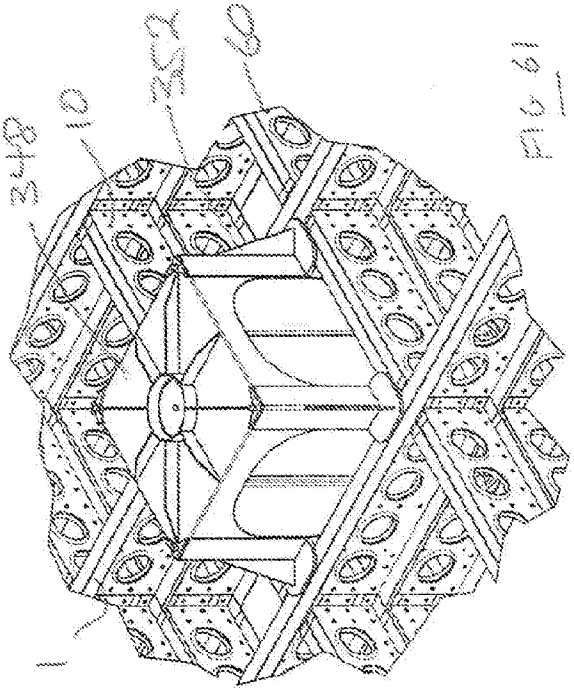


FIG 61

JACK: Closed condition
Showing the upper grid in place on the upper housing of the jack, with the upper keepers in place

