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(54) **Title:** METAL FRAMING SELF-LOCK CONNECTORS

(57) **Abstract:** The present invention relates to metal framed wall components with self- locking fixed and sliding connections between support members and crossing connecting members without using fasteners to connect the two crossing metal framing members together. Different variations of the shapes of the connecting members as well as the location and shape of the notches, ledges, tabs and notched-tabs are used between the members at the holes, punch-outs or indentations all determine the self-locking connections.

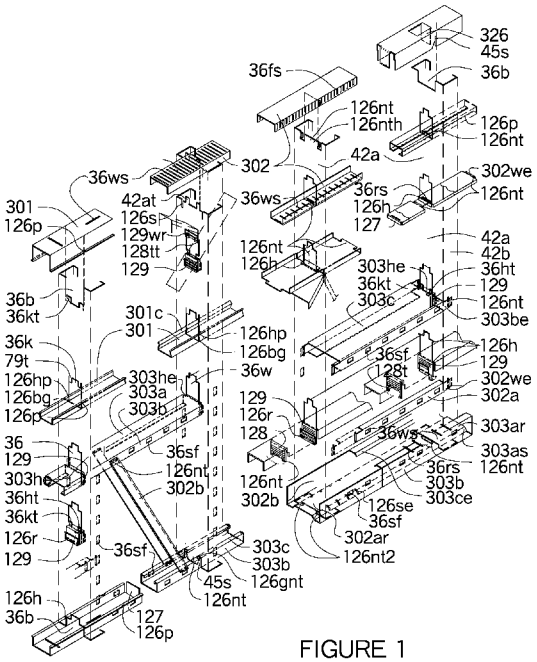


FIGURE 1

METAL FRAMING SELF-LOCK CONNECTORS

CROSS REFERENCED TO RELATED APPLICATION

[0001] This application claims priority from US patent application No. 15/430,781 filed Feb. 13, 2017 plus US patent application No. 15/449,250 filed March 3, 2017 that included US provisional application No. 61/628,044 dated Nov. 24, 2011 and US provisional application No. 61/629,552 filed Nov. 22, 2011 by the inventor hereof the entire disclose of which is incorporated herein by reference. The disclosures of the above cited US Patent Applications and US Provisional Applications of the Applicant, including all drawings and all the specifications, are hereby in incorporated by reference in their entireties into this US Patent Application.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable

PARTIES OR JOINT RESEARCH

[0003] Not applicable

FIELD OF THE INVENTION

[0004] The present invention relates to forming self-locking fixed or self-locking sliding connections using various shaped connectors between the first framing elements referred to as support members and second framing elements referred to as spacer braces without using fasteners to connect the two crossing metal framing members. Different variations of the shapes of the connecting members as well as the location and shape of the notches, ledges, tabs and notched-tabs are used between the members at the holes, punch-outs or indentations all determine the self-locking connections.

BACKGROUND OF THE INVENTION

[0005] Light gauge metal framing have been used in the construction of buildings for many years, however interior and exterior metal framing has always been difficult to assemble as well as construct horizontal and diagonal bracing between support framing members because of the configuration of

the support members like a C channel and poor energy efficient shear wall construction. The lip and flange of the C channel protrudes from the web making it difficult to make connections. When bracing members are installed between support members for additional strength, insulation became even more difficult to install as well as form a better insulated wall.

[0006] When assembling metal framed walls the vertical support members are not rigid until the bracing members or fasteners are added to help stabilize the support members from moving. In the past there have been attempts to stiffen support members by providing lateral bracing, drywall backing or bracing members between vertical support members.

[0007] The bracing members within the wall forming structure are generally required to connect support members together, however horizontal bracing members can be very long and next to impossible to connect horizontal bracing members to individual spacer blocks located between support members. In addition the bracing members are not used to form shear walls or diagonal framing with the walls or have the flexibility to form trusses having diagonally framing members.

[0008] Metal framing has developed computer systems to form pre-punched screw holes to designate how and where to install fasteners between metal framing. Different types of notches or shapes of bracing members have help speed up framing assembly. There have been no innovation developed allow metal framing to be connected without using fasteners and nothing has been developed where the spacer brace connects support members together using W clips, U clips, punch-out tables and ledges that form a self-lock connectors that fit together to form a fast an easy connection means to form metal framed wall panels without using fasteners at the support members. The unique wall construction allows wall panels to be fabricated quickly and easily without using fasteners thereby saving money in labor and material.

DESCRIPTION OF PRIOR ART

[0009] The horizontal and diagonal connections between metal support members do not form continuous bracing that interlocks between each other but rather are individual components. Individual mounting brackets are used to support trusses or horizontally brace support members. Many different shapes of horizontal bracing members are used to connect metal framing members together and include various grooves, tabs, bridging backing, notches to connect the metal framing members together. Some types of connections between support members use bent hooks, bent flanges, clamping tabs, anchoring hand rail system, adjustable braces or extended tabs to connect trusses. Different types of brackets, shapes, leg supporting connections and blocking are used to install support members together. Slotted holes and bent tabs at the top base plate have been used to compensate for vertical movement between vertical and horizontal support member. Spacer braces do use various types of clips with fasteners to interlock between support members to prevent vertical and horizontal movement. There is no prior art for U or W shaped clips with spacer braces to secure support members together. Some support members have been shown to have a rim around the hole for extra strength or to reduce thermal conductivity through the support member, but not used a part of a self-locking connector. Punch out tabs has been used as spacers or as tabs where the tabs have been used to support another object. A ceiling suspension system uses clips to secure a crossing channels by using tabs and hooks and a demountable attachment for modular construction uses hooks to install a crossing channel or hooks to install electric junction boxes and ceiling base plates use bendable tabs.

SUMMARY OF THE INVENTION

[0010] The present invention relates to forming a connector between first and second metal framing elements self-locking fixed or self-locking sliding connections between spacer braces and support members without using fasteners to connect the two crossing metal framing members. Various shapes or configurations of spacer braces intersect the support members at the top or bottom of the support member and through the holes in the webs.

The holes can have rims or ledges that extend from the side edges of holes to form ledge shafts or tabs. The tab ends can be bent to form bent tabs or notches can be installed in the tab to form notched-tabs. The notches, ledges, tabs and notched-tabs can be used to form many variations of self-locking connections between spacer braces intersecting support members as well as between the tongue ends and receiver ends of various shaped spacer braces. The spacer braces have various shapes along with bulges that have notches in the bulges or notches in the web, slide gaps, lips or holes to secure the spacer braces and support member together without having fasteners to secure the member together. The vertical or horizontal direction of the notches and the longitudinal direction of the spacer braces crisscross one another to form self-locking screw-less connections between framing members.

[0011[The self-locking connections are formed when the ledge extends through from the hole in the web of the crossing member. The ledge shafts or tab end can be bent to form a self-locking fixed connection or the ledge shaft can have an indentation or notch installed so the web of the crossing member gets inserted into the notch also forming a self-locking connection by using a notched-tab.

[0012] Another version is to have the ledger shafts be longer so that the ledger shafts can than have a tab which is just the extension of the longer ledger shaft. These tabs can be pre-bent at a manufacturing plant or can be bent at the job site after the spacer braces are installed into the ledger shafts. The ends of the ledger shafts where the ledger tabs are located can have ledge caps installed over the ends of the ledger shafts or ledger tabs. The ledge caps serve a similar function as bending the tabs over the spacer braces webs to secure the spacer braces to the support member. The slot holes can be notches so the ledger shafts fit into notches at the sides of the web of the spacer braces for a faster and easier installation.

[0013] When the rims at the top, bottom and sides of the hole in the web of the support member intersect the crossing spacer braces so the extensions of

the webs of the spacer braces engage the hole, rims or the ledge shafts and ledge tabs. The rims at the sides of the hole can have rim notches that engage the spacer brace on three sides that prevent the spacer brace or clips from moving. The spacer braces as previously explained span between support members and the spacer braces have a receiver end and a tongue that fits into a receiver end of an adjacent spacer brace. On the other hand a clip only has two one receiver ends and/or a finger end and a receiver end than engages the web of a support member where the tongue ends fit into the receiver ends. The rim notches at the rims or hole notches engage the extensions that cross the web of the support members. The notched-tabs are also formed by ledge shafts, web tabs or hooked tongue tabs that extend from the web along with the ledge tabs that extend over the ledge shafts that also secure the space braces to the support members by indentations or bending of the tabs. The edge of the rims can be considered as the width of the hole and the rims are notched instead of the web of the support member, but in both cases the notches engage the spacer braces. Sometimes the spacer braces can have flange slot holes where notched-tabs with its ledges tabs with ledge shafts can penetrate the flange slot holes in the spacer braces again securing the spacer braces to the support member. The notched-tabs at the webs can interlock into the hole notches and be extended by adding another spacer brace when being connected between the holes of the support members. The various types of notches act as fasteners when connecting to crossing spacer braces. The notches or tabs with shafts allow the spacer braces to be oriented horizontally or vertically as well as installed as ~~at~~ diagonals. The receiver ends can have receiver notches for the notched-tabs at the tongue ends to engage one another interlocking the receiver and tough ends together.

[0014] The self-locking connections do not always have to be secured to the support members and spacer braces, but can be connected to one another so the support member can slid vertically within a wall structure so that the top and bottom spacer braces are secured to the floor and ceiling above and still have the floor structure move vertically when additional floor loads occur from additional live loads or dead loads add additional weight causing the floor

structure to bend. In this case the tabs of the punch out tabs and the side edges of the flanges in the spacer braces plus the side edges of a web indentation in the support members allow the support member to remain in place when then additional floor structure above the wall framing moves.

[0015] The reverse lip spacer braces has many hat channel configurations with longitudinal webs, with two flanges and extending lips where the lips have lip notches that engage the webs of a support members. The reverse lip spacer braces can be fixed as to not move in a vertical direction when the lip notches engage the hole notches interlocking the two notches together or can slide in a vertical direction when the lip notches engage the hole side edges or an indentation in the web so the cross member can move vertically within the support members. The reverse lip spacer braces can be oriented having the U-shape facing upward or downward so the stacked webs or lips can be connected together. The webs being connected by overlapping notched-tab intersections with slot holes or the notched lips being connected into the same hole notches at both sides of the hole opening.

[0016] Another aspect of the invention relates to forming self-locking fixed and self-locking sliding connection between spacer braces and support members without using fasteners to connect the two crossing metal framing members. The spacer braces intersect the support members at the top or bottom of the support member and through the holes in the webs. The spacer braces have various shapes along with bulges that have notches in the bulges or web notches, slide gaps, lips or holes to secure the spacer braces and support member together without having fasteners to secure the member together. The vertical or horizontal direction of the notches and the longitudinal direction of the spacer braces crisscross one another to form self-locking connections between framing members.

[0017] Another aspect of the invention relates to forming self-locking fixed connections between spacer braces and support members without using fasteners to connect the two crossing metal framing members. The spacer braces intersect the support members at the top or bottom of the support

member and through the holes in the webs. Various types of bent tabs are used to form self-locking connections between spacer braces intersecting support members as well as between the tongue and various types of receiver ends. The spacer braces have various shapes along with bulges that have notches in the bulges or notches in the web, slide gaps, lips or holes to secure the spacer braces and support member together without having fasteners to secure the member together. The vertical or horizontal direction of the notches and the longitudinal direction of the spacer braces crisscross one another to form self-locking screw-less connections between framing members.

[0018] The description of the drawings and the description via the claims sound different, but are similar. At the end of the figure description is a figure table of contents noting the embodiments to a number. After that figure table of contents is a claim glossary of terms relating to the figure numbers. Since the spacer brace can be used in so many different configurations and orientations, but are installed the same, the interlocking connections need to be claimed in a different manner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. 1 shows an isometric view of four support members having various configurations and crossing members all having various self-locking connections using support tabs, notched-tabs and openings with notches. The support tabs can be ledge tabs, hole tabs, web tabs, L-shaped tabs, hook receiver tabs, key tabs, punch-out tabs, wrap-around tabs, notched-tabs or bent tabs that can be installed in holes, slot holes, hole notches, lip notches, flanges slot holes, web slot holes, raised slot holes, receiver slot holes, bracing holes, tab holes, rim notches, bulge notches, slide notches, clip notches and that can be installed vertically, horizontally or diagonally using the different configured support members and crossing members.

[0020] FIG. 2 is an isometric of the ledge or its components consisting of a tooth shaft extending through the tab hole in the web of the U shaped spacer brace allowing the end of the ledge tab to extend above the web..

[0021] FIG. 3 shows a vertical section through the hole shown in FIG. 2.

[0022] FIG. 4 shows a plan view of the U shaped spacer brace shown in FIG. 2.

[0023] FIG. 5 has a ledge shafts penetrate the slot holes and the ledge tabs are bent after the shafts penetrates the slot holes.

[0024] FIG. 6 is a cross section of FIG. 5.

[0025] FIG. 7 is a plan view of FIG. 5.

[0026] FIG. 8 is similar to FIG. 5 except the spacer brace rests on the hole bottom edge and the left tab has an indentation forming a notch creating a notched-tab securing the horizontal spacer brace at the hole.

[0027] FIG. 9 shows the hole having only one notched-tab where head of the notched-tab with rounded edges.

[0028] FIG. 10 shows the tabs in the punch out tabs are shown allowing vertical movement at intermediate support members along the space brace at the top of a framing structure.

[0030] FIG. 11 shows a hole at the web with a web shaft and web tab where the web tab is longer than the web shaft.

[0031] FIG. 12 shows the W shaped clip with the hook receiver end on both sides of the hole having a notch at the web for the web shaft and web tab to fit into.

[0032] FIG. 13 shows two holes notches in the key hole and two ledge shafts in the middle of the larger hole along with two hole notches that intersect a reverse lip spacer brace with lip notches.

[0033] FIG. 14 is similar to FIG 13 except a U shaped spacer brace is installed at a diagonal in the hole notches at the key hole and a vertical oriented U shaped spacer brace is installed at a diagonal between the notched-tabs on the right side of the hole.

[0034] FIG. 15 shows an isometric view of a U shaped spacer brace having its hook receiver end pass through the hole so the hole notch at the extension fits into hole notches at the side edges and the second leg of the hook receiver end shows receiver notches on both side edges so the tongue end of an adjacent U shaped spacer brace can fit into the gap between the first and third leg of the hook receiver end and the hook tongue with the tongue shaft and the tongue tabs fit into the receiver notches at the second leg of the hook receiver end.

[0035] FIG. 16 shows a similar isometric view, however the U shaped spacer brace has the bottom edge of the tongue end having two notched-tabs shown as tongue shafts with tongue tabs located near the middle so the two tongue tabs fit into the receiver slot holes in the second leg of the hook receiver end.

[0036] FIG. 17 shows a U shaped spacer brace at the top and bottom ends of the support member where the lower U shaped spacer brace has the exterior side against the floor and has slotted holes of the flanges where the slotted hole lower edge is level with the interior side of the web of the U shaped spacer brace and the reverse occurs on the top U shaped spacer brace. The top and bottom edge of the web of the support member shown as a C channel has a gap where the flange fit between and also has a horizontal extension referred to as a web shaft with a web tab where the web tab has the gap between the web and the web tab. The web tab is longer so the web tab can be inserted into the slot holes having the longer edge bind against the slot hole. At the upper U shaped spacer brace a web tab is shown extended through the slot hole and is bent at the slot hole for an even stronger connection.

[0037] FIG. 18 shows the floor spacer brace similar to FIG. 17 however the top spacer brace shows slotted holes at the web and web tabs extending from the support member extending through the slot holes.

[0038] FIG. 19 shows a vertically oriented support channel also referred to as a floor joist intersecting a vertically oriented U shaped spacer brace sometimes referred to as a rim joist where the webs of both members intersect at the web so that the web of the C channel has a pair of web shafts with web tabs that can fit through the slot holes of the U shaped spacer brace so the gaps fits between the flanges of the U shaped spacer braces.

[0039] FIG. 20 shows an front elevation view of a W-shaped clip where the top side of the web is inserted into the notches of the rim of the triangular shaped hole along with the notches at both sides of the second leg..

[0040] FIG. 21 shows a plan view of the W-shaped clip where the web is inserted into the notches on both sides of the rim with the notches on the outer edge of the second leg of the hook receiver end.

[0041] FIG. 22 shows an elevation of a triangular shaped hole with a reverse lip spacer brace where the lips have horizontally oriented notches of the reverse lip spacer brace meet the vertically oriented notches at hole rim have notches so that the horizontal oriented notches intersect the vertically orient notches with the protruding side edges the protruding side edges of the horizontal oriented side edges eliminating any horizontal and vertical movement between notches.

[0042] FIG. 23 shows the plan view where the reverse lip spacer brace passes through the triangular shape hole so that only the horizontally oriented holes straddles both side of the hole rim which is also angular being a triangular shaped hole therefore making the notches not a rectilinear shape which would occur had the hole been a rectilinear shape and the hole rim also has the notch that straddles the top and bottom edges of the lip of the reverse lip spacer brace.

[0043] FIG. 24 shows a partial view of a metal framed wall with two reverse lip spacer braces at the top and bottom with a support member connected between spacer braces.

[0044] FIG. 25 shows an enlargement of the support member intersecting the reverse lip spacer brace.

[0045] FIG. 26 shows an enlargement of the reverse lip spacer brace where the support member self-locking connection occurs.

[0046] FIG. 27 shows an isometric of a reverse lip spacer brace within a hole and using a hook finger, bent flap and ledge shaft to secure the end.

[0047] FIG. 28 shows an isometric of a reverse lip spacer brace installed diagonally through the hole.

[0048] FIG. 29 shows an isometric view of the tabs passing through the web slot holes of the reverse lip spacer braces then getting bent after passing through.

[0049] FIG. 30 shows an isometric of a C shaped spacer brace at the top and bottom of a wall using the self-locking slide and fixed connections.

[0050] FIG. 31 shows an isometric of the U shaped spacer brace at the ceiling using the flange bulge notch as the sliding connecting and the reverse lip spacer brace at the floor using the lip notch and the web notch to form a self-locking fixed connection.

[0051] FIG. 32 shows a wall section at the ceiling with a U shaped spacer brace where the flange bulge has a flange bulge notch for the support channel to slide through.

[0052] FIG. 33 shows a wall section at the floor with a U shaped Spacer Brace where the flange bulge has a flange bulge notch for the support channel to slide through.

[0053] FIG's 34-41shows various spacer brace bulge notches and flange bulges when intersecting the support member.

[0054] FIG. 42 shows the bulge of the spacer brace insert into the hole notch at the lower corners of the hole in the support member.

[0055] FIG. 43 shows the bulge having a bulge notch where the side edge hole fits into and the lip of the space brace fits into the hole notch of the web in the support member.

[0056] FIG. 44 shows an isometric view of FIG. 43 where the bulge notch fit into the side edge of the hole and the lip from the spacer brace fits into the hole notch of the web in the support member.

[0057] FIG. 45 shows a similar isometric view of FIG. 43 however the flange and lip form obtuse angles.

[0058] FIG. 46 shows the same isometric view of the spacer brace 45 except the side-edges of the hole are inserted to the depth of the back of the notch allowing the spacer brace to be inserted into the deeper side-edges of the hole.

[0059] FIG. 47 shows an isometric view of FIG. 45.

[0060] FIG. 48 shows a perspective view of the web of the support member with the receiver end of the spacer brace extending through the receiver notch into the key hole tabs at the key hole.

[0061] FIG. 49 shows the interior side of the support member with the extension having a receiver notch for the key hole tabs to fit into and the top

edge of the hole shows a web receiver having the tongue of the spacer brace extending through the notches on the bottom edge of the web receiver for the two bent tabs.

[0062] FIG. 50 shows a W-Clip having clip notches that extend on both sides of the W-Clip for the key tabs to fit into.

[0063] FIG's 51 shows the same W-Clip as FIG. 50 and a web hook receiver at the top edge of the hole with the tongue tabs for the diagonal spacer brace above passing through the receiver notches at the bottom of the web receiver.

[0064] FIG. 52 shows the similar spacer braces in FIG. 31 however here the top and bottom of the support member shows bracing holes having a key hole and key tabs on both sides of the key hole.

[0065] FIG. 53 an irregular shape hole have a continuous rim extending around the hole edges leaving a narrow edge in the corner where the W-Clip could be inserted into the rim of the hole if the rim had a notch or the W-clip was bent to create a notch to form a secure connection.

[0066] FIG. 54 shows a U shaped spacer brace extending through the hole in FIG. 53 where the bottom edge of the rim penetrates the first leg of the hook receiver.

[0067] FIG. 55 shows the hook tongue intersecting a hook receiver where the hook receiver also has receiver tabs that extend around a hole or lip and the tongue tabs overlap the receiver tabs.

[0068] FIG. 56 is an enlargement of the diagonal space brace being installed into a C-shaped spacer brace with its extended flange and notched-tab inserted into the flange hole as shown in FIG. 1.

[0069] FIG. 57 is an enlargement of the diagonal spacer brace and the support member intersecting the C-shaped spacer brace shown in FIG. 1.

[0070] FIG. 58 is an enlargement of the diagonal spacer brace being installed into a C-shaped spacer brace shown in FIG. 56 & 59 except the web of the diagonal space brace has an indentation at the lips of the horizontal spacer brace and a notched-tab extension has a notched-tab at the end that is inserted into the raised slot hole at the web of the horizontal spacer brace.

[0071] FIG. 59 shows the diagonal spacer brace intersecting the horizontal spacer brace as shown in FIG. 58 however the a vertical support member is shown intersecting the horizontal spacer brace also having notched-tab indentation at the web with a notched-tab extension having a notched –tab at the end inserted into the raised slot hole.

[0072] FIG. 60 shows an enlarged view of the vertical support member inserting the horizontal spacer brace as shown in FIG. 1 where the web of the support member is indented at the raised area of the web and a notched-tab is extended into the slot hole.

[0073] FIG. 61 shows an enlarged view of the vertical support member inserted into two diagonally oriented notches at the raised web as shown in FIG. 1 where the web has a ½ notched-tab inserted into one of the diagonally oriented notches and another ½ notched-tab is inserted into the opposite diagonally oriented notches on the opposite side of the raised web.

[0074] FIG. 62 shows notched-tab having rounded edges and the crossing member having slot holes.

[0075] FIG. 63 shows only the notched tab as shown in FIG. 62.

[0076] FIG. 64 shows a C shaped spacer brace as a crossing member having notches at the lips being supported at the hole bottom edge of the support member where the notches in the lips are secured at the notch of the notched-tab at the hole bottom edge.

[0077] FIG. 65 is similar to FIG. 64 except the notched-tab in located at the top edge of a support member and the crossing member is a C shaped spacer brace having the web outside edge even with the top edge of the support member and the notched-tab is the anchor space at the interior side of the web of the crossing member.

[0078] FIG's 66 & 67 are similar to FIG's 58 & 59 except the hooked tongue is V-shaped.

[0079] FIG. 68 is similar to FIG. 15 & 16 except the V-shape tongue is used therefore the hooked receiver is slightly different shape.

[0080] FIG's 69 & 70 shows a reverse lip spacer brace extending through a V shaped hole having a blunt end and also connected by lip notches and hole notches..

[0081] FIG's 71 & 72 shows a V shaped hole having a V shaped spacer brace with a notched-tab at the vertex and FIG's 73 & 74 show the V shaped spacer brace being connect by holes notches and leg notches. FIG's 75 & 76 also use the V shaped hole but the notched-tabs extend from the angular hole bottom edge.

[0082] FIG. 77 shows two spacer braces having notched-tab ends overlapping and intersecting at a notched hole.

[0083] FIG. 78 shows two spacer braces intersecting a notched hole where one end has the extension engaged in the notched hole with the finger extending over the bottom edge having a web-slot hole for the opposite end of an adjacent spacer brace having a notched-tab end engage the web-slot hole.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0084] FIG. 1 shows an isometric view of four support members having various types of connections using interlocking support members crossing spacer braces and bracing clips, hook clips all having various self-locking

connections using support tabs, notched-tabs and openings with notches. The support tabs can be ledge tabs 79t, hole tabs, web tabs 42at, J-shaped gap tabs 45jt, hook receiver tabs 129t, key tabs 36kt, punch-out tabs 326, wrap-around tabs 326tw, notched-tabs 126nt, hook tongue tabs 128tt that can be bent after being installed in holes 36, slot holes 36s , hole notches 126h, lip notches 126p , flanges slot holes 36fs , web slot holes 36ws, receiver slot holes 36rs, bracing holes 36b, tab holes 36tb, rim notches 126rm, bulge notches 126g, slide notches 126s, clip notches 126c, lip notches 126p, receiver notches 126r and that can be installed vertically, horizontally or diagonally using the different configured support members and crossing members.

[0085] Fig. 2-4 shows another tongue and receiver combination where ledge tabs 79t extends from the bottom edge of the tab holes 36tb in the web 42a of a support member. An array of ledge tabs 79t extend upward forming a ledge shaft 79s that extends through the tab holes 36tb in the web 302a of the U shaped spacer brace 302. The ends of the ledge tabs 79t are slightly larger than the tab holes 36tb so the ends can extend over the tab holes 36tb allowing the ends of the ledge tabs 79t to retain the U shaped spacer brace 302 from moving vertically. On the other hand, the flanges 302b have flange notches126fg that extend halfway the height of the flanges 302b of the U shaped spacer brace 302. When the U shaped spacer brace 302 is inserted into the hole 36 which is the approximate width as the hole 36, the flanges 302b are resting on the flange notches126fg and the ends of the ledge tabs 79t are extending above the web 302a. The flange notches126fg are shown ~~have~~ having a flared edge 126f so the U shaped spacer brace 302 can bend and easily slide into place. The flange notches 126fg in the side walls keep the longitudinal U shaped spacer brace 302 from moving horizontally as the flange notches 126fg extend approximately half the height of the flanges 302b. The flange notches 126fg reduce the height of the ledge shafts 79s to reduce the horizontal bending stress of the ledge shafts 79s. FIG. 3 shows a vertical cross section with the ledge shafts 79s extend through the tab holes 36tb allow the wider end of the ledge tab 79t to secure the web 302a. FIG. 4 shows a plan view of the tab holes 36tb which are slightly larger than the

ledge shafts 79s in order for the ledge-shafts 79s can bend slightly to allow for the wider end of the ledge tabs 79t to secure the web 302a.

[0086] FIG. 5 shows an isometric view of a U shaped spacer brace 302 extending the width of the hole 36 having the interior side facing downward toward the bottom edge of the hole 36 at the web 42 of the support member. The flanges 302b have flange notches126fg with flare edges 126f so the U shaped spacer brace 302 rests at the end of the flange notches126fg. The bottom edge of the hole 36 has two ledge shafts 79s with ledge indentation 79i on either side so the ledge shafts 79s can extend through the web slot hole 36ws in the web 302a of the U shaped spacer brace 302. The ledge shaft 79s is long enough so the end of the ledge shaft 79s can be bent to form ledge tab 79t. The ledge tab 79t can be bent in both directions so the ledge tabs 79t cannot move side to side and the ledge tabs 79t with its bent side fitting firmly against the web 302a secures the U shaped spacer brace 302 from moving in a vertical movement between the bent edge of the ledge tabs 79t and the flange notches126fg forming a self-locking connection. FIG's 2 & 5 are similar as the
U shaped spacer brace 302 is installed at an angle allowing the side walls of the flanges 302b with the flange notches 126fg side into the hole side edges 36se for a faster easier connection to the hole 36. The flanges 302b are installed first then the ledge shafts 79s are installed through the web slot holes 36ws. FIG. 6 shows the cross section and FIG. 7 shows a plan view of the self-locking connection. Since the ledge shafts 79s are long the excess length that extends through the web slot holes 36ws are bent after the ledge shaft 79s has been installed into the web slot holes 36ws.

[0087] FIG. 8 is similar to FIG. 5 however in FIG. 8 the U shaped spacer brace 302 has the side walls of the flanges 302b extending away from the hole bottom edge 36be located in the web 42a of the support member referred to as a C shape channel 42. The web 302a is shown having web slot holes 36ws where the left web slot hole 36ws shows a ledge shaft 79s that extend from the hole bottom edge 36be. The left ledge shaft 79s is described as a ledge shaft 79s also shown in FIG's 5-7. The right ledge shaft 79s is

described as a notched-tab notch 126ntn when extending through the web slot holes 36ws and the ledge tabs 79t that extend above the web slot holes 36ws are the end or heads 126nth of the notched-tab 126nt. The head 126nth of a notched-tab 126nt is wider than the length of the web slot hole 36ws that forms the notched-tab notch 126ntn. The hole side edges 36se engage the outside plane of the flanges 302b of the U shaped spacer brace 302 from moving horizontally between the hole side edge 36se and the notched-tab notch 126ntn secures the inside and outside planes of the web 302b from moving horizontally within the hole 36 and vertically being secured by the head 126nth of the notched-tab 126nt. The notched-tab notch 126ntn of the notched-tab 126nt function the same as the ledge shaft 79s, except the ledge shaft 79s is only the height of the notch 126ntn therefore reducing any horizontal bending stress at the notch 126ntn. The ledge shafts 79s or notched-tabs 126nt from the first framing element of the web 42a can extend through the web slot holes 36ws of FIG. 5 then continue through the web slot holes 36ws of FIG. 8 to the underside of the head 126nth and/or bending the ledge shafts 79s_after extending through the web slot holes 36ws of the second U shaped spacer brace 302 thereby securing both members together both horizontally and vertically. The lower the notches 126ntn are in relation to the hole bottom edge 36be the greater the leverage to produce a stronger notched-tab 126nt to reduce horizontal movement between support members.

[0088] FIG. 9 is similar to FIG. 8 except only one notched-tab 126nt without showing the U shaped spacer brace 302. The notched-tab 126nt is shown having rounded edges at the head 126ntn in order to more easily slide through the web slot holes 36ws. Since the head 126nth has the rounded edges, the U shaped spacer brace 302 might have to be installed at a slight angle in order for the head 126nth to pass through the web slot hole 36w. When only one notched-tab 126nt is used as in FIG. 8 only one web slot hole 36ws is required which is easier and faster to install. The notch 126ntn of the notched-tab 126nt does not have a ledge shaft 79s, but extends directly from the hole bottom edge 36be also referred to as the bottom shoulder of the hole notch 36be. Therefore the notch 126ntn is a configuration consisting of the hole bottom edge 36be, the depth of notch 126nt within the notched-tab and

the head 126nth of the notched-tab 126nt forming the three side planes of the notch 126ntn.

[0089] FIG. 10 shows the U shaped spacer brace at the floor with its ~~dorsal side~~ exterior planar surface facing the floor and the interior side shows the flanges 302b extending upward from the web 302a. At the center of the U shaped spacer brace 302 shows a wrap-around tab 326tw extending from the pivot edge 326pe of the punch out tab 326 wrapping around the ledge 79 extending from the web 42a of the support member shown as a C channel 42. The ledge 79 is shown the same width as the U shaped spacer brace 302. The ends of the ledge 79 get inserted into the flange notches 126fn on both flanges 302b and the end of the ledge 79 is inserted into a notch gap 126ng. The one side of the flange notches 126fn has flare edges126f so the web 42a can more easily fit into the flange notches 126fn. The wrap-around tab 326tw wraps around the ledge 79 just enough so that the inner side closed the web 42a can extend pass the ledge 79 than veer away from the ledge 79 leaving a sort of angular shape so the web 42a can extend past the wrap-around tab allowing the wrap-around tab to slight bend so the ledge 79 can become lodged into the flange notches 126fn and the notch gap 126ng. After the U shaped spacer brace 302 is installed at the floor another U shaped spacer brace 302 can be installed at the top end of the support members. The upper U shaped spacer brace 302 is shown so the support member can move vertically within the wall framing structure unless a fastener (not shown) is attached to the tab 326t and the web 42a. The top end of the C channel 42 shows the web 42a having a bracing hole 36b which is the same width as the U shaped spacer brace 302. The U shaped spacer brace 302 shows its flanges 302b extending ~~ventrally~~ downward from the interior side of the web 302a. The flanges 302b have flange notches 126fn extending into the flanges 302b with one side having a flare edge 126f and the straight edge on the opposite side for a simple and easy connection. The U shaped spacer brace 302 is inserted into the bracing hole 36b so that the flanges 302b are inserted between the side edges of the bracing hole 36b, so the flange notches 126fn engage the bottom edge of the bracing hole 36b. When inserting the U shaped space brace 302, the web 302a has a punch out tab 326 with the tab

326t extending downward so that the tab 326t is against the interior side of the web 42a on one side and the opposing side of the web 42a rests against the straight edge of the notch 126. When the U shaped spacer brace 302 has the ~~dorsal~~ exterior side web 302a secured to a floor joist above, the floor joist above (not shown) can bend due to earthquakes or increase floor loading (by live or dead loads) the U shaped spacer brace 302 will slid up and down between the tab 326t and the straight edge of the flange notch 126fn and will also not move sideways as the U shaped spacer brace 302 is wedged between the side edges of the bracing hole 36b of the support member. If the tab 326t was longer in length at the punch-out hole 326, fasteners (not shown) could secure the tabs 326t to the web 42a and if the wall framing structure would be panelized.

[0090] FIG.11 shows an isometric view of a support member shown as a C channel 42 with a rectilinear shaped hole 36 at the web 42a also shown with hole notches 126h at the hole side edges 36se. The hole bottom edge 36be has two vertical oriented notched-tab shafts 126nts that extend above the hole bottom edge 36be with a notched-tab head 126nth above. The notched-tab head 126nth are slightly longer so that the notched-tab shafts 126nts forms a notched-tab notch 126ntn with an indentation between the hole bottom edge 36be and the notched-tab head 126nth. The longer the notched-tab head 126nth the easier the notched-tab head 126nth are to bend as shown in FIG. 5.

[0091] FIG. 12 shows the notched-tab 126nt described in FIG. 11 on the right side of the hole 36. The hole bottom edge 36be is shown without the notched-tab 126nt as described above, however the right side shows the notched-tab 126nt extend above a W shaped clip 307. When a W shaped clip 307 is used at a hole 36 having the notched-tab 126nt, the web 307a of the W shaped clip 307 has a clip notch 126c at both sides of the web 307a at the vertical side edges of the hole bottom edge 36be. The notched-tab shafts 126nts and notched-tab heads 126nth are shown in FIG 11 as extending from the hole bottom edge 36be, however the notched-tab shafts 126nts and notched-tab heads 126nth could also originate at the hole side edges 36se.

The W shaped clip 307 has an anchor space 355 on the interior side of the web 307a at the hole bottom edge 36be where the two hook receiver 129 ends extend downward with the first leg 129a extending parallel to the web 42a of the support member then bending outward at the second leg 129b then back upward forming a gap 45 between the first leg 129a and the third leg 129c. When the interior side of the W-shaped clip 307 is installed into the hole 36 the first legs 129a of each hook receiver 129 straddle the hole bottom edge 36be and the side edge of the web 307a gets inserted into the side edges of the notched-tab notches 126ntn with the notched-tab head 126nth extending over the outside of the web 307a securing the web 307a to the notched-tab 126nt and the hole bottom edge 36be. In FIG's 2 & 5 the U shaped spacer brace 302 are installed at an angle allowing the side walls of the flanges 302b and the flange notches 126fg to slide into the hole side edges 36se for an easier connection to the hole 36. The ledge shafts 79s as well as the notched-tab heads 126nth are located adjacent to the hole side edges 36se. FIG. 12 shows notched-tab slot holes 126nts so the U shaped spacer brace 302 with the notched tabs 126nt or ledge shaft 79s fit directly into the notched-tab slot holes 126nts. The three sided notched-tab slot holes 126nts allow the flange notches 126fg to slide directly into the holes side edges 36se. The webg slot hole 36ws at the hole side edge 36se shows the opening having only three sided edges at the web 307a allowing for an easier connection into the hole 36.

