(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 November 2003 (27.11.2003)

PCT

(10) International Publication Number
WO 03/098405 A2

(51) International Patent Classification[7]: G06F

(21) International Application Number: PCT/US03/09831

(22) International Filing Date: 31 March 2003 (31.03.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/380,465 15 May 2002 (15.05.2002) US

(71) Applicant and
(72) Inventor: **TURNER, Jerry, Randall** [US/US]; P O Box 1613, Mt Juliet, TN 37121 (US).

(74) Agent: **WINTERS, David, Douglas**; 2277-C Suite 154, Wilma Rudolph Blvd, Clarksville, TN 37040-5898 (US).

(81) Designated State *(national)*: GB.

(84) Designated States *(regional)*: European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 03/098405 A2

(54) Title: MODULAR STRUCTURES AND CONNECTOR ASSEMBLY APPARATUS

(57) Abstract: Disclosed is a modular construction system (MCS) for knock down structures. It is illustrated by three structures, each having connecting portions detachably secured to one another by Trapezoidal Quick Slide Connector Assemblies, also disclosed, that enable a user to erect, without tools, a pre-designed structure. The male and female connector components comprise flat trapezoids that can be mated by sliding the narrow end of the male connector component into the wide end of the female connector component. Structures according to this system include a plurality of interchangeable parts, each formed of a rigid material such as, illustratively, metal, plastic, fiberglass, or wood. The system allows maximum flexibility in structural configuration and permits a user to assemble a structure and also disassemble and move it without the use of any tools. Also disclosed is a manufacturing device for quickly and accurately positioning connector components taught in this patent for mounting on the modular construction parts that are to be connected.

MODULAR STRUCTURES AND CONNECTOR ASSEMBLY APPARATUS

CLAIM OF PRIORITY

This application relates to and claims the benefit of U.S. Provisional Application No: 60/380,465 filed 15 May 2002 by Mr. Jerry R. Turner with respect to the disclosed trapezoidal quick slide connectors and modular knock down structure construction system for a residential deck system.

TECHNICAL FIELD

The technical field of the invention relates generally to connector assemblies used to construct appliances and structures, and more particularly to a sliding connector assembly for rigid construction of prefabricated structures.

BACKGROUND ART

Various types of connector assemblies are known and used in construction of appliances and structures to provide releasable connections between one or more structural components. For example, pin and slot connectors have been used to connect deck blocks formed of strips of lumber of essentially equal length that are laterally disposed side by side. (Refer to US patent 4,028,858 issued to Rehbein.) Hook and rail connectors have been used to construct modular knockdown structures. (See US patent 5,758,988 issued to Theodorou.) V-shaped, slotted cross-brace connectors have been used to assemble plank grating for decking, flooring, or sub-flooring in which the V-shaped, slotted cross-braces are inserted through openings and rotated to an assembled position. (See US patent 4,566,243 issued to Dahlin) Finally, trapezoid-shaped connector assemblies have been used to construct items such as bathroom fixtures, lamp brackets, and machine mounts as in US patent 1,356,745 issued to Schwartz, US patent 5,566,917 issued to Wu and US patent 6,227,514 B1 issued to Williams.

Advantages of these aforesaid connectors include ease in manufacturing and ease of assembly for the structures in which they are used. Often the structures may be built with few tools. In such designs,

the fits and tolerances are consistently and intentionally very loose. These loose fits and tolerances are what make the devices easier to manufacture and easier to fit together in assembling structures.

However, in each case, these necessarily loose fits and manufacturing tolerances associated with each connector create significant disadvantages. One such disadvantage is that in many of them, locking devices, such as pivot pins, grub screws, levers and the like, must be used to finally, securely and rigidly mate opposing connector parts together. Often, these locking devices must be installed using hand tools, a process that may be time-consuming and challenging for the manufacturer or for the do-it-yourself customer. Furthermore, the extra parts required may be lost or damaged during the shipping or assembly.