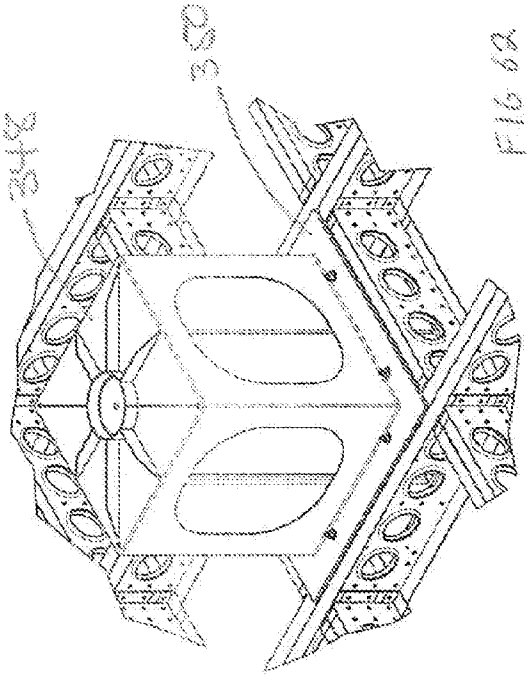


FIG 62

JACK: Closed condition
seated on the top face of a lower grid

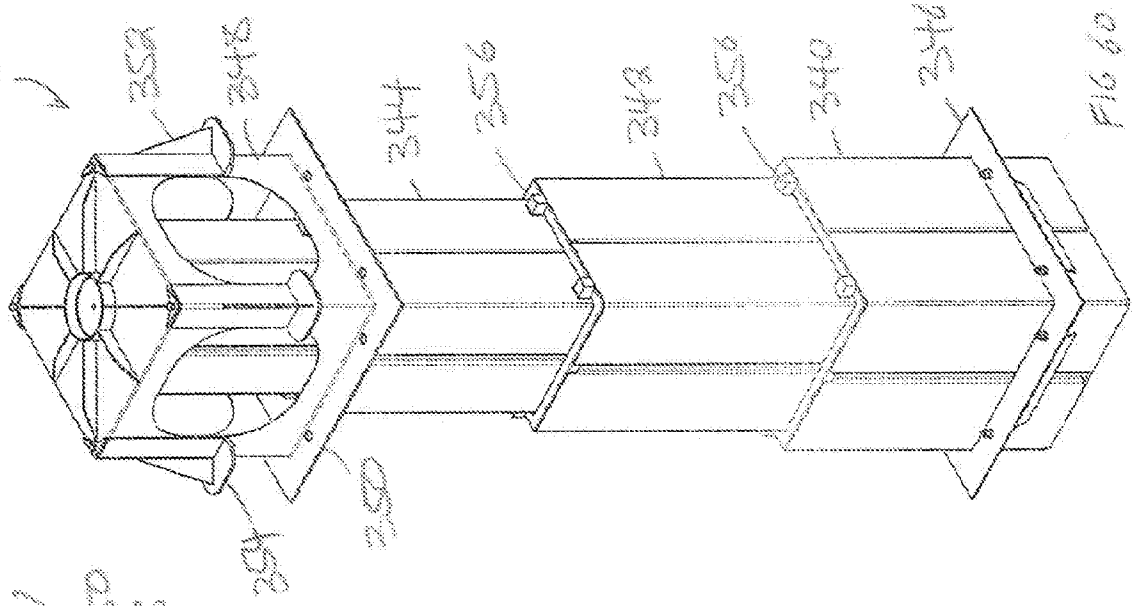


FIG 60

JACK EXTENDED

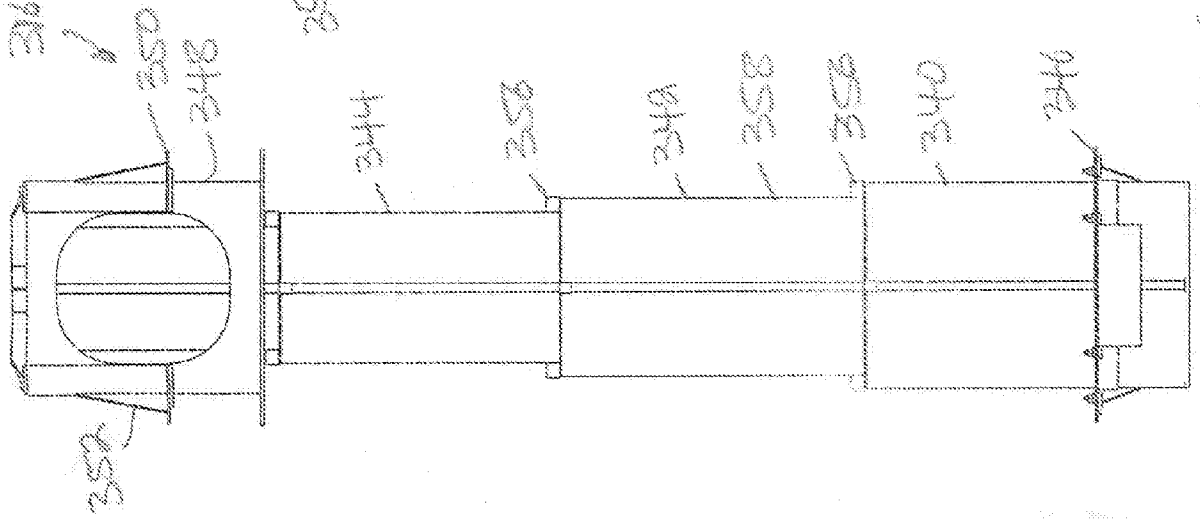


FIG 59

FIGURE 3: COLUMN

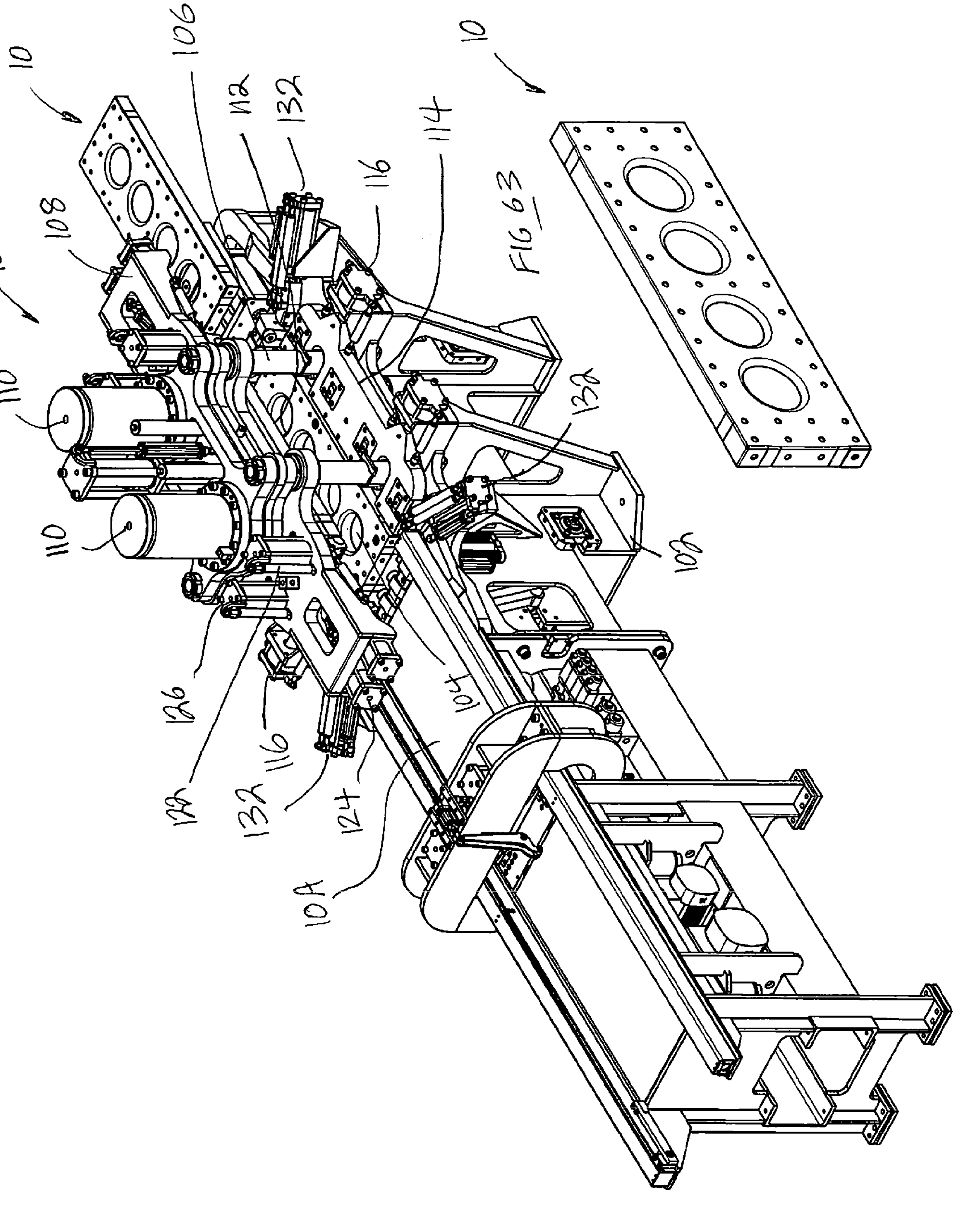
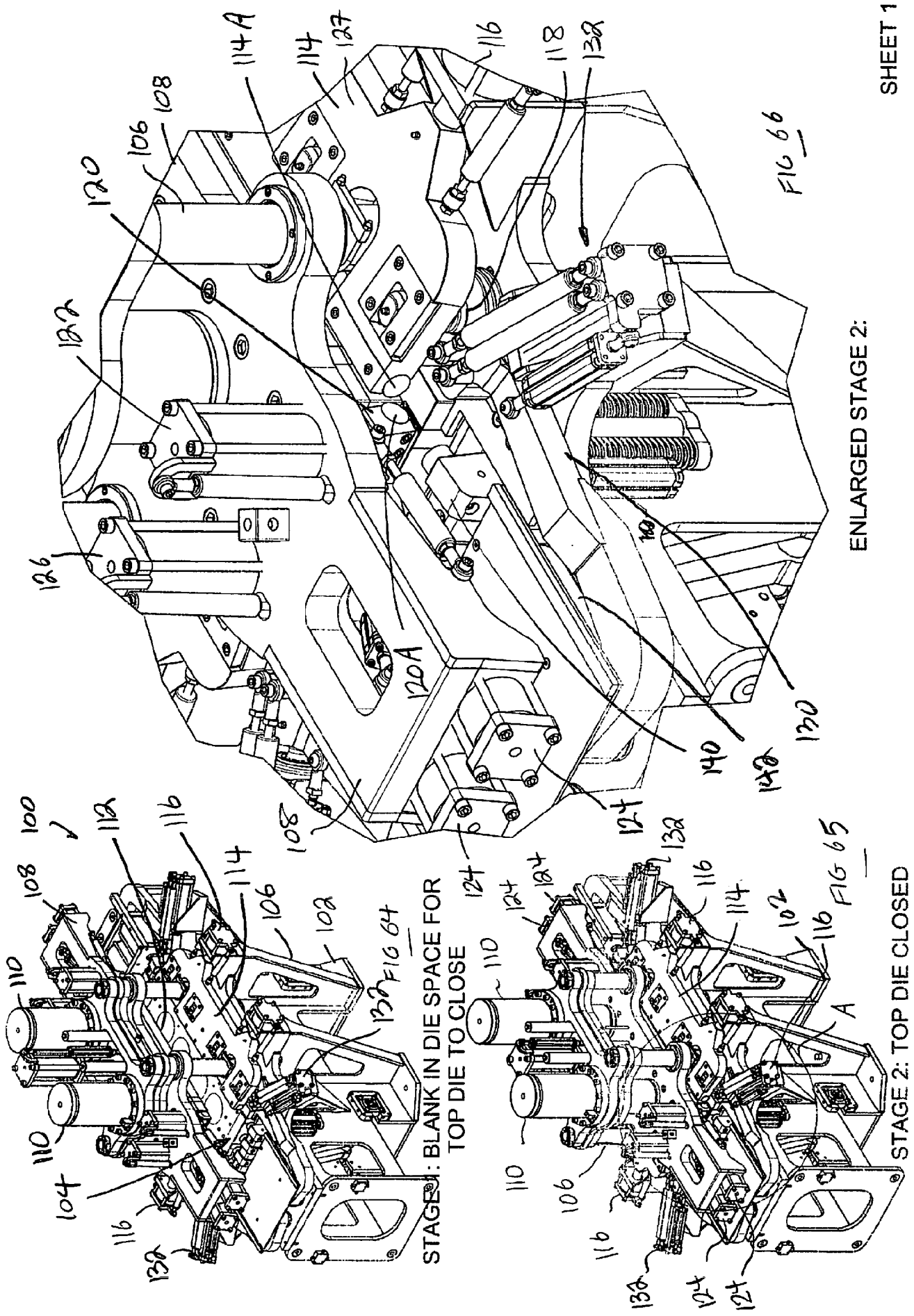
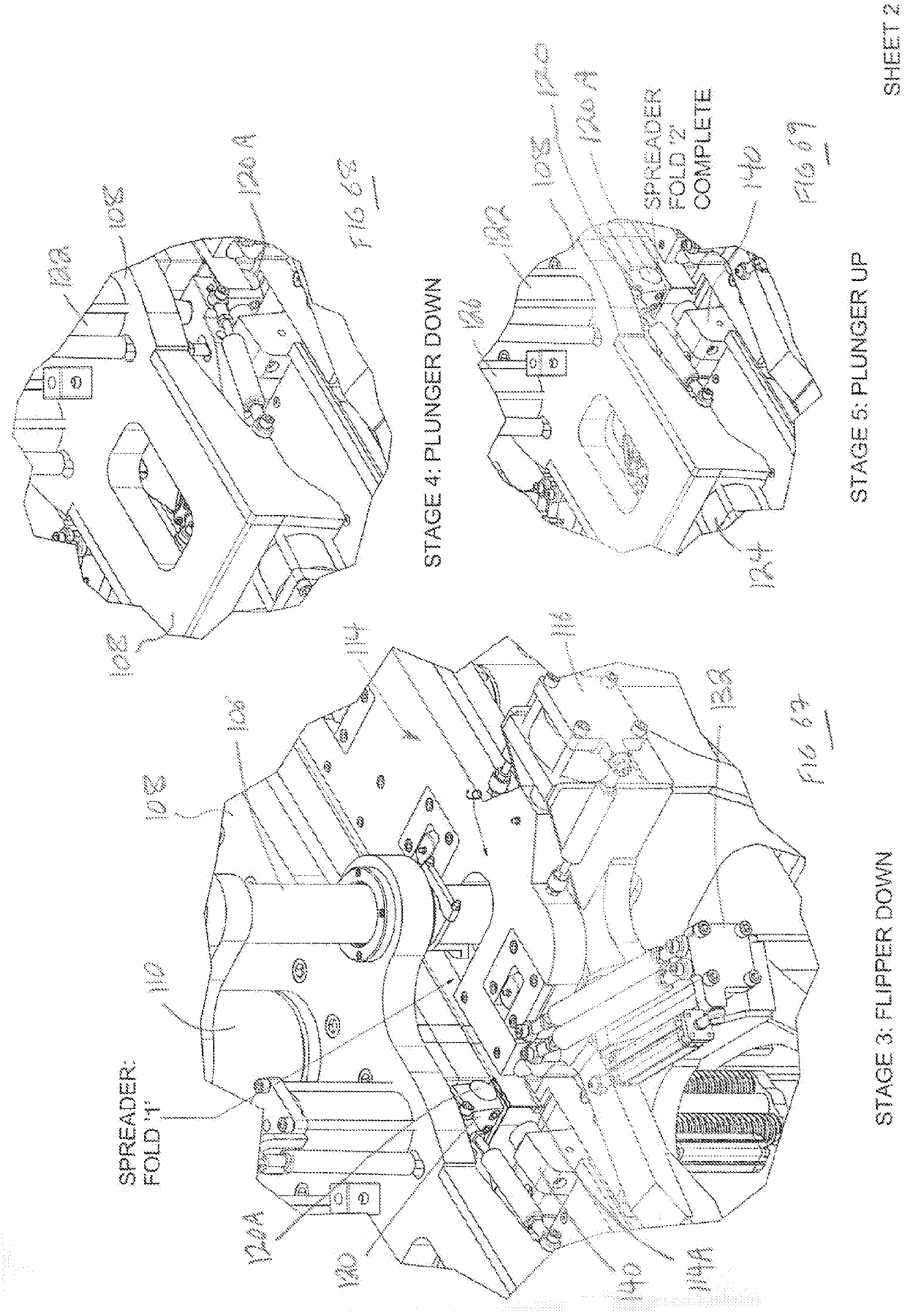

10
106
112
132
114
116
10
100
108
110
110
138
102
104
126
122
132
116
124
10A

FIG 63


SHEET 1
ENLARGED STAGE 2:
FIG 6
STAGE 1: BLANK IN DIE SPACE FOR TOP DIE TO CLOSE
FIG 4
STAGE 2: TOP DIE CLOSED
FIG 5


SHEET 2
STAGE 3: FLIPPER DOWN
SPREADER: FOLD '1'
STAGE 4: PLUNGER DOWN
STAGE 5: PLUNGER UP
SPREADER FOLD '2' COMPLETE

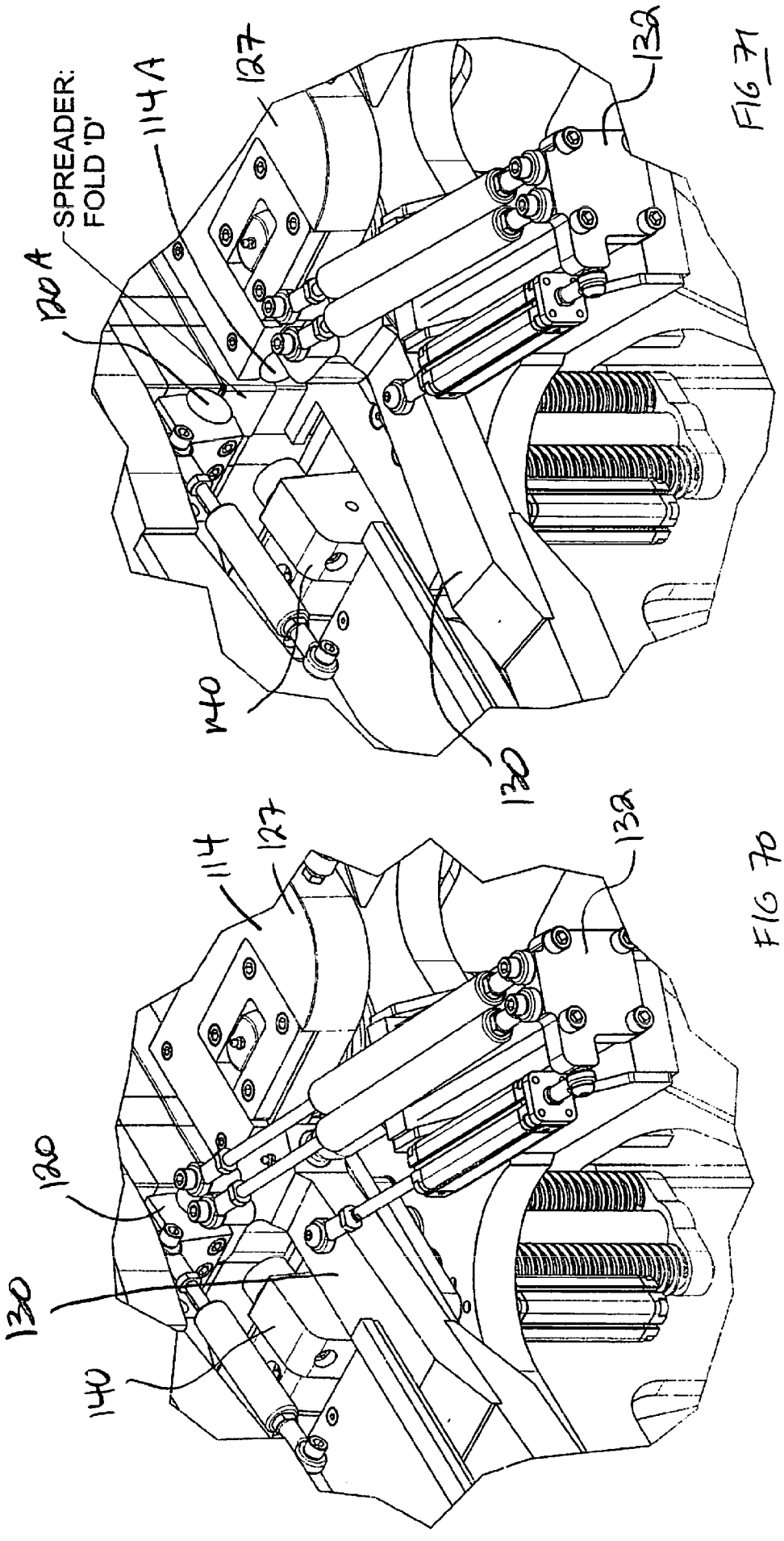


FIG 71

STAGE 7: TAIL ARM OUT (NORMAL POSITION)