[0092] FIG. 13 shows a reverse lip spacer brace 301 with the exterior side of the web 301a resting on the hole bottom edge 36be with the flanges 301b extending upward and the lip 301c extending outward. Above the hole 36 shows a smaller size hole referred to as a key hole 36k where the key hole 36k becomes part of the hole 36. The side edges of the key hole 36k shows hole notches 126h cut into the web 42a where one edge of the hole notch 126h is an extension of the top edge of the key hole 36k. At the upper side of hole 36 shows two ledge shafts 79s that are used in FIG. 14 below. In addition, two additional hole notches 126h are installed on both the hole side edge 36se at the intersection of the lips 301c which have lip notches 126p installed at the outside side edges of the lip 301c. The reverse lip spacer

brace 301 shows the horizontal oriented lip 301c with its lip notch 126p installed into the hole notch 126h where the hole side edges 36se are in a vertical orientation. The depth of the lip notch 126p is longer engaging the both planes of the web 42a and the hole notch 126h engages both top and bottom plane of the lip 301c thereby interlocking both vertically and horizontally forming a self-locking connection between the two notches. Before one the two notches are totally secure, the lip notch 126p on the opposing side lip 302c is engaged against the hole side edges 36se so the second lip notch 126p is continually being forced into the hole notch 126h until both lip notches 126p are secured into both the hole notches 126h by completing the self-locking connection of all four notches. The flanges 301b will bent until the lip notches 126p are installed into the hole notches 36h and then return back to their original configuration after being installed into the hole notches 36h. FIG. 1 shows many solutions for connecting adjacent spacer braces together. In FIG. 13 hole notches 126h are shown at the key hole 36k as well as at the hole side edges 36se. Additional pairs of holes notches 126h can be added at a hole 36 or in other locations so adjacent spacer braces can also connect support members together. By adding additional holes notches 126h within the same hole 36, two adjacent reverse lip spacer braces 301 can have their iip notches 126p connected to the same hole 36 using a separate pair of hole notches 126h. On the other hand if the hole notch 126h is larger, two adjacent reverse lip spacer braces 301 with their lip notches 126p can be inverted with the lip notches 126p installed into a wider hole notch 126h opening. In FIG. 77 the hole notches 126h are noted as double height in order to have two horizontal notched-tabs to be inserted into the same hole. In addition, the hole 36 can vary in size and smaller or larger width reverse lip spacer braces 301 can each have the lip notches 126p inserted into the same holes.

[0093] FIG. 14 shows a hole 36 and a key hole 36k near the hole top edge 36te. The hole notches 126h on both sides of the key hole 36k shows the width of the hole notch 126h slightly wider to accommodate the flange 302b having an angular orientation of the U shaped spacer brace 302. In addition the U shaped spacer brace 302 at the key hole 36k shows a ~~the~~ flange

notches 126fg engaging the hole top edge 36te. The self-locking connection is again made, but this time the top and bottom edges of the hole notches 126h at the key hole 36k and the outside plane of the flanges 302b form the self-locking connection. The hole 36 shows two notched-tabs 126nt at each of the vertical hole side edges 36se. A diagonally oriented U shaped spacer brace 302 is installed between the notched tab 126nt on the right side of the hole 36. The U shaped spacer brace 302 has the exterior side of the web 302a abutting the hole side edge 36se and the head 126nth of the notched tab 126nt extending over the flange 302b and where the notched-tab notch 126ntn extend into the flange notch 126fg connecting the notched-tab 126nt against the hole side edge 36se. A flange notch 126fg is shown in the flanges 302b so that flange 302b with its flange notch 126fg can be inserted into the ledge tab 79t and the opposing the web 302a & flange 301b can be pressured so the ledge tab 79t can be inserted into the flange notch 126fg forming another self-locking connection. Previously, ledge tabs 79t are shown with notches 126n or notched-tab 126nt are shown having a notched-tab notch 126ntn. The ledge tabs 79t as shown in FIG. 11 function the same as the notched-tabs 126nt as the key tabs 36kt. Holes 36 are shown with hole notches 36n and lips 302c show lip notches 126p and in FIG. 14 flange notches 126fg are shown.

[0094] FIG. 15 shows the self-locking connection between the hook receiver 129 at one end of one U shaped spacer brace 302 and the opposing end of another U shaped spacer brace 302 having the hook tongue 128 at the opposing end. The isometric view shows the U shaped spacer brace 302 abutting the hole 36 where the flanges 302 abut the web 42a on one planar surface at the indentation 302i in the hole side edge 36se and the extension 302e passes through the hole notches 126h occurring at the bottom corners of the hole 36 than passes over the anchor space 355 which is the hole bottom edge 36be and extends downward at the hook receiver 129 which formed a self-locking connection with the hole notch 126h. Since the extension 302e passes into the hole notches 36h, the U shaped spacer brace 302 has to be installed where one side edge of the extension 302e fits into the one hole notch 36h then the opposing side edge of the extension 302e is

pressured to fit into the opposing hole notch 36h thereby securing the U shaped spacer brace 302 from moving vertically as well as horizontally within the hole 36. The hook receiver 129 has the first leg 129a extending downward along the web 42a plane, then turning outwardly at the second leg 129b then back upward at the third leg 129c forming a gap 45 between the first and third leg 129a & 129c. The second leg 129b shows receiver notches 126r at both the side edges. The receiver notches 126r at both sides of the second leg 129b function the same the web slot holes 36ws shown in FIG. 12 as they both have the head 126nth of a notched-tab 126nt extending through the holes. The adjacent U shaped spacer brace 302 shows a hook tongue 128 extending downward from the web 302a so that the hook tongue 128 fits into the gap 45 of the hook receiver 129. The hook tongue 128 shows a notched-tab 126nt comprising of the hook tongue 128, two tongue shafts 128s with a tongue tab 128tt extending from the tongue shafts 128s. The tongue tab 128tt is slightly longer so the tongue tabs 128tt can fit into the receiver notches 126r at both sides of the second leg 129b allowing the tongue tabs 128tt to extend over the bottom edge of the second leg 129b forming a self-locking connection between the hook tongue 128 and the hook receiver 129. The hooked tongue tabs 128tt can be long so the hooked tongue tabs 128tt can be bent either at the first or third legs 129a or 129c of the hook receiver 129 or are shorter and have a hook tongue tab-indentation 128ti to connect the hook receiver 129 and hook tongue 128 together.

[0095] FIG. 16 is the similar as FIG. 48 except the interlocking self-locking connection is slightly different. The second leg 129b has two receiver slot holes 36rs between the first leg 129a and the third leg 129c and the hook tongue 128 has two corresponding tongue shafts 128s and tongue tabs 128tt that fit into the receiver slot holes 36rs. The length of the hook tongue tab-indentation 128ti will depend how much pressure is required to insert the tongue tab 128tt through the receiver slot hole 36rs. When the tongue tabs 128tt are very long, the tongue tabs 128tt can be bent to secure the tongue tabs 128tt to the hook receiver 129 in lieu of using the hook tongue tab-indentations 128ti to secure the hook tongue 128 to the hook receiver 129. The notched-tab 126nt is slightly different than shown in FIG. 17 as the

hooked tongue 128 has tongue shafts 128s having hook tongue tab-indentations 128ti on both sides of the tongue tabs 128tt.

[0096] FIG. 17 has a U shape spacer brace 302 at the top and bottom of the support member have the same configuration that is they are both U shaped having two flanges 302b extending from the web 302a with an array of flange slot holes 36fs where the narrow edge of the flange slot holes 36fs are flush with the plane of the interior side of the web 302a. The top and bottom ends of the web 42a of the support member have a J-shape gap 45jt where the gap is a J-shaped. The vertical edge of the J-shape gap 45j is formed by the space occupied by the outside edge of the flange 302b. The interior side of the U spaced spacer brace consists of a web shaft 42s and a web tab 42at where the web tab 42at forms the bottom edge of the J-shape gap 45jt and the web shaft 42s forms the short vertical section of the J-shape gap 45jt and where the web shaft 42s is connected to the web 42a. The J-shaped gap 45j forms a J-shape because the flange 302b fits into the vertical space of J-shaped gap 45jt plus the web tab 42at fits into the slot hole 36s and when the first web tab 42at slides into the slot hole 36s the flange 302b will bend outwardly and the opposite J-shaped gap 45jt will have the opposite side flange 302b also bend until both the web tabs 42at pass through the flange slot holes 36fs allowing the web indentation 42ai to be logged between the interior and exterior side of the flange slot holes 36fs in both flanges 302b forming a self-locking connection between the web tabs 42at in the support member and the slot holes 36s in the U shaped spacer brace 302. If the web tabs 42at are long enough the web tabs 42at can be bent to form a stronger connection between the support member and the spacer brace.

[0097] FIG. 18 shows several different ways to form bent tabs. At the top of the C channel web tabs 42at extend from the top edge of the web 42a and having a slight web indentation 42ai where the interior side of a horizontal U shaped spacer brace 302 having web-slot holes 36ws in the web 302a for the web tabs 42at to pass through an be bent horizontally forming another self-locking connection. The bottom end of the C channel showing U shaped spacer brace 302 (shown in solid lines) is the same configuration as FIG. 17

which only allows one J-shaped gap tab 45jt to be bent per U shaped spacer brace 302. Another version of a notched-tab 126nt is shown as a dashed configuration, with the two J-shaped gap tabs 45jt having the J-shaped gaps 45j configured in the same direction. The U shaped spacer brace 302 has the flange 302b inserted into the vertical portion of the J-shaped gap 45j and when the top edge of the flange slot holes 36fs becomes aligned with the hinged side of the J-shaped gap tabs 45jt are bent against the flange-slot holes 36fs forming a self-locking secured connection. The bottom flange and crossing member is showed and explained in FIG. 17 as well as FIG's 60 & 61 that are similar.

[0098] FIG. 19 shows the C channel 42 as a horizontal support member having a web 42a with two flanges 42b and lips 42c with the web 42a having a notched tab 126t at its end intersecting a horizontally oriented stringer. The stringer is a U shaped spacer brace 302 having a web 302a with slight canted flanges 302b extending outwardly at an angle. The notched-tab 126nt at the web 42a is a J-shape gap 45j as previously described in FIG. 18, however in FIG. 19 a ledge 79 has been added to the head 126nth of the notched-tab 126nt. The longitudinal edge of the web 42a is the end of the notched tab 126t has a ledge 79 similar to the ledge 79 in FIG. 10. The ledge 79 corresponds to the wrap-around tab 326 in the web 302a so the pivot edge 326pe is under the ledge 79 and the tab 326t at the vented edge 326ve wraps around the ledge 79 securing the vented edge 326ve against the web 42a. Because the flanges 302b are slightly angled it will be visually easier to install the web tabs 42at into the flange slot holes 36fs in the flanges 302b which again forms the self-locking connections between a stringer shown here as the U shaped spacer brace 302 and a floor or ceiling joist or support member shown here as a C channel 42. A similar J-shape gap 45j is shown in FIG's 30 & 31 where a C shaped space brace 303 and reverse lip spacer brace 301 are used to secure the support member and stringer together.

[0099] FIG 20 shows a W-shape clip 307 having a web 308a that extends over the rim 36r at the triangular shaped hole 36tr having a hook receiver 129 shown extending over the interior and exterior side of the C channel 42. The

first leg 129a is braced on the exterior side of the web 42a of the support member and the opposite first leg 129a extends over the rim 36a. Both side edges of the web 307a are inserted into the rim notches 126rn at each side of the rim 36r. The hole 36 and the rim 36r are angular in shape making it difficult to be inserted into the rim notches 126rm, however once the side edge of the web 307a is inserted into the diagonal oriented rim 36r the opposite side edge of the web 307a will snap into the rim notch 36rn on the opposing side similar to the method used in FIG. 15. FIG. 20 shows an elevation view of the triangular shaped hole 36tr and the rim 36r along with the hook receiver 129 passing through the triangular shaped hole 36tr. FIG. 21 shows a plane view of the W-shape clip 307 passing through the triangular shaped hole 36tr with the hook receiver 129 extending over the side plane of the web 42a and over the hole rim 36r at the first leg 129a then turning outward at the second leg 129b and then turning upward at the third leg 129c leaving a gap 45 between the first and third leg 129a & 129c where receiver notches 126n are located at their outside edges in FIG's 15 & 16.

[0100] FIG's 22 & 23 show the same triangular shaped hole 36tr as in FIG's 20 & 21 except a reverse lip channel 301 is shown with a web 301a and extending flanges 301b and horizontal extending lips 301c where the lips 301c have lip notches 126p that extend into the rim notches 126rm shown in the rims 36r of the triangular shaped hole 36tr. Because the rims 36r are canted ~~ventrally~~ inward the area occupied by the rim notch 126r are an unusual shape. Again the interlocking self-locking connections are made when the lip notches 126p installed into the rim notches 126rm in the rim 36r by having the vertical oriented rim notches 126rm interlock to the horizontal oriented lip notches 126p creating the interlocking self-locking connections between the two members.

[0101] FIG. 24 shows two reverse lip spacer braces 301 connected by a support member shown as a C channel 42 has a web 42a with extending flanges 42b and outwardly extending lips 42c with longitudinal edges of the lips 42c having a lip notch 126p with a flare edge 126f. The reverse lip spacer brace 301 shown at the top edge of the support member is also shown in

FIG's 31, 32 & 52 and the reverse lip spacer brace 301 is shown in FIG's 24-26 where the exterior side of the web 301a is against the floor. The support member is shown with the web 42a having two L-shaped gaps 126e where the flanges 301b and lip 301c would intersect the web 42a. The web 42a of the support member is narrow at the L-shaped gaps 45e and is wide enough for the flange 301b and lip 301c to slide into. The flange 301b will bent ~~ventrally~~ inward when the lip 301c and flange 301b are inserted into the narrow portion of the L-shaped gap 45e~~.~~ The opposing L-shaped gap 45e will also be inserted at the same time. The lips 301c will become slanted downward as pressure is applied to insert the lips 301c into the L-shaped gap 45e. The lips 301c could be slanted initially in order to more easily fit into the L-shaped gap 45e. Once the lips 301c are completely inserted into the L-shaped gap 45e the lip 301c will flex back into their original position when the lips 301c reach the web notch 126w at the top of the L-shaped gap 45e. The web gap 45w is more clearly shown in FIG. 25 and the lip notch 126p is more clearly shown in FIG. 26. When the lip notch 126p is oriented to the longitudinal direction of the reverse lip spacer brace 301 and the web notch 126w which is oriented in the direction of the C channel 42 cross, the vertical and horizontal notches becomes a self-locking secured connection between the two framing members. The web 42a between the L-shaped gaps 45e at the bottom edge of the support member describes the notched-tab 126nt with the notched-tab notches 126ntn and head 126nth as previously described in other notched-tabs.

[0102] The second reverse lip channel 301 shown at the top of the support member in FIG. 24 shows the interior side extending downward toward the C channel 42. The reverse lip spacer brace 301 has the interior side of the web 301a abut the longitudinal edge of the web 42a. The web 42a shows an web-indentation 42ai where the 301a crosses the web 301a of the reverse lip spacer brace 301. The two slide gaps 45s shown at the top end of the web 42a has a narrow width wide enough for the flange 301b to slide into so the lip notch 126p can fit into and wrap around the both side planes of the web 42a of the C channel 42. When the exterior side of the reverse lip spacer brace 301 has the web 301a secured to a floor or structure above, the reverse lip

spacer brace 301 is forced to move or bent when a vertical load is applied to the reverse lip spacer brace 301 then the lip notches 126p will slide vertically between side edges of the lip notches 126p at the top reverse lip spacer brace 301 forming a self-locking sliding connection between the two framing members.

[0104] FIG. 27 shows an isometric view of a reverse lip spacer brace 301 being terminated at the end of the hole 36 where the web 301a is extended to form a hook finger 127 that extends downward over the hole bottom edge 36be and the two lips 301c are show with lip notches 126p on the near side and the flanges 301b being wrapped around the far side of the hole side edges 36se. The near side of the lip notch 126p and the flap 76 will prevent the reverse lip spacer brace 301 from moving horizontally. The hook finger 127 and lip notch 126p prevent the reverse lip from moving horizontally. The whole notch 126h that support the lip notch 126p prevents the reverse lip spacer brace from moving vertically. Another alternative is the ledge shaft 79s (not shown), but described in FIG's 22 & 23 that could fit above the lip 301c to secure the reverse lip spacer brace 301 at the lip and the hole bottom edge 36be secured the web 301a. In previous pending applications a ledge 79 (not shown) extends from the hole bottom edge 36be and the hook finger 127 can wrap around the ledge 79 to also secure the reverse lip spacer brace 301 from moving vertically.

[0105] FIG. 28 shows an isometric view of a reverse lip spacer brace 301 installed diagonally passing through the hole 36. The lip notches 126p would typically be deeper since the lip notches 126p have to pass over the web notches 126w into the hole notches 36h so the lip 301c can still be supported in the web notches 126w.

[0106] FIG. 29 shows a similar isometric view as FIG. 24 except here a web shaft 42s is the anchor space 355 at the interior side of the reverse lip spacer brace 301 at the top of the support member while bottom of the support member has a web tab 42at at the head 126nth of the notched tab 126nt. The web tabs 42at extends through the web slot holes 36ws and the web tabs

42at can be bent or have a notch installed similar to the head 126nt of a shown in FIG. 8. This usually occurs when metal framing is assembled horizontally then erected vertically after the web tabs 42at are bent. The top reverse lip spacer brace 301 shows two web tabs 42at, while the bottom reverse lip spacer brace 301 shows the notched-tab 126nt as shown in FIG. 24.

[0107] The reverse lip channel 301 shown mounted at the floor can also be used at the top of the support members. Other types of spacer braces previously shown in previous pending patents can be installed as a diagonal or using any of the hole notches, rim notches, wrap-around tabs, the tabs from the punch out holes, the hook receiver with hook tongues and hook fingers.

[0108] FIG. 30 shows an isometric drawings of a C shaped spacer brace 303 where the exterior side of the web 303a is mounted typically by fasteners (not shown) against the underside of a floor or ceiling with the flanges 303b extending downward and the lips 303c turning inward and the longitudinal edge of the lips 303c has a lip notch 126p that occurs at a standard array spacing in alignment with the web 42a of an intersecting support member. The bottom of the wall shows another C shaped spacer brace 303 with the exterior side of the web 303 against the floor and connected by fasteners (not shown). The C shaped spacer brace 303 is shown having a sharp bulge 303sg at the intersection of the web 303a and the flanges 303b extending upward being connected to the lips 303c. The sharp bulge 303sg protrudes from the exterior side of the flanges 303b enough to have a bulge notch 126bg that is also in alignment with web 42a of the support member. After the C shaped spacer braces 303 are installed at the floor and ceiling the support members can be installed between the two C shaped spacer braces can now be installed. Each of the ends of the web 42a have L-shape gaps 45e also described as slide gaps 45s that correspond to the flanges 303b in both the top and bottom spacer braces and the web 42a has an web indentation 42ai so all the edges of the web 42a will rest on the interior side of a crossing member or on the same plane as the exterior side of the crossing member.

The web 42a at the top of the support member is inserted vertically into slide gap 45s and moved horizontally until the web 42a is inserted into the lip notch 126p. Taking the support member and lifting the support member higher into the interior side of the web 303a, the bottom end of the web 42a of the support member will detect the slide gap 45s at the bottom edge of the support member. Since the C shaped spacer brace 303 at the floor has a lip 303c that is narrower than the slide gap 45s, the flange 303b will flex allowing the lip 303c having a longitudinal edge be allowed to enter the slide notch 126s at the end of the slide gap 45s, securing the lip 303c into the slide notch 126s. Once the web 42a is secured into the slide notch 126s the end of the web 42a of the support member can be installed into the bulge notch 126bg. A bulge notch 126bg can be any type of notch that can protrude from a flange in order form a notch that can be inserted into the web 42a of a support member. At the top and bottom C shaped spacer brace 303 the web 303a has a web slot hole 36s where the web slot hole 36ws is oriented so the length of the web slot hole 36ws is the width of the C shaped spacer brace 303. So when a fastener not shown is installed in the web slot hole 36ws the C shaped spacer brace 303 will be able to slide horizontally in the direction of the web slot holes 36ws.

[0109] FIG. 31 is similar to FIG. 30 except a U shaped spacer brace 302 has its exterior side of the web 302a mounted against the ceiling with its flanges 302b extending downward. A rounded shape bulge 302g is shown extending outward from the flange 302b and in the middle of the longitudinal oriented bulge 302g shows a bulge notch 126bg that is in alignment with the web 42a of the support member. The bottom reverse lip spacer brace 301 has the exterior side of its web 301a fastened (not shown) to the floor with its flanges 301b extending upward and its lips 301c extending outward. A bulge 301g is shown extending outward from the web 301a protruding outward from the flange 301b so a bulge notch 126g can be located in the bulge 301g aligned with the web 42a of the support member. Again the top and bottom spacer braces are mounted at floor and ceiling and the support member has its web 42a with its sliding gaps 45s inserted into the flanges 302b & 301b. The bottom end of the support member also has a slide gap 45s, but is shown with

a slide notch 126s at the end and aligned so the slide notch 126s is on the flange sides of the slide gap 45s. After the web 42a is inserted in the flanges 301b at the slide gap 45s of the L-shaped gap 45e, then the lip 301c is inserted into the slide gap 45s and adjusted to fit into the two slide notches 126s in both slide gaps 45s and the support member is then slid horizontally so the web 42a can fit into the bulge notches126bg. One end of the web 302a is bent to form a hook finger 127 at one end of the reverse lip spacer brace 301. At the top of the support member additional vertically oriented web slot holes 36ws are shown and are aligned with the slide gaps 45s above. Should a support member need to be cut shorter, the web slot holes 36ws would then be used as the slide gaps 45s.

[0110] FIG 32 shows a wall section through a longitudinal U shaped spacer brace 302 where the web 302a has the exterior side mounted against the ceiling with fasteners (not shown) and two flanges extending downward where the right flange 302b shows a bulge notch 126bg projecting from the exterior sides of the flanges 302b. As further explained bugles 302b with bulge notches 126bg are required on both flanges 302b for the U shaped spacer brace 302 to slide vertically in the slide gaps 45s. The bulge 302g have vertical oriented bulge notches 126g located at the slide gaps 45s so the sides of the vertically oriented bulge notches 126bg engage both planes of the web 42a of the support member. The bulges 302g can be located on the interior or exterior side of the U shaped spacer brace 302. The bulge notches 126bg are notched typically 16” or 24” on center and can have a flared edge to make it easier to insert into the slide gap 45s which is also shown to have a flared edge at the end of the support member. When bending occurs from a ceiling or floor member above, the slide gaps 45s located in the web 42a of the support members, allows the U shaped spacer brace 302 to move vertically by allowing the support member to slide vertically within the slide gaps 45s. On the left side the bulge 302g is shown extending inward on the interior side of the U shaped spacer brace 302. In this case the left bulge 302g does not have a bulge notch 126bg in the bulge 302g, but a slide bulge notch 126sg is shown on the interior side of the slid gap 45s so the bulge 302g can be inserted into the slide notch 126s. By having the right slide gap

45s have a bulge notch 126bg and the left slide gap 45s having a slide notch 126s, the two different types of notches interlock the support member and the U shape spacer brace 302 together. Also in FIG. 41 a lip 302c is shown in lieu of the bulge 302g. When the lip 302c is turned so the lip 302c is extending on the exterior side the spacer brace has been referred to as a reverse lip spacer brace 301, however for explanation purposes the lip 302c has a lip notch 126p shown at the longitudinal end that engages the slide gap 45s similar to a previous FIG. 29.

[0111] FIG. 33 shows the wall section in FIG 32 extending to the floor line where the C shaped spacer brace 303 has the web 303a with its exterior side mounted at the floor by fasteners (not shown). The flanges 303b extend upward with the lips 303c extending from the interior side of the flanges 303b. The flanges 303b also have the bulge 303g protruding exterior from the flanges 303b and have a bulge notch 126bg occurring typically 16" or 24" on center. The support member has the slide gap 45s at the bottom of the web 42a along with a slide notch 126s for the lip 303c to be inserted into. When the web 42a is inserted into the slide gap 45s the lip 303c along with the flange 303b will bend then the bulge notch 126g will engage the side planes of the web 42a at the slide gap 45s until the lips 303c are inserted into the slide notches 126s in the web 42a of the support member.

[0112] FIG's 34-41 shows the cross section of various configurations of bulges that can be used to form the bulge notches 126bg located in the bulges 302g or slide notches 126s located in slide gaps 45s or holes notches 126h located in the holes of the support members. Only one flange is shown in the enlargements, however typically the bulges 302g are located on both flanges of the spacer brace. The bulges 302g can be located anywhere along the plane of the flanges and are located in a slide gap 45s of a web 42a of a support member. A U shaped spacer brace 302 is used where the bulge 302g extends wider than the slide gap 45s so a bulge notch 126bg can be formed on the exterior side of the bulge notch 126bg so both sides of the bulge slide notch 126sg engage both sides of the slide gap 45s. The bulges 302g can be located on either side of the slide gap 45s. FIG. 34 shows a

pointed shape bulge 126g having a vertex where the two planes intersect with a bulge slide notch 126sg located where the web 42a of the slide gap 45s intersect the bulge slide notch 126sg and in FIG. 35 the pointed shaped bulge 126g does not have a bulge slide notch 126sg, but instead has a slide notch 126s so the bulge 302g can fit into and will be lodge into the slide notch 126s and will not move vertically within the slide notch 126s. FIG's 36 & 37 are similar however the bulge 302g is like a half-circle shaped bulge and in FIG. 36 the bulge 302g has a bulge notch 126bg and in FIG. 46 the bulge 302g is continuous and the slide gap 45s has a slide notch 126s to fit into. FIG. 38 & 39 are similar to FIG. 36 that is the bulge 302g is a combination of two bulges 302g as shown in FIG. 36 where one-half of the bulge 302g extends over the interior side of the slide gap 45s and the other half of the bulge 302g extends over the exterior side and both halves have the bulge notch 126bg that extends over the side plane of the slide gaps 45s. FIG. 39 is similar to FIG. 38 having two half bulges 302g each extending over the exterior and interior sides of the slide gap 45s, however both bulges 302g extend into the slide notches 126s of the slide gap 45s. FIG. 40 is similar to FIG's 38 & 39 as the bulge 302g consist of two half bulges where one half bulge has bulge notch 126bg and the other half bulge has a slide notch 126s. FIG. 41 is the same as FIG. 40 except the slide gap 45s is horizontal rather than vertical and the half bulges are the same as in FIG. 40.

[0113] FIG's 35-40 shows several different configurations of spacer braces crossing and passing through the hole 36 of a support member. At both sides of the key hole 36k shows two ledge tabs 79t that are formed by making a tab forming cut 251 along the hole side edge 36se to the hole top edge 36te. The ledge tabs 79t were previously described in FIG's 13-16. FIG. 35 shows a U shaped spacer brace 302 that has a bulge 302g that first extends outward forming a half-circle shape then upward forming the flange 302b. The half-circle shape of the bulge 302g corresponds to the half-circle shape of the web-bulge notch 126wg for the bulge 302g to fit into as shown in FIG. 44.

[0114] FIG. 43 is similar to FIG. 42 except the space brace is a reverse lip spacer brace 301 however they both have a half-circle shape at the bulge

301g. The bulge 301g is shown as a half-circle being vertically oriented having a bulge notch 126bg on the exterior side of the bulge notch 126bg for the hole side edges 36se to fit into. The flanges 301b extend from the bulge notch 126bg to the lips 301c that extend exterior at an angle. The hole lip notches 126hp are vertically oriented and inset into the hole side edges 36se for the longitudinal edges of the lips 301c to be inserted into. The reverse lip spacer brace 301 is inserted into the hole 36 at a slight angle allowing the flanges 301b to bend where the bulge notches 126bg slide into the hole side edges 36se and the reverse lip spacer brace 301 is continually pressed downward until the lips 301c engage the both hole side edges 36se.

[0115] FIG. 44 shows a reverse lip spacer brace 301 having a web 301a with bulges 301g at each intersection of the flanges 301b with the left side having a horizontal oriented lip 301c and the right side having an angular oriented lip 301c. The left hole side edge 36se at the bottom corner has a web-bulge notch 126wg as shown in FIG. 42 for the bulge 301g to fit into and the left lip 301c has a lip notch 126p for the hole side edge 36se to fit into. The right side would typically have the same above described combination of self-locking connections on the opposing side of the reverse lip spacer brace 301. Another combination of self-locking connection is shown on the right side which is the same combination as shown in FIG. 43.

[0116] FIG's 45-47 show a reverse lip spacer brace 301 having a web 301a with bulges 301g on both sides having flanges 301b extending ~~ventrally~~ inward at an angle from the bulges 301g then bending outward forming a lip 301c. In FIG. 45 the reverse lip spacer brace 301 passes through the hole 36 so the bulge notches 126bg intersect the hole side edges 36se and the longitudinal side edges of the lips 301c are inserted into the hole lip notches 126hp forming a self-locking connection with the hole 36. FIG. 46 has the same reverse lip spacer brace 301 along with the bulge notch 126bg at the bulge 301g. The hole lip notch 126hp is shown as a web notch 126w because the hole side edge 36se at the reverse lip spacer brace 301 is recessed rather than shown as a hole lip notch 126hp. The isometric in FIG. 47 has the same profile as FIG. 45.

[0117] FIG. 48 shows a perspective view of the exterior side of the support member shown as a C channel 42 with a large shaped hole 36 and a key hole 36k below with key hole tabs 36kt on both sides of the key 36k. A U shaped spacer brace 302 with the exterior side of the web 302a facing upward and the extension 302e extending through the key hole 36k with the extension 302e and the flanges 302b abut the interior side on the web 42a. The extension 302e has receiver notches 126r on both side edges for the key tabs 36kt to fit into. The first leg 129a of the hook receiver 129 and the extension 302e abuts the interior side of the web 42a and the first leg 129a is bent inwardly downward against the exterior side plane of the web 42a. The second leg 129b extends away from the web 42a and is then bent vertically leaving a gap 45 between the first leg 129a and the third leg 129c. The second leg 129b has receiver notches 126r on both side edges similar to the hook receiver in FIG. 49. The key hole tabs 36kt form a triangular shape because the key tabs 36k are bent at an angle shown as a dashed line at the corner edges of the hole 36 and the edge of the key tabs 36kt where the extension 302e intersects the key tabs 36kt. At the hole top edge 36te two tongue tabs 128tt are shown extending downward from the hook tongue 128 shown in FIG. 58 with the right tongue tab 128tt bent.

[0118] FIG. 49 shows the interior side of the C channel 42 shown in FIG. 57 and the lower edge of the hole 36 shows the exterior side of a U shaped spacer brace 302 extending through the key hole 36k with the key-tabs 36kt shown ready to be bent. At the hole top edge 36te shows a hook receiver 129 shown as a web hook receiver 129wr where the exterior side of the web 42a is the same as the first leg 129a of a hook receiver 129. The second leg 129b is a continuation of the web 42a bent perpendicular to the web 42a and then bent vertically leaving a gap 45 between the third leg 129c and the web 42a. The second leg 129b has receiver notches 126r at both side edges for tongue tabs 128tt to pass through. The web hook receiver 129wr shows a U shaped spacer brace 302 with its hook tongue 128 extending into the gap 45 of the web hook receiver 129wr with its tongue tabs 128tt extending through the receiver notches 126r and where the left tongue tab 128tt is bent forming a

secure self-locking connection between the U shaped spacer brace 302 and a web hook receiver 129wr.

[0119] FIG. 50 shows an isometric view of a W-shaped clip 307 having a hook receiver 129 extending over exterior and interior sides of the web 42a of the C channel 42 and where the first leg 129a is against the plane of the web 42a and the second leg 129b extends outward with the third leg extending upward leaving a gap 45 between the first and third legs 129a & 129c. The web 307a of the W-shaped clip 307 shows clip notches 126c on both side edges of the web 307a for the key tabs 36kt to extend through the clip notches 126c to fit through and upon the interior side of the web 307a being secured into the anchor space 355, the key tabs 36kt are bent at an angle of least resistance allowing the W-shaped clip 307 to have a self-locking connection into the key hole 36k. The left key tab 36k shows a notched-tab notch 126ntn at side edge of the key hole 36k similar to FIG. 11 that shows the notched-tab 126nt with the notched-tab notch 126ntn. A key tab 36k is part of the web 42a along with the shape of the hole 36, while the notched-tab 126nt at the hole side edge 36se is the key tab 36k separated from the web 42a. The key tab 36k and the notched-tab 126nt at the corner of the hole 36 are similar as the key tab 36k is bent at a diagonal while the notched-tab 126nt is bent horizontally.

[0120] FIG. 51 shows an isometric view of the C channel 42 with the same W-shaped clip 307 shown installed at the key hole 36k as shown in FIG. 59 and the web hook receiver 129w as shown in FIG. 49. At the top of the hole 36 shows a web hook receiver 129wr that is formed from the web 42a of the C channel 42. When the hole 36 is manufactured the center section of the hole 36 is removed, however for a web hook receiver 129wr the first leg 129a is the web 42a of the C channel 42 and the second leg 129b and third leg 129c is the cut-away area of the web 42a that is discarded to create the hole 36. Therefore the second leg 129b is bent perpendicular to the web 42a with the third leg 129c extending upward leaving a gap 45 between the web 42a and the third leg 129c. A receiver notch 126r is installed at both the side edges of the second leg 129b of the web hook receiver 129wr for the two tongue tabs

128tt that are extending into the receiver notches 126r from the U shaped spacer brace 302 shown dotted.

[0121] FIG. 52 is similar to FIG. 24 except a bracing hole 36b is shown between the previously described slide gaps 45s and the web indentation 42i is now shown as a bracing hole 36b with a key hole 36k and two key tabs 36kt form the hole bottom edge 36be. When the flange 303c from the reverse lip spacer brace 303 extends to the bottom of the slide gap 45s the web 302a would be flush with the exterior side of the reverse lip spacer brace 303. To form a recess base at the top or bottom of the metal framing the slide gap 45s is required to be shorter than the flange 303b then the flange 303b will extend beyond the top and bottom edge of the support member. The reverse occurs at the bracing hole 36b at the lower bottom edge of the web 42a where the key hole 36k and the two key tabs 36kt form the hole top edge 36te.with the side edges of the key hole 36k being the side edges of the key tabs 36kt. The bottom edge of the key tabs 36kt in the bottom bracing hole 36b shows a web-hole notch 126wh at both side edges of the bracing hole 36b for the lip notches 126p at the longitudinal side edge of the lips 303c for the reverse lip spacer brace 303. The web 303a shows web-slot holes 36ws extending in both a width and longitudinal direction for fasteners (not shown) to be installed into a floor.

[0122] FIG. 53 shows a rectilinear shaped hole 36 having a continuous rim 36r extend from the web 42a of the support member and where the corners have a short depth at the rims 36r. FIG. 54 shows a U shaped spacer brace 302 extending through a hole 36 shown similar to the U shaped spacer brace 302 in FIG. 15, however the hole bottom edge 36be in FIG. 53 has an irregular shape configuration. The hook receiver 129 is shown extending over the irregular shape of the hole bottom edge 36be due to the shape of the rim 36r. The first leg 129a of the hook receiver 129 shows a receiver slot hole 36rs so the rim 36r can fit into. If the hook receiver 129 extends through the hole 36 in reverse, the flanges 302b would have notches 126 at the end side edges of the flanges 302 for the rim 36r could fit into will the hook receiver 129 would have extended over the hole bottom edge 36be against the web

42a. The rims 36r are irregular in shape allowing the rim 36r to extend through the receiver slot hole 36rs forming another similar self-locking connection.