Another disadvantage is that the "looseness" inherent to these systems requires that construction systems using these connectors sacrifice strength, rigidity and resiliency to achieve ease of assembly. Such structures must be relatively imprecise in fitting together for assembly. They may not be dimensionally consistent at all joints. Therefore, the overall lengths that result from joining several structural components may vary unpredictably. This renders them unsuited for use in building complex structures such as residential decks, with rails and stairs, particularly those capable of repeated assembly and disassembly by hand without the use of tools.

Such connectors also tend to become progressively looser, weaker, and less rigid when subjected to loads and vibrations. Moreover, such structures cannot comply with strict construction safety standards as are demanded for residential use.

Further, although the connector parts and their associated locking devices may be designed with loose tolerances, they are still complex to manufacture and assemble, requiring secondary forming operations and assembly, and/or separate packing of multiple parts.

Finally, of the prior art, no trapezoidal slide based design is capable of rigidly joining faces of two opposing parts.

DISCLOSURE OF INVENTION

Disclosed herein, is a modular construction system (MCS) that includes a plurality of interchangeable parts, each formed of a rigid material such as, illustratively, metal, plastic, fiberglass, or wood. The design allows maximum flexibility in structure configuration and permits an individual to assemble, disassemble, and move a structure without the use of any tools.

A connector assembly for connecting a first part to a second part is also disclosed. The connector assembly includes a first male connector component to be rigidly mounted on the first part and a second female connector component to be rigidly mounted on the second part. The male and female connector components comprise flat trapezoids that can be mated by sliding the narrow end of the male connector component into the wide end of the female connector component.

Also disclosed is a manufacturing device for quickly and accurately positioning connector components taught in this patent for mounting on the modular construction parts that are to be connected.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded partial view of an MCS residential deck system excluding floor panels

Fig. 2 is an exploded partial view of an MCS residential deck system excluding rail assembly.

Fig. 3 is an exploded partial view of an MCS residential deck system showing how the rail assembly mounts in place.

Fig. 4 is an assembled view of an MCS workbench.

Fig. 5 is an exploded view of an MCS workbench.

Fig. 6 is a partial view and an exploded end view of an MCS picnic table.

Fig. 7 is a partial view and a partial exploded quarter view of an MCS picnic table.

Fig. 8 is four views of a male connector component according to one embodiment.

Fig. 9 is four views of a female connector component according to one embodiment.

Fig. 10 is a view of a female connector component according to one embodiment that incorporates alignment tabs and a width web in the process of being mated with vanes of a male connector component with alignment tabs

Fig. 11 is three views of a female connector component according to one embodiment that incorporates a width web and an integral ledger.

Fig. 12 is four views of a female connector component a width web and two integral ledgers.

Fig. 13 is a view of a male connector component and a female connector component aligned for mating.

Fig. 14 is three views of a male connector component with alignment tabs.

Fig. 15 is two views of a male connector component and a female connector component each equipped with alignment tabs and in a mated configuration.

Fig. 16 is four views illustrating the function of Dimension Control Radii by comparing connector component vanes without Dimension Control Radii to vanes equipped with Dimension Control Radii.

Fig. 17 is two views of a mounting skewer equipped with mounting indices.

BEST MODE FOR CARRYING OUT INVENTION

In the following descriptions when referring to connectors, the terms "top" and "bottom" are arbitrary and used only as a means of orienting the reader. In actual operation either end of the connector assembly may be used in the superior position, so long as the male and female components are matched in orientation.

Disclosed herein is a Modular Construction System (MCS) driven by multiple parameters. The resultant structure must, and does, comply with International Building Code standards for residential structures, where applicable. The resultant structure must be, and is, tight and rigid when fully assembled. The resultant structure must be, and is, quickly and easily assembled without tools. The connector assembly must be, and is, sufficiently precise to permit building extended and complex structures capable of disassembly and reassembly. Finally, the components must be, and are, capable of efficient manufacture to ensure their affordability.

As disclosed herein, an MCS includes a plurality of interchangeable parts, each formed of a rigid material such as metal, plastic, fiberglass, wood or the like. Illustratively, each interchangeable part may be formed of pressure-treated lumber, such as #1 grade Southern Yellow Pine. (See figs. 1, 2, 3, 4, 5, 6 and 7.)