FIG 70

STAGE 6: TAIL ARM IN

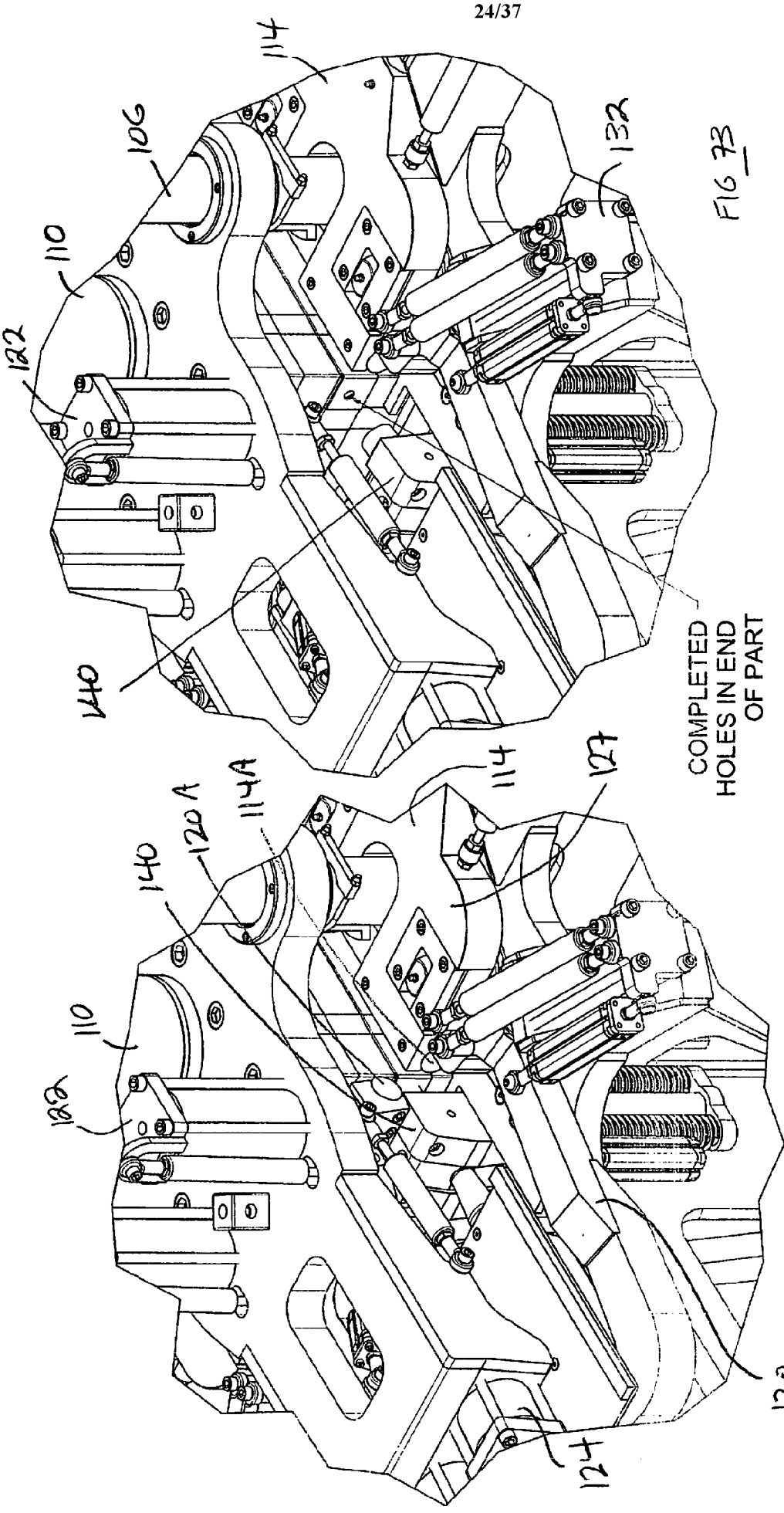
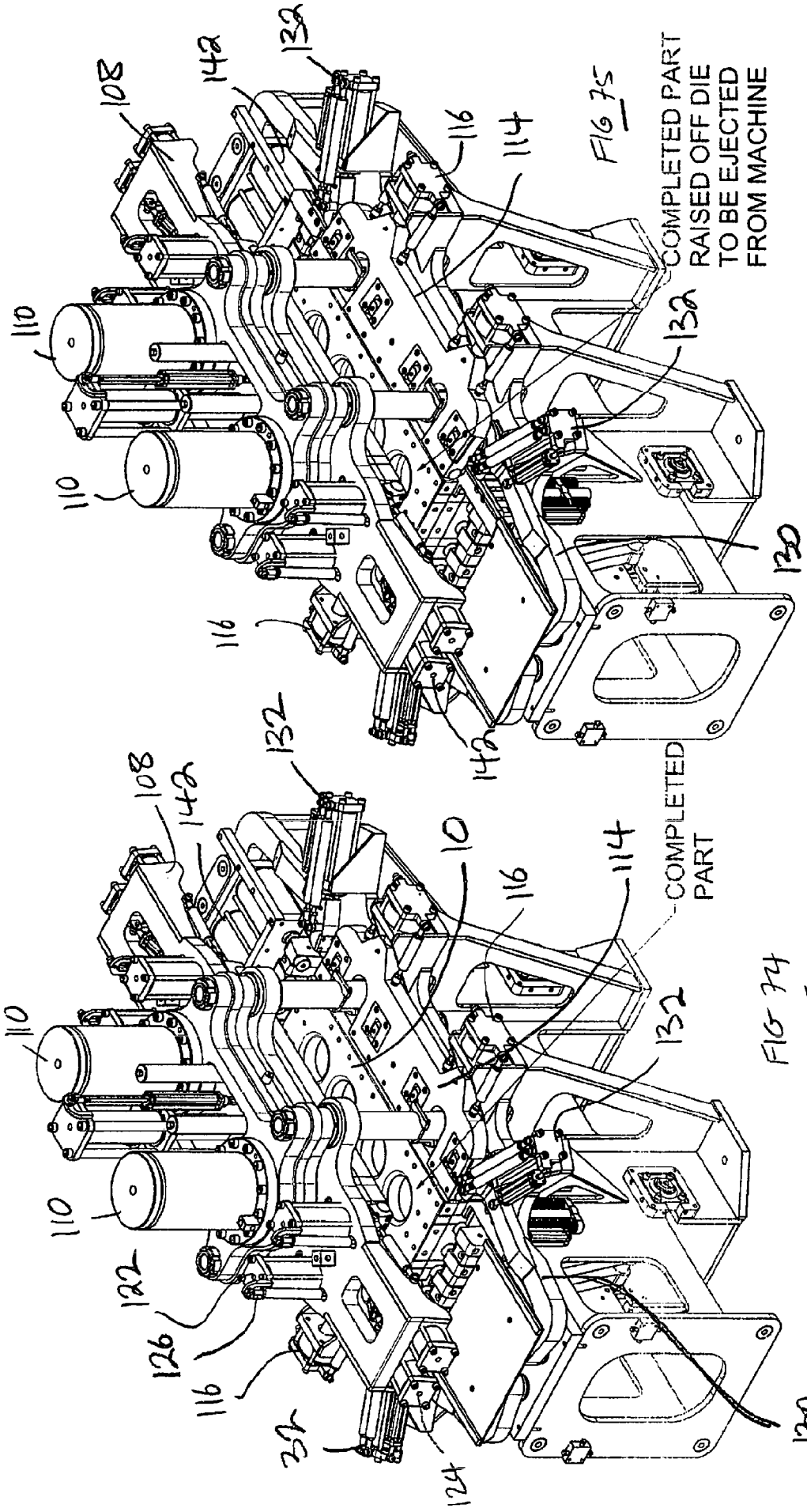


FIG 73 STAGE 9: END PUNCH OUT (NORMAL POSITION)

ITEM 9 NOT SHOWN FOR CLARITY

FIG 72 STAGE 8: END PUNCH IN

SHEET 4


110
108
142
132
116
114
COMPLETED PART RAISED OFF DIE TO BE EJECTED FROM MACHINE
120
STAGE 11: TOP DIE OPEN
FLIPPERS UP
PART EJECTED FROM DIE
FIG 7S
10
COMPLETED PART
126
122
124
STAGE 10: TOP DIE OPEN
FLIPPERS STILL DOWN
FIG 7A