[0123] FIG. 55 shows a U shaped spacer brace 302 with it exterior side facing upward having a hook receiver 129 at the end with an adjacent U shaped spacer brace 302 having its hook tongue 128 ready to be connected to each other. In FIG. 15 a similar connection occurs between the hook tongue 128 fits into the hook receiver 129, except here the hook receiver 129 is not required since the hook tongue tabs 128t wrap around the bottom edge of the first leg 129a of the hook receiver 129. The hook tongue 128 still fits into the gap 45 between the first and third legs 129a & 129c, however in lieu of shorter tongue tabs 128tt the tongue tabs are longer and extend around the hook receiver tabs 129t.

[0124] FIG. 56 shows an enlargement of FIG. 58 where the diagonal oriented framing member shown as a U shaped spacer brace 302 is installed into the horizontal C shaped spacer brace 302. The diagonal oriented U shaped spacer brace 302 is slightly wider than the horizontal oriented C shaped spacer brace 303 so the extended flanges 302be are flush with the exterior side of the flanges 303b. The extended flanges 302be form the beginning side of the notched-tabs 126nt so the extended flanges 302be can be bent to fit into the flange slot holes 36sf. The extended flanges 302be have an indentation 302bei at the hole top edge 36te so the head 126nth of the notched-tab 126nt can fit into and be secured at the flange slot hole 36sf. The web 302g of the diagonal U shaped spacer brace 302 has the same or similar notched-tab 126nt as described in FIG. 58 & 59.

[0125] FIG. 58 is similar to FIG. 56 as they both show a vertical oriented C channel 42 and a diagonal oriented U shaped spacer brace 302 intersecting a horizontal oriented C shaped spacer brace 303. FIG. 58 shows the horizontal oriented C shaped spacer brace 303 having a raised web 303ra with sloped sides 303sa; however the web 303a is still resting on the exterior side against a floor. The raised web 303ra shows a raised slot hole 36rs oriented to be

aligned parallel to the web 42a of the support member. The notched-tab 126nt starts as a notched-tab extension 42nte at the web 42a of the support member. The notched-tab extension 42nte is shown having an indentation 42nti that is indented around the lip 303c and the lip extension 303ce. The notched-tab extension 42nte has a notch 126ntn where the notched-tab 126nt intersects the raised slot hole 36rs and the head 126nth of the notched-tab 126nt extends through the raised slot hole 36rs. FIG. 58 also shows a similar diagonal oriented U shaped spacer brace 302 intersecting the horizontally oriented C shaped spacer brace 303 as shown in FIG. 56 & 57.

[0126] FIG. 59 shows an enlarged isometric view of the diagonal oriented U shaped spacer brace 302 intersecting the C shaped spacer brace with the raised web 303ar. The web 302a has an indentation 302nti at the lips 303c and extended lips 303ce with the web 302a having an extension 302nte at the start of the notched-tab 126nt. The notched-tab 126nt at the raised slot hole 36rs has a notch 126ntn at the raised slot hole 36rs with the head 126nth extending through the raised slot hole 36rs to the exterior side of the raised web 303ra of the C shaped spacer brace 303.

[0127] FIG. 60 also has the support member shown as a C channel 42 intersect the C shaped spacer brace 303 where the web 303 has a raised web 303ra with raised sloped sides 303sa, however here the left side of horizontal spacer brace is shown as a U shaped spacer brace 302 where the lips 303c & extended lips 303ce are removed and the right horizontal spacer brace is shown as a C shaped spacer brace 303 with lips 303c and extended lips 303ce. On the left side of the horizontal spacer brace the web 42a for the support member rests on the interior side of the web 303a while the right side the web 42a would be required to have an indentation 42i (but not shown here). Depending on the width of the vertical support member and the width of the horizontal spacer brace the bearing point or the anchor space 355 would vary. Should the support member fit into the interior side of the flanges the bearing point would be at the web 42a adjacent to the flanges and at the head 126nth of the notched-tab 126nt. When the raised slot holes 35rs are located in the middle of the raised web 303sa or 302sa, the notched-tab 126nt

is aligned with the raised slot holes 36rs and the notches 126ntn of the notched-tab 126nt as similarly described in FIG. 70. FIG's 1, 60 & 61 show vertical oriented slot holes 36s at the flanges of adjacent support members where a U shaped spacer brace 302 is shown spanning between adjacent support members. The U shaped spacer braces 302 are shown having notched-tabs 126nt extending from their webs 302a. The flanges 302b abut the webs 42a or lips 42c of the support member and the web extension 302e are part of the notch 126ntn of the notched tab 126nt as the web extension 302e wraps around the hole side edge 36se and the head 126nth becomes wider than the slot hole 36s and therefore becomes a notched-tab 126nt when extended through the slot hole 36s. Even though FIG's 14 & 15 or FIG's 60 & 61 show the notched-tab 126nt at the top or bottom edges of the web 42a in the support members, a smaller width U shaped spacer brace 302 with flange slot holes 36fs can be inserted into the hole 36 having the notched-tab 126nt extending from the holes bottom edge 36be. The notches 126ntn would be inserted from the bottom side of the U shaped spacer brace 302 rather than from above as shown in FIG's 60 & 61.

[0128] FIG. 61 is similar to FIG. 59 as the horizontal spacer brace can be U shaped or C shaped as described above. FIG. 60 has sloped edge notches 126se at the raised sloped sides 303sa where the sloped edge notches 126se are notched at the sloped edges and slightly indented into the raised web 303sa to give additional bearing to the web 42a which is the beginning side of the notched-tab 126nt, but in this case it is a one-half notched-tab 126nt2 where one-half of the notched-tab 126 is located in the sloped edge notches 126se. The web 42a is the beginning side of the one-half notched-tab 126nt2 with the notches 126n being inserted into the side edge of the sloped edge notches 126se and the finish side being at the same plane as the interior side of the web 303a. Therefore notches 126n form the same function as the two one-half notched-tabs as the notches 126 secures two crossing members together.

[0129] FIG. 62 is similar to FIG's 8 & 9 except only one notched-tab 126nt is shown along with one slot-tab hole 36st. The notched-tab 126nt also shown

in FIG. 63 is shown having rounded edges to be inserted easier into the slot-tab holes 36st.

[0131] FIG. 64 is similar to FIG. 63 in spacer brace 14 (a previous application), however the C shaped spacer brace is smaller and passes through the hole 36 in a support member. The C shaped spacer brace is shown having the exterior side of the lips 303c supported on the hole bottom edge 36be with the side edges of the lip 303c extending against the notch 126n of the notched-tab 126nt. If the C shaped spacer brace 303 is required to be fixed a lip notch 126p needs to be installed so the C shaped spacer brace 303 will not be allowed to slide horizontally.

[0132] FIG. 65 is a sectional view but similar to FIG. 57 ~~279~~ in the previous application, however the exterior side of the web 302a of the U shaped spacer brace 303 is shown even with the top edge of the support member and the notched-tab 126nt has it top edge being the anchor space 355 for the interior side of the web 303a to rest on. In addition the flanges 303b extend into the web-gap 45w allowing the lips 303c to flex and become engaged into the notch 126n of the notched-tab 126nt.

[0133] FIG. 66 & 67 are similar to FIG. 58 & 59 in spacer brace 14 (previous application) where the notched-tab 126nt extends through the raised slot hole 36rs, however in both figures the notched-tab 126nt is a V-shaped notched-tab 126v where the first leg 126va extends from the notched-tab extension 126nte but is narrower than the length of the raised slot hole 36rs forming the top edge of a notch type of connection. The second leg 126vb of the V-shaped notched-tab 126v is angled back in the direction of the raised slot hole 36rs so the end of the edge of the second leg 126vb abut the exterior side of the C shaped spacer brace 303 at the web 303a. Since the V-shaped notched-tab 126v is used, the raised slot hole 36rs should have edge extension that extends on the exterior side of the raised web 303ra. The edge extension is not shown but is similar to the fourth leg 129d of the hook receiver 129 shown in FIG. 294.

[0134] In FIG. 68 the hooked tongue 128 and hooked receiver are slightly different than in FIG. 219a. In FIG. 68 the hooked tongue 128 has a V-shaped notched-tab 126v having the first leg 126va extend downward from the web 302a with the second leg 126vb extending at an obtuse angle back to the interior side of the U shaped spacer brace 302. The V shape of the hooked tongue 128 is inserted into the hooked receiver 129 where the first leg 129a is extended from the hole extension 302he extending downward then extending horizontally at the second leg 129b then extending upward as the third leg 129c then turning again at the fourth leg 129d back toward first leg 129a leaving a gap 45 between the first leg 129a and the fourth leg 129d. The hooked tongue 128 referred to as a V-shaped notched-tab 126v extends into the hooked receiver 129 so the first leg 126a and second leg 126b become compressed together so when the V-shape is fully extended into the hooked receiver 129 the second leg 126b of the V-shaped notched-tab 126v springs back so the second leg 126b becomes lodged under the fourth leg 129d of the hooked receiver 129.

[0135] FIG's 69-76 show different variations of a V-shaped hole 36v also described as V' & V"". A V-shaped hole 36v has the hole bottom edge 36be in a V-shape. In FIG. 69 the V-shaped hole V'' has the bottom edge oriented horizontally or the blunt end 159 of the V-shaped hole V'' while both the hole side edges 36se are at an angle similar to FIG. 73, in addition the vertical hole side edges 36se has hole notches 36h similar to other previous figures at the intersection of the hole side edges 36se and the angular side walls of the V-shaped hole 36V''. A reverse lip spacer brace 301 is shown having a web 301a abutting the blunt end 159 with the flanges 301b parallel with the angular side walls of the V-shaped hole 36'' and lips 301c extending externally having lip notches 126p extending into the hole notches 36h.

[0136] FIG. 71 is similar to FIG 69 except the V-shaped hole 36v' has a notched-tab 126nt at the vertex and does not have holes notches 36h. In FIG. 72 a V-shaped channel or V-shaped spacer brace 299 has two angular legs 299a that meet a the vertex of the angular legs 299a, however at the vertex a vertex slot hole 36v is installed so the notched tab 126nt can fit into.

The notched tab 126nt is extended from the web 42a through the vertex slot hole 36v with the head 126nth being larger and taper so the head 126nth can slide into the vertex of the vertex slot hole 36v.

[0137] FIG. 73 is similar to FIG. 69 as the V shaped hole 36v has hole notches 36h at the angular oriented hole bottom edges 36be and the hole side edges 36se In FIG. 74 the V shaped spacer brace 299 has leg notches 126eg to fit into the hole notches 36h thereby eliminating any vertical and horizontal movement of the V shaped spacer brace 299.

[0138] FIG. 75 is showing a V shaped hole 36v''' having a slightly different configuration where a notched-tab 126nt is shown at each of the angular oriented hole bottom edges 36be. In FIG. 76 a U shaped spacer brace 302 is installed in the V shaped hole 36v''' and corner slot holes 36cs are installed at the intersection of the web 302a and flanges 302b on both side corner edges. The corner slot holes 36cs are large enough for the head 126h to fit through and become engaged at the notched-tab notch 126ntn of the notched-tab 126nt.

[0139] FIG. 77 shows a horizontally oriented U shaped spacer brace 302 intersecting a vertical oriented hole 36 in the web 42c of the C channel 42 from the left side and another U shaped spacer brace 302 intersecting the hole 36 from the right side. The ends of the U shaped spacer braces 302 have notched-tabs 126n that extend from the webs 302a at the indentations 301i forming a head 126nth greater than the width of the hole 36. When installing the web 302a and flanges 302b the notched-tab 126nt abuts one side plane of the web 42a of the C channel 42 at the indentation 302i with the web extension 302we passing through the hole side edges 36se extending from the web 302a over the hole bottom edge 36be then extending along the opposing side plane of the web 42 forming a notch 126ntn in the notched-tab 126nt to the end of the head 126nth of the notched-tab 126nt. In addition, hole notches 126h are installed at the hole side edges 36se to eliminate vertical movement and provide a stronger metal framing connections. The notched-tab 126nt passes through the vertical oriented hole notches 126n,

notches 126ntn are installed on both side edges of the notched-tab 126. The adjacent U shaped spacer brace 302 also has the notched-tab 126 at each end along with the notches 126ntn at the notched-tabs 126nt. When two notched-tabs 126nt are installed over each other into the same hole notch 126h the notched-tabs 126nt are stacked above each other forming a hole notch 126h having a wider opening to accommodate two notched-tab notches 126ntn. The notched-tab notch 126ntn of the notched-tab 126nt has the web 42a as one side edge the web extension 302we as the second side edge and the head 126nth as the third side edge of the notched tab 126nt. Since the U shaped space brace 302 and the notched-tabs 126nt are wider than the width of the hole 36, the U shaped spacer brace 302 is installed at an angle installing one notched-tab notch 126ntn into the hole notch 36h at one hole side edge 36se then pushing the opposing notched-tab notch 126ntn into the opposing hole notch 126h on the opposing hole side edge 36se. The notched-tab 127nt could also be used at the end of a notched-finger 127n similar to FIG. 78 or as an extension of the web 302a having a notch 126n and now referred to as notched-tab notch 127ntn. As previously described, spacer braces vary in size, shape and connect differently between framing elements. The notched-tab 126nt can be installed as a connection means at the ends of any metal framing member needing a connection without requiring fasteners and an even stronger connection when holes notches 126h are used. In addition, the hole notches 126h and the lip notches 126p secure the support member to the crossing member without fasteners.

[0142] FIG. 78 shows two horizontal oriented U shaped spacer braces 302 connected together when passing through the hole 36 of a support member having hole notches 126h at the hole side edges 36se with the bottom edge of the hole notches 126h being the at the hole bottom edge 36be. The web 302a and flanges 302b abut one side of the 42a of the C channel 42 at the indentation 302i with the web extension 302we passing over the hole bottom edge 36be and into the hole notches 126h so the hook finger 127 can extend downward over the hole bottom edge 36be and against the planar surface of the web 42a. At the web 302a a receiver slot hole 36rs that extends parallel to the web 42a less than the width of the hole 36 for an adjacent spacer brace

to connect into. The opposing end also has the web 302a and flanges 302b abut the planar surface of the adjacent web 42a of another support member. The opposite end of a second U shaped spacer brace 302 has a web extension 302we with a notched-tab 126nt at the end which is installed over the hook finger 128 and web 302a of the first U shaped spacer brace 302. The web extension 302we is wider than the width of the receiver slot hole 36rs of the first U shaped spacer brace 302 so notches 126ntn can be bent and installed at the side edges of the web extension 302we and then inserted into the web slot hole 36we. The notched-tab 126nt in the web slot hole 36ws and the hole notches 126h and the hook finger 128, web 302a and flanges 302b engage the opposing end making a self-locking connection between the two U shaped spacer braces 302. Since the web 302a of the first framing member is installed in the hole notches 126h and abuts the support member at the web 302a, flanges 302b and the hook finger 127 the first framing member is secured within the opening of the hole 36. When the notched-tab 126nt of the second framing member is inserted into the slot hole 36s of the first framing member, the notched-tab 126nt and slot hole 36s eliminates horizontal and vertical movement between spacer braces and support members having the notched hole 126h.

[0143] There are many different variations of the connections that have been shown in the figures and when discussed in the claims could be referred to as connectors. Since a notched tab 126nt could extend from a web or flange of either a support member or spacer braces the tab as explained in the claims is the first metal framing element. When a crossing member intersects say the notched tab, the notches of the notched tab engage an opening which could be the edge of a lip of a U or C shaped support or spacer brace as well as many of the different types of holes or notches that the notched-tab notch 126ntn would connect or engage too. Sometimes a notch for example a hole notch could be considered as a pocket to receive a crossing element that fits into the pocket. In addition sometimes the construction of the spacer brace being the web, flanges or lips are referred to as a wall. The notched-tab can be installed in various positions where a wall description can be considered is many different locations.

FIGURE NUMBER GLOSSARY OF TABLE OF CONTENTS

36 hole: 36be-hole bottom edge, 36se-hole side edge, 36te-hole top edge, 36tr-triangular shaped hole, 36k-key hole, 36ws-web slot holes, 36bf-bent flange edge, 36b-bracing hole, 36kt-key tab, 36fs-flange slot holes, 36rs-receiver slot hole, 36tb-tab holes, 36v-vertex slot hole, 36cs-corner slot hole, 36v-V shaped hole,

36r rim

42 C channel: 42a-web, 42b-flange, 42c-lip, 42at-web tab. 42ai-web indentation, 42s-web shaft

45 gap: 45j–J-shaped gap, 45e-L-shaped gap, 45w-web gap, 45s-slide gap, 45jt-J-shaped gap tab, 45g-ledge gap

76 flap

79 ledge: 79i-ledge indentation, 79t ledge tab, 79s-ledge shaft, 79cp ledge cap, 79cr cap rim, 79sh-hollow shaft ledge

126 notches: 126n-notch, 126f-flare edge, 126ng-notch gap, 126c-clip notch, 126r-receiver notch, 126h-hole notches, 126rm-rim notch, 126p-lip notch, 126w-web notch, 126bg-bulge notch, 126wg-web-bulge notch,126wh-web-hole notch, 126nt-notched-tab,126hp-hole lip notch, 126fg-flange notch, 126s-slide notch, 126sg-bulge slide notch, 126c-clip notch, 126nth-notched-tab head, 126eg-leg notch

127 hook finger

128 hook tongue: 128s-tongue shaft, 128tt-hook tongue tab, 128ti-hook tongue tab-indentation

129 hook receiver: 129a-first leg, 129b-second leg, 129c-third leg, 129wr-wide hook receiver, 129fr-flange receiver, 129wr-web hook receiver, 129t-hook receiver tab

157 blunt end

251 tab forming cut

299 V shaped spacer brace, 299a-angular leg

301 reverse lip spacer brace: 301a-web, 301b-flange, 301c-lip, 301g- bulge

302 U shaped spacer brace: 302a web, 302b flange, 302we-web extension, 302fe-flange extensions, 302he-hole extension, 302re-receiver extension, 302i-indentation, 302g-bulge

303 C shaped spacer brace: 303a-web, 303b-flange, 303c-lip, 303g-bulge, 303ar-raised web, 303s-sloped ledge, 303ce-lip extension, 303be-flange extension, 303ar-raised web, 303as-sloped web edge, 303sg-sharp bulge

307 W-shaped clip: 307a-web, 307b-flange

320 ridges

326 punched out tabs: 326ve-vented edge, 326pe-pivot edge, 326t-tab, 326tw- wrap-around tab

340s starting position, 340e-ending position

355 anchor space

Claims

1. A connector between first and second metal framing elements, the connector comprising:

a first metal element having the hole opening in a planar wall, the opening adapted to receive the second metal framing element, a notch open to the side edges of the hole opening in the wall of the first metal framing element , the opening having two opposing shoulders on the side of the notch, the notch having a back edge, the back extended into the wall, the width of the notch at its opening at the side of the wall being a first width, the width of the notch at its back edge being a second width, the second width being smaller and at least equal to the first width; and

a second metal framing element having two opposing longitudinal openings on a common longitudinal plane and a framing element residing between the two longitudinal openings, the two shoulders of the first metal framing element adapted to be received by the two longitudinal openings of the second metal framing element so that the section of second metal framing element residing between the two longitudinal openings resides on the back edge of the notch of the first metal framing element.

2. The connector for first and second metal framing elements comprising according to claim 1 wherein:

the second metal framing element having a pair of longitudinal parallel walls spaced apart a first distance, the first side of each wall extending from a first metal framing element, the second side of each wall spaced apart approximately parallel to the first of each wall, each wall having a lip extending approximately perpendicularly outward from the second side of each wall; and

the first metal framing element having a pair of notches spaced apart at hole opening and each hole notch adapted to fully receive one of the pair of parallel walls, each notch having a pocket extending perpendicularly from the notch and adapted to receive the lip of the wall received in the notch.

3. The connector according to claim 1 wherein the first metal element having the opening in a planar wall, the opening adapted to receive a second metal framing element and a third framing element into the first metal element, with two pair of notches open to the side edges of the wall of the first metal framing element, the opening having two opposing shoulders on the side of the notch and two opposing hole notches on the side of the planar wall, the notches having a back edge, the back extended into the wall; and

the second metal framing element having two opposing longitudinal openings on a common longitudinal plane and a framing element residing between the two longitudinal openings engaging one pair of shoulders of the first metal framing element adapted to be received by the two longitudinal openings of lip notches in the second metal framing element; and

the third metal framing element having two opposing longitudinal openings on a common longitudinal plane and a framing element residing between the two longitudinal openings engaging another pair of shoulders of the first metal framing element adapted to be received by the two longitudinal openings of lip notches in the third metal framing element.

4. The connector according to claim 1 wherein the tab head extending from the first metal framing element engages the opening of the second metal framing element from one direction into the second metal framing element and a third metal framing element having the same tab elements as the first metal framing element engages the same hole notch opening in the opposing direction; and

the hole notch opening adapted to receive the first and third metal framing element, having a hole notch open at the hole side edges of the wall of the first metal framing element , the opening having two opposing shoulders on the side of the notch, the notch having a back edge, the back extended into the wall, the width of the notch at its opening at the side of the wall being a first width, the width of the notch at its back edge being a second width, the second width being at least equal to the first width.

5. The connector according to claim 4 wherein the hole notch openings at the side edges of the hole opening at the first metal framing element have two opposing

shoulders on the side of the notch for the second metal framing elements having longitudinal lip edges with lip notches and a third metal framing element having longitudinal lip edges with lip notches engage into the back edges of the hole notches.

6. The connector between the first and second metal framing elements according to claim 1 wherein the second metal framing element is wider than the opening of first framing element ~~and~~ extends through the opening-bent so the planar surface extends over one edge of the notch and the wider width element extends over the opposing planar surface of the opening.

7. The connector according to claim 1 wherein the notched-tab shape on the planar wall of the first metal framing element having two L-shaped gaps openings with the long leg of the “L” being the height of the head and the short legs of the “L” being the notches with the distance between the L-shaped gaps being the width of the notched-tab connector.

8. The connector according to claim 7 wherein the notched-tab shape in the first metal framing element connects a C shaped second framing element with the web and flanges encase the head with the lips extending into the notched-tab notches.

9. The connector according to claim 7 wherein the longitudinal end of first metal framing element has L-shaped gaps opening ends with long legs and the short legs for:

the second framing member being a reverse lip shape where the first metal framing element extends across the longitudinal web and wherein the longitudinal side walls with lips extend into the L-shaped gaps.

10. The connector according to claim 7 or 9 wherein the lip notches at the longitudinal lip edges of the second framing elements engages the short gaps notches of the L-shaped gap framing elements.

11. The connector according to claim 7 wherein the lip notches of the second framing member engage the side edges of the long leg gaps of the planer wall to slide within the gap.

12. The connector according to claim 7 wherein the connector extending from the first metal framing element has L-shaped gap openings on the planar wall of the first metal framing element forming the notched-tab connector wherein the sides edges of the head has recessed notches extending into the tab head for the flanges with protruding bulges of second framing element extend into the L-shaped gap opening engaging the recessed notches.

13. The connector according to claim 11 wherein the notched-tab connector extending from the first metal framing element has L-shaped gap openings on the planar wall forming the notched-tab shape where the sides edges of the head have bulge notches at the head for the notches in the bulges engage the sides edges of an opening.

14. The connector according to claim 7 wherein the flanges of the second framing member has raised bulges that extend outward from the plane of the flanges, the width of the bulges extending the length of the second framing member for the contour of the side edges of the first framing member extending into the contour shape of the bulge in the metal framing to conform to the profile of the hole notch.

15. The connector according to claim 14 wherein the flanges of the second metal framing member has raised bulges that extend outward from the plane of the flanges, having the width of the bulge extending the length of the second framing member for the contour of the side edges with the bulges in second metal framing member having notches in the bulges to conform to align with the metal framing spacing to engage the bulge notches.

16. The connector according to claim 14 wherein the bulges projecting from either side of the flanges of a second framing member bulge notches that extend the width of the bulge so the side edge of the metal framing can extend to the flange of the crossing member and the notch bulge extends around both the inner and outer planes of the metal framing member.

17. The connector according to claim 7 wherein the tab head extending from the first metal framing element has a ledge extending from the tab head end; and

the second metal framing element has an opening with a tab head extending outward and wraps around the ledge.

18. The connector according to claim 7 wherein the web of first metal framing element has tabs extending through the web slot holes openings of the second framing element and bent over the outside edge of the second framing member.

19. The connector for the first metal framing element according to claim 1 wherein the hole opening to receive the second metal framing element has planar tabs extending from the hole opening at the corners with the hole side edges and the hole bottom edges with notches open to the side edges of the walls extending from the hole bottom edge to an upper opening, the notches having a back edge for the second framing element to reside between the back edges.

20. The connector for the first metal framing element according to claim 19 wherein the hole opening to receive the second metal framing element has an additional hole side edge within the hole opening forming another concentric hole opening having side edges being a smaller hole shape in the planar surface of the first framing member with notch openings having top and bottom edges and back edges.

21. The connector in the first metal framing element according to claim 19 wherein the planar tabs extend from the bottom edge openings at the corner being separated from the hole side edges with opposing side edges having notches at the point of jointer;

the web openings of the second metal framing element having two parallel side edges with back side edges for the notches in the planar tabs in first metal framing element to engage into.

22. The connector in the first metal framing element according to claim 21 wherein the web opening has two planar tabs with hole notches; and

the second metal framing member having two opposing longitudinal openings on a common longitudinal plane and a framing element residing between the two longitudinal openings, the two shoulders of the first metal framing element to that the section of second metal framing element residing between the two longitudinal openings resides on the back edge of the notch of the of the two planar tabs.

23. The connector in the first member framing element according to claim 22 wherein at least one planar tab having a tab head long enough to extend through the opening of the second metal framing member to bend securing the first member to the second member.

24. The connector according to claim 7 wherein the notched-tab connector between the L-shaped gaps of the first metal framing element engages the second framing element having a common longitudinal plane with a pair of parallel longitudinal walls with slot hole openings for the tab head extending from the first metal framing element having a longer length head forming a side head tab engaging the openings of the second metal framing element; and

the openings in the second metal framing element in the flange slot holes are smaller and aligned with the side head tabs and notches to slid into the openings side edges in the flanges of the second metal framing member.

25. The connector according to claim 7 wherein the notched-tab connector between the L-shaped gaps of the first metal framing element engages the second framing element having a common longitudinal plane with a pair of parallel longitudinal side walls forming a raised common longitudinal plane having spaced apart slot hole openings for the notched-tab connector to fit into.

26. The connector according to claim 25 wherein the notched-tab connector between the L-shaped gaps of the first metal framing element with the tab head end of the notched-tab is bent after extending through the notched hole to secure the underside of the second metal framing element.

27. The connector according to claim 9 wherein the notches in the notched-tab connector of the first metal framing element are the same length as the length of the side wall openings in the second framing element for the notches to fit into.

28. The connector between first and second metal framing elements at the side edges of the opening according to claim 12 and a third metal framing element, the connection comprising:

a first metal framing element having an opening in a planar wall to receive the second metal framing element into the hole notches; and

a second and third framing elements having two longitudinal side walls with a common longitudinal wall that abut the first framing element at each side of the planar wall with one end have having a slot hole and the opposing end having an extension with a planar tab and notches at both side edges; wherein

the common longitudinal wall of second framing element extends through the opening having the end with the slot hole adjacent the opening of the planar wall for the third faming member having the head tab extend through the slot hole for the side edge notches to engage the underside of the slot holes.

29. A connector for metal framing elements comprising:

a planar tab extending from an opening in first metal framing element the tab having a notch at the first width at its point of joinder with the metal framing element and a second width beyond its point of joinder being the tab head equal to or greater than the first width with spaces around the planar edges of the tab head forming a notched-tab connector and the opening for;

an opening in a second metal framing having a longitudinal web with longitudinal side walls extend against the side walls of the opening in first metal framing with notched side walls extending and engaging the bottom side edge of web opening of first metal framing element and adapted to receive the tab head through the slot hole openings, the width of the opening being greater than the head of the first width.

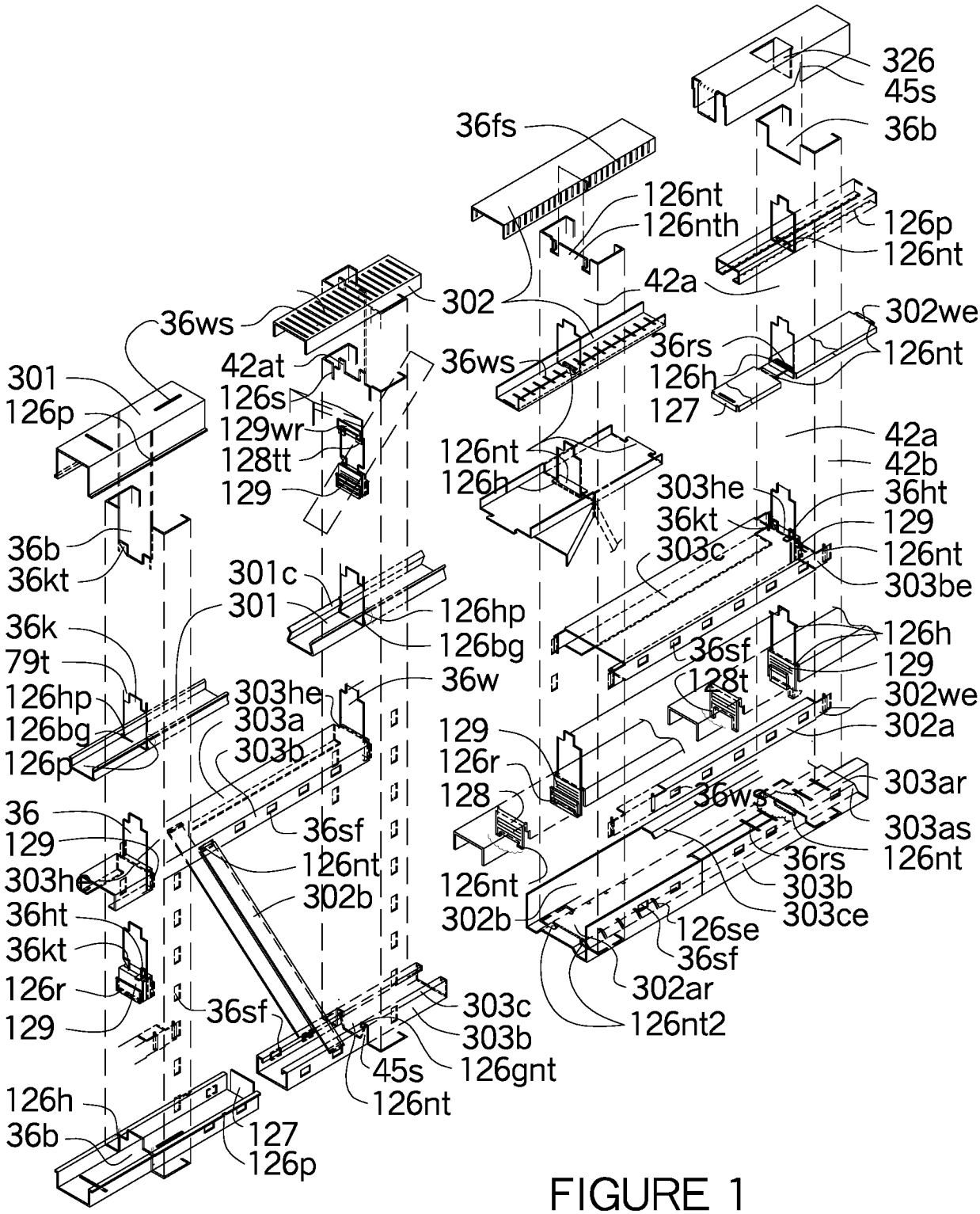

326
45s
36b
36fs
126nt
126nth
126p
126nt
42a
302
302we
36ws
36rs
126nt
301
126p
42at
126s
129wr
128tt
129
36ws
126h
127
42a
42b
126nt
126h
303he
36ht
36kt
129
303c
126nt
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36kt
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36b
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126p