Referring to figs. 1, 2 and 3, the MCS and connector assemblies allow a user to erect a modular structure, in one embodiment, a residential deck/porch system or RDS, which is sufficiently strong to comply with load-bearing requirements as set forth in the International Residential (IRC 2000) standards for residential structures. The International Code Counsel revises these standards periodically, but the invention for which patent application is applied herein is inherently capable of adjustment to meet any new strength standards that might be promulgated.

The design of this residential deck/porch system (RDS) allows maximum flexibility in structure configuration and permits an individual to assemble, disassemble, and move a structure without the use of tools.

In one embodiment, the RDS includes a unique 4 X 4 foot joist-grid system where no span between support posts exceeds 8 feet. This joist-grid system is easily assembled without the use of any tools into nearly any imaginable shape or size combination. Flooring panels are envisioned in either 2 x 8 foot or 4 x 4 foot sections, but other dimensions are also possible and contemplated. With these standard components, the sizes and shapes of the decks, porches, and other modular structures that can be manufactured are virtually endless. Illustratively, such structures may include square, rectangular and L-shaped designs. The RDS design includes IRC 2000 compliant handrail sections that are integrated into an assembled structure using an outside rim of exterior joists to provide additional structural rigidity. (See fig. 1.)

In use, various sizes of connector assemblies are attached to interchangeable parts at predetermined points of structural connection. By following instructions and/or assembly plans and diagrams, virtually any number of modular structures, including but not limited to stairs, decks, porches, furniture, buildings, and recreational structures, can be assembled without the use of tools. Disclosed in illustration are an MCS

deck with stairs and rails (figs. 1, 2 and 3), an MCS workbench (figs. 4 and 5) and an MCS picnic table (figs. 6 and 7). Disassembly requires the use of a mallet or other such means of forcibly and suddenly applying solid blows to un-mate connector components. Thereafter, the interchangeable parts may be transported and/or reassembled as needed.

In illustration, to construct a deck or porch, the RDS is delivered to a job site in pieces and a joist-grid system is assembled. Deck flooring panels with substructures dimensionally compatible with the joist grid plan are then nested onto the resulting grid. The resulting deck or porch is at least as rigid and strong as a deck built using conventional construction techniques. Because the RDS and connector assemblies are designed for maximum flexibility of end user design, they may be used to assemble a deck surface in many residential applications, including but not limited to decks for manufactured homes, trailers, or recreational vehicles or for above ground swimming pools

In the MCS workbench and the MCS picnic table embodiments, a workbench or table may be assembled that is strong and rigid. The workbench or table can be assembled, disassembled, transported, and reassembled without the use of tools and with no loss of structural rigidity. Moreover, the dimensional designs are such that all pre-fabricated structural components nest neatly for efficient packaging and transport.

A Trapezoidal Quick Slide Connector assembly for connecting a first part to a second part is also disclosed, hereinafter referred to as a "Connector Assembly." (See figs. 8, 9, 10, 11, 12, 13, 14, 15, and 16.) The connector assembly includes a first male connector component to be rigidly mounted on the first part and a second female connector component to be rigidly mounted on the second part. The male and female connector components comprise flat trapezoids that can be mated by sliding the narrow end of the male connector component into the wide end of the female connector component. (See figs. 10, 13.) Because the female component is much wider at its entry point than the corresponding male component, the parts are easily guided into mated position. (See fig. 10, item number F15.)

Male and female components may, in one embodiment, be made of galvanized steel to resist corrosion.

Referring to fig. 13, in one embodiment, the connector assembly design avoids costly secondary forming operations by limiting manufacture to basic blank, form, and piercing operations in the shapes and configurations shown in the drawings.

As vertical load is applied to the structure, the mating connector components wedge more tightly together. The resultant joint is strong, rigid, precisely dimensioned, and ready to use.

Referring to fig. 8, the male connector component is formed of rigid material in illustration, galvanized steel, and consists of a male base plate (M1) with a male front face (M2), a male back face (M3), a male top edge (M4), a male bottom edge (M5), two male side edges (M6), and two longitudinal male connector vanes (M7). The male connector vanes are situated in a spaced apart relation such that the vanes are spaced apart more widely near the top edge and more narrowly near the bottom edge of the male base plate. In this relation, the outer edges of the vanes define a trapezoidal shape by encompassing two sides and the points of four corners of the trapezoid.