SHEET 5

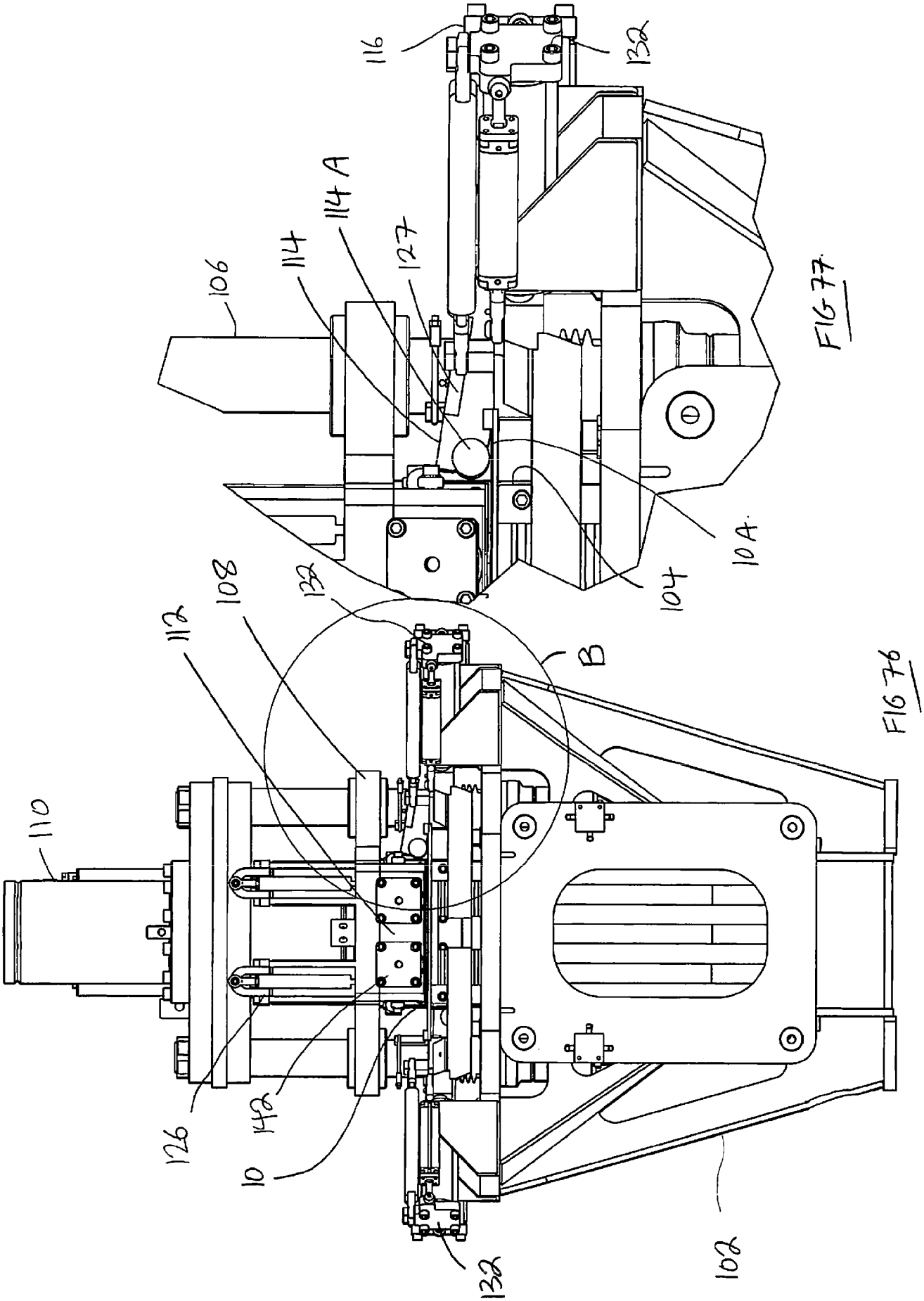


FIG 77

FIG 76

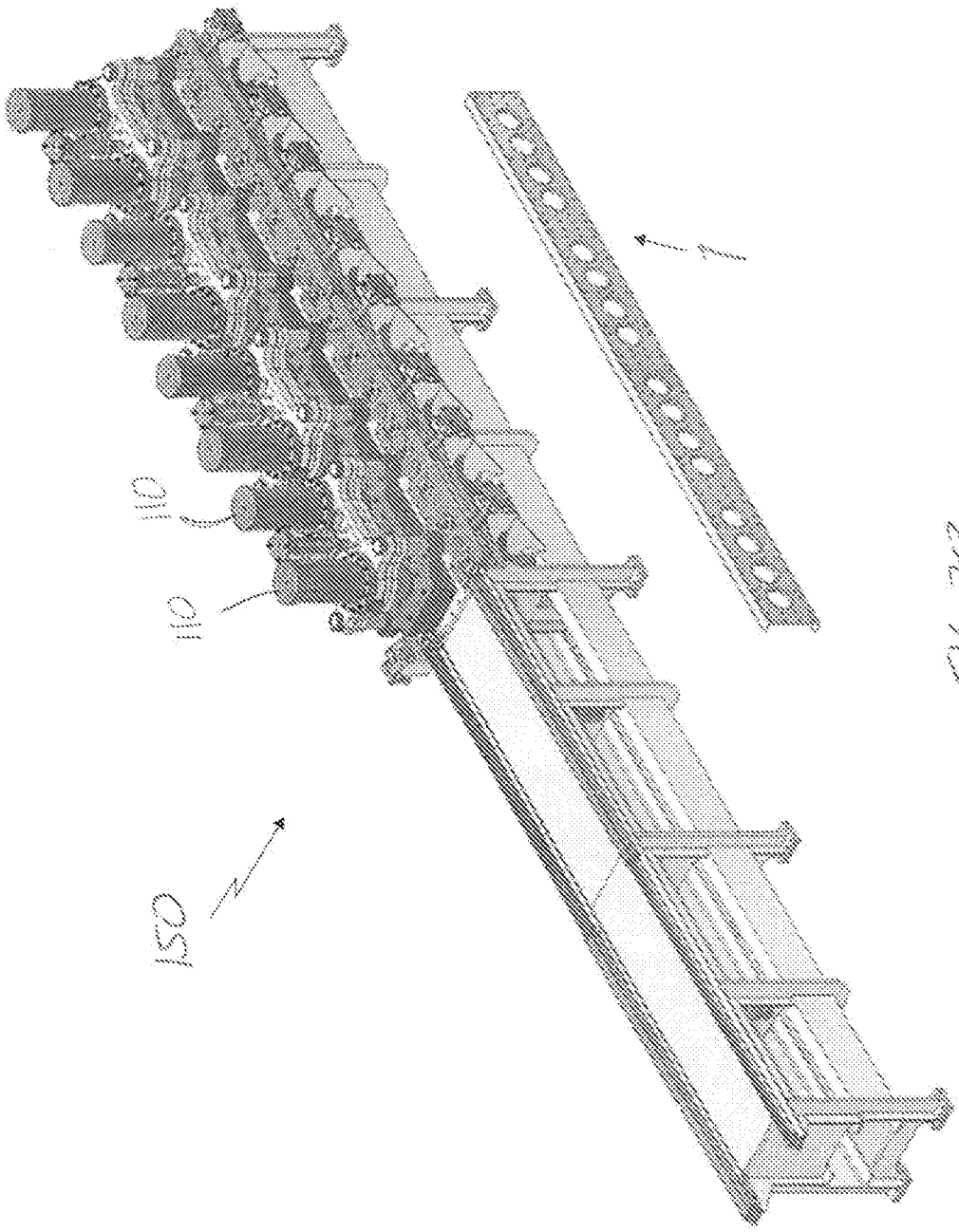


FIG 9A

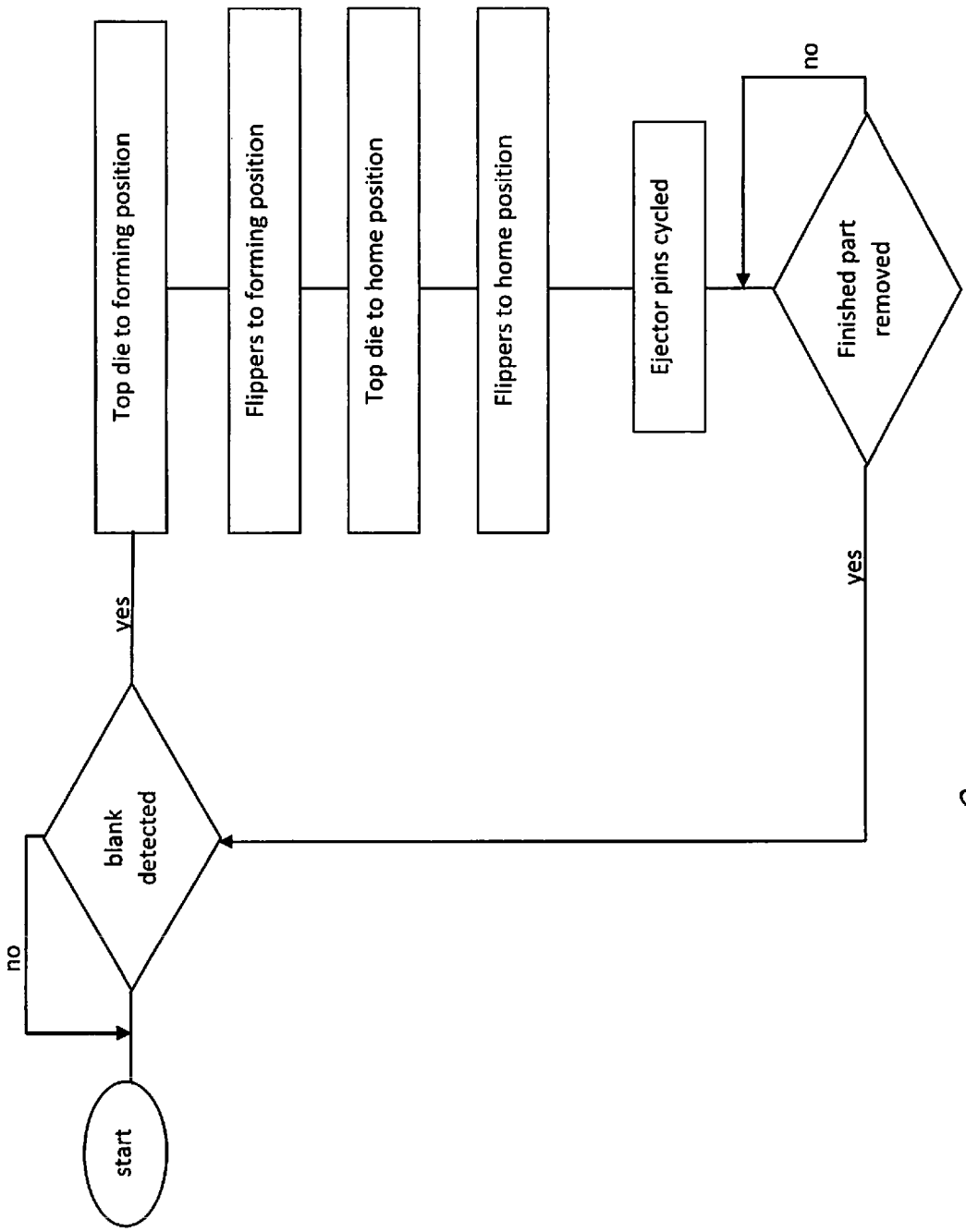

start
blank detected
no
yes
Top die to forming position
Flippers to forming position
Top die to home position
Flippers to home position
Ejector pins cycled
Finished part removed
no
yes

FIG 79

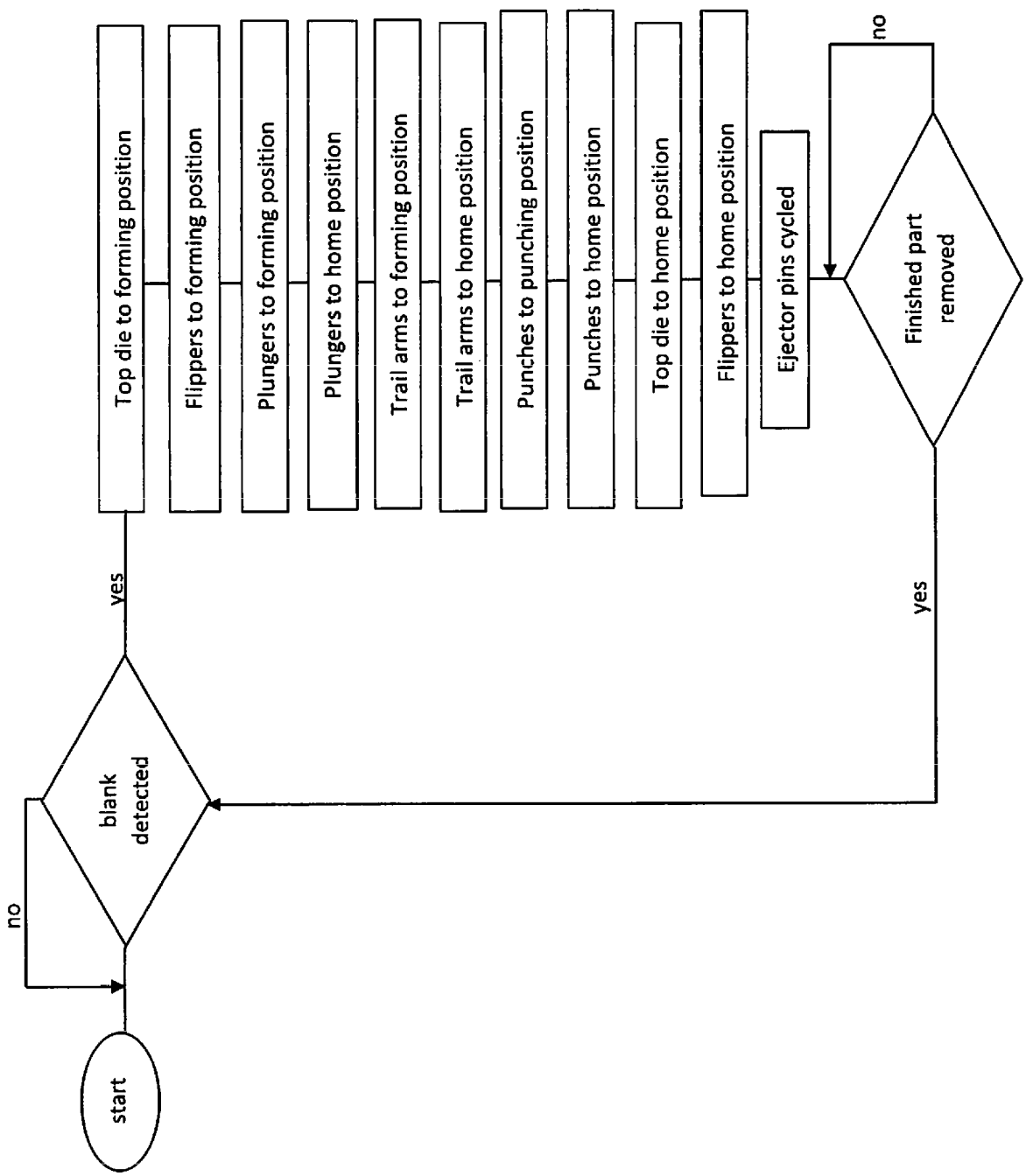

start
blank detected
no
yes
Top die to forming position
Flippers to forming position
Plungers to forming position
Plungers to home position
Trail arms to forming position
Trail arms to home position
Punches to punching position
Punches to home position
Top die to home position
Flippers to home position
Ejector pins cycled
Finished part removed
no
yes