FIGURE 1

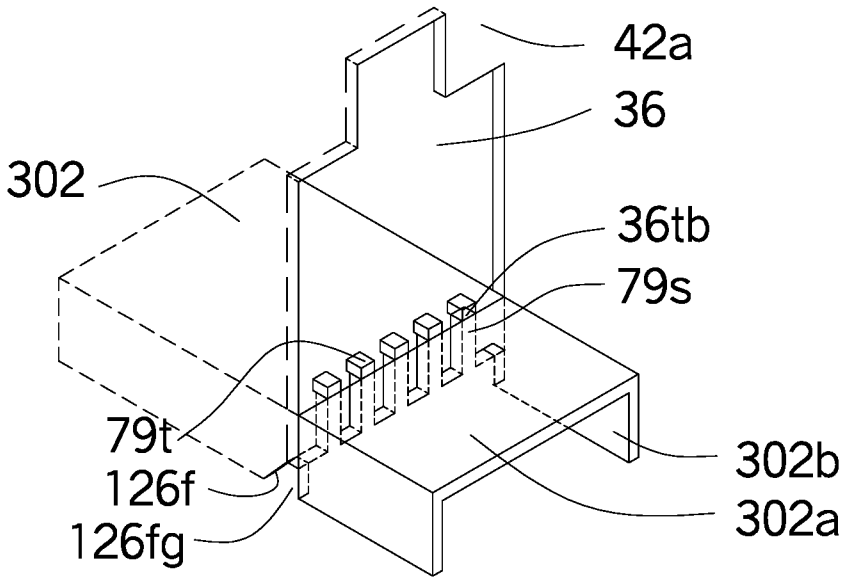


FIGURE 2

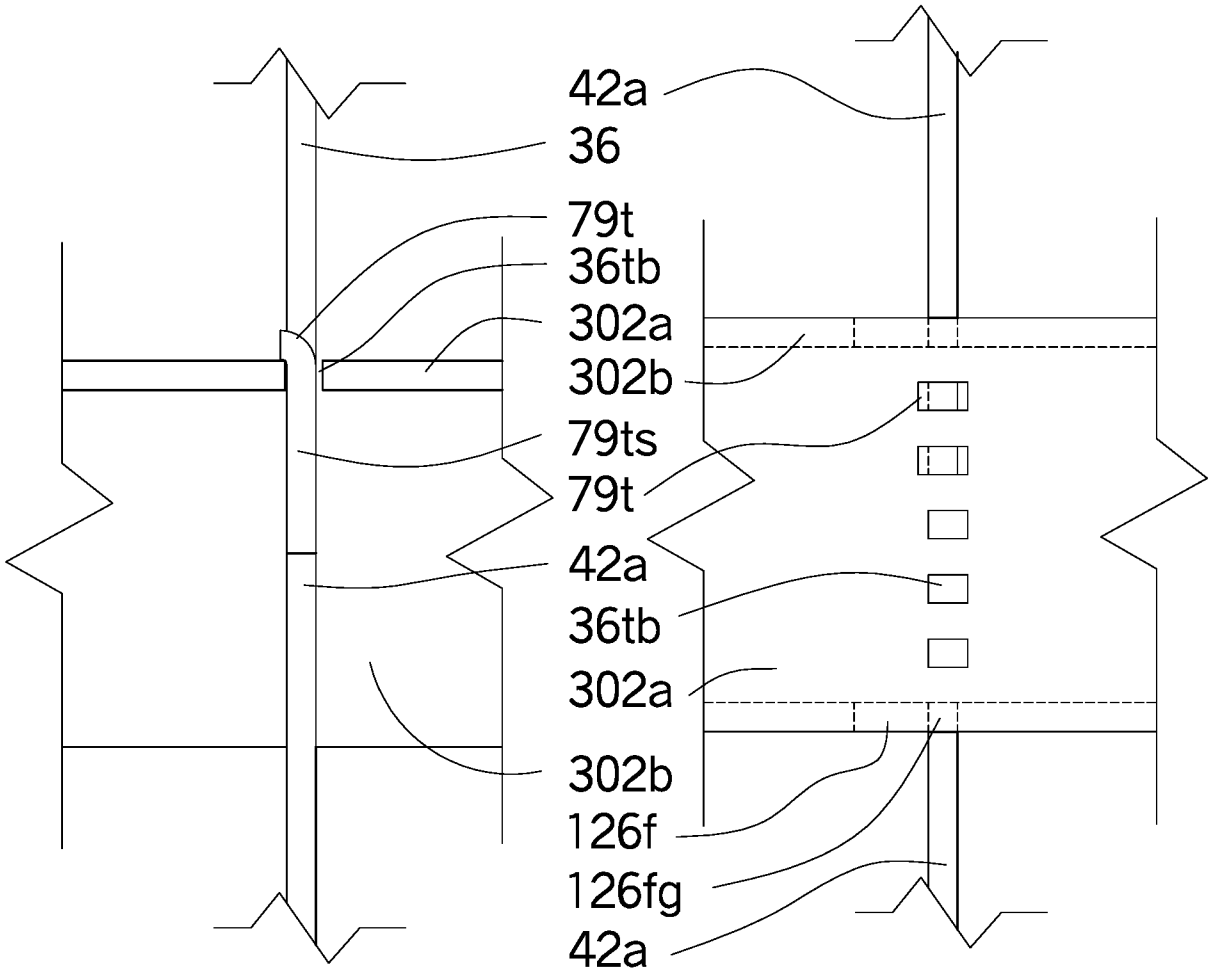


FIGURE 3

FIGURE 4

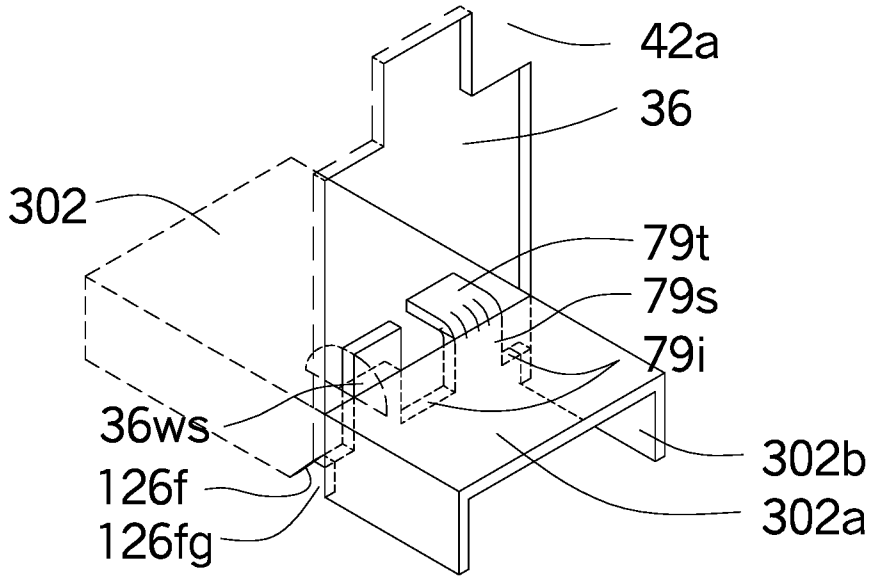


FIGURE 5

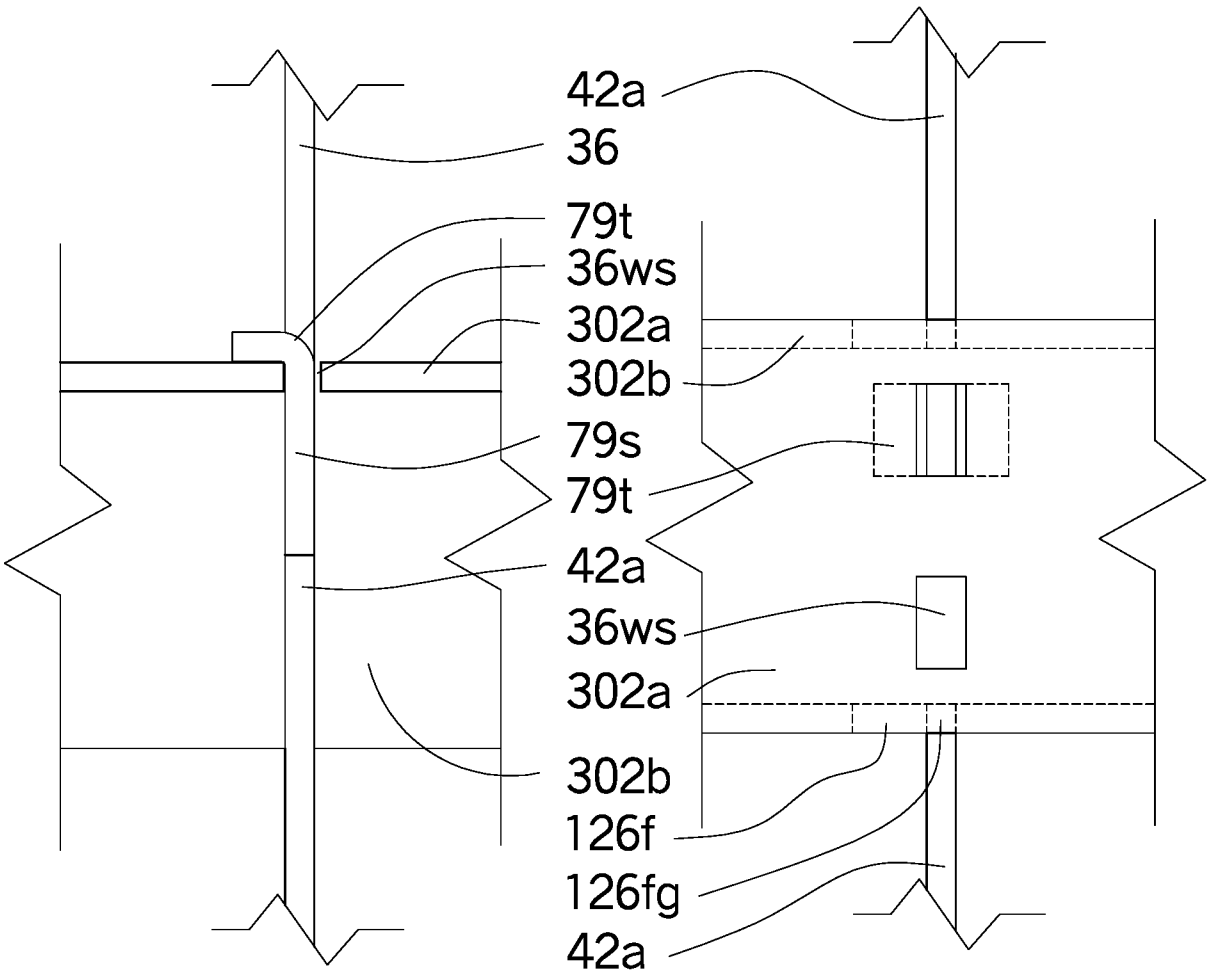


FIGURE 6

FIGURE 7

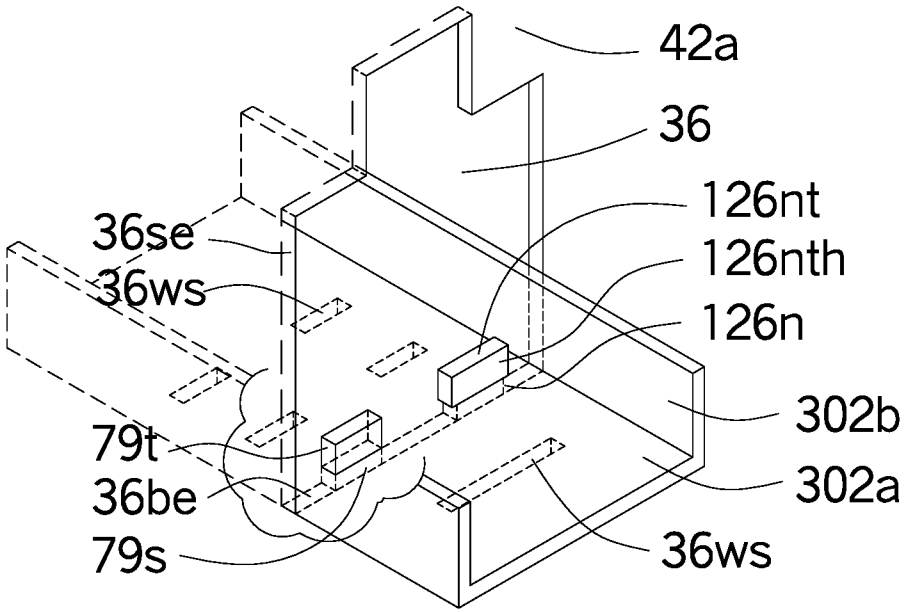


FIGURE 8

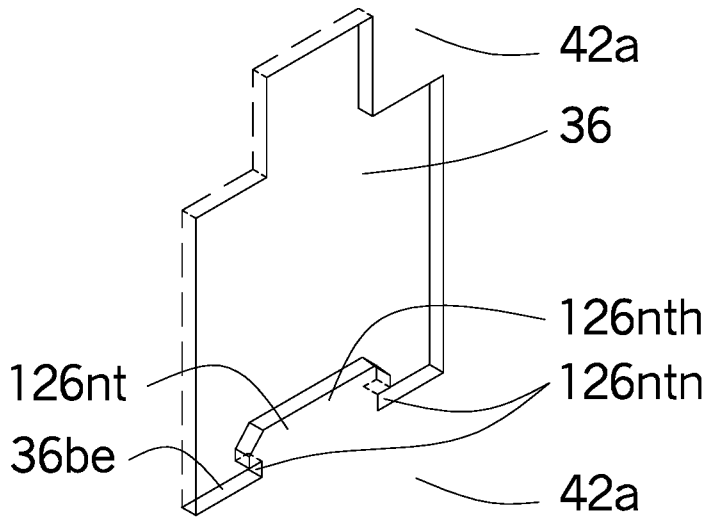


FIGURE 9

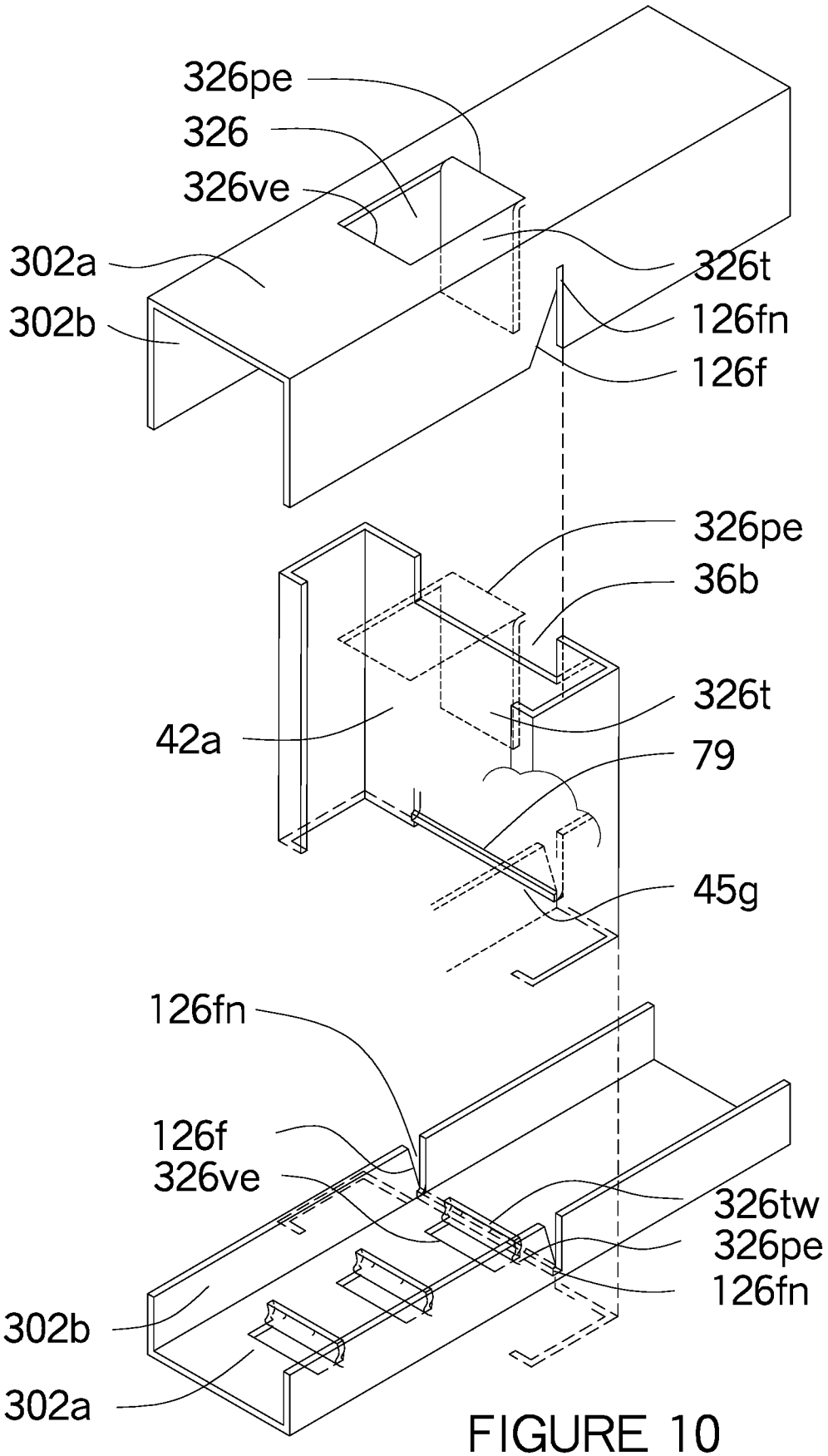

326pe
326
326ve
302a
302b
326t
126fn
126f
326pe
36b
326t
42a
79
45g
126fn
126f
326ve
326tw
326pe
126fn
302b
302a

FIGURE 10

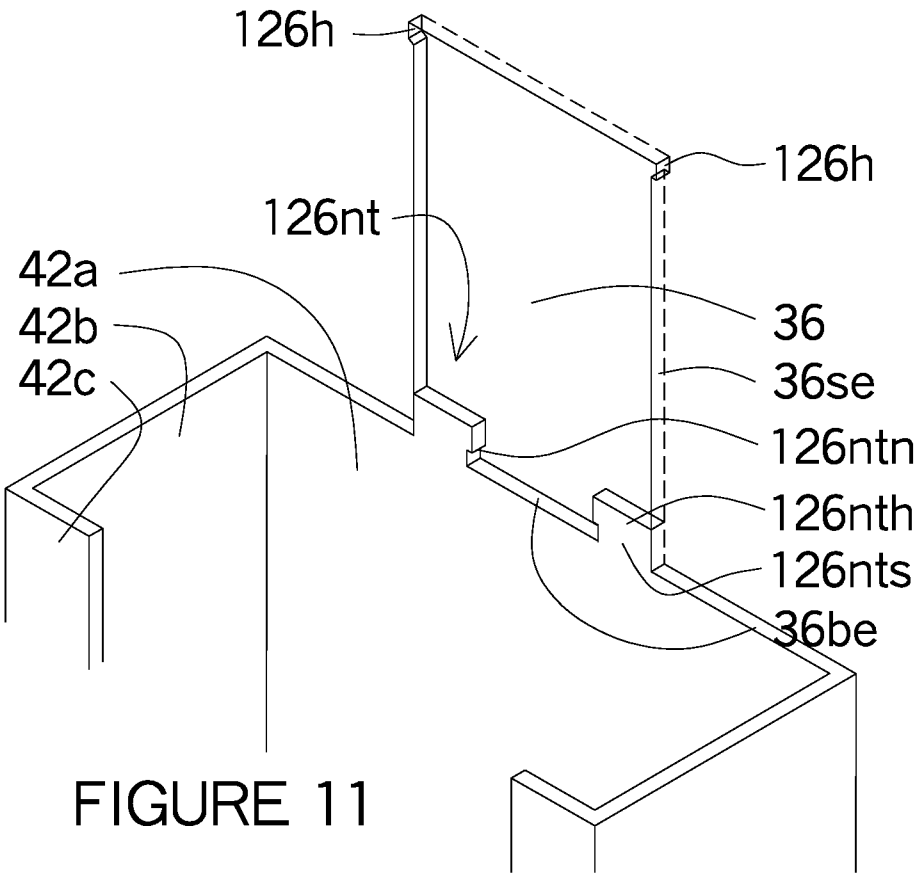


FIGURE 11

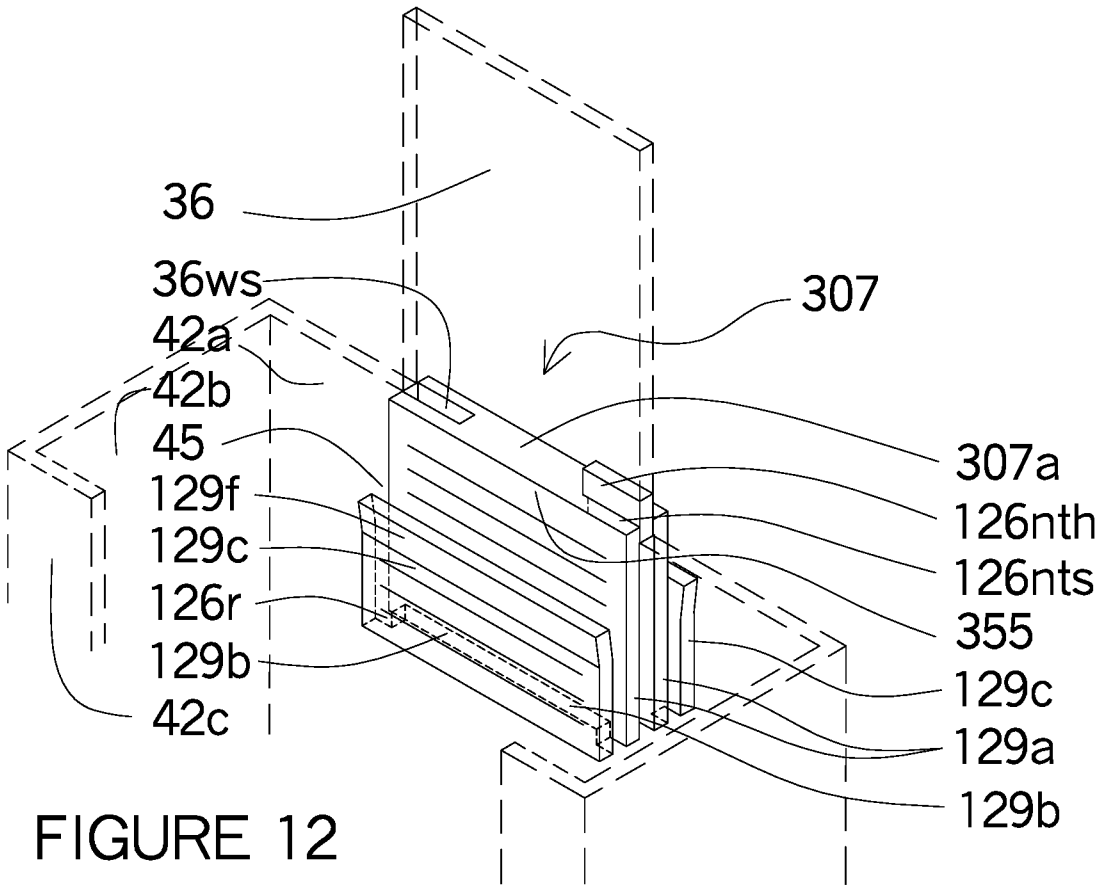


FIGURE 12

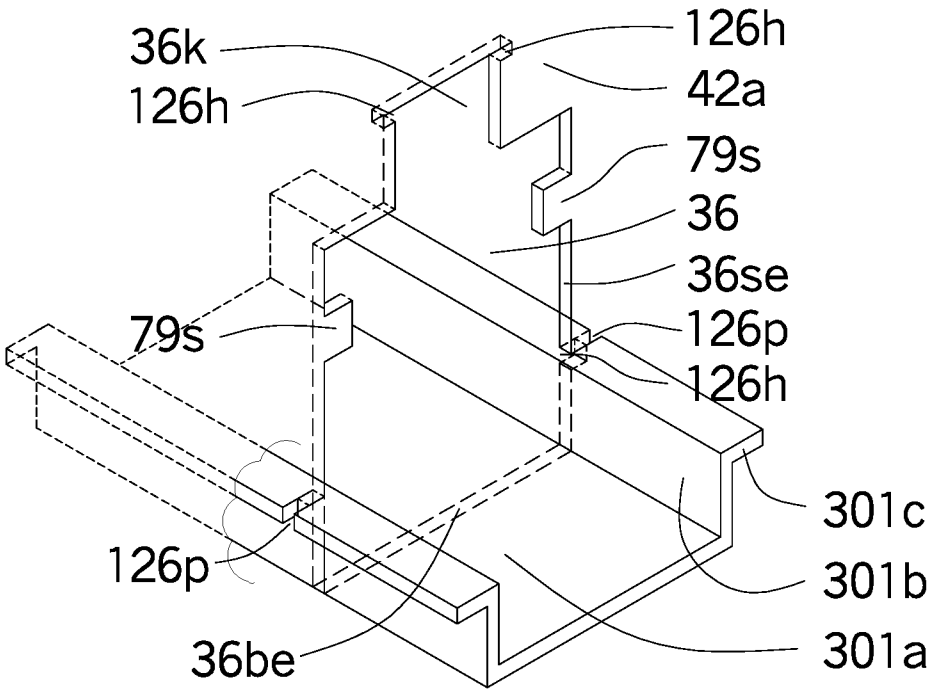


FIGURE 13

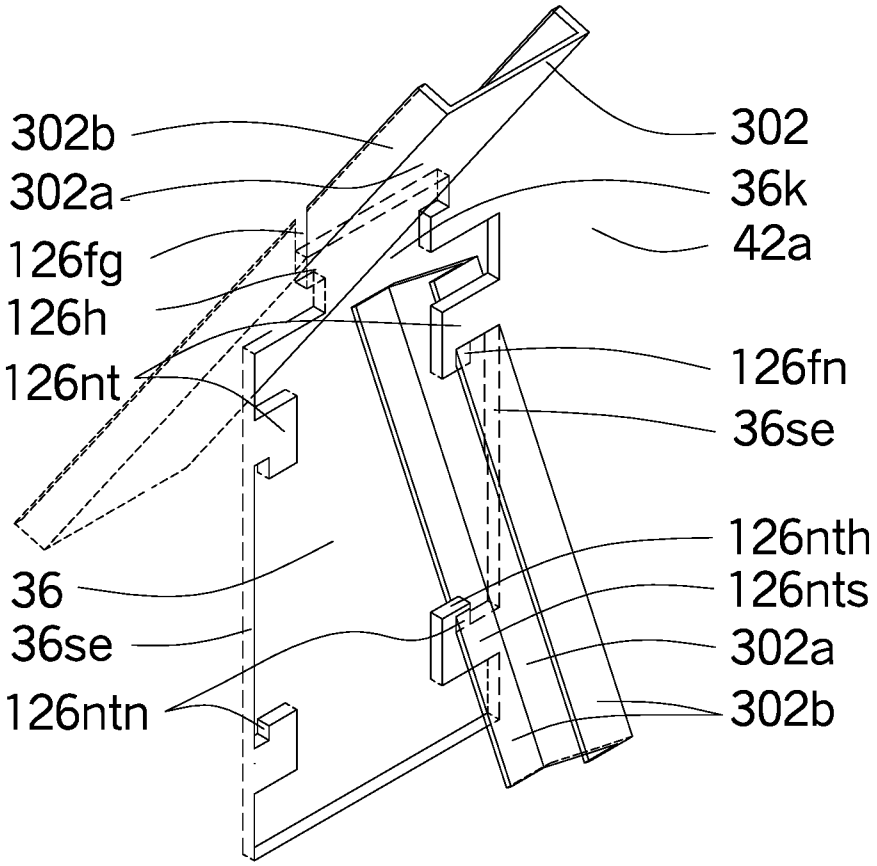


FIGURE 14

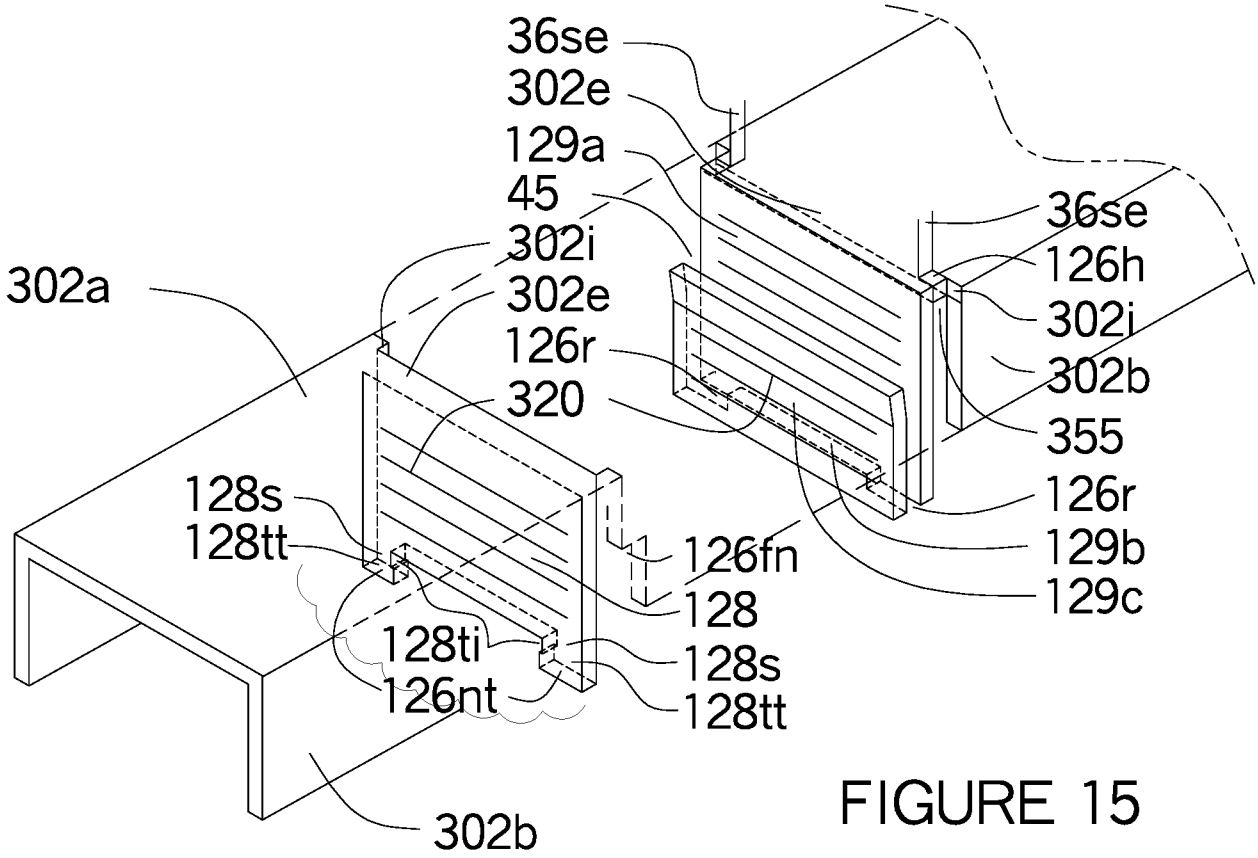


FIGURE 15

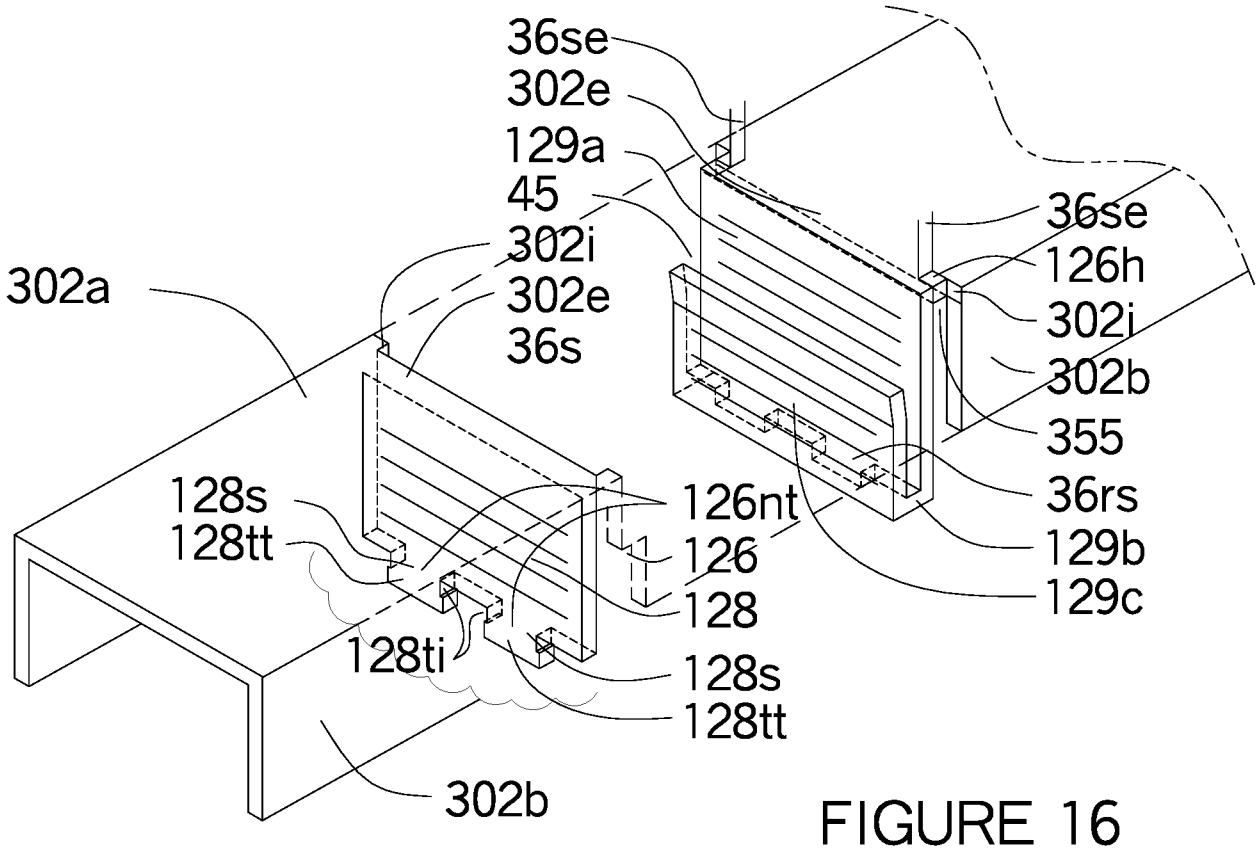


FIGURE 16

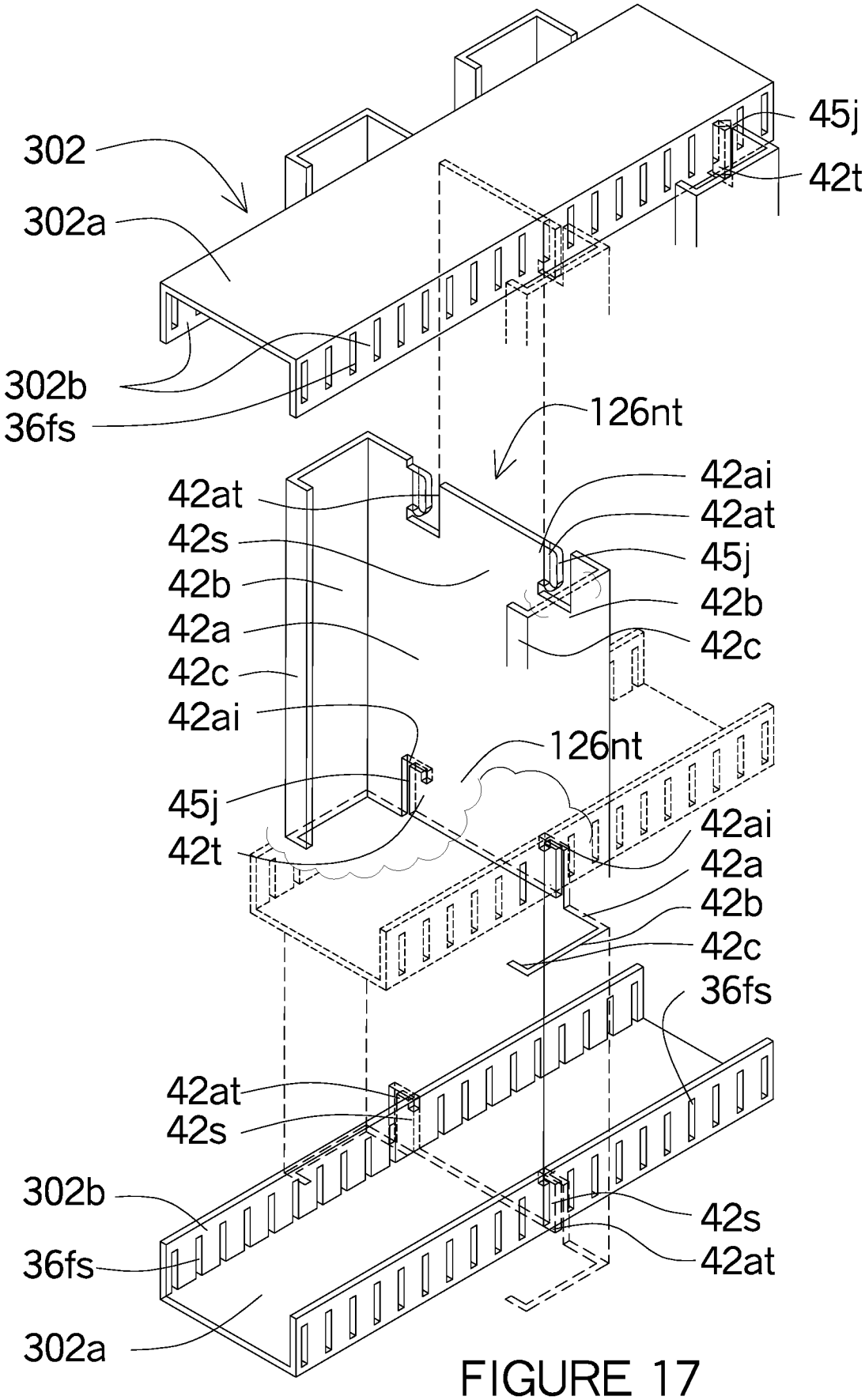

302
302a
302b
36fs
45j
42t
126nt
42at
42s
42b
42a
42c
42ai
45j
42t
126nt
42ai
42at
45j
42b
42c
42ai
42a
42b
42c
36fs
42at
42s
302b
36fs
302a
42s
42at