Each male connector vane consists of a male sill (M8) and a male ledge (M9). The male sill (M8) extends from the face of the male base front face (M2) plate to the male ledge (M9), rigidly connecting the two and supporting the male ledge. The male ledge (M9) extends outwardly from the male sill (M8) in a plane essentially parallel to the plane of the male base plate front face (M2).

Each male ledge includes a load bearing outer edge (M10) and a load bearing inner face (M11). Each male sill includes a load bearing outer face (M13) that comes into contact with the load bearing inner edge (F10) of its corresponding female connector component female ledge (referred to below). Each male ledge load bearing outer edge (M10) comes into contact with the load bearing inner surface (F13) of the corresponding female sill. By design, the male ledge load bearing inner face (M11) actually comes into little or no contact with the female load bearing inner face (F11).

The load bearing outer edges of the male ledges and the load bearing inner faces of the male sills are dimensioned and angled in such a way as to precisely conform to the interior (essentially trapezoidal) dimensions and angles of the load bearing inner faces and edges of the corresponding female connector component, such that when the male connector component is fully slid into the female connector component, the load bearing surfaces of the male and female connector components rest in essentially full contact, each with those of the other, except, that as mentioned above, the male ledge load bearing inner face (M11) actually comes into little or no contact with the female load bearing inner face (F11). At this point, the male connector component becomes jammed into place in the female connector component after the manner of a wedge and locks solidly into position.

The male connector component vanes are configured such that when the male component is fully inserted into the female component, the top ends of the male vanes extend beyond the top ends of the female vanes but not beyond the top edge of the female base plate. In this configuration, the top ends of the male vanes rest on the face of the female base plate, preventing compression of the joint and further ensuring dimensional integrity.

Referring to fig. 9, The female connector component consists of a female base plate (F1) with a female front face (F2), a female back face (F3), a female top edge (F4), a female bottom edge (F5), two female side edges (F6), and two longitudinal female connector vanes (F7) in a spaced apart relation such that the vanes are spaced apart more widely near the top edge and more narrowly near the bottom edge of the base plate. In this relation, the interior surfaces of the vanes define a trapezoidal shape by encompassing two sides and the points of four corners of the trapezoid.

Each female connector vane consists of a female sill (F8) and a female ledge (F9). The female sill (F8) extends from the face of the female base plate front face (F2) to the female ledge (F9), rigidly connecting the two and supporting the female ledge. The female ledge (F9) extends inwardly from the female sill (F8) in a plane essentially parallel to the plane of the base plate front face (F2).

Each female ledge (F9) includes a load bearing inner edge (F10) and a load bearing inner face (F11).

Each female sill (F8) includes a load bearing inner surface (F13).

The load bearing inner surfaces of the female ledges and load bearing inner faces of the female sills are dimensioned and angled in such a way as to precisely conform to the dimensions and angles of the load bearing faces and edges of the corresponding male connector component.

Thus, when the male connector component is fully slid into the female connector component, the load bearing surfaces of the male and female connector components rest in essentially full contact, each with those of the other, except that the male ledge load bearing inner face (M11) actually comes into little or no contact with the female load bearing inner face (F11). At this point, the male connector component becomes jammed into place in the female connector component after the manner of a wedge and locks solidly into position (See fig. 8.)

The female connector component vanes are configured such that when the male component is fully inserted into the female component, the bottom ends of the female vanes extend beyond the bottom ends of the male vanes but not beyond the top edge of the male base plate. In this configuration, the top ends of the female vanes rest on the face of the male base plate, preventing compression of the joint and further ensuring dimensional integrity.

Referring to figs. 10, 11 and 12, in one embodiment, the male and/or female connector component also include(s) a width web (F14) a reinforcing member designed to ensure that the integrity of the connector component's width dimension is controlled until the connector component is rigidly mounted to its interchangeable part. This width web also serves as a piloting device to help position the female component as the male component is inserted.