FIG 8C

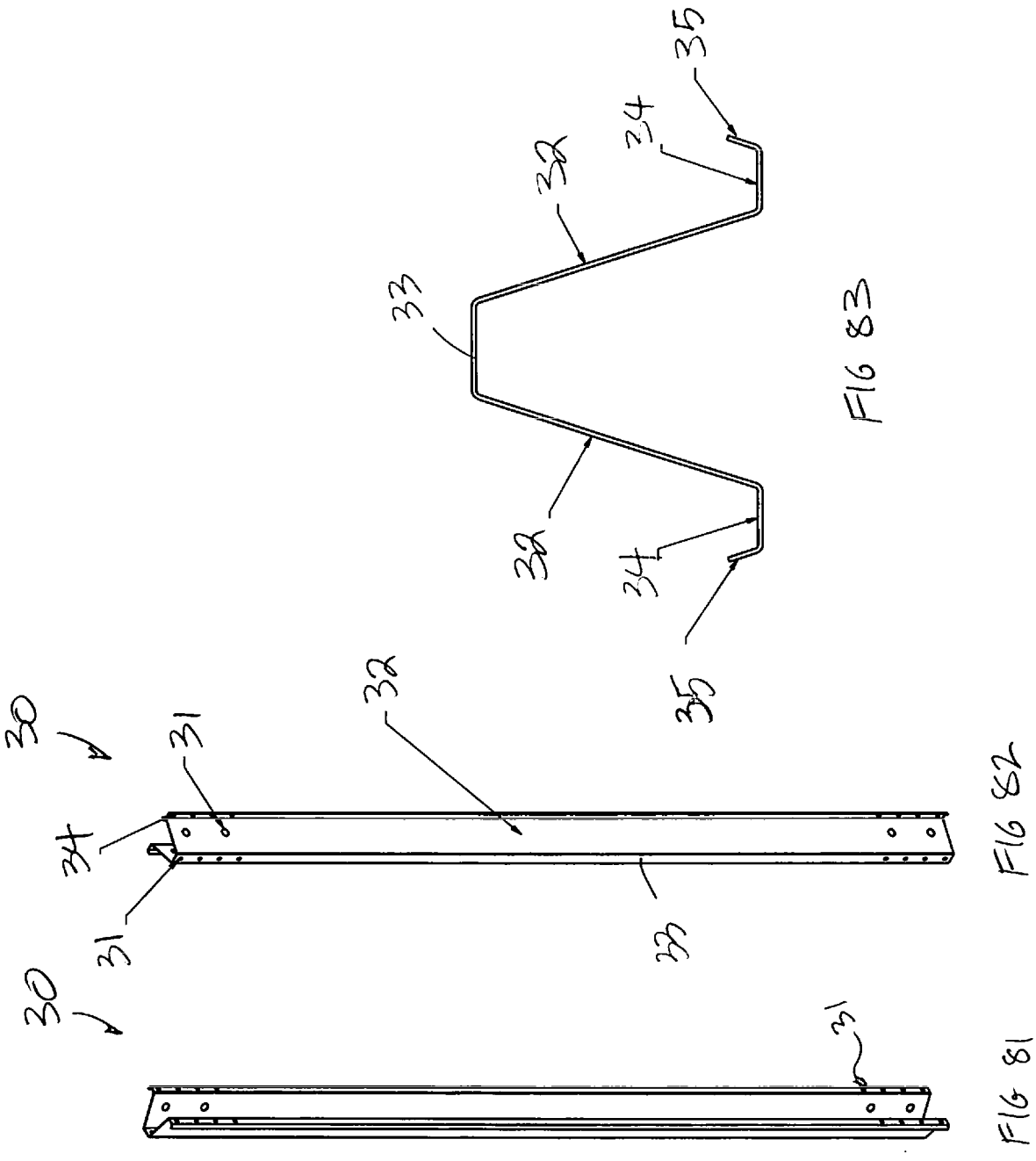


FIG 83

FIG 82

FIG 81

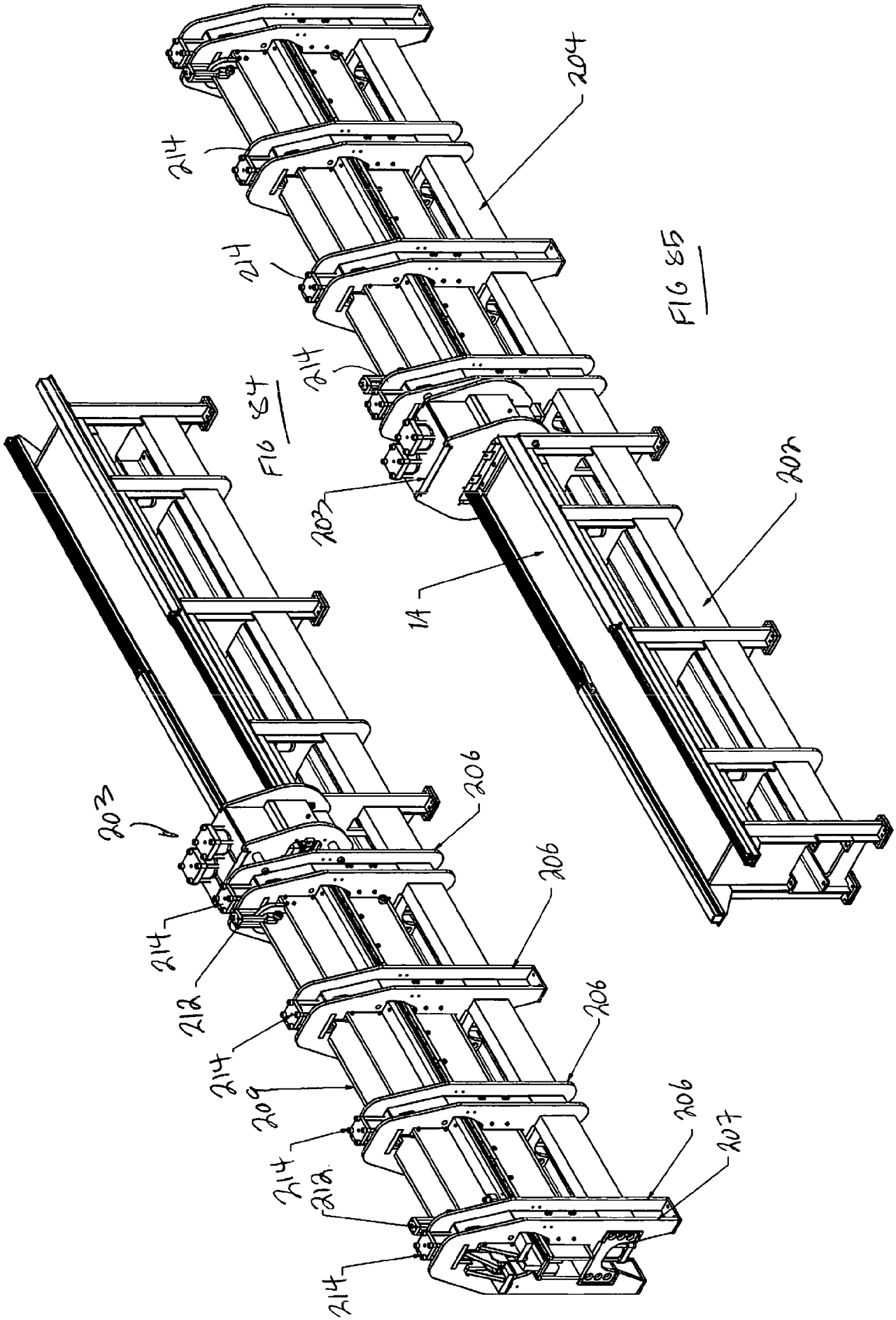

214
204
214
214
203
202
14
203
206
214
206
212
206
214
209
206
214
218
207
214

FIG 84

FIG 85

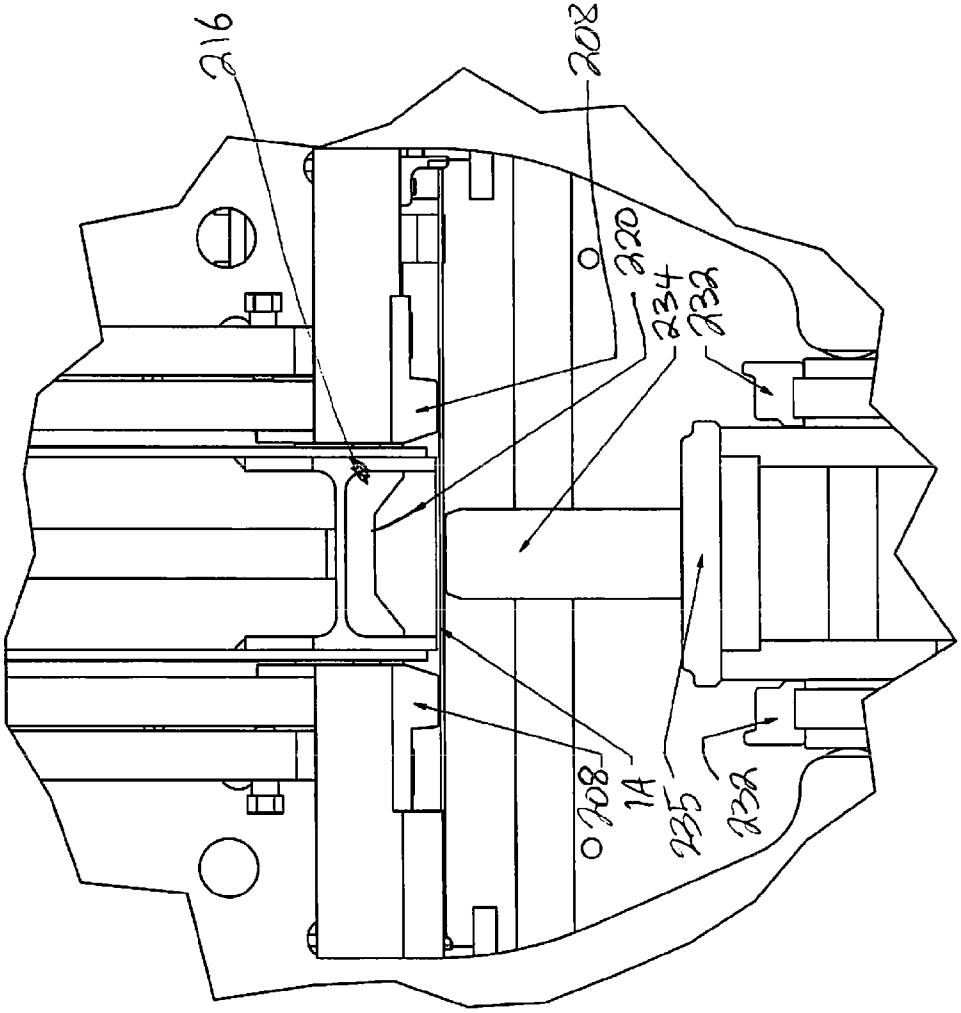

216
202
220
234
232
208
14
225
222