FIGURE 17

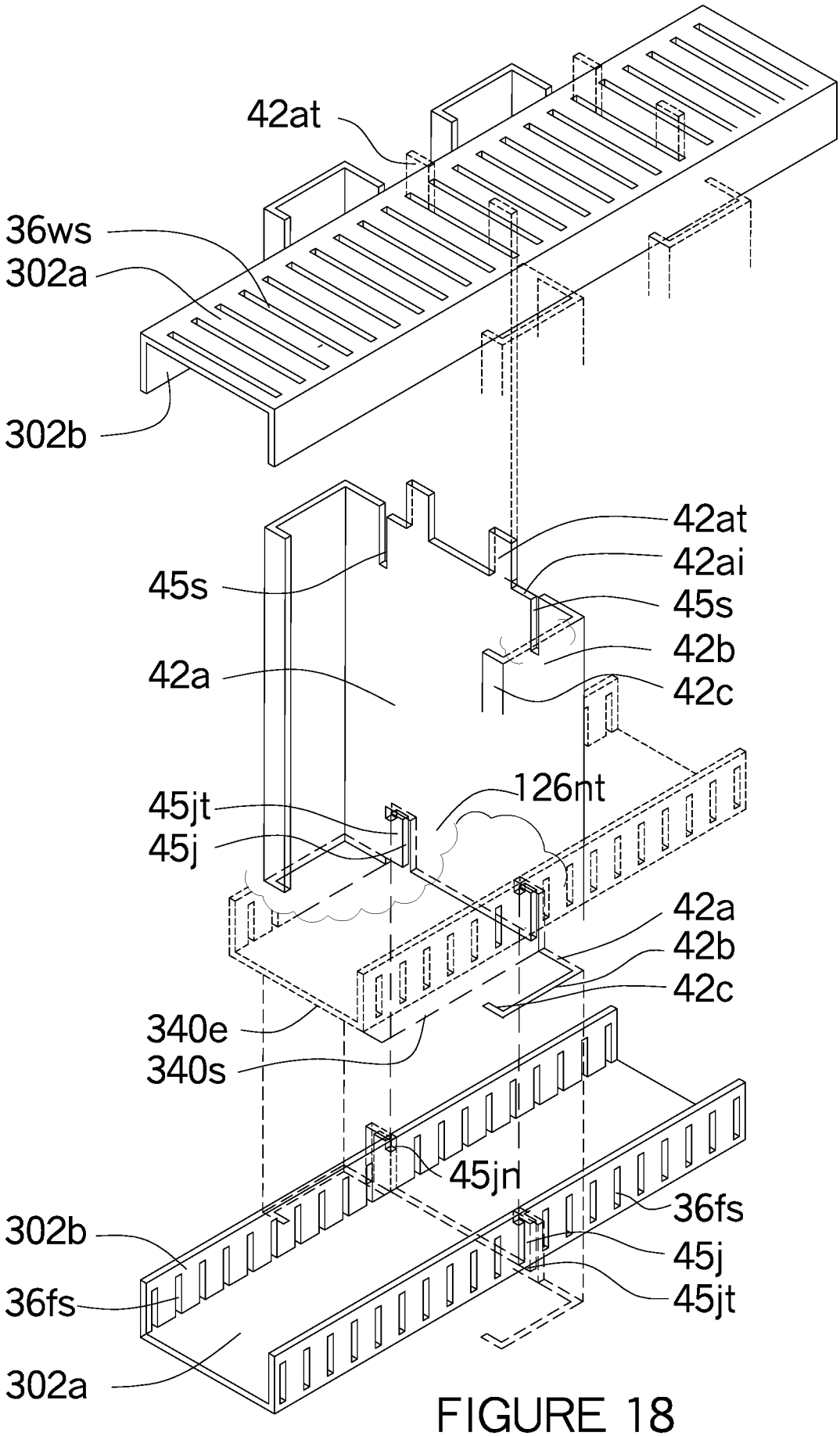

42at
36ws
302a
302b
42at
42ai
45s
45s
42b
42a
42c
126nt
45jt
45j
42a
42b
42c
340e
340s
45jn
36fs
302b
45j
36fs
45jt
302a

FIGURE 18

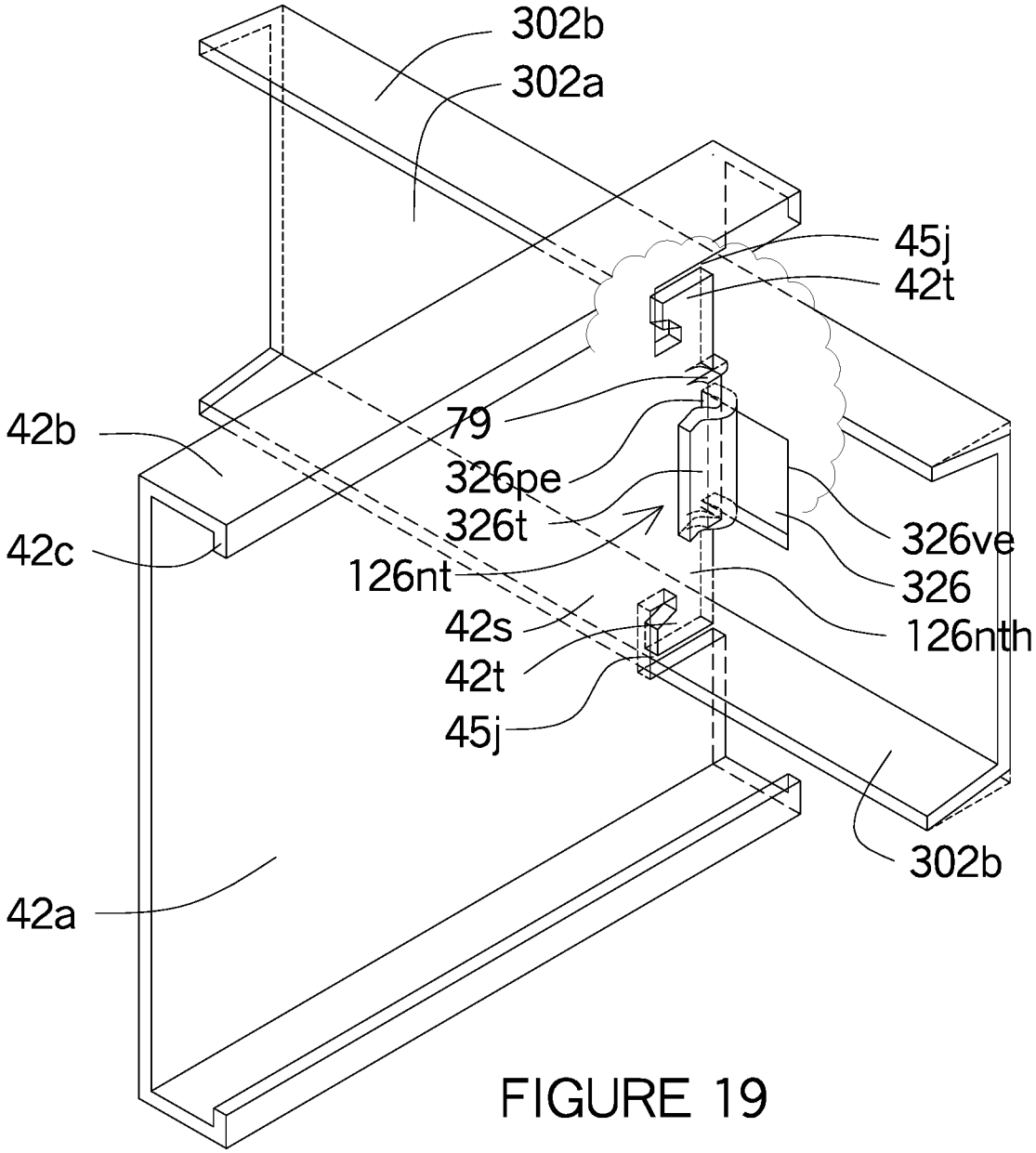

302b
302a
45j
42t
42b
79
326pe
326t
42c
126nt
326ve
326
126nth
42s
42t
45j
302b
42a

FIGURE 19

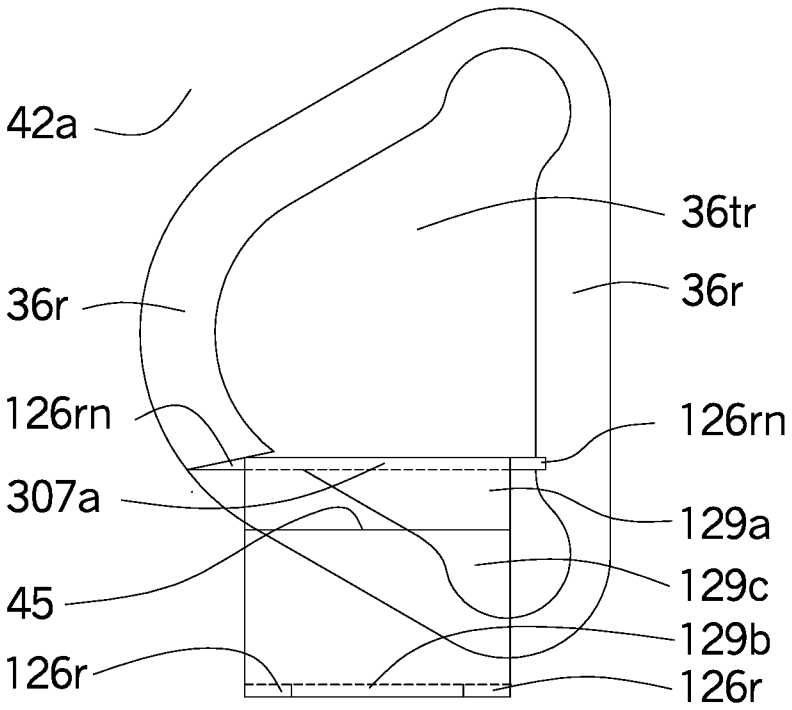


FIGURE 20

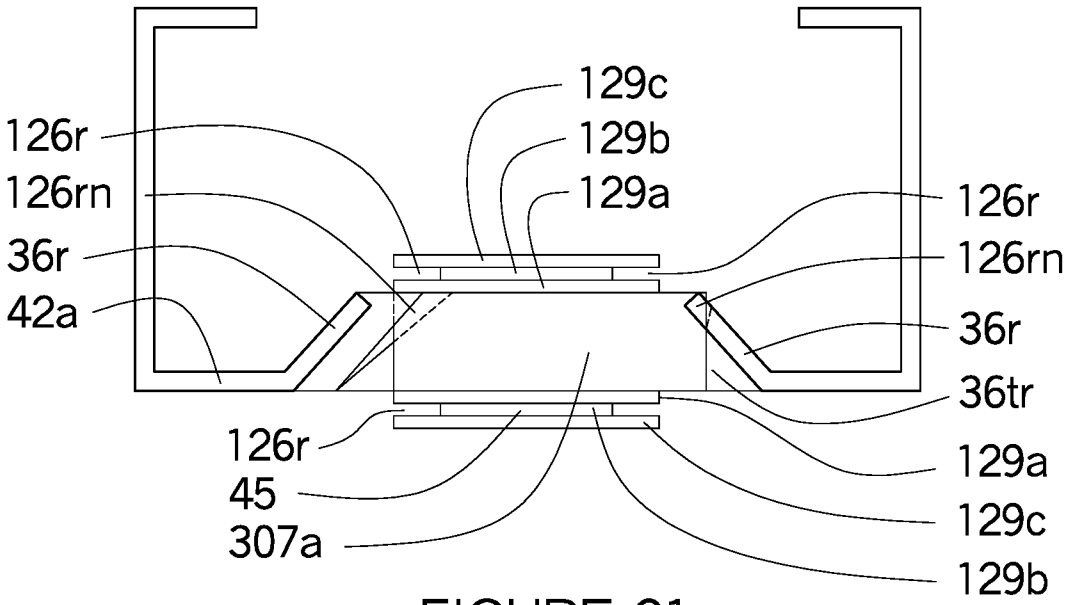


FIGURE 21

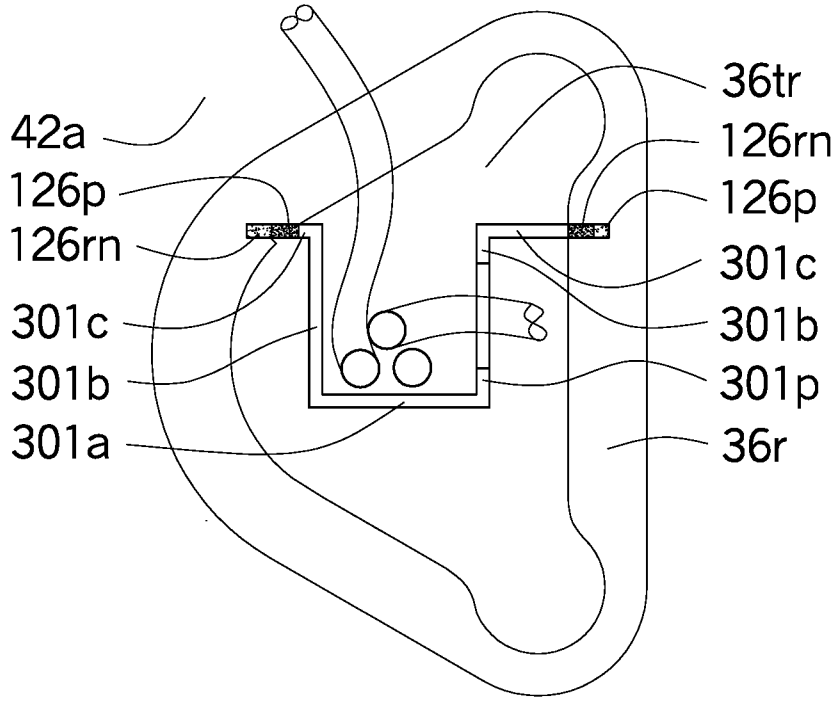


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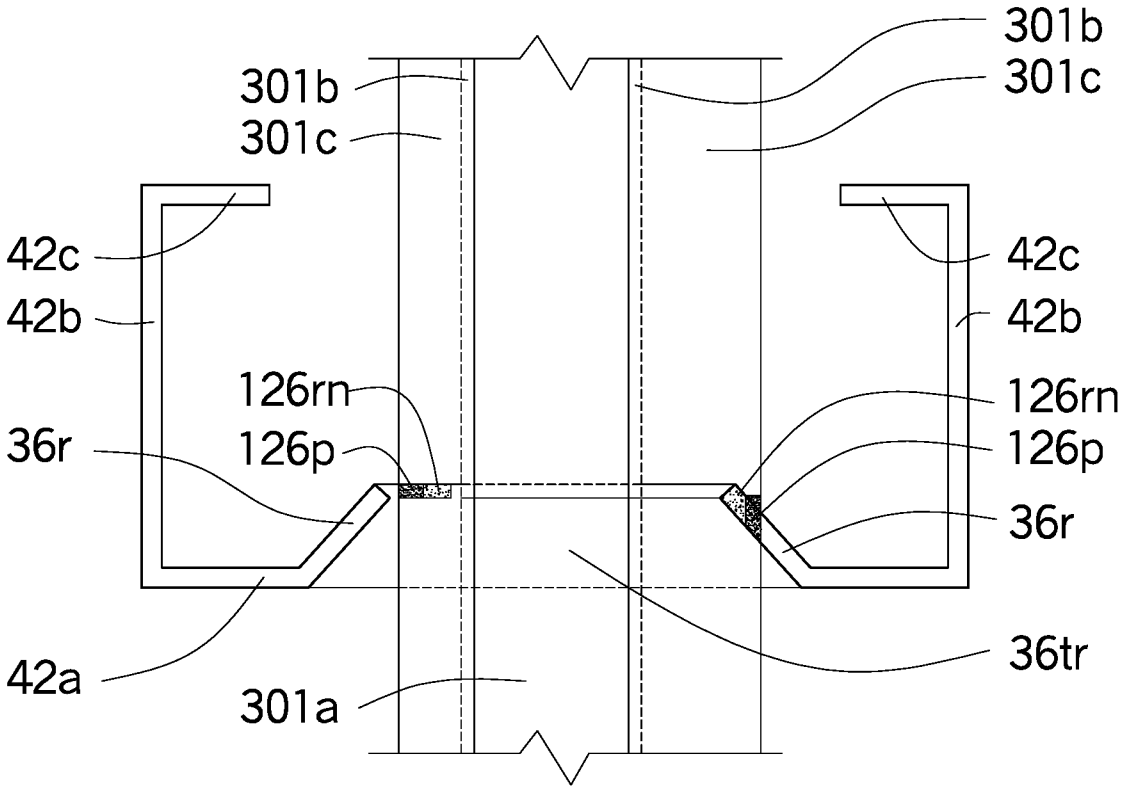


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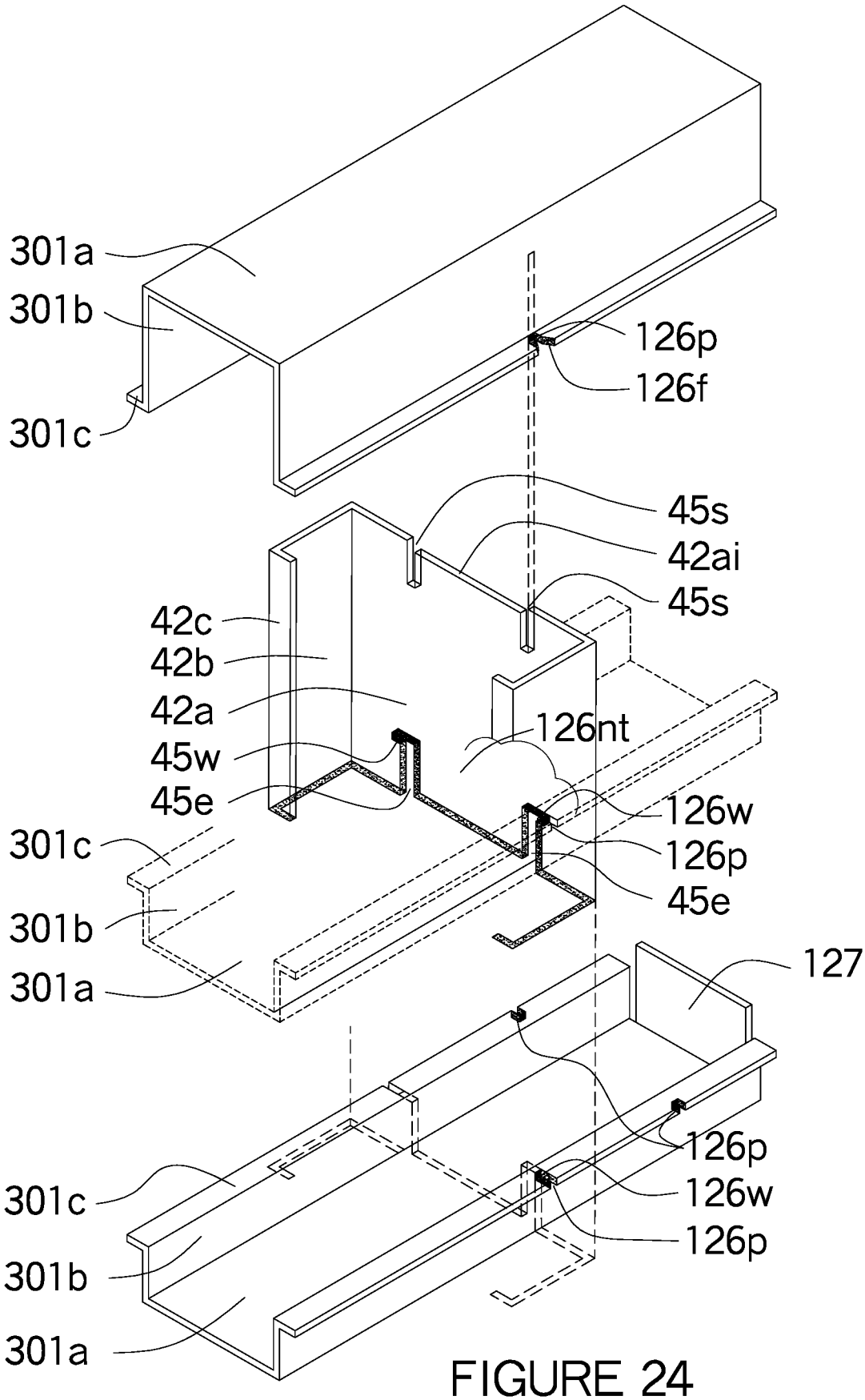

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301b
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126f
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45s
42c
42b
42a
45w
45e
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301c
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301a
127
126p
126w
126p
301c
301b
301a

FIGURE 24

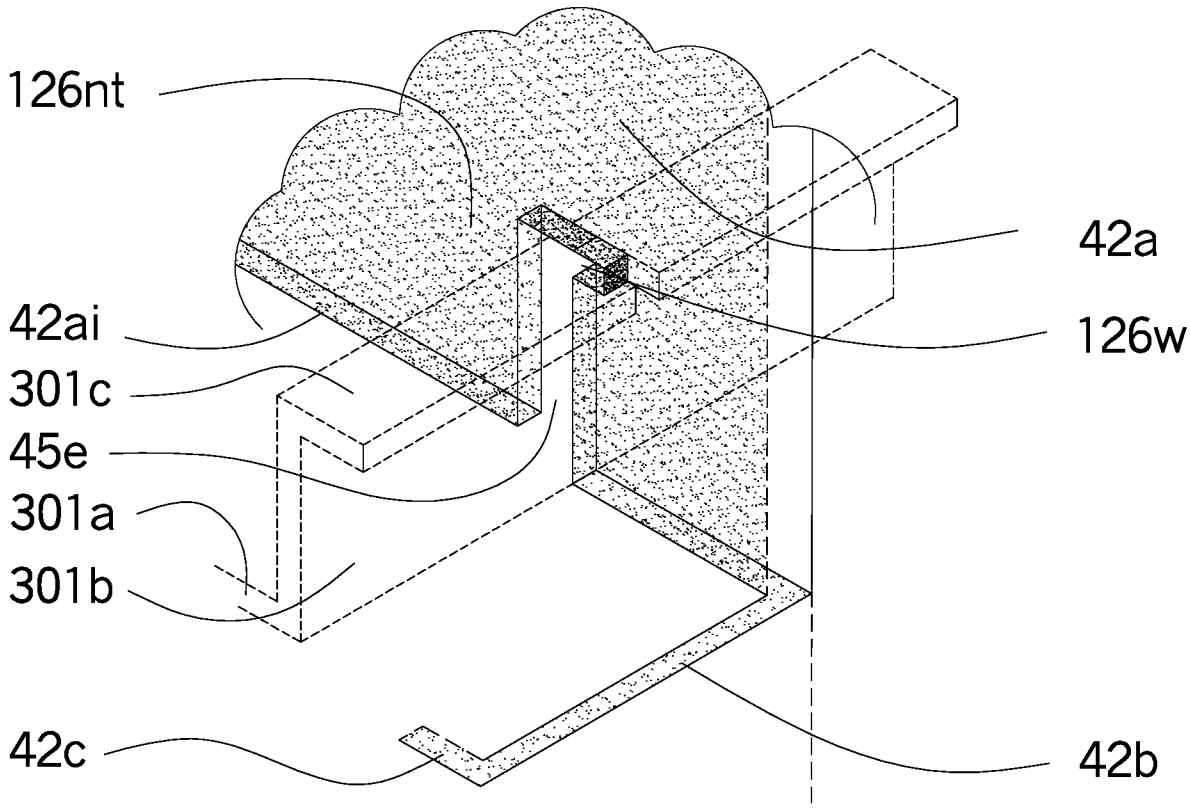


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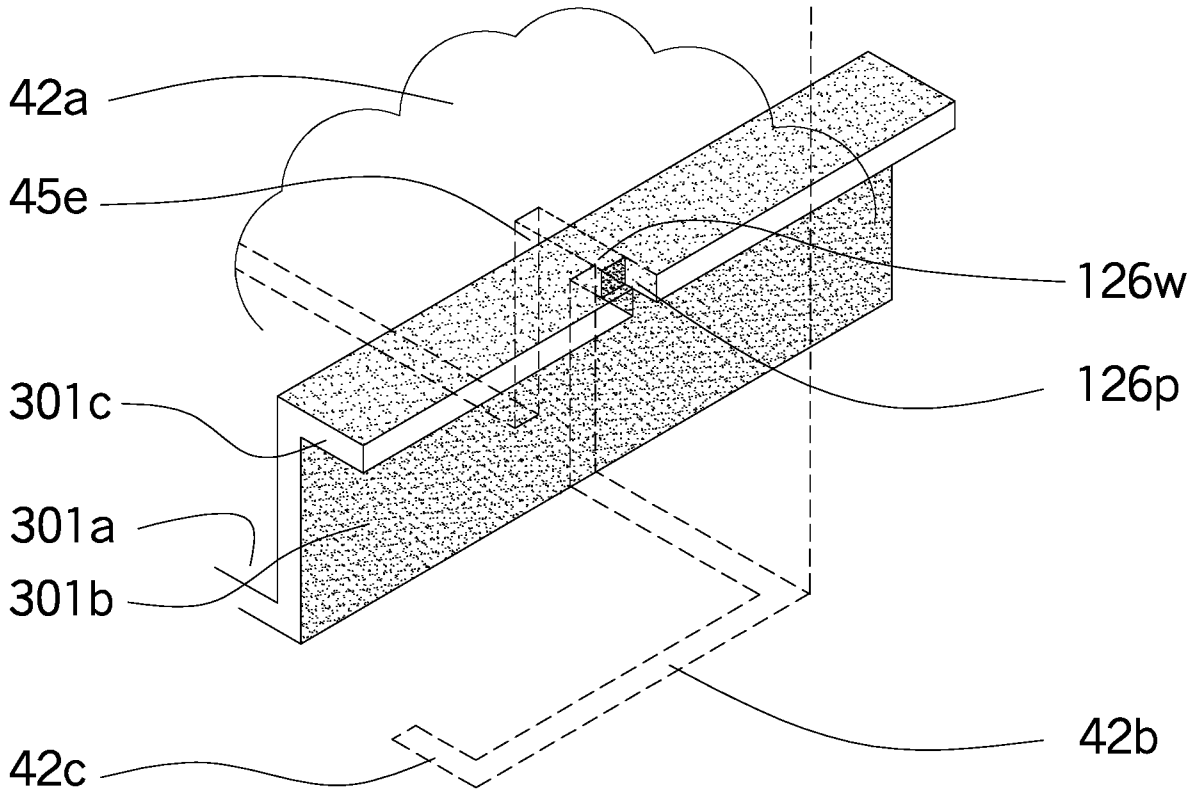


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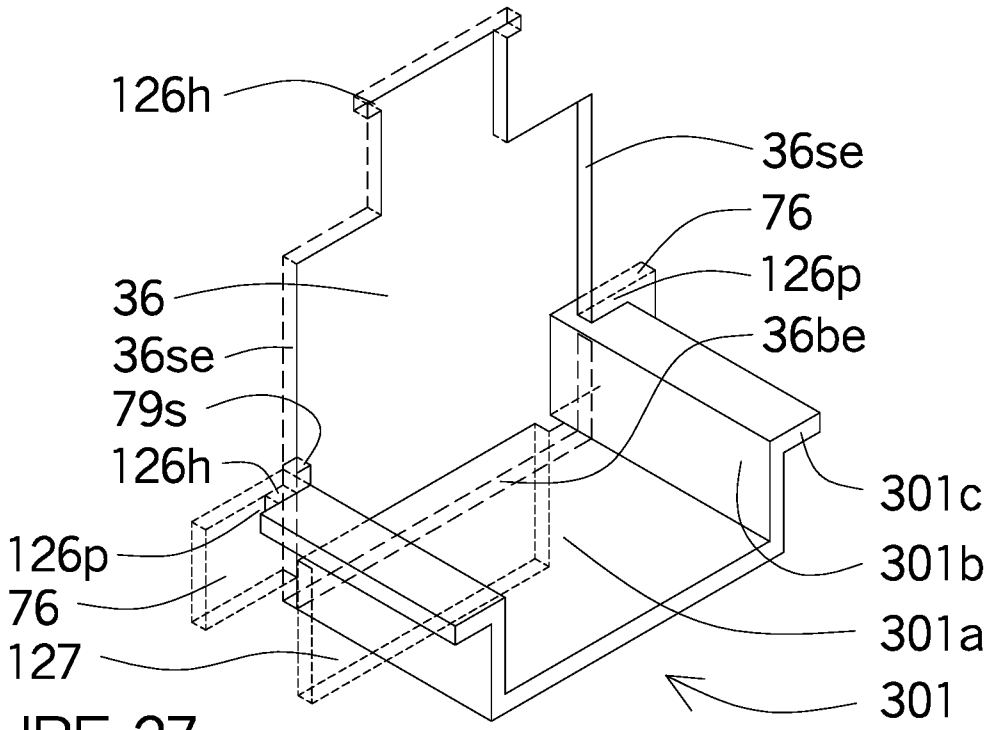


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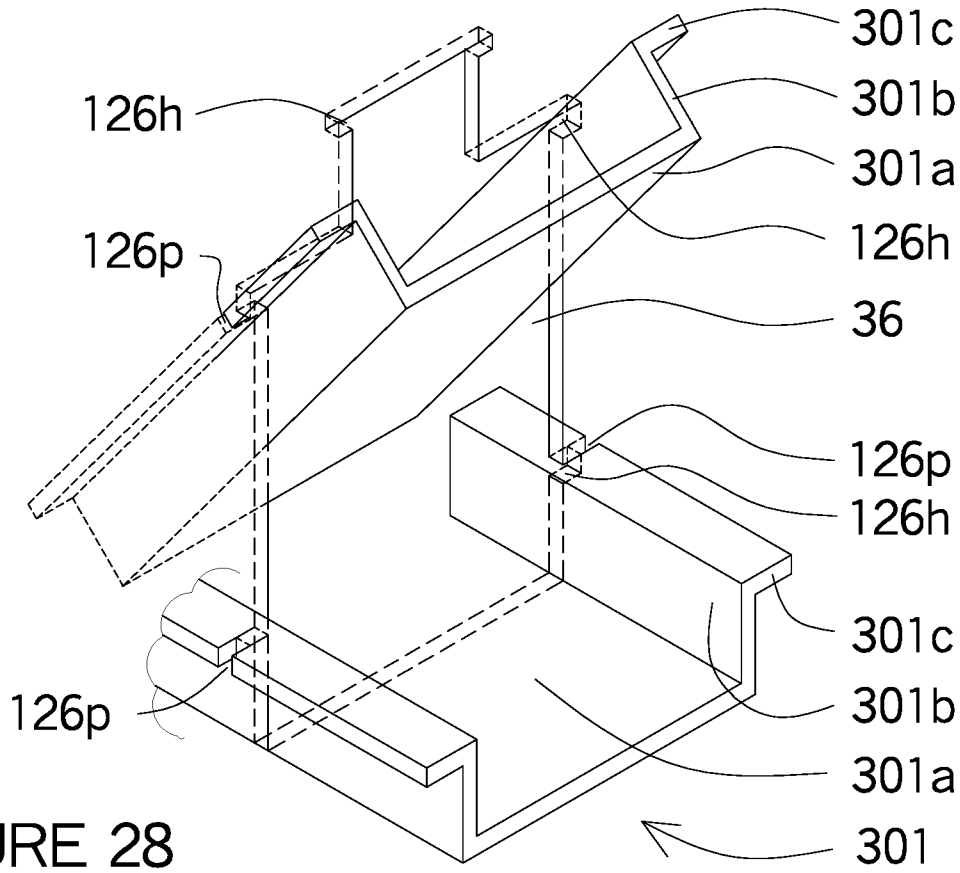


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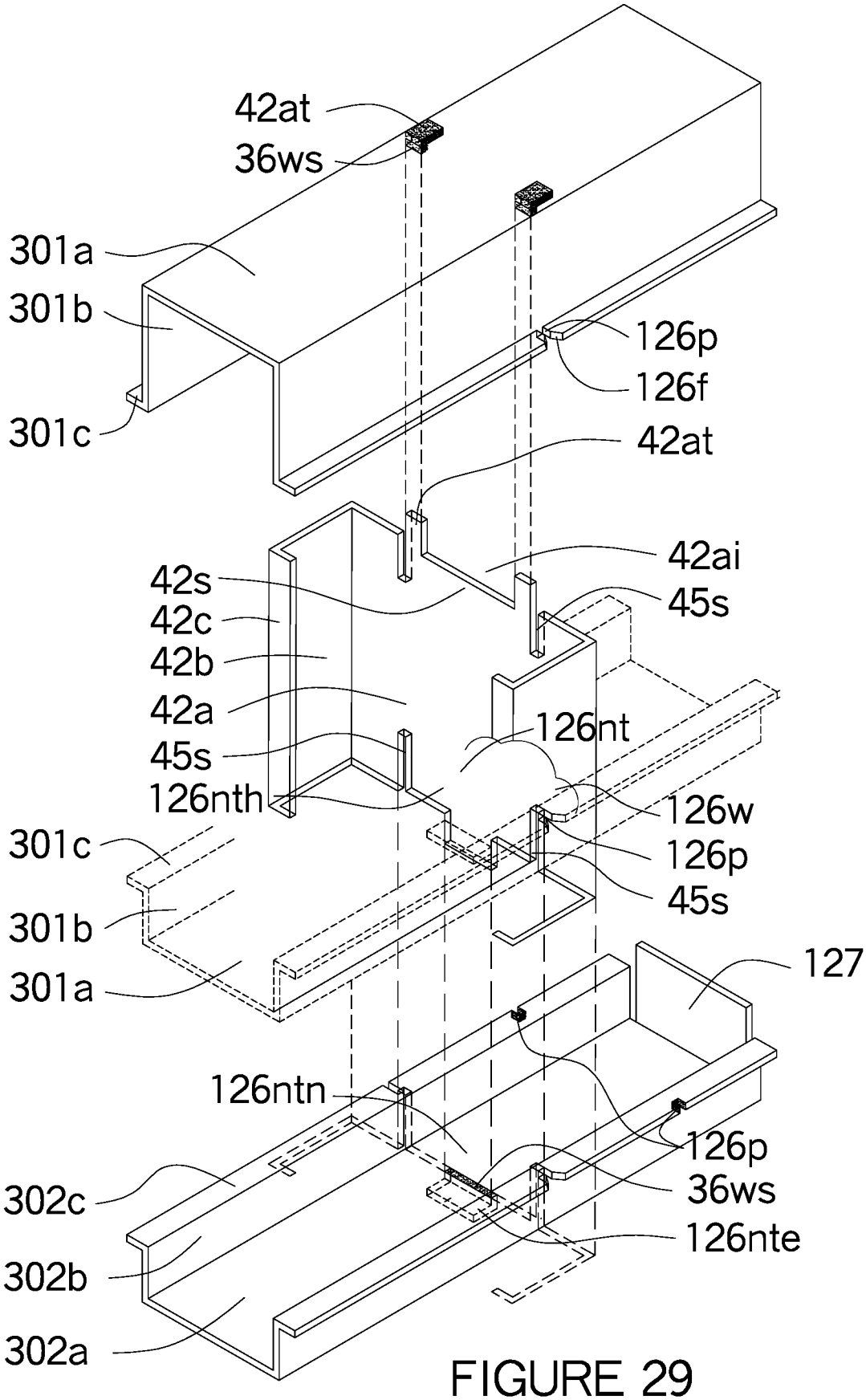

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42c
42b
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126nth
126nt
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126p
36ws
126nte
302c
302b
302a