Normal handling during production of the connector assembly can cause inadvertent distortion of its critical width dimension, and the reinforcing width web is incorporated to prevent this from happening. By accomplishing this, the width web ensures that the mating load-bearing surfaces will fully contact each other at the final point of engagement. The

width web parallels a center horizontal axis of the male and/or female connector component and bifurcates the male and/or female connector component vanes.

Referring to figs. 11 and 12, in one embodiment, an integral ledger (L1) may be incorporated on one or more top, bottom or side edges of each male and/or female connector base plate. Each integral ledger includes an outer face, an inner face, an outer edge, and inner edge and two side edges.

The inner edge of each integral ledger is rigidly connected to a top, bottom or side edge of its male or female base plate and extends through the plane of the back of the base plate (fig. 8, item M3 and fig. 9 item F3).

In use, the integral ledger snugly contacts the surface of the structural part to which the connector component is attached. So applied, the integral ledger ensures proper positioning of the connector component on the structural part to which it is attached. When placed in operating position, it also serves as a source of support for the connector component of which it is an integral part. (See figs. 14 and 15, item number A1.)

In one embodiment, alignment tabs control the space between adjoining structural components of the male and female connector components. Alignment tabs are formed on the female and male ledges of the connector assembly. At the moment of final engagement, these tabs force the load bearing faces of the male and female ledges (fig. 8, M11 and fig. 9, F11) apart, situating the interchangeable parts in a predictable controlled position. Consequently, this permits spacing between adjoining interchangeable parts to be controlled to a precision within the normal rolling tolerances of mild steel. Use of alignment tabs allows precise control of connection dimensions and angles, thereby allowing large and complex structures to be built using interchangeable parts without sacrificing precision.

Referring to figs. 8 and 9, item DCR1 and to fig. 16, in one embodiment, the aforesaid functions of the alignment tabs are accomplished, instead, by forming a Dimension Control Radii curvature at the corners of the joints where the male or female ledge joins its male sill or female sill respectively. The radius of this curvature is essentially equal

to the thickness of the material comprising the male or female ledge of it's opposite connector component.

As the male component slides into place the gradual bend in transition from male sill to male ledge forces the faces of the male and female ledges and sills away from each other, thereby positioning and jamming the male connector component snugly and precisely inside the female connector component. (See fig. 16, item numbers R1, R1A, R2 and R2A.)

In item numbers R1 and R2, two conditions are shown absent Dimension Control Radii. In the first condition, R1, before final engagement, although the joint should be controlled to a 5x dimension, joint expansion to a full 6x is possible. In the second condition, R2, at moment of engagement, the joint may be expanded to an uncontrolled 6x dimension since there is no interference to prevent this joint movement.

In item numbers R1A and R2A two conditions are shown incorporating Dimension Control Radii. In the first condition, before final engagement, joint growth is possible to a full 6x dimension. In the second condition, at moment of engagement, points of interference created by the Dimension Control Radii prevent the joint dimension from increasing, resulting in a tightly controlled joint dimension.

In one embodiment, the base plate and/or integral ledger of either or both the female and the male connector assembly is penetrated by portals through which fasteners, such as nails, screws, bolts, or other rigid fasteners may be passed in order to fasten the connector assemblies to the structural parts that they will join and support. (See figs. 11 and 12, item number P1.)

Referring to fig. 17, also disclosed is a manufacturing device for quickly and accurately positioning connector components taught in this patent for mounting on the modular construction parts that are to be connected. Precise mounting placement of connector components is essential to successful manufacture of the modular structure systems described in this patent. This mounting skewer acts as a guide that eliminates need for measurements or independent placement of individual

connector components. The skewer is made with two or more male or female connector components, organic to the device (S1).

In one embodiment, these aforesaid connector components organic to the device are configured with one or more indexing tabs to ensure precise positioning of the skewer when using it to install connectors (S2).

In operation, the connector components to be mounted are simply attached to the aforesaid skewer by sliding them into place on the organic connector components of the skewer in the same manner as they would be slid into place when connecting two modular parts. The skewer is then used to position them against a structural component for mounting on that component. The mounting skewer automatically ensures proper and precise relative positioning and spacing of the connector components being mounted. Additional precision relative to the modular construction part receiving connector component installation is obtained by fitting the index tab(s) (S2) snugly against said modular construction part.