FIG 9A

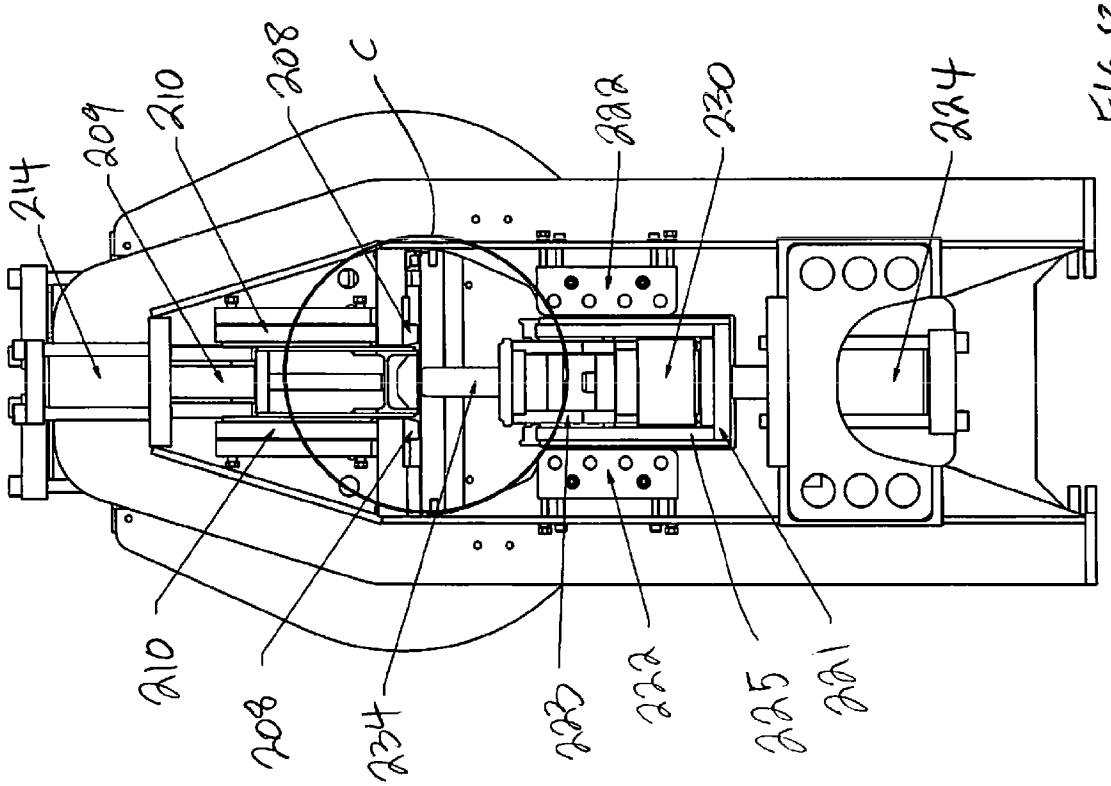

214
209
210
208
C
212
230
224
210
208
234
232
222
225
226

FIG 9B

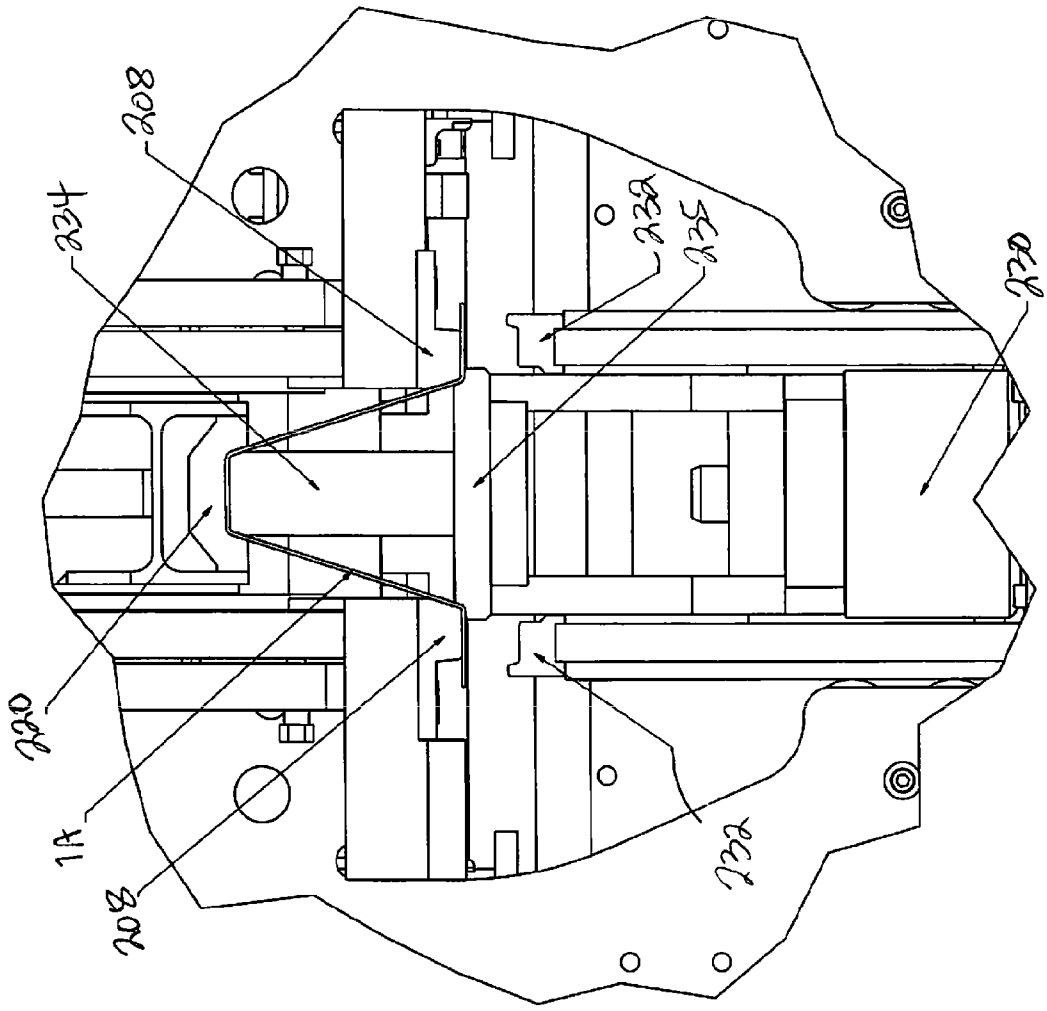

208
224
228
235
220
1A
208
232

FIG 89

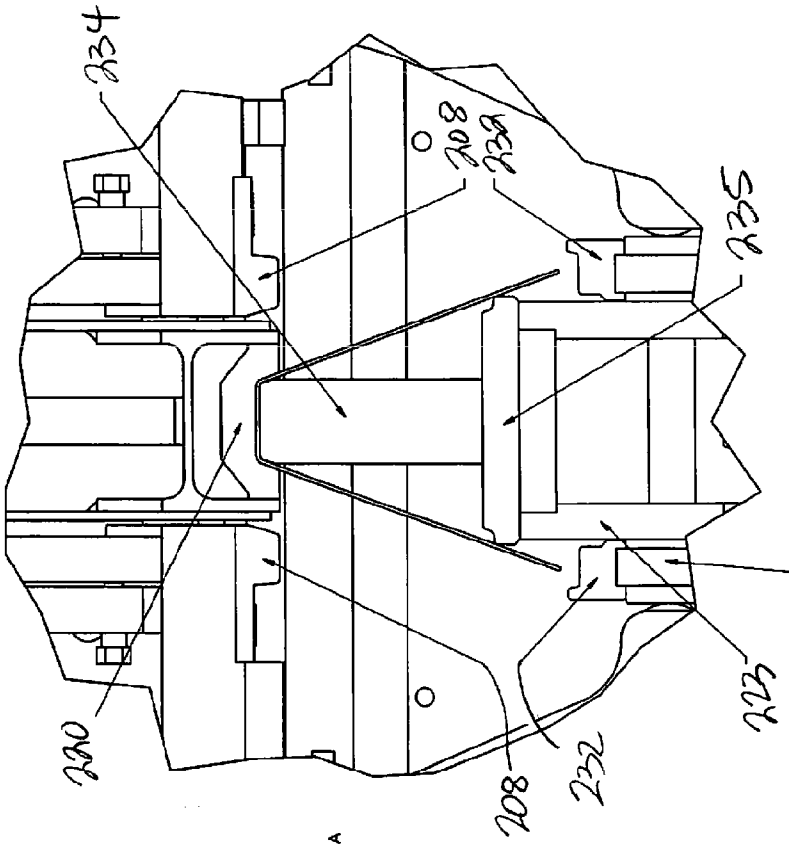

234
208
228
235
220
208
232
225
222
A

FIG 88