FIGURE 29

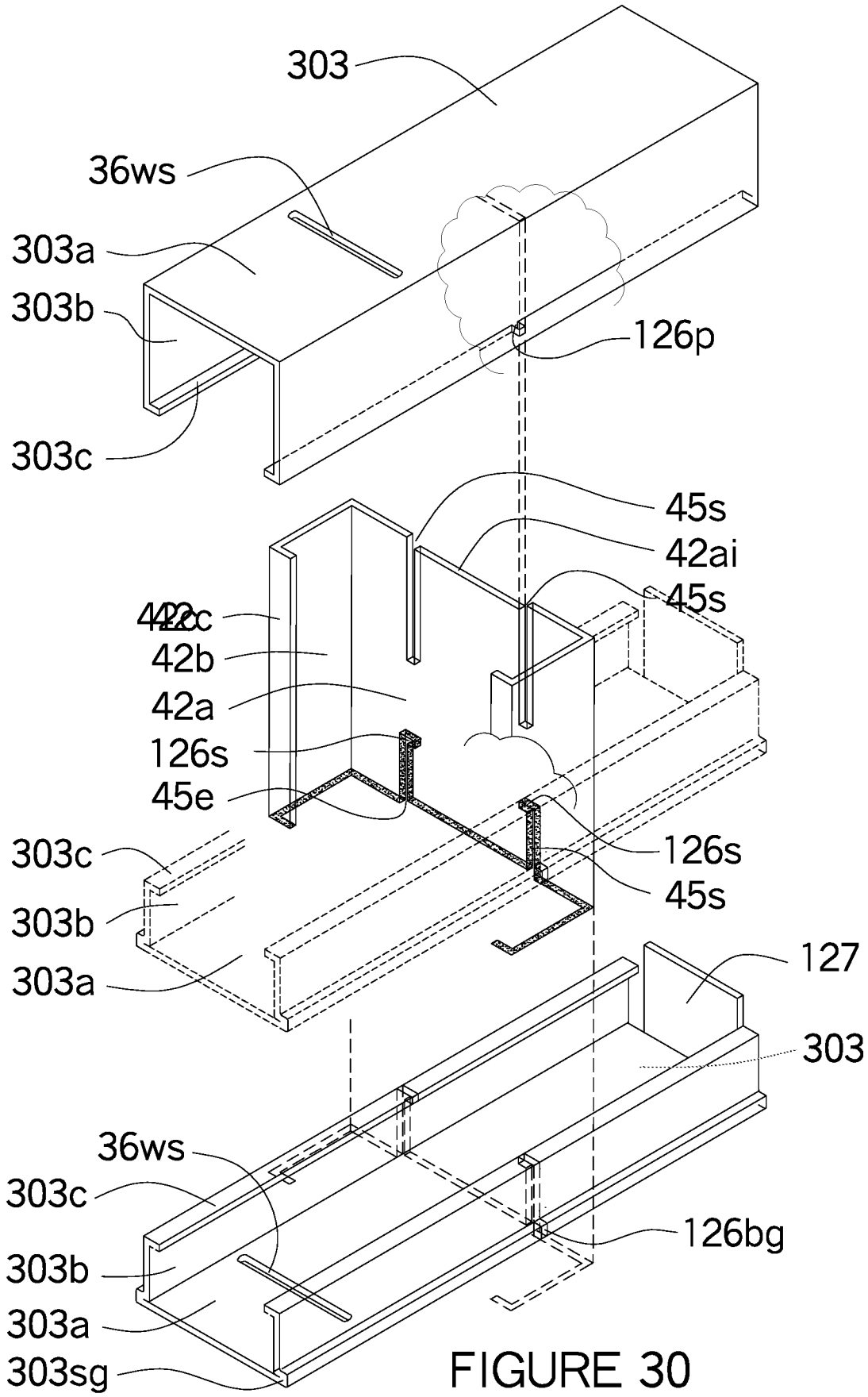

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36ws
303c
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303b
303a
303sg

FIGURE 30

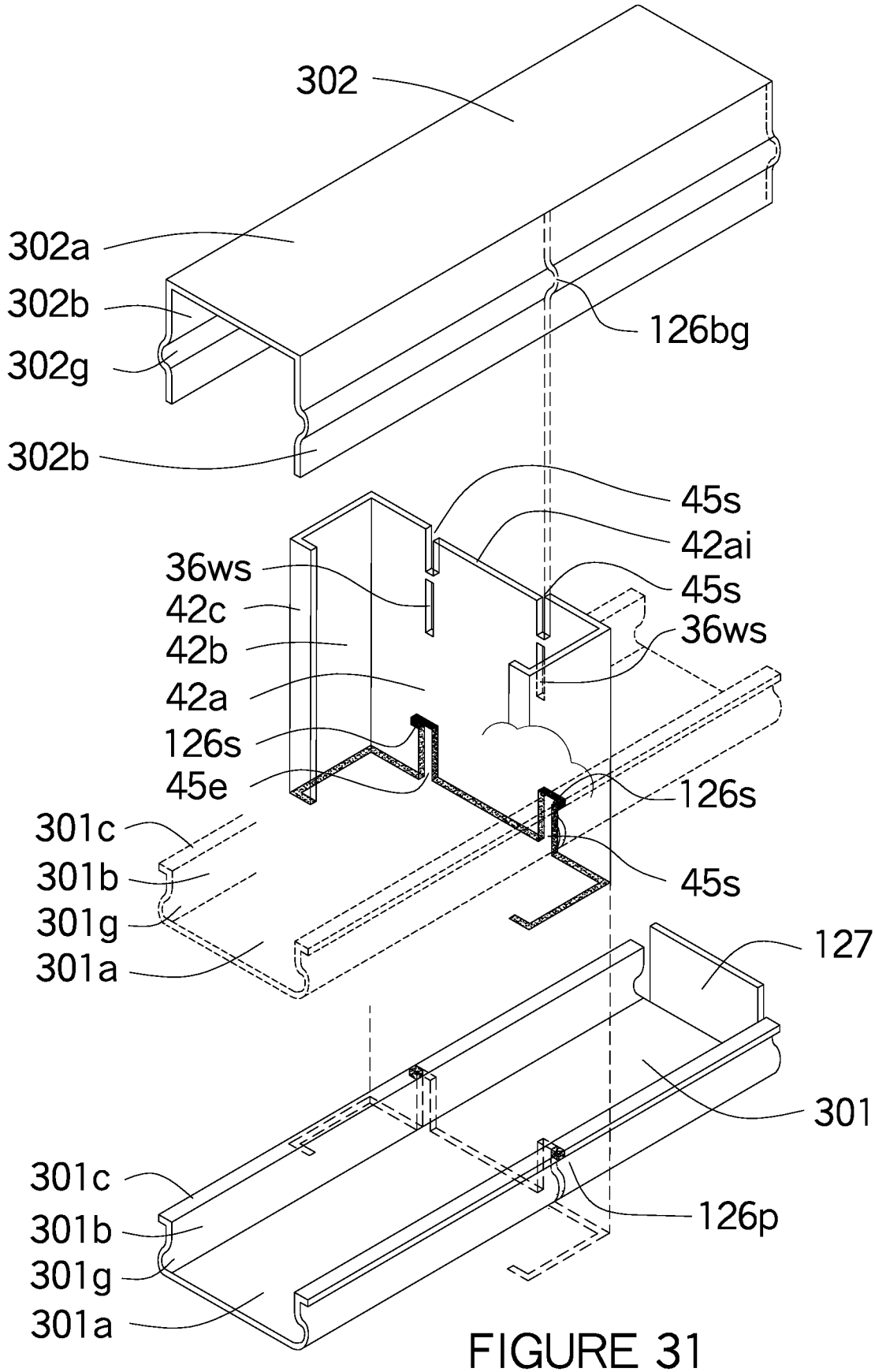

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42ai
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36ws
42c
42b
42a
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301g
301a
126p

FIGURE 31

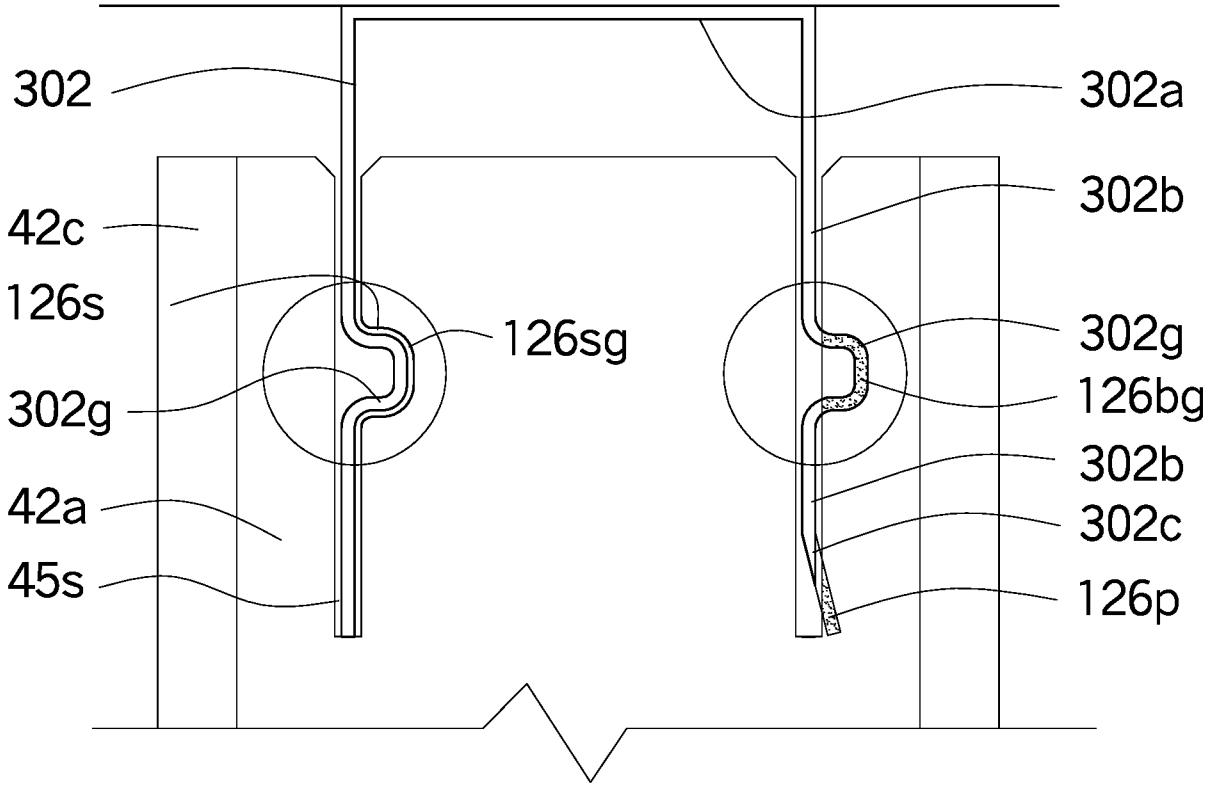


FIGURE 32

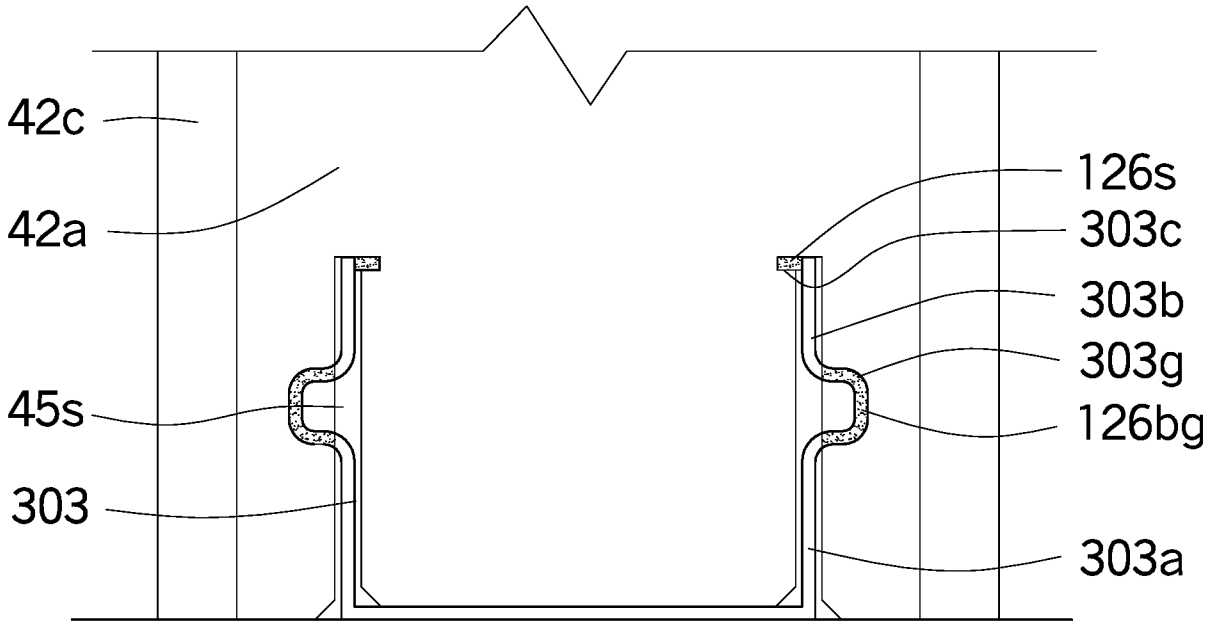


FIGURE 33

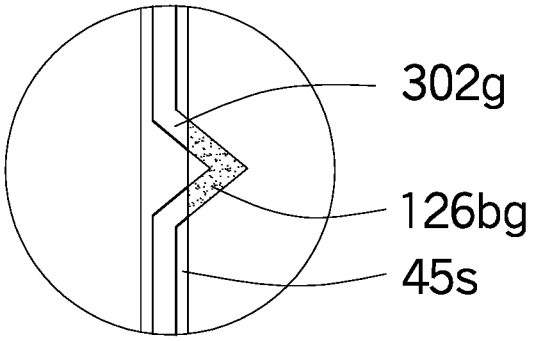


FIGURE 34

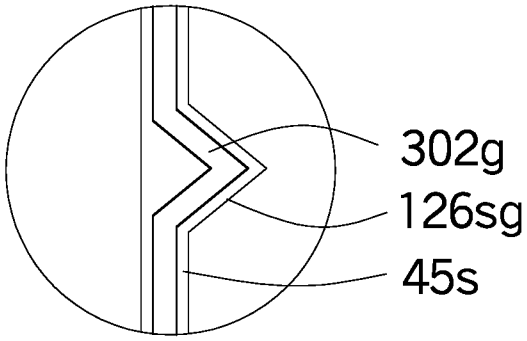


FIGURE 35

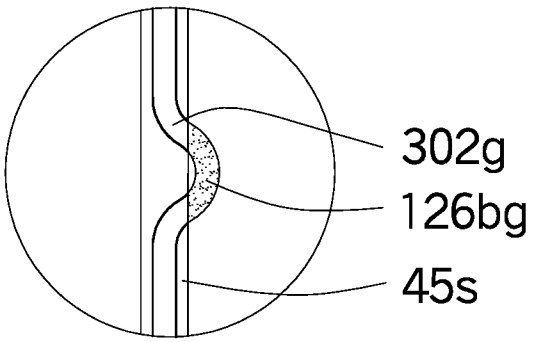


FIGURE 36

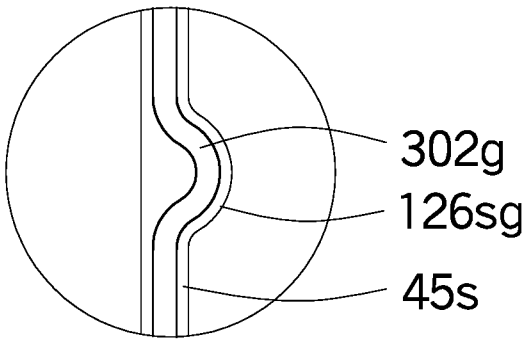


FIGURE 37

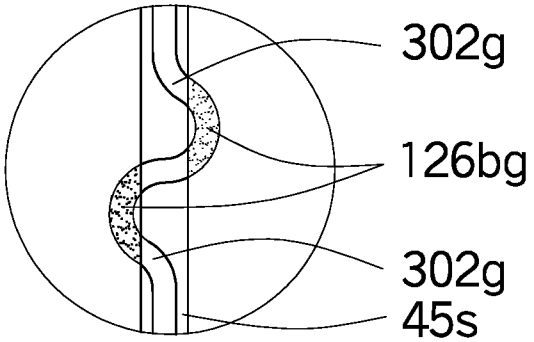


FIGURE 38

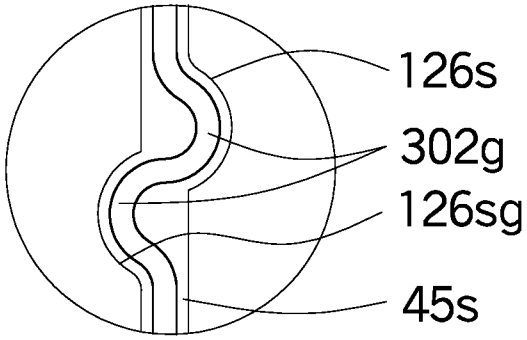


FIGURE 39

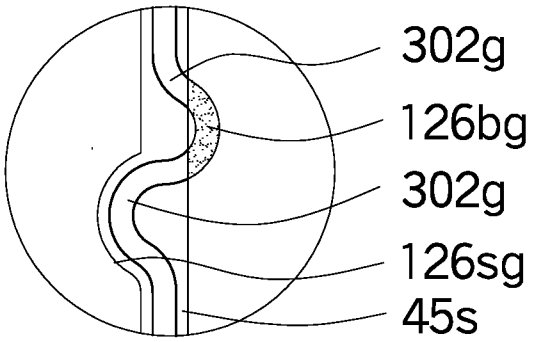


FIGURE 40

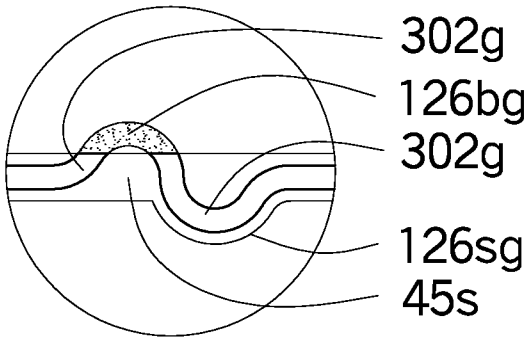


FIGURE 41

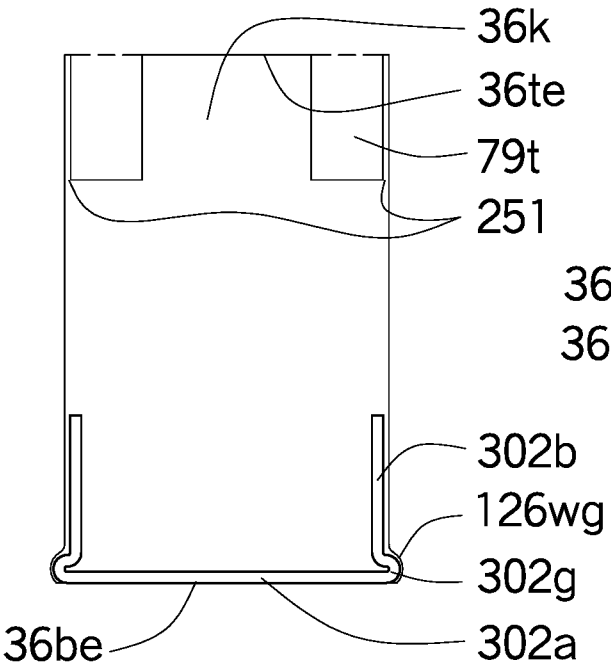


FIGURE 42

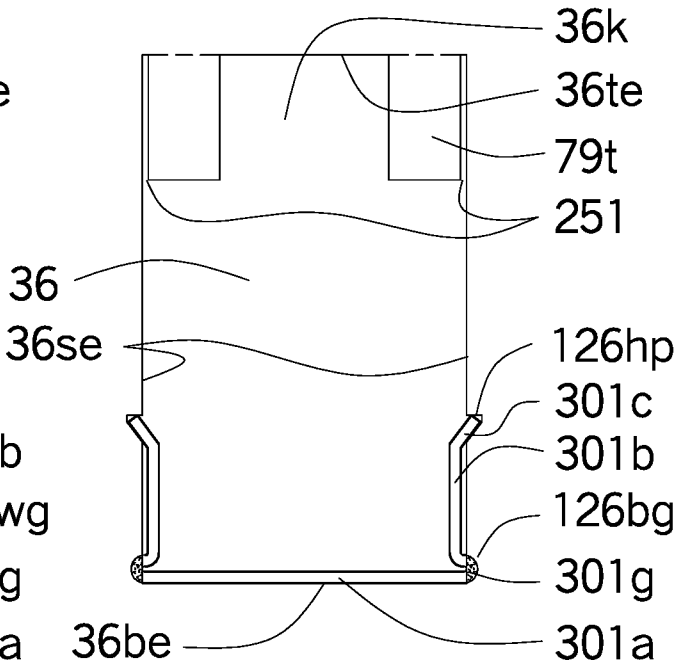


FIGURE 43

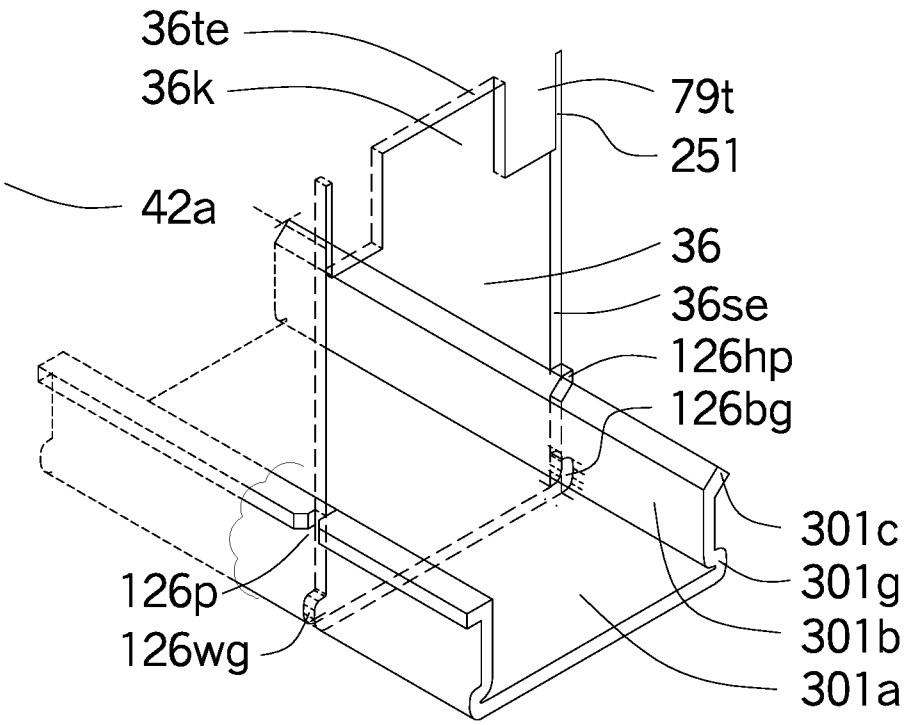


FIGURE 44

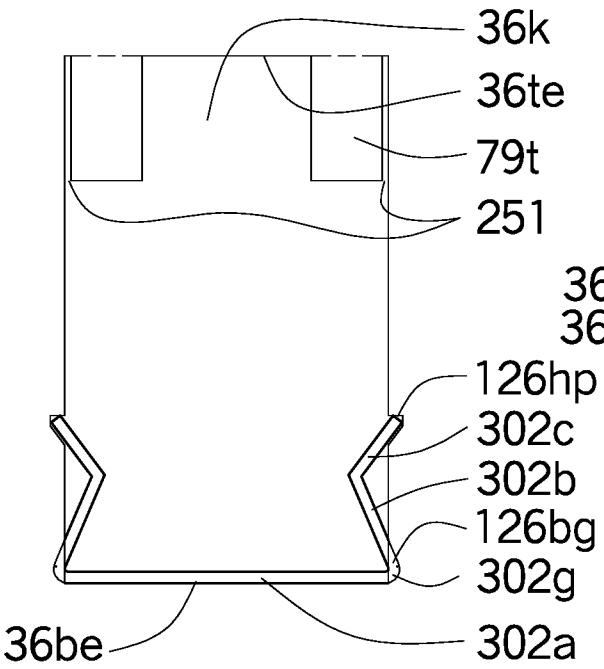


FIGURE 45

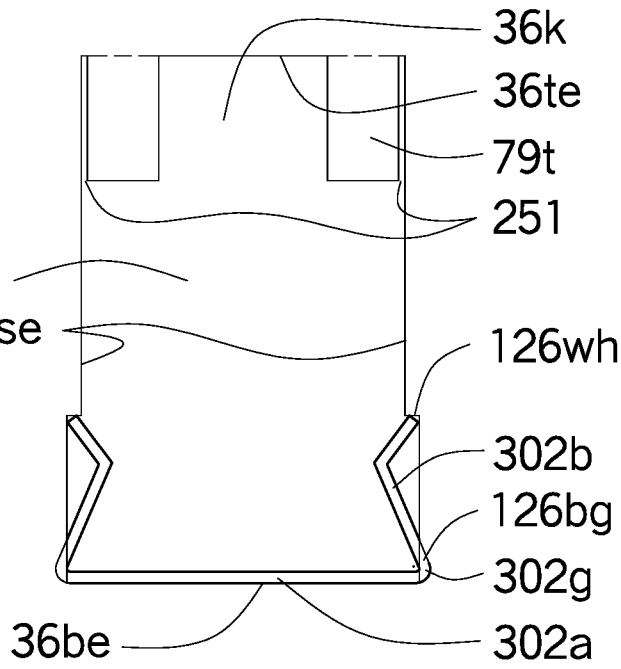


FIGURE 46

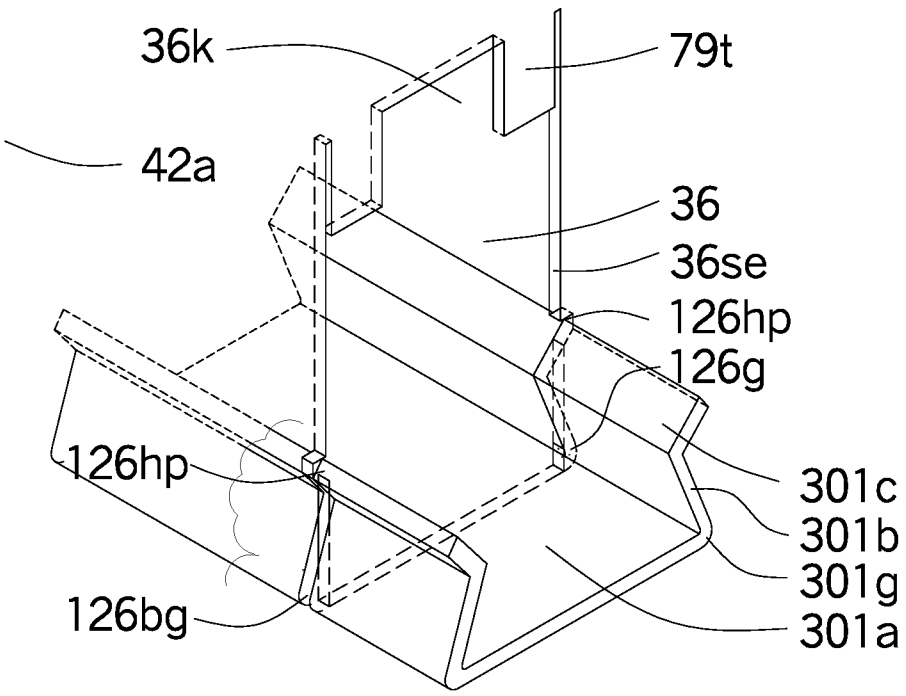


FIGURE 47

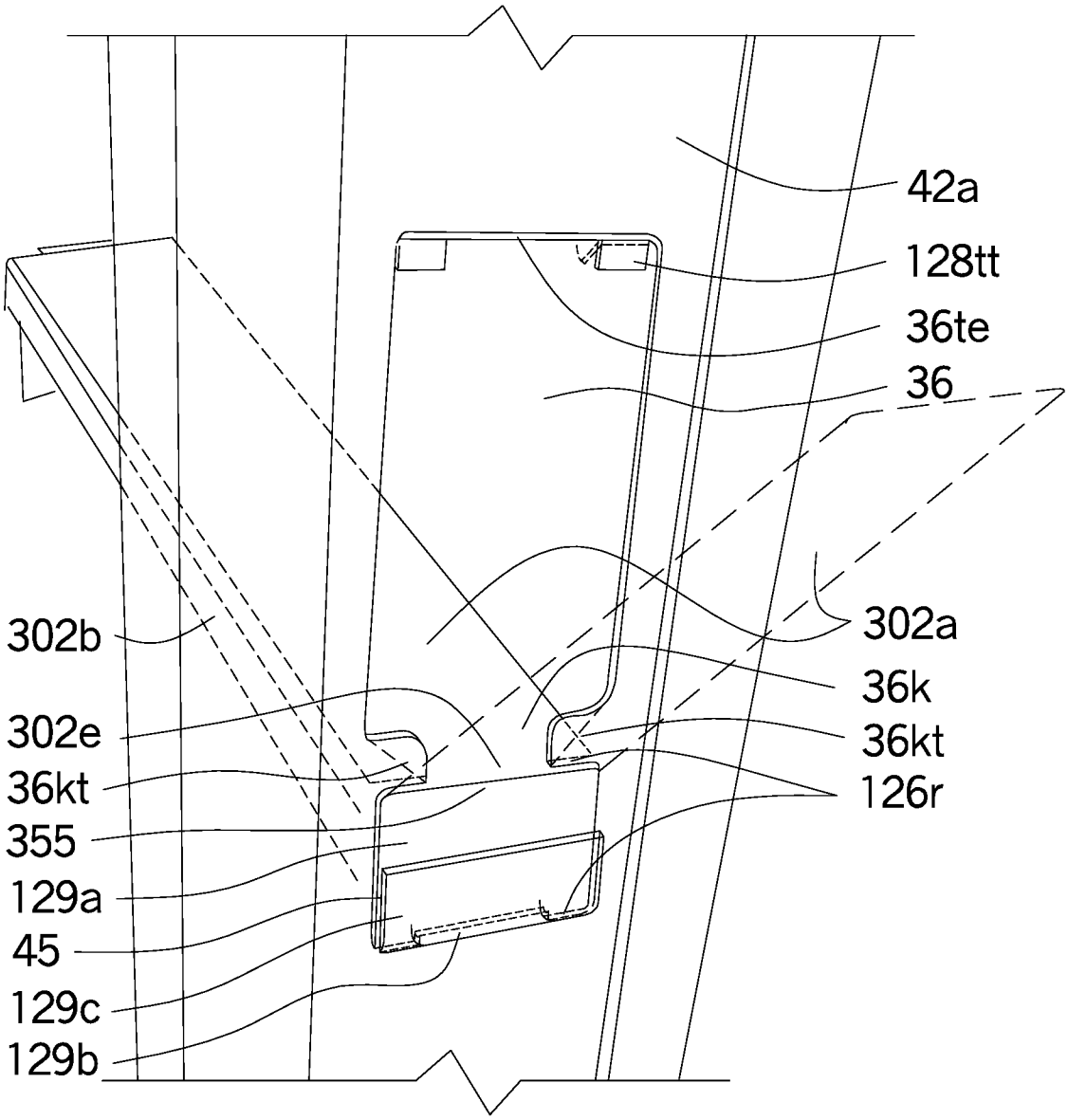

42a
128tt
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302b
302e
36kt
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129a
45
129c
129b
302a
36k
36kt
126r

FIGURE 48

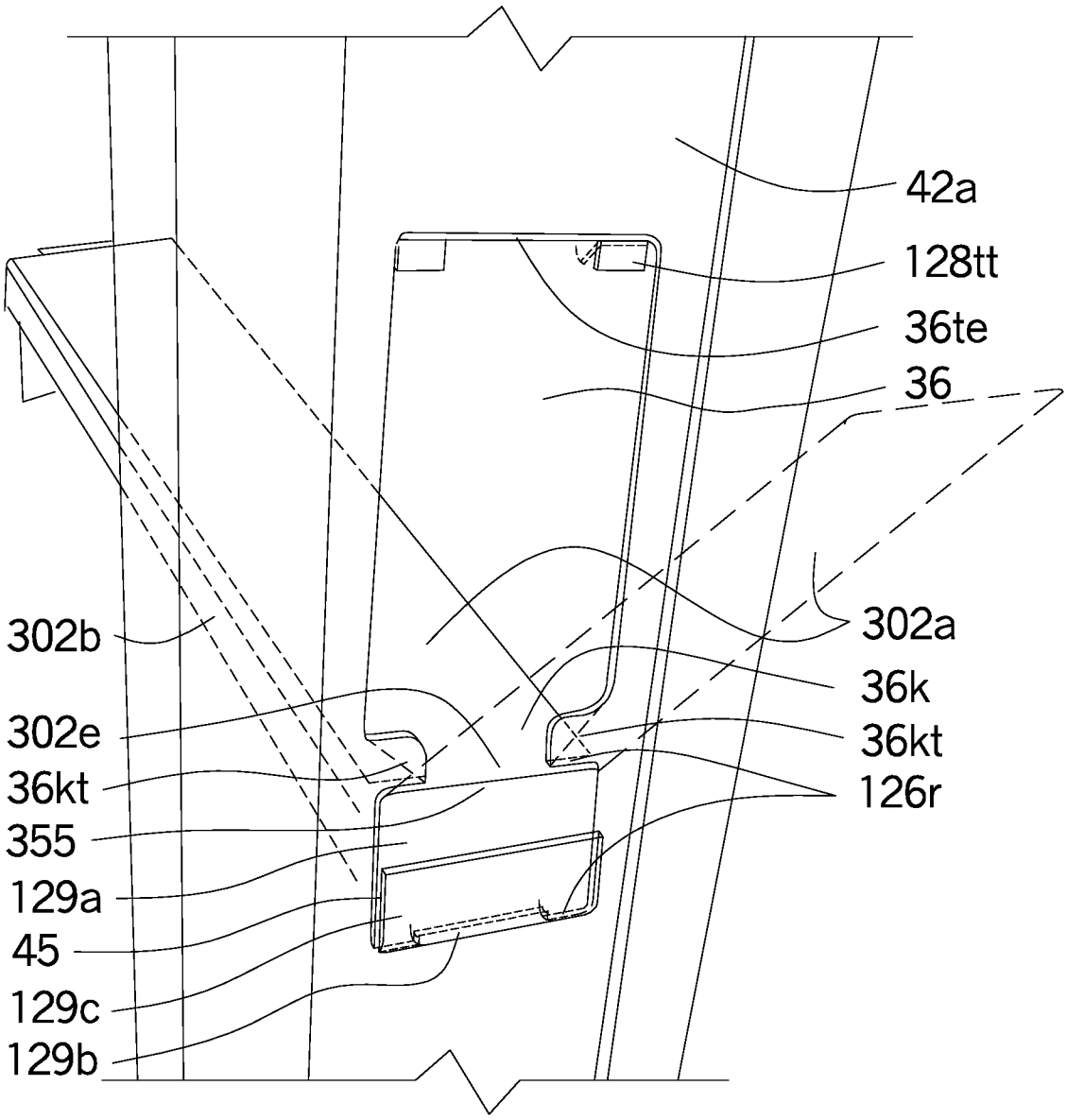

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36kt
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129c
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FIGURE 48