Once the aforesaid connector components are secured to the aforesaid modular construction part, the skewer is disengaged from the components by sliding it off of the now mounted connector components in a reverse manner as to that which was previously used to connect the components to the skewer. This leaves the connector components attached to the modular construction part and ready for use.

The foregoing outlines and describes some of the more pertinent embodiments of the invention. These should be construed as merely illustrative of some of the more prominent forms and applications of the invention. They should not be considered to limit the invention to these embodiments. Many other beneficial results may be obtained by applying the disclosed invention in a different manner or by modifying the invention within the scope of the disclosure.

INDUSTRIAL APPLICABILITY

The invention disclosed herein retains or even improves on the advantages of the connector devices described above under in the "Background Art" section and also those of the construction systems using them, and also overcomes all the above-described disadvantages.

The connector assembly described herein offers ease of manufacturing, and shipping in that it avoids costly secondary forming operations by requiring nothing of the manufacturing process beyond basic blank forming and piercing, and requires no assembly or packing of parts beyond the interchangeable, solid, one piece male and female connectors components.

The connector assembly invention disclosed herein also provides ease of assembly for the end user, requiring no tools at all. It uses no moveable part locking devices, thereby eliminating the need for pivot pins, grub screws, levers or other parts that may require manipulation and may be subject to loss or damage.

The disclosed connector assembly also retains the advantage of "looseness" in the first stages of assembly, making for easier use in the initial stage of fitting components together, but upon completion of assembly, connector components automatically lock tightly and precisely into place. Therefore, the overall structural dimensions produced are more consistent than was possible with previous art.

Additionally, the connector assembly disclosed herein does not suffer from the tendency to become more loose and weak with time and use as did earlier art. Instead, the connector components tend to become stronger and more securely joined as time passes and usage continues. This is because the assembly is so oriented as to use gravity and loads as means of fixing its components together. As vertical load is applied to the assembled components, they become more tightly and rigidly united. However, the connectors can be easily un-mated as necessary, making them particularly well adapted to use for "knock down" structures.

Finally, the disclosed connector assembly can easily join together wide flat surfaces, face to face, in contrast to previous art, that cannot. By the foregoing, thus, the connector assembly disclosed herein facilitates creation of modular construction systems as also disclosed herein. Integral to the disclosed invention is the mounting skewer also herein disclosed that facilitates manufacture of the aforesaid modular construction systems.

CLAIMS

What is claimed is:

1. A connector assembly for connecting a first part to a second part, the connector assembly comprising a first male component to be rigidly mounted on the first part, and a second female component to be rigidly mounted on the second part;

2. A connector assembly of claim 1 wherein the male connector component is formed of rigid material such as, in illustration, galvanized steel, and consists of a base plate with a male front face, a male back face, a male top edge, a male bottom edge, two male side edges, and two male connector vanes separated such that the ends of the vanes near the top edge of the base plate are farther apart than the ends of the vanes nearest the bottom edge of the base plate, the outer edges of the vanes defining a trapezoidal shape by encompassing two sides and the points of four corners of the trapezoid, each vane comprising a male sill and a male ledge, each male sill including a front edge and a load bearing outer face, and each male ledge including a load bearing outer edge, and a load bearing inner face, the male sill extending forward from the face of the male base plate to the male ledge, rigidly connecting the two and supporting the male ledge, and the male ledge extending outwardly from the front edge of its male sill in a plane essentially parallel to the plane of the front face of the base plate, the load bearing outer edges of the male ledges dimensioned and angled in such a way as to precisely conform to the interior essentially trapezoidal dimensions and angles of the female connector component except that the male connector component vanes are longer than the female connector component vanes, such that when the male component is fully inserted into the female component, the top ends of the male vanes extend beyond the top ends of the female vanes but not beyond the top edge of the female base plate, thus resting on the face of the female base plate, preventing compression of the joint and wherein the female connector component is formed of rigid material and consists of a base plate with a front face, a back face, a top edge, a bottom edge, two side edges, and two female connector vanes separated

along the longitudinal axis of the base plate such that the top ends of the vanes