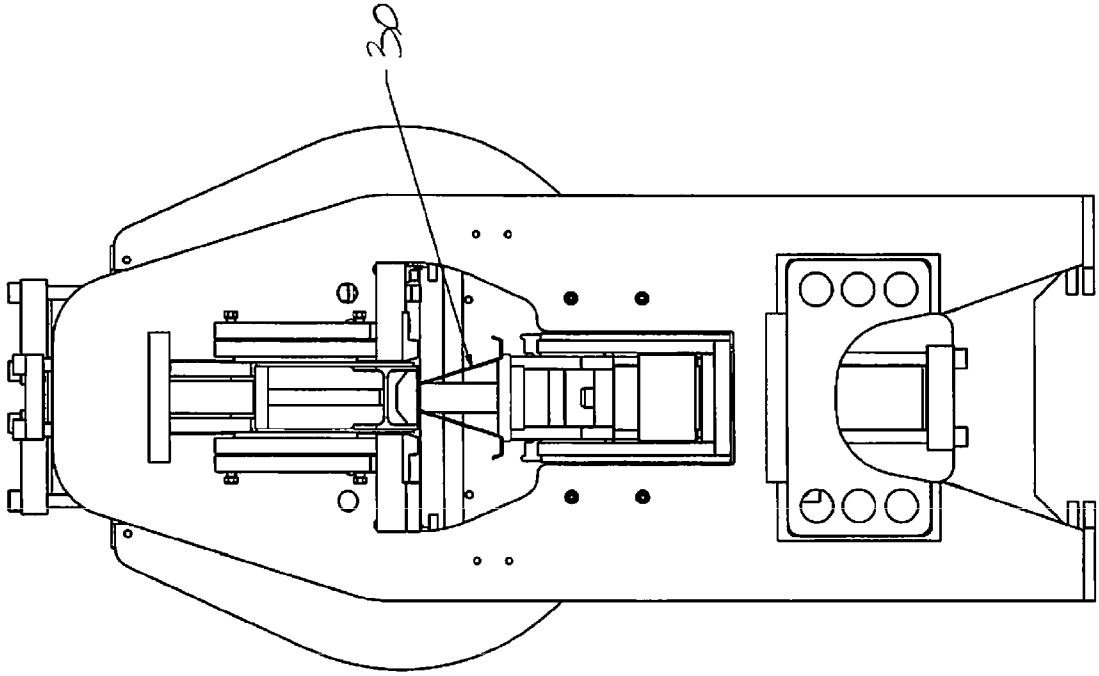


FIG 91

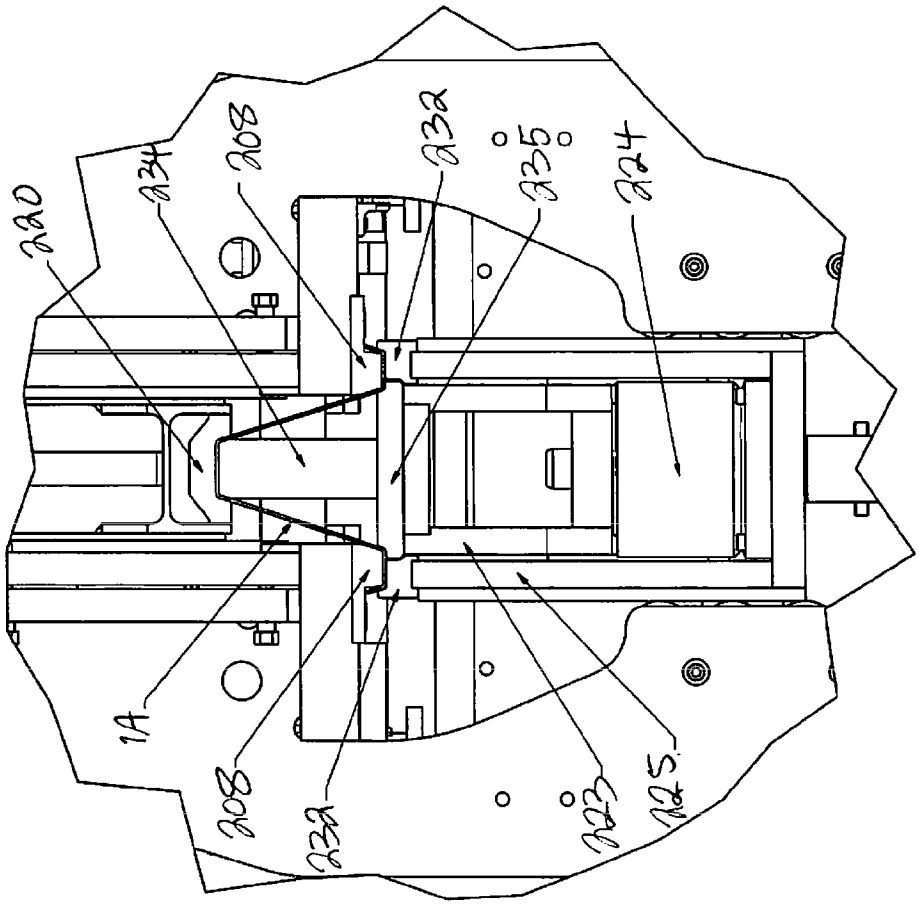


FIG 90

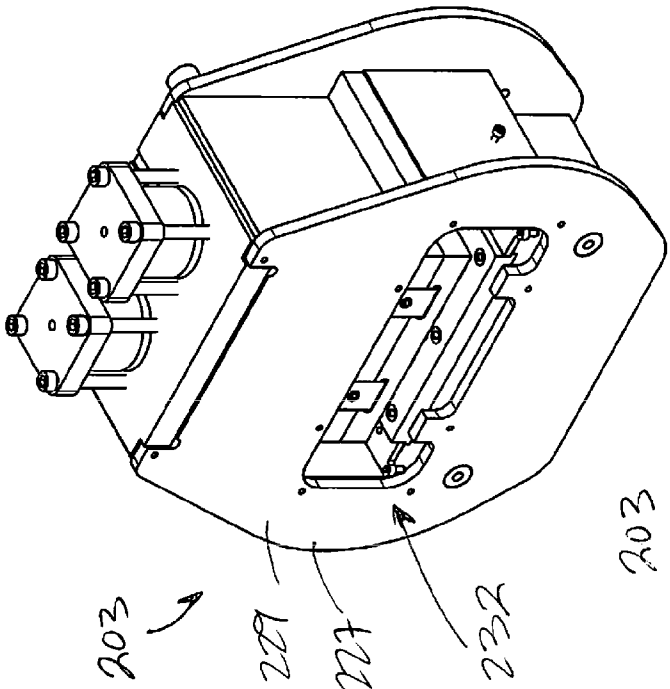


FIG 93

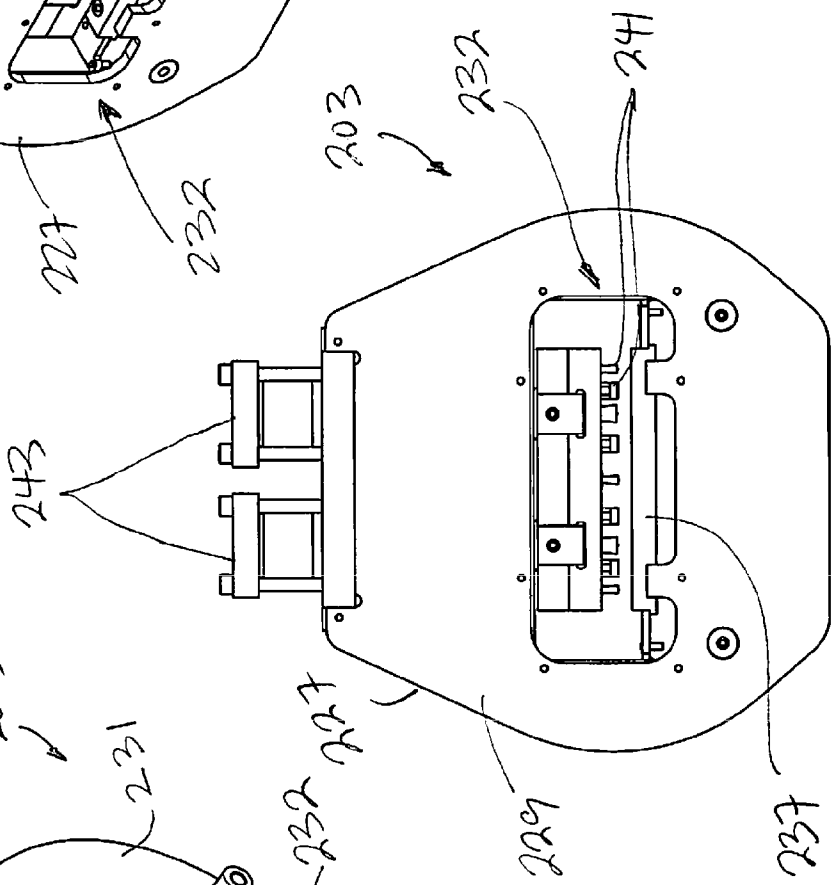


FIG 94

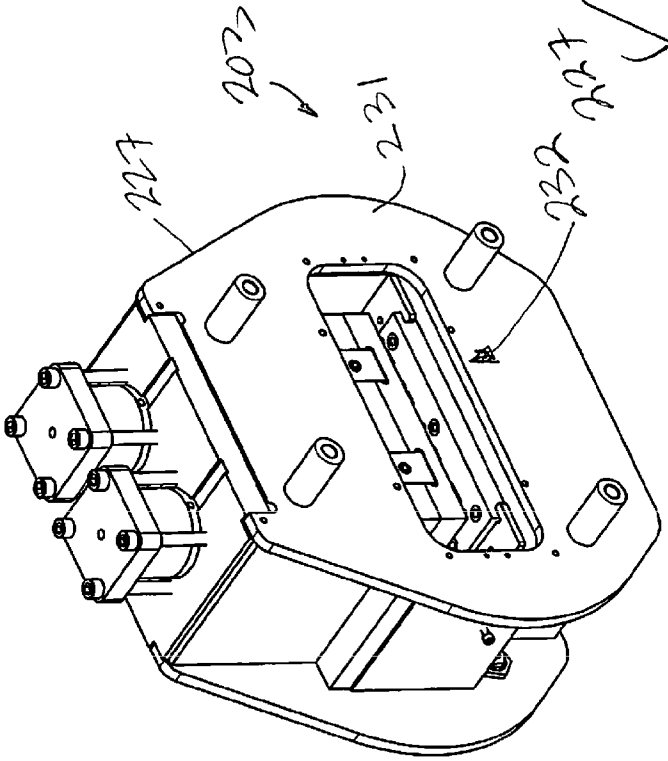
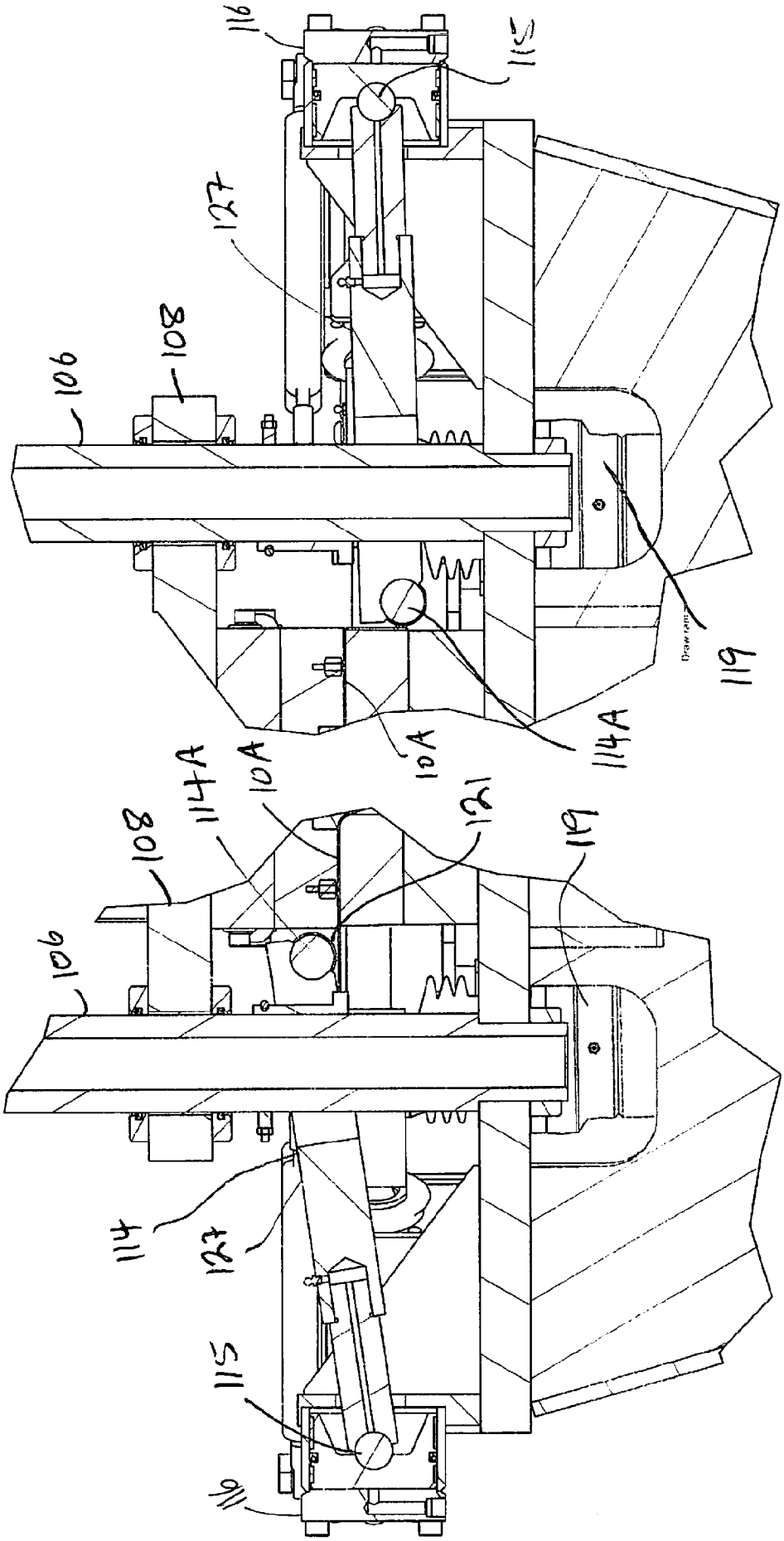