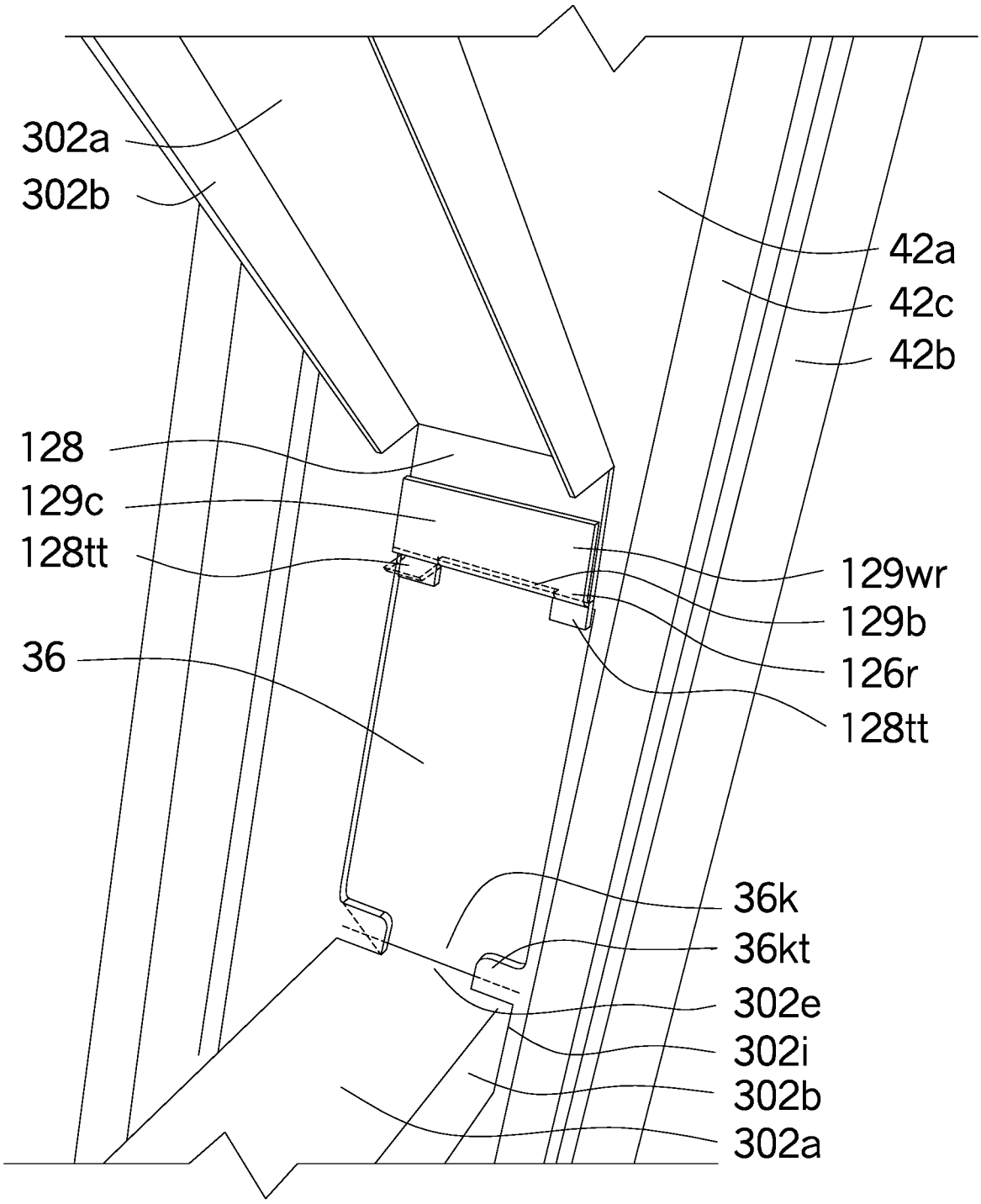

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302b
42a
42c
42b
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129c
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129b
126r
128tt
36
36k
36kt
302e
302i
302b
302a

FIGURE 49

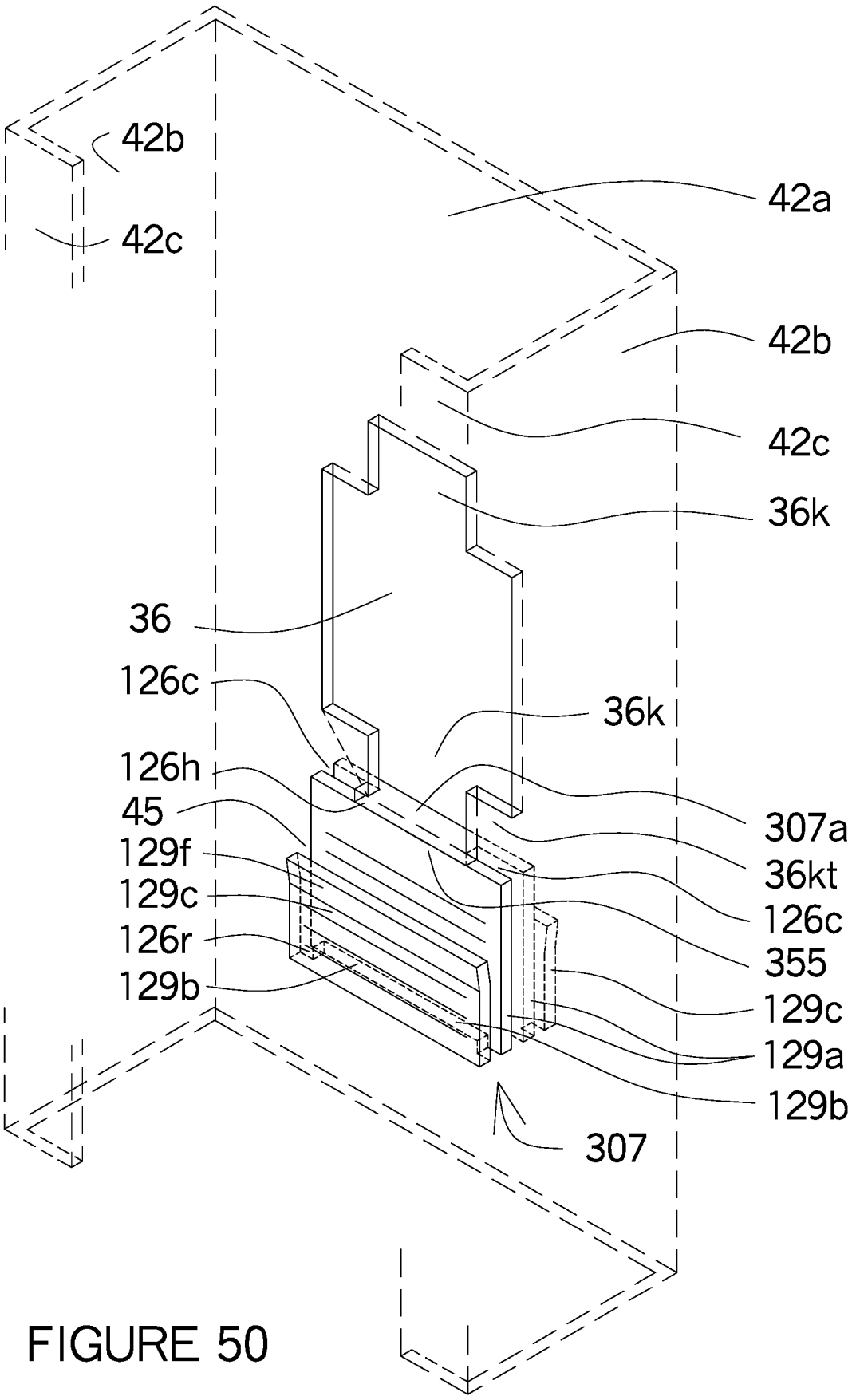

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42b
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126c
36k
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126c
355
129c
129a
129b
307

FIGURE 50

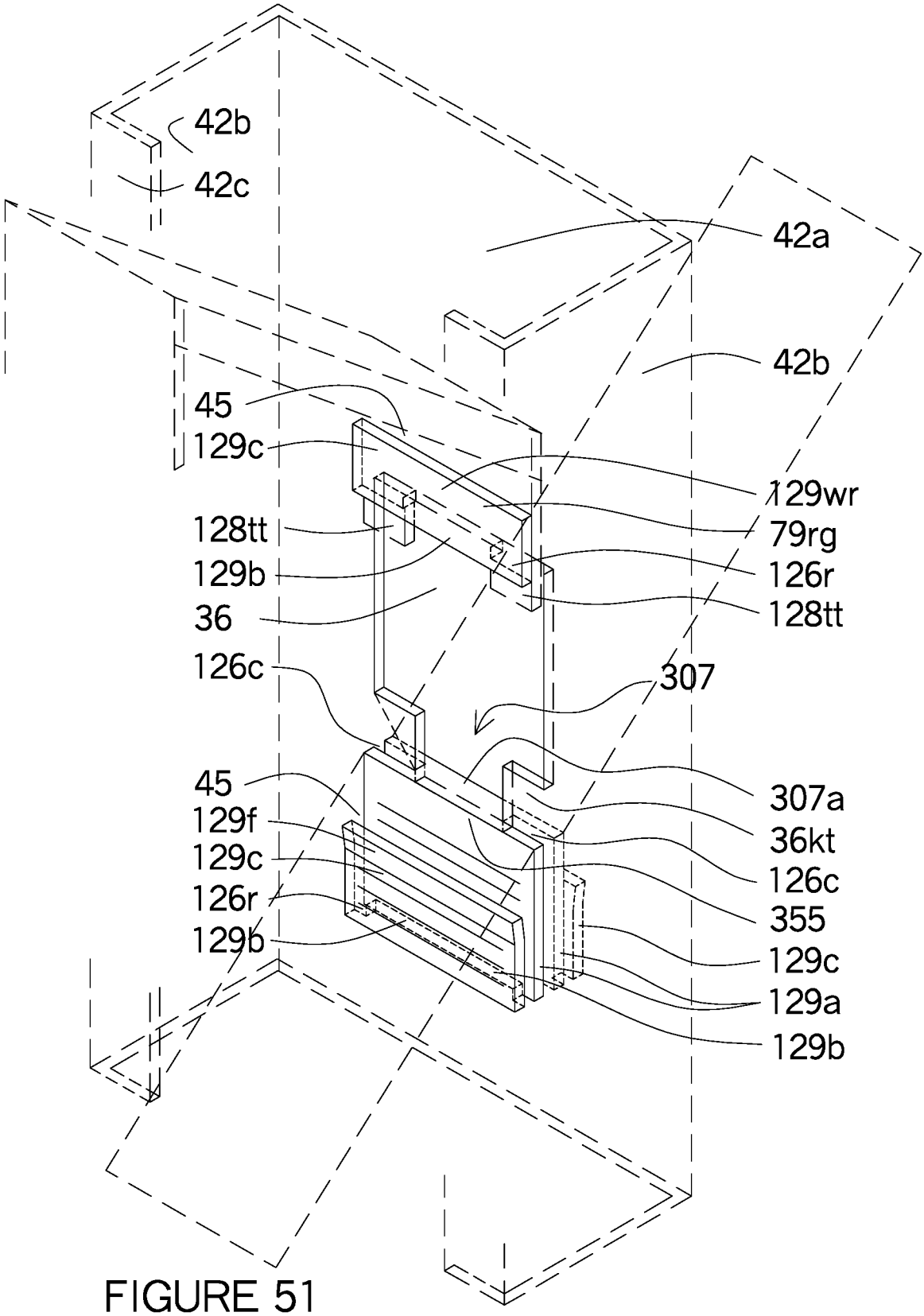

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129b
126r
36
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126c
126r
355
129b
129c
129a
129b

FIGURE 51

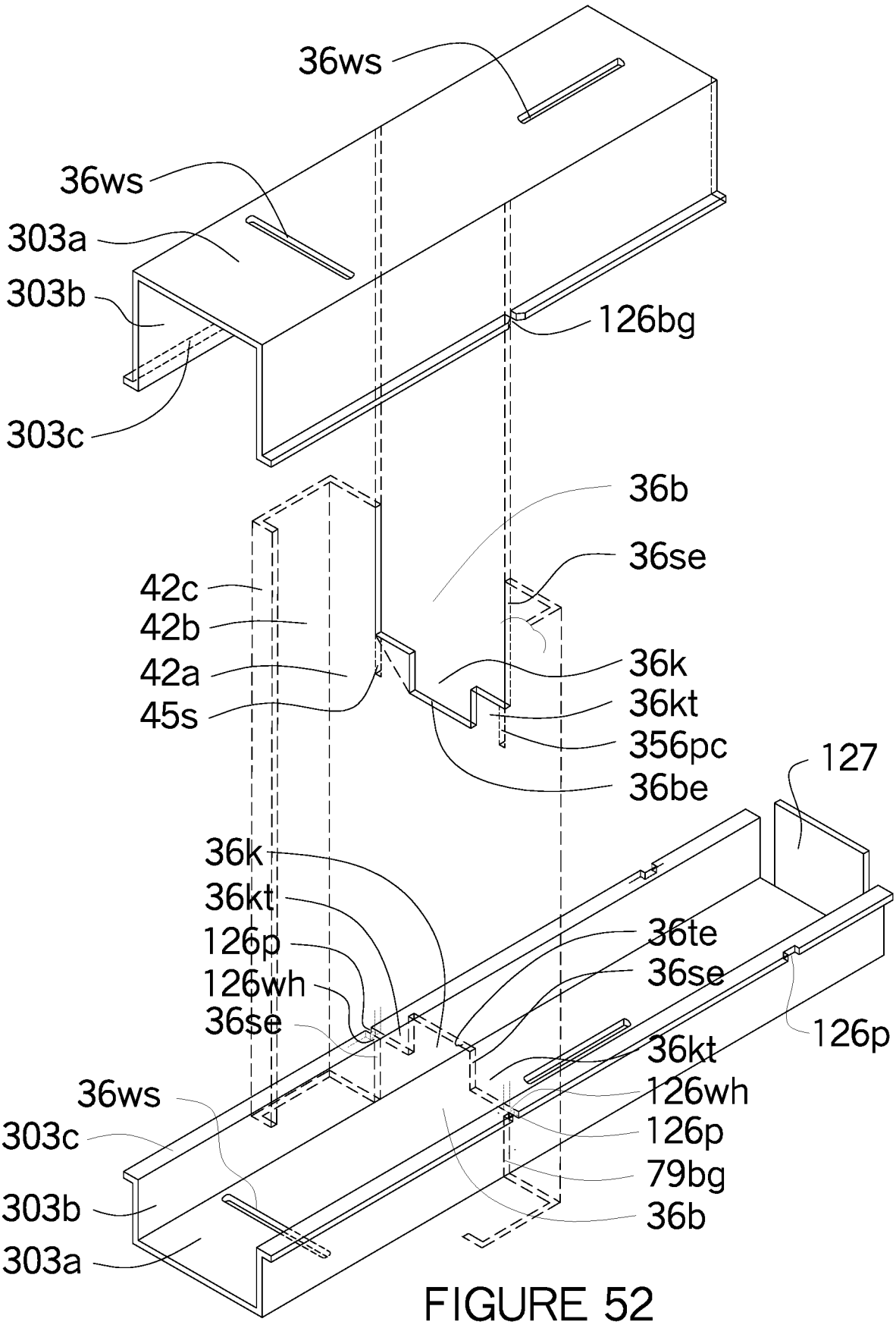

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303c
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36se
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42b
42a
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36k
36kt
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36k
36kt
126p
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126p
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36b
126p
36ws
303c
303b
303a

FIGURE 52

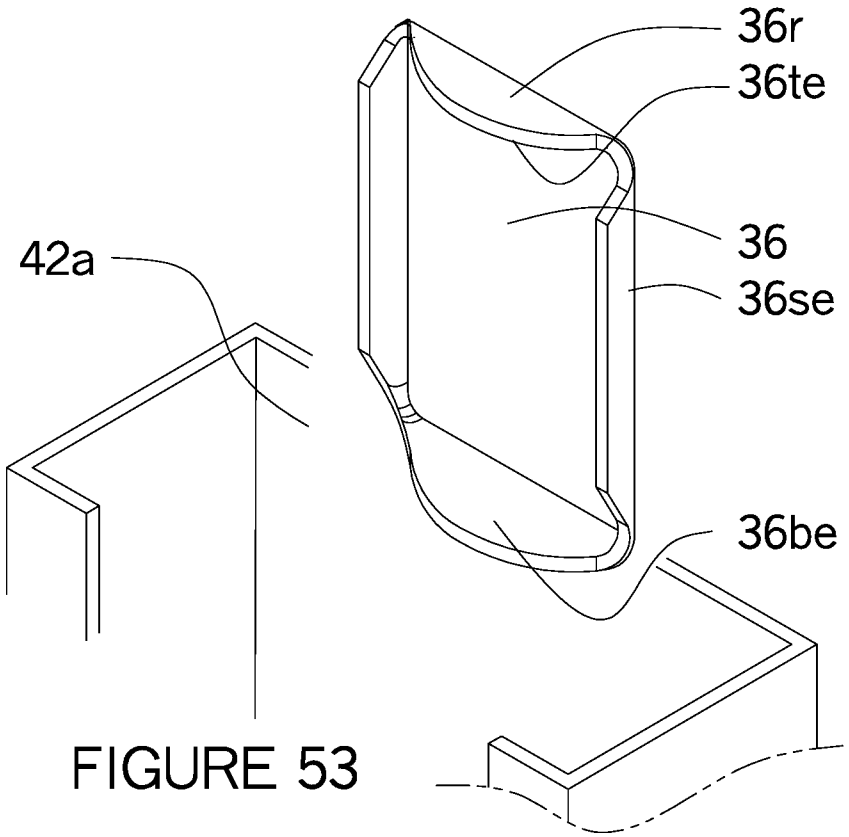


FIGURE 53

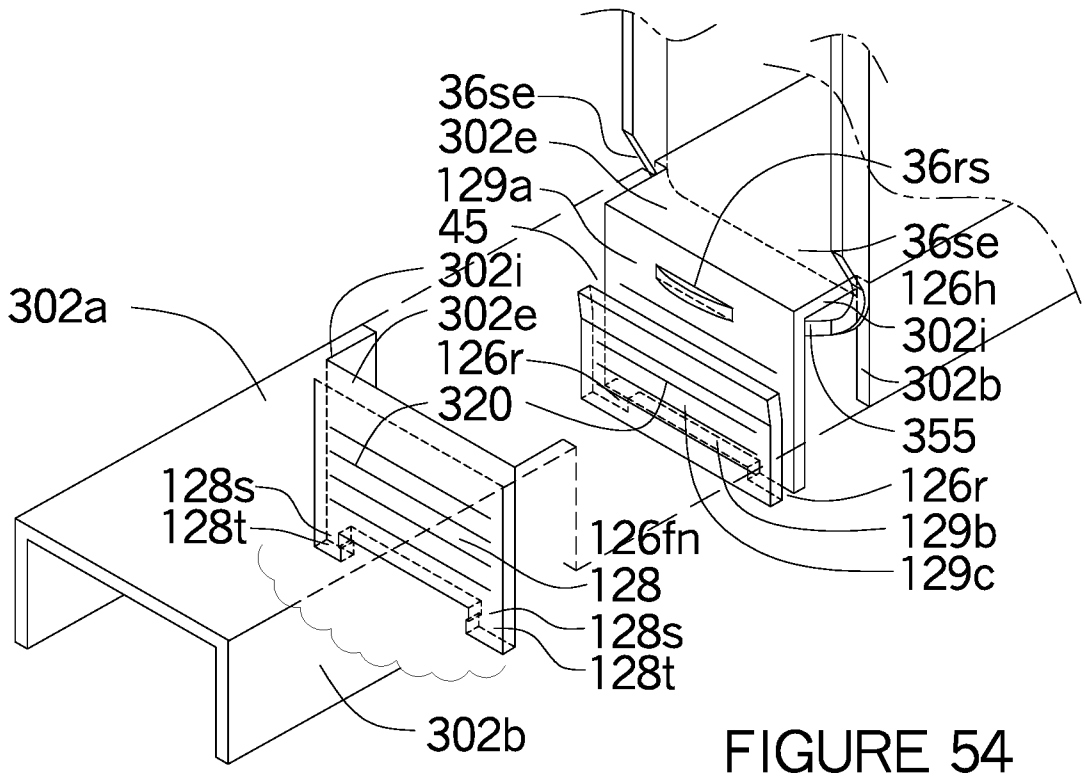


FIGURE 54

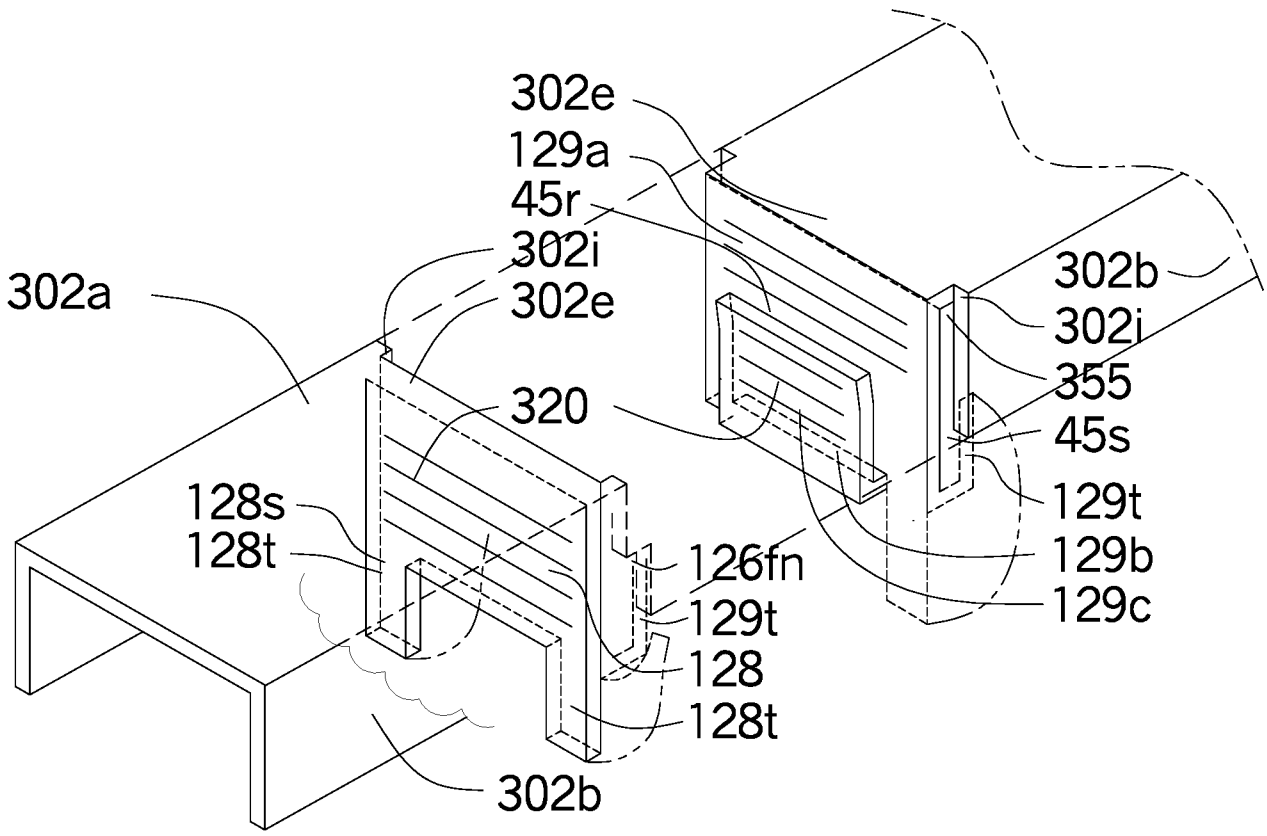

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302i
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302e
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128t
302b
302b
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355
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129t
129b
129c

FIGURE 55

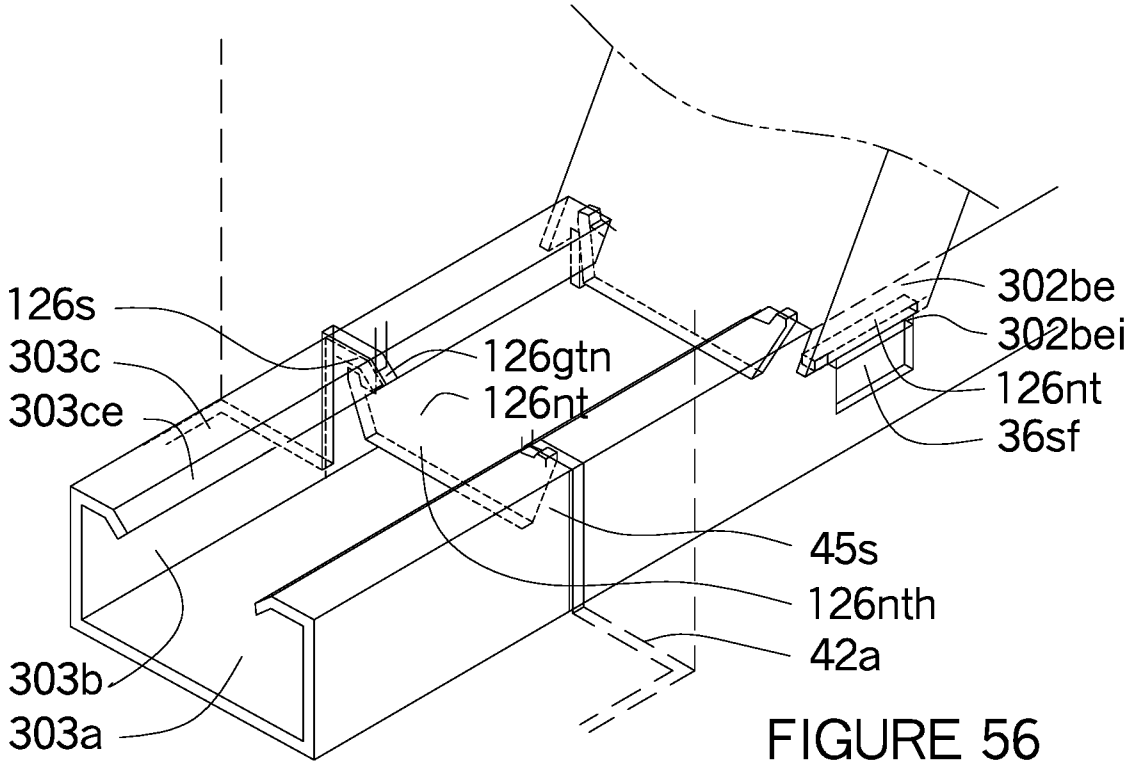


FIGURE 56

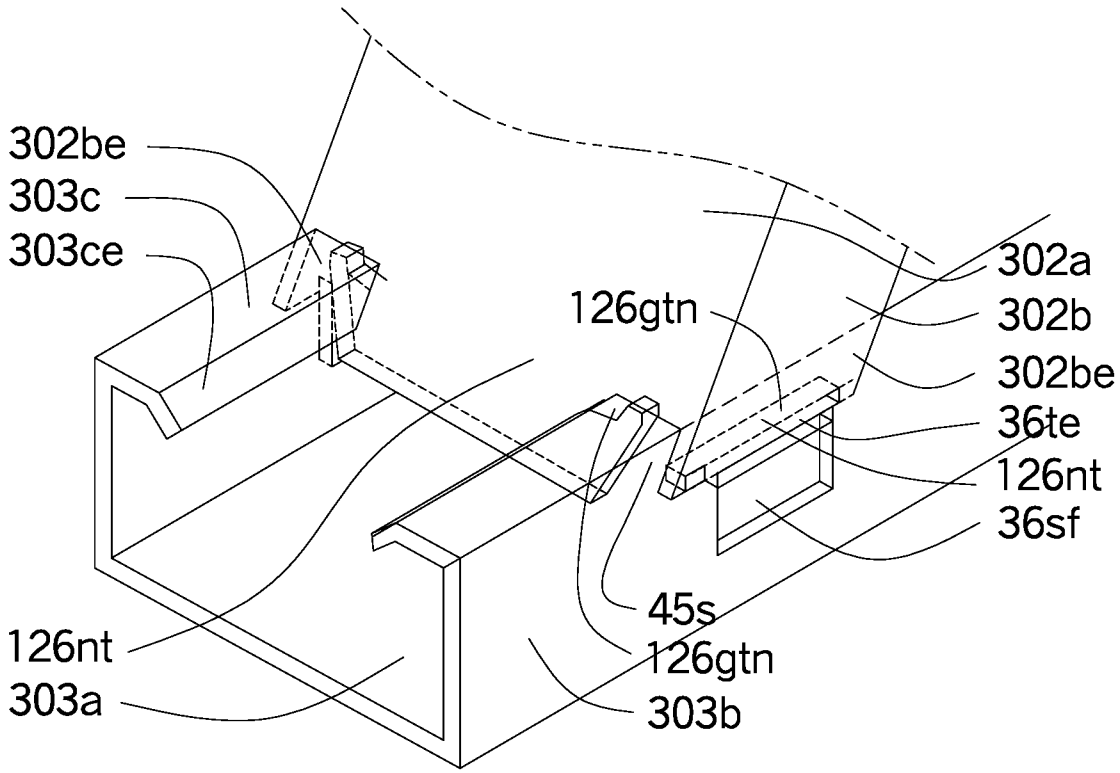


FIGURE 57

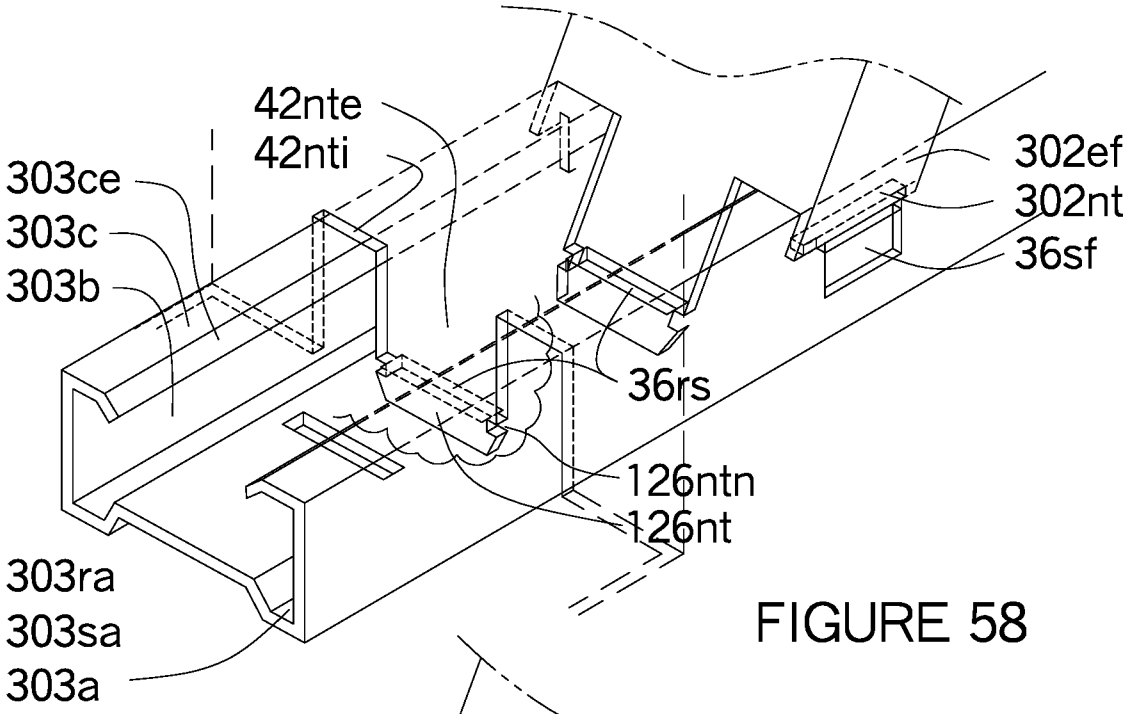


FIGURE 58

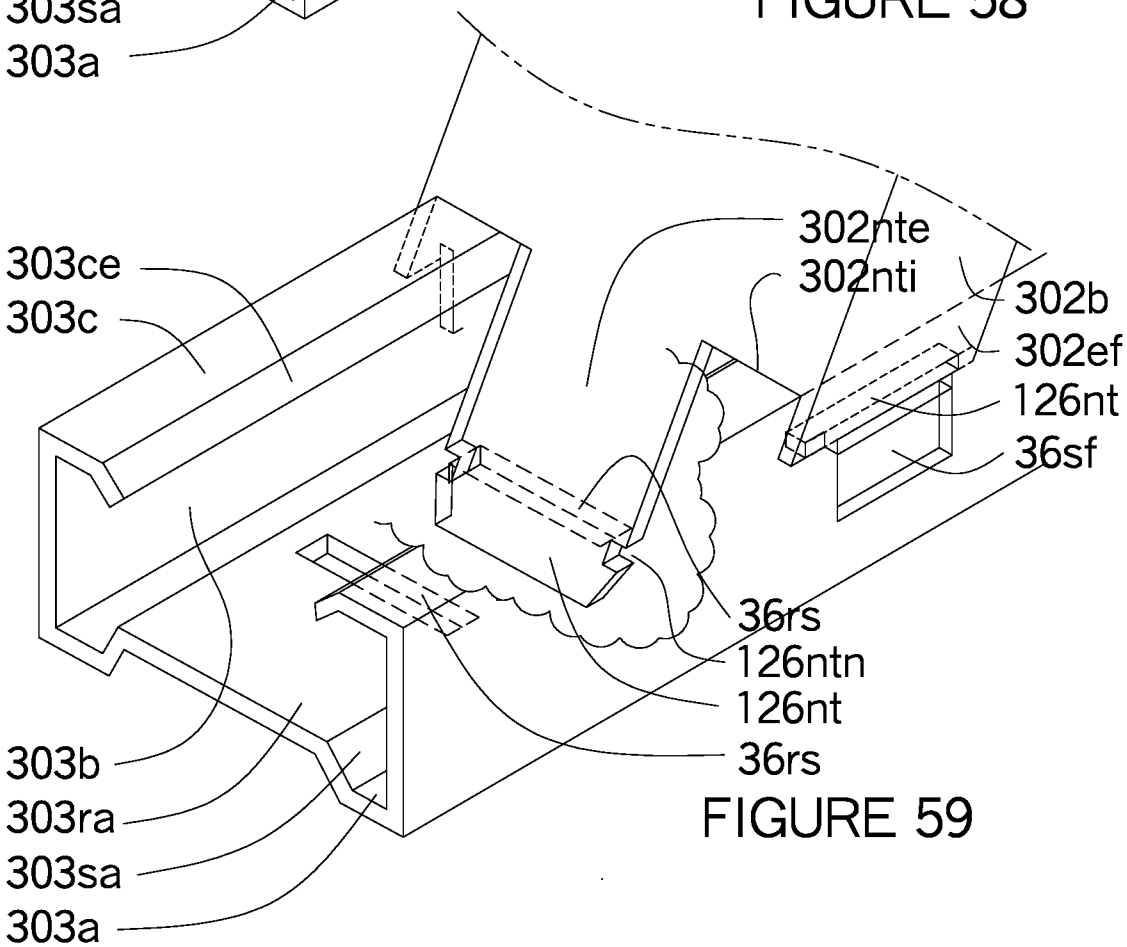


FIGURE 59

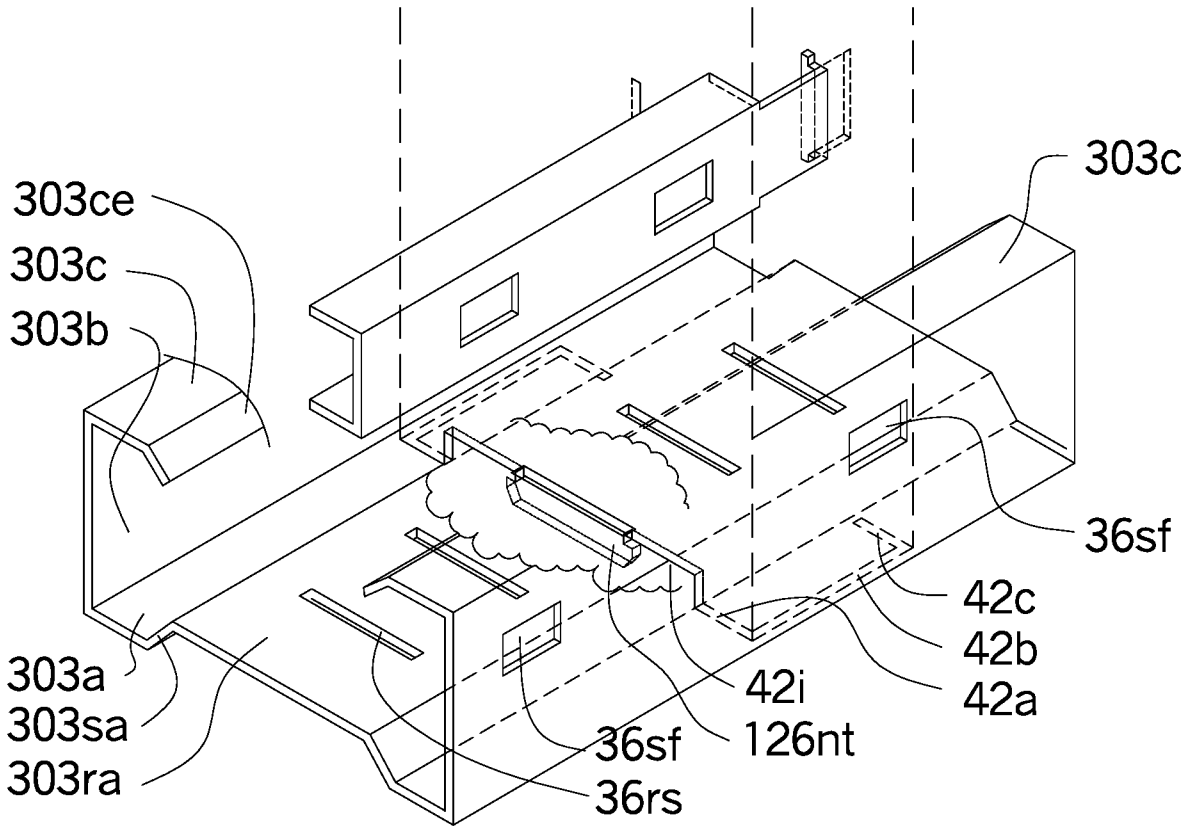


FIGURE 60

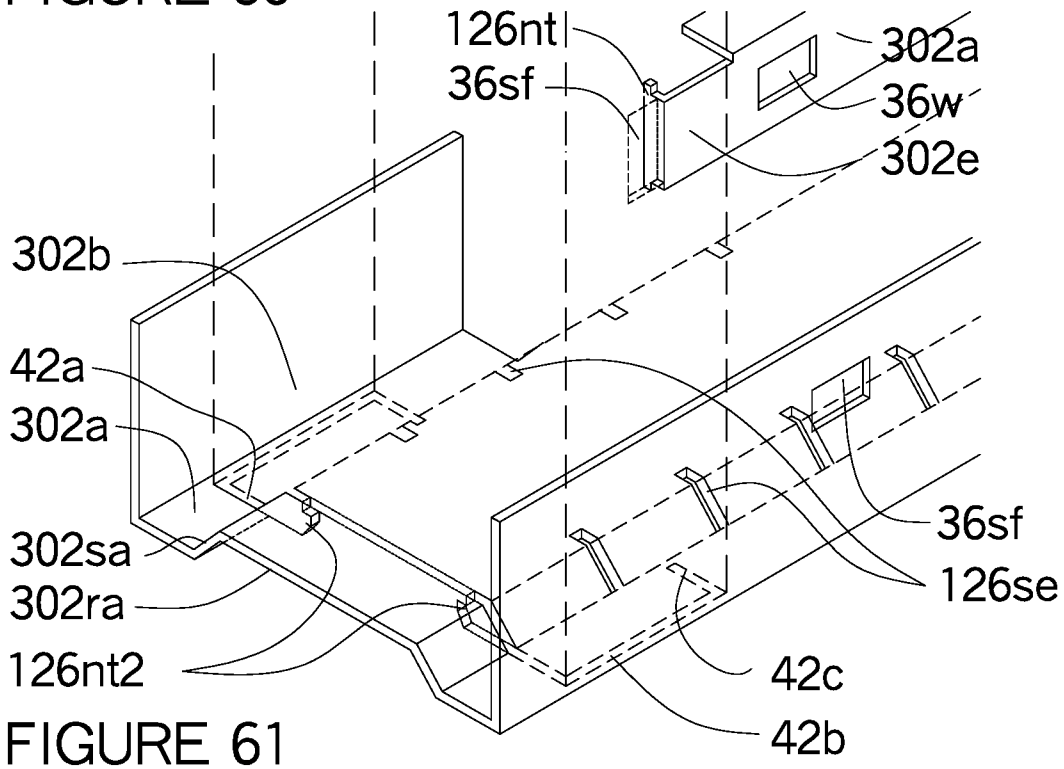


FIGURE 61

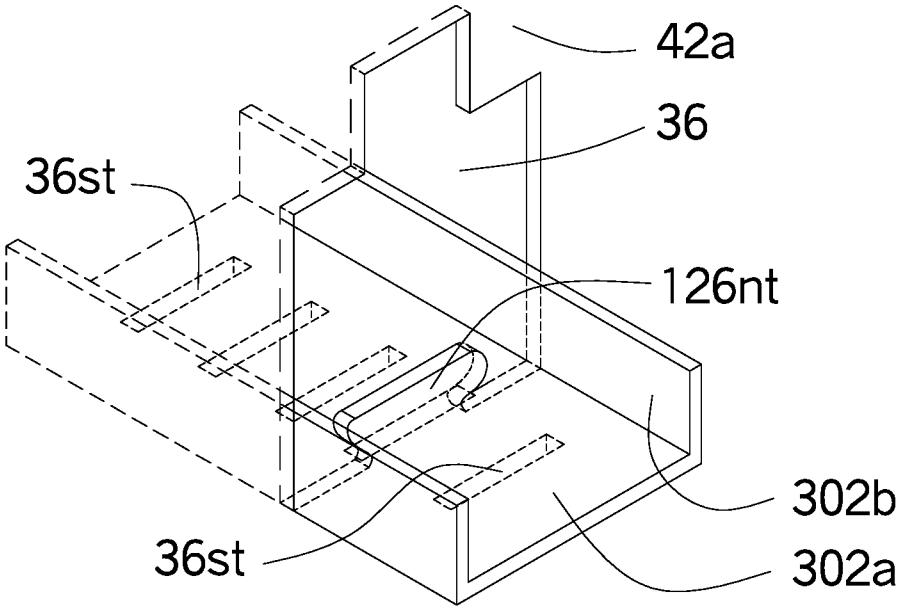


FIGURE 62

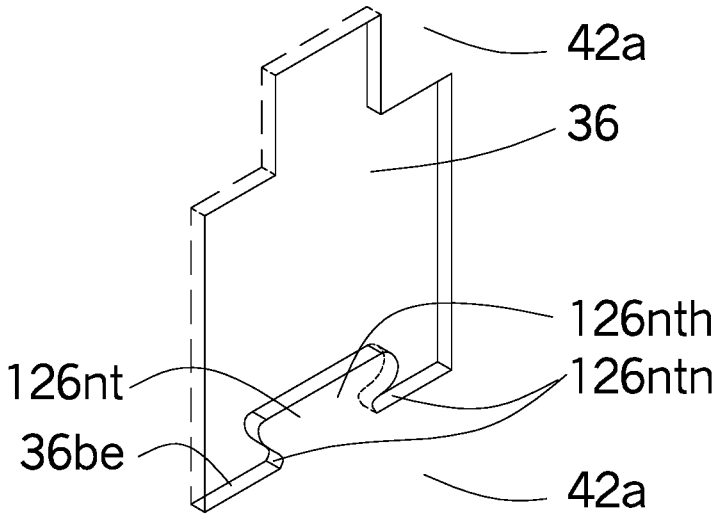


FIGURE 63

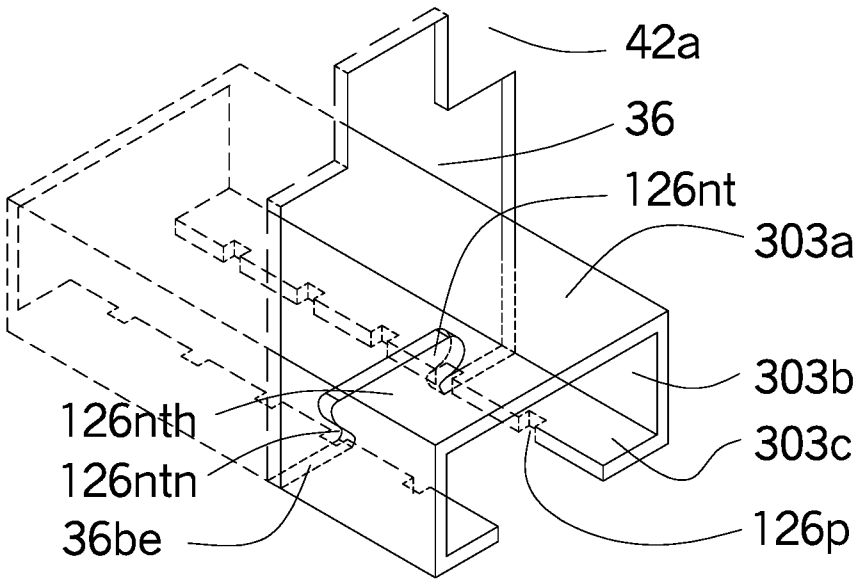


FIGURE 64

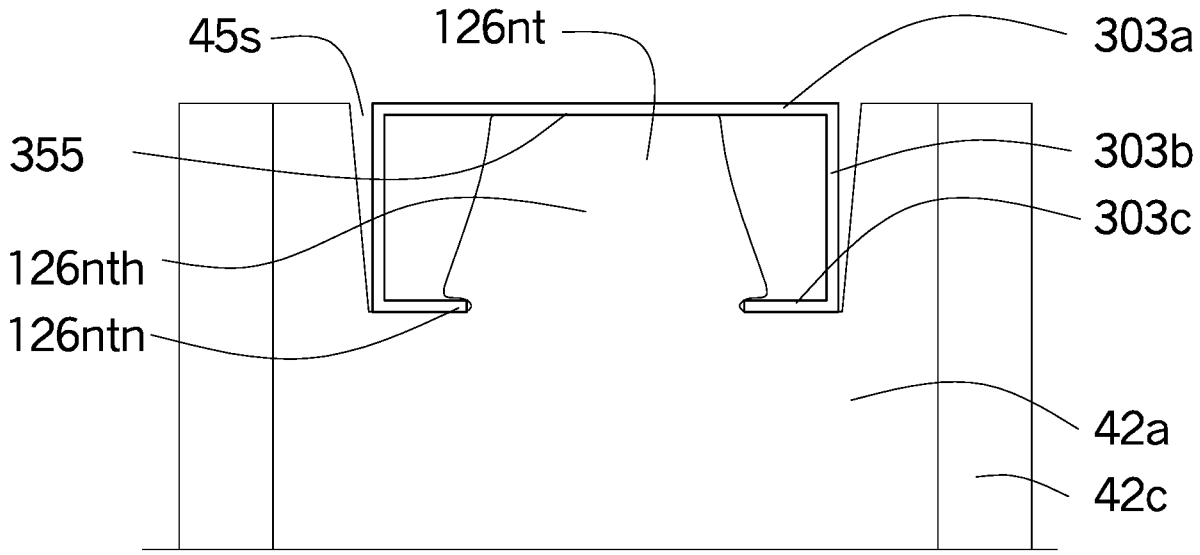


FIGURE 65

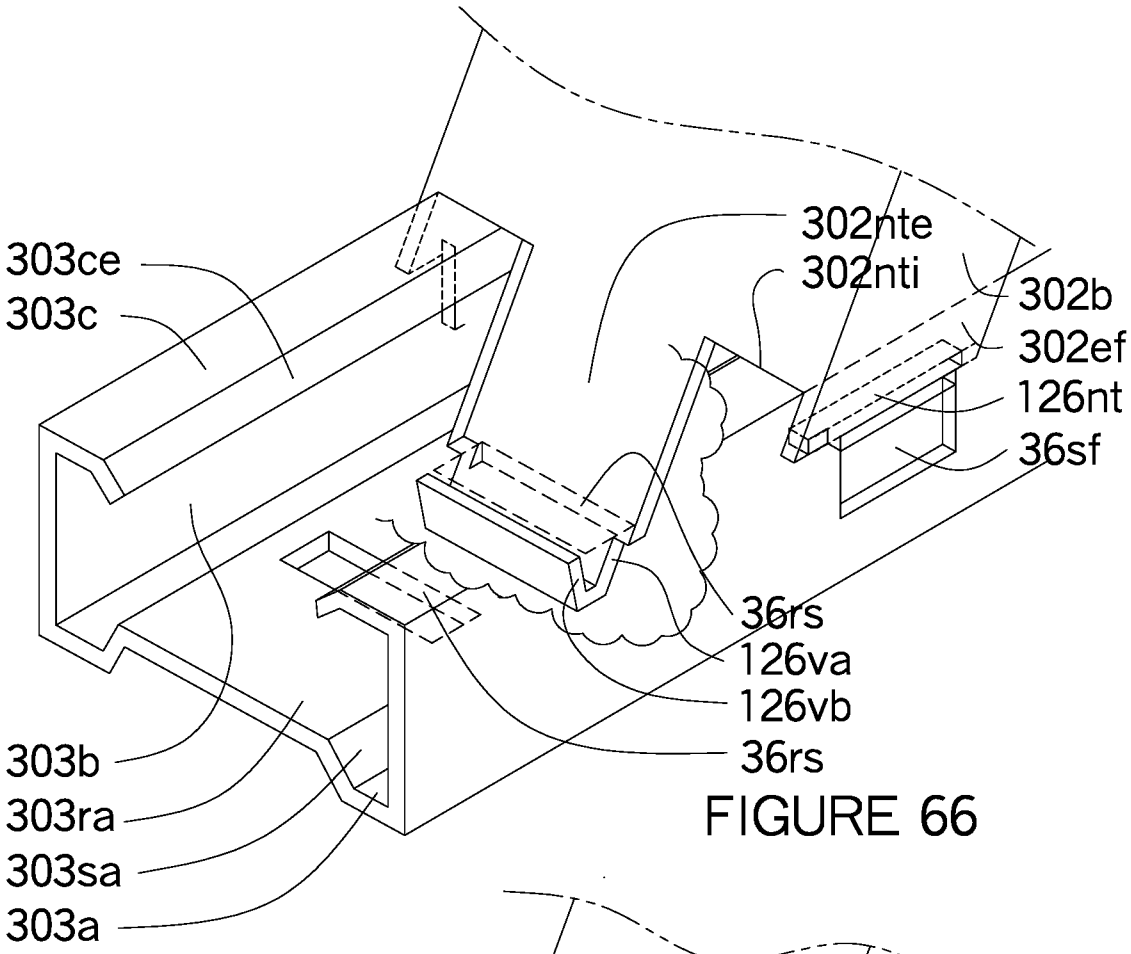


FIGURE 66

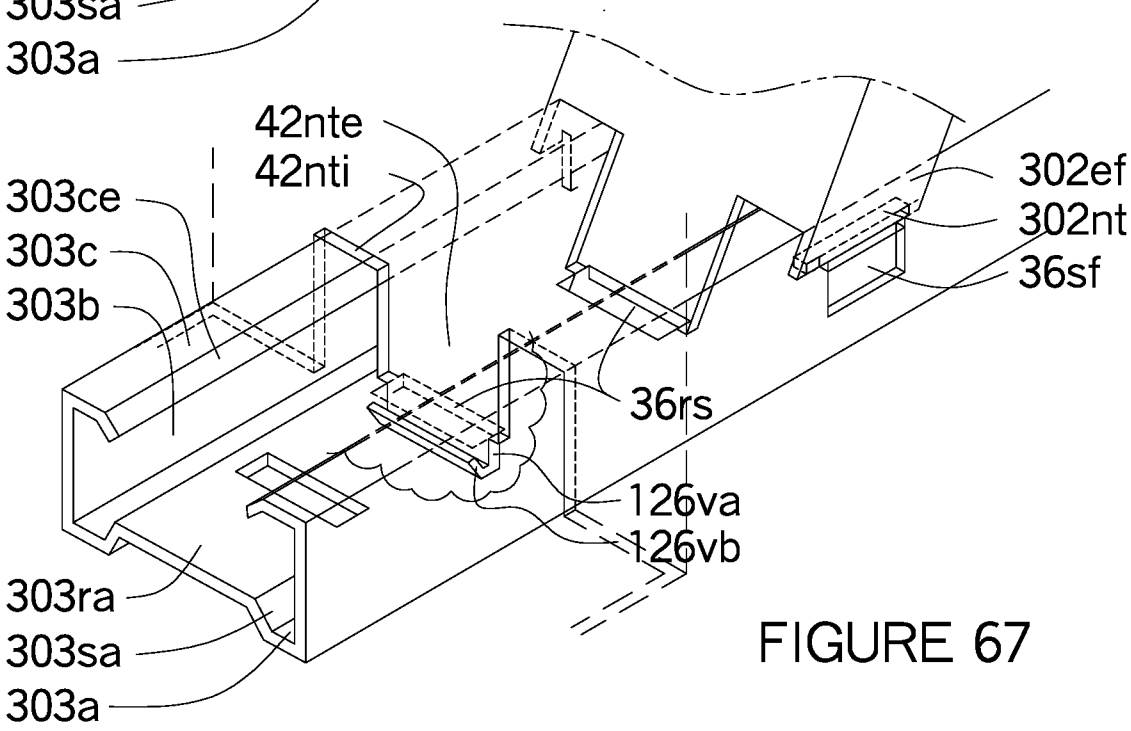


FIGURE 67

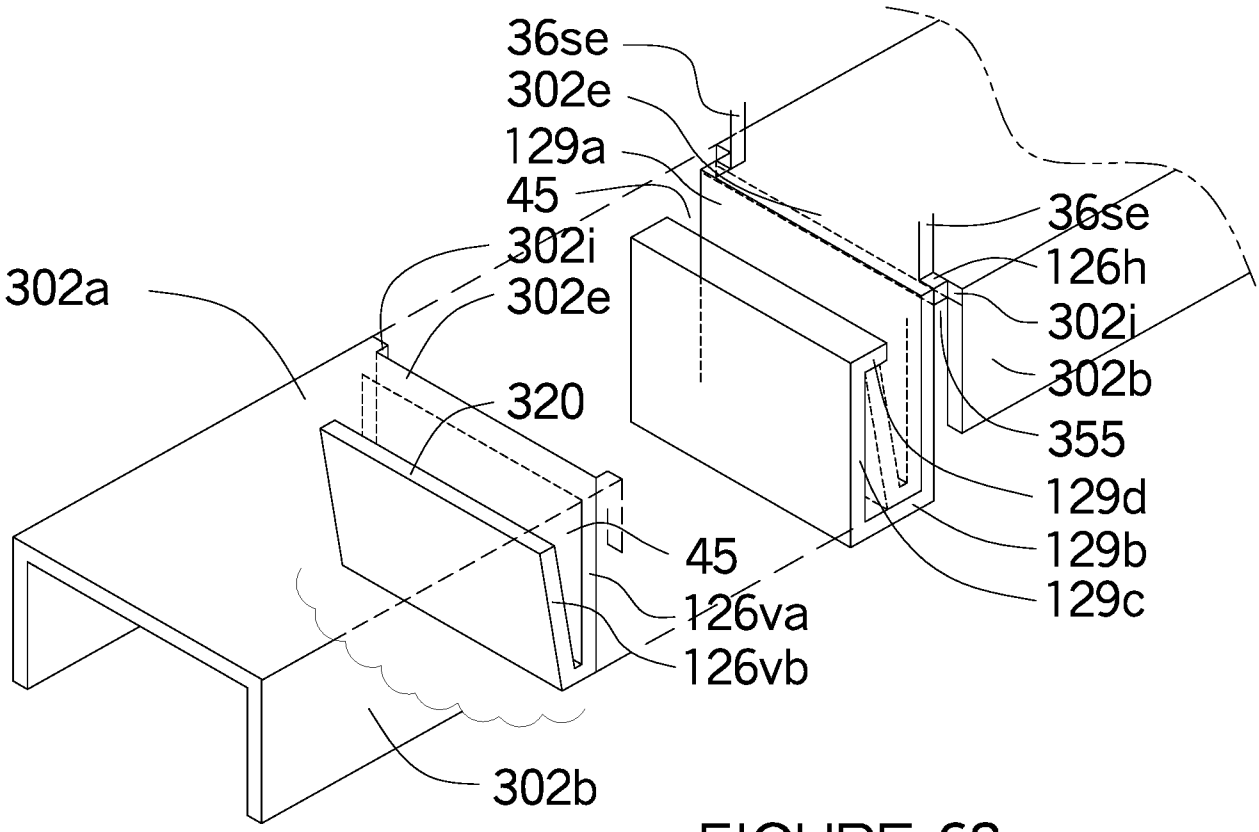


FIGURE 68

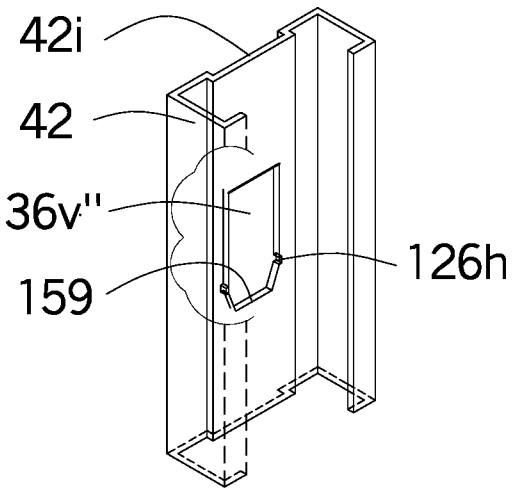


FIGURE 69

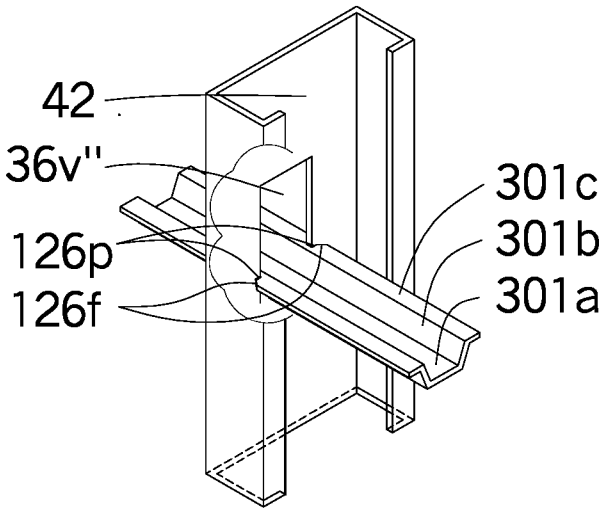


FIGURE 70

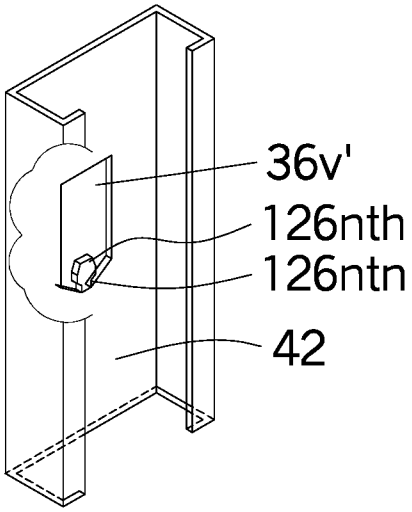


FIGURE 71

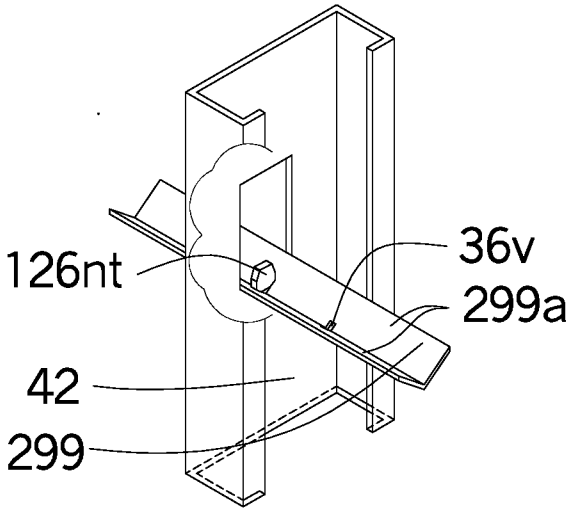


FIGURE 72

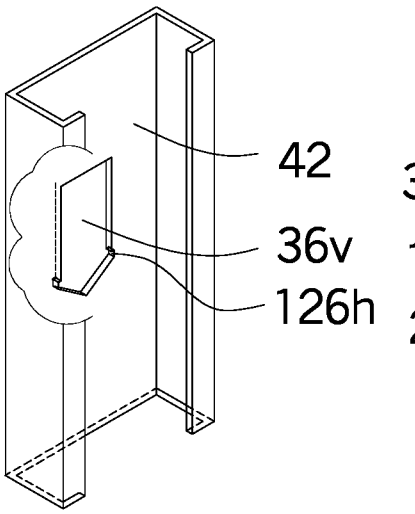


FIGURE 73

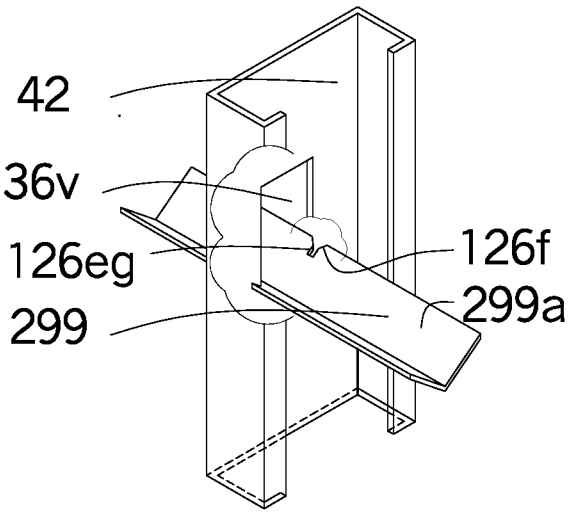


FIGURE 74

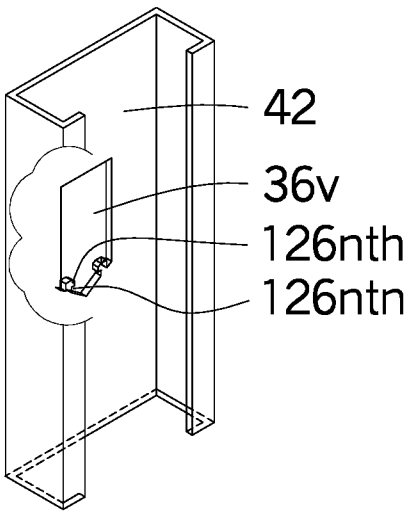


FIGURE 75

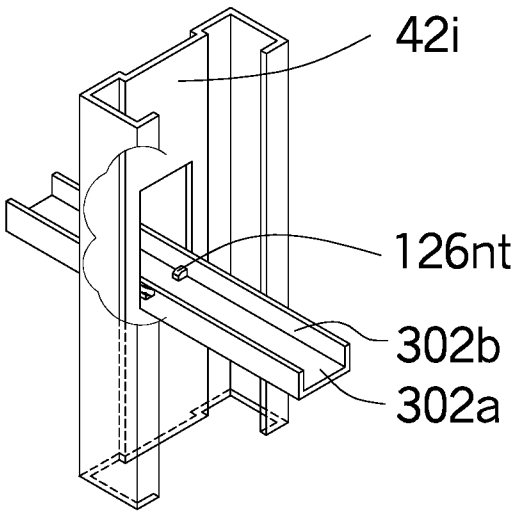


FIGURE 76

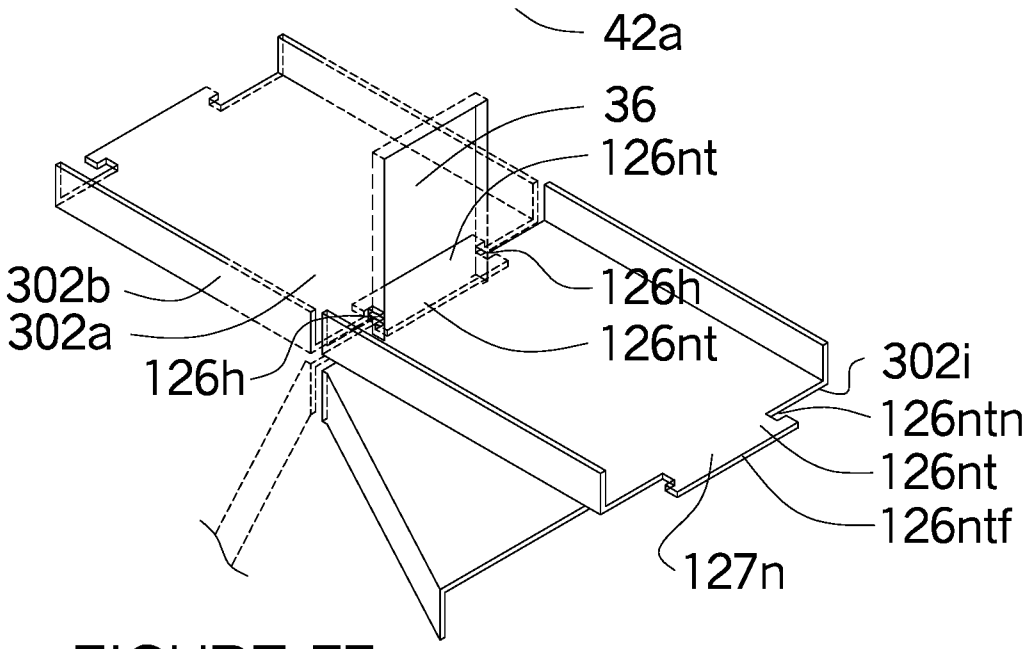


FIGURE 77

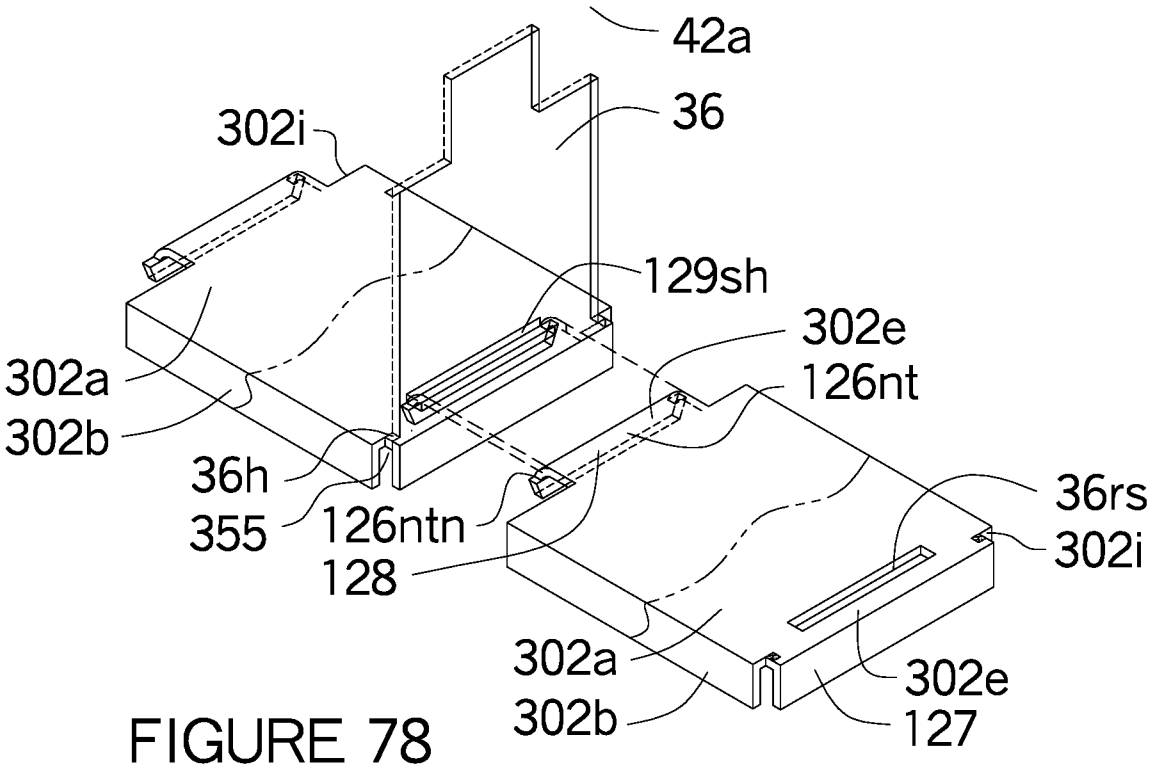


FIGURE 78

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 18/17848

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - E04B 1/18, E04B 1/24, E04B 1/58, E04B 2/58, E04B 2/76 (2018.01)
CPC - E04B 1/18, Y10T 403/7073, E04B 2/58, E04B 1/2403, Y10T 403/7096, E04B 2001/2406, E04B 2001/2409, E04B 2001/2469, E04B 1/5818, E04B 2/76, E04B 2/764, E04B 2/58

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)
See Search History Document

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,680,271 A (SATCHELL) 01 August 1972 (01.08.1972), entire document, especially Fig. 3; col. 2, ln. 53-55; col. 2, ln. 52-55, 63-67; col. 3, ln. 1-5.	1-5, 19-23
X	US 2002/0059773 A1 (ELDERSON) 23 May 2002 (23.05.2002), entire document, especially Fig. 1, 2, 3, 5; para [0059].	1, 6
X	US 4,062,301 A (PITCHFORD) 13 December 1977 (13.12.1977), entire document, especially Fig. 1, 6, 10; col. 2, ln. 26-29; col. 3, ln. 10-11, 28-30.	1, 7-17, 27-28
X	US 3,044,586 A (CASSELS) 17 July 1962 (17.07.1962), entire document, especially Fig. 3-5; col. 2, ln 55-60.	1, 7, 10
X ----- Y	WO 96/23945 A1 (HADDOCK) 08 August 1996 (08.08.1996), entire document, especially Fig. 2, 5.	1, 7, 18 ---------- 26
X ----- Y	US 7,464,509 B1 (BROWN) 16 December 2008 (16.12.2008), entire document, especially Fig. 12, 13; col. 2, ln. 48-53.	1, 7, 24-25 ---------- 26
A	EP 2 395 168 A1 (WEERNINK) 14 December 2011 (14.12.2011), entire document, especially Fig. 1-4; para [0024]-[0025].	29
A	US 4,760,680 A (MYERS) 02 August 1988 (02.08.1988), entire document.	1-29

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"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
15 May 2018	31 MAY 2018
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 18/17848

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,983,569 B1 (ROSENBERG) 10 January 2006 (10.01.2006), entire document.	1-29
A	US 4,840,005 A (COCHRANE) 20 June 1989 (20.06.1989), entire document.	1-29