FIG 95



Flipper in the down position after the drawing process

FIG 9B

Flipper in the up position before drawing process

FIG 9S

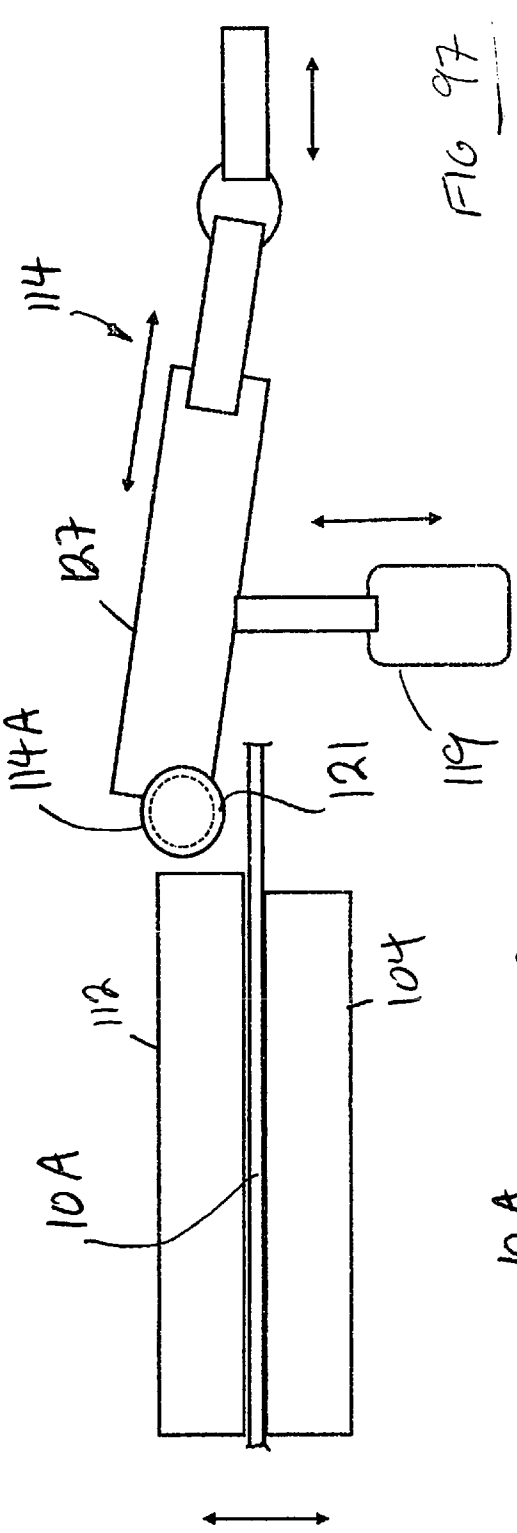


FIG 97

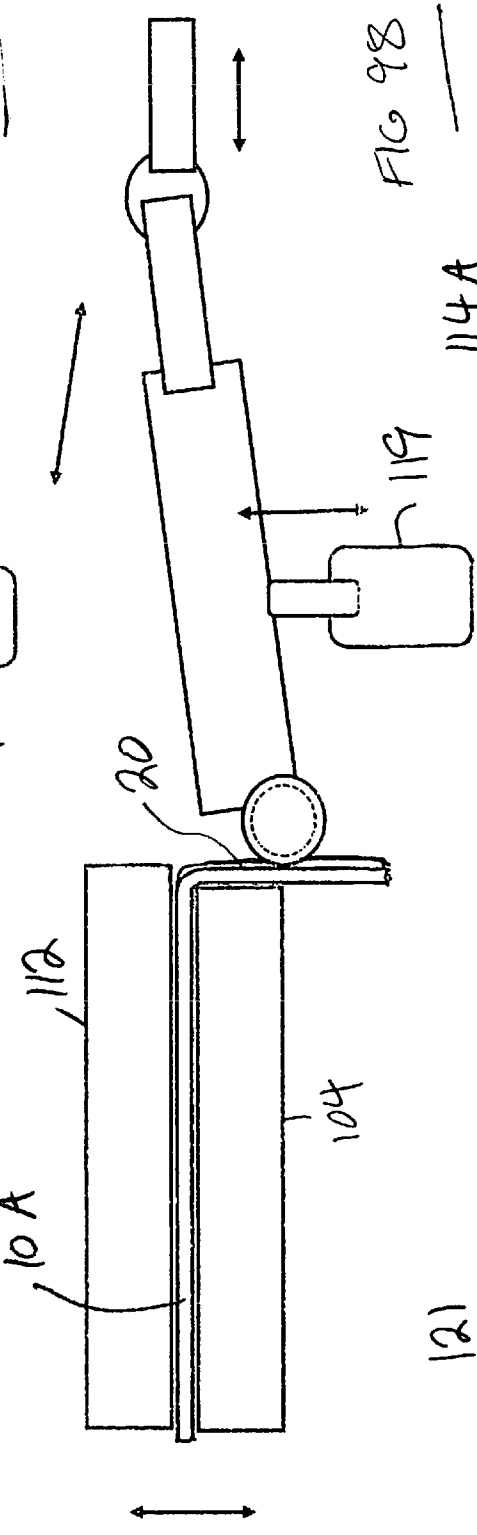


FIG 98

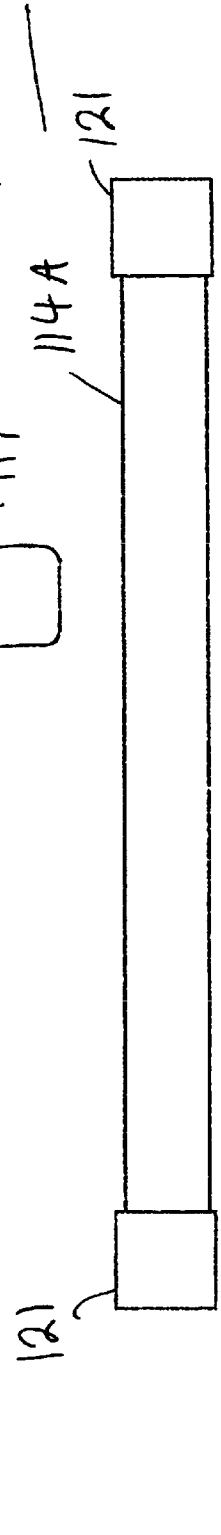


FIG 99

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2015/050381

A. CLASSIFICATION OF SUBJECT MATTER

E04B 5/10 (2006.01) ***E04B 5/14 (2006.01)*** ***E04B 1/19 (2006.01)*** ***E04B 1/24 (2006.01)*** ***E04B 1/08 (2006.01)***
B21D 5/00 (2006.01) ***B21D 19/00 (2006.01)*** ***B21D 22/00 (2006.01)*** ***B21D 11/00 (2006.01)*** ***B21D 37/00 (2006.01)***
B21D 28/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DATABASES: EPODOC, WPIAP, TXTE (Public English Full Text Cluster); IPC/CPC/LOW: E04B5/10, E04B5/14, E04B1/19, E04B1/24, E04B1/08, E04C3/04, B21D5/00, B21D19/00, B21D22/00, B21D11/00, B21D37/00, B21D28/00; Keywords: Joist, Spreader, Bearer, U-channel, C-channel, Connect, Couple, Member, Beam, Cut, Stamp, Steel, Metal, Aperture, Hole, Deform, Fold, Flange, Lip, Top, Upper, Die, Punch, Notch, Four, 4, End, Side, Stud, Spreader and similar keywords.

ESPACENET AND AUSPAT: Applicant/Inventor name searched; Viewed cited/citing of relevant documents.

Google patents: Keywords: Frame system, beam, spreader, flange, web; Connection between steel frame members

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 October 2015	26 October 2015
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Victor Maluki AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262256112

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2015/050381

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:

because they relate to subject matter not required to be searched by this Authority, namely:

the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including

2. ☐ Claims Nos.:

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2015/050381**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3751870 A (VESEI) 14 August 1973 See column 1 lines 37 – 44, column 2 lines 18 – 46 and fig 3, column 3 lines 30 – 36 and figs 1 - 2.	1 - 19
A	AU 640566 B (EL BARADOR HOLDINGS PTY LTD) 26 August 1993 See page 4 lines 15 – 35, page 5 lines 22 – 25 and figs 1 – 2,	1 - 19
A	US 2002/0035815 A1 (DAUDET et al.) 28 March 2002 Entire document.	1 - 19
A	AU 602119 B (EL BARADOR HOLDINGS PTY LTD) 27 September 1990 Entire document	1 - 19
A	AU 622263 B (THE ROOFING CENTRE ALBURY/WODONGA PTY LTD) 02 April 1992 Entire document	1 - 19
X	US 2004/0144057 A1 (MEEK et al.) 29 July 2004 See para [0010] – [0014] and figs 1 – 3.	1 - 19
A	CA 2643248 A1 (GCG HOLDINGS LTD) 05 May 2010 Entire Document	20 - 22
A	US 2007/0277463 A1 (HEIRICH) 06 December 2007 Entire document	20 - 22
A	US 2966873 B (HOFFMAN et al.) 03 January 1961 Entire document	20 - 22
A	US 4875274 A (FOSTER) 24 October 1989 Entire Document	20 - 22

INTERNATIONAL SEARCH REPORT	International application No. PCT/AU2015/050381

Supplemental Box

Continuation of: **Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- • Claims 1 - 19 relate to a frame system for a building structure. The features of beam members with opposed parallel flanges and spreaders are specific to this group of claims.
- • Claims 20 - 22 relate to a forming machine for forming a spreader member of a frame system for a building structure. The feature of a base, a platform, a top and bottom die are specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a priori*.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2015/050381**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 3751870 A	14 August 1973	US 3751870 A	14 Aug 1973
AU 640566 B	26 August 1993	None	
US 2002/0035815 A1	28 March 2002	US 2002035815 A1	28 Mar 2002
		US 6418694 B1	16 Jul 2002
		AU 731914 B2	05 Apr 2001
		AU 6267999 A	13 Jun 2000
		CA 2319346 A1	02 Jun 2000
		EP 1049836 A1	08 Nov 2000
		EP 1049836 B1	02 Mar 2005
		EP 1253256 A2	30 Oct 2002
		EP 1514974 A1	16 Mar 2005
		MX PA00007243 A	08 Sep 2005
		US 6301854 B1	16 Oct 2001
		US 2002134036 A1	26 Sep 2002
		US 6691478 B2	17 Feb 2004
		US 6761005 B1	13 Jul 2004
		US 2004074178 A1	22 Apr 2004
		US 7240459 B2	10 Jul 2007
		WO 0031354 A1	02 Jun 2000
AU 602119 B	27 September 1990	None	
AU 622263 B	02 April 1992	None	
US 2004/0144057 A1	29 July 2004	US 2004144057 A1	29 Jul 2004
		CA 2541673 A1	21 Apr 2005
		WO 2005035891 A2	21 Apr 2005
CA 2643248 A1	05 May 2010	CA 2643248 A1	05 May 2010
US 2007/0277463 A1	06 December 2007	US 2007277463 A1	06 Dec 2007
		US 7677071 B2	16 Mar 2010
		US 2008016818 A1	24 Jan 2008
		WO 2007143181 A2	13 Dec 2007
		WO 2008024144 A1	28 Feb 2008

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2015/050381**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 2966873 B	03 January 1961	None	
US 4875274 A	24 October 1989	US 4875274 A	24 Oct 1989
		US 4787283 A	29 Nov 1988

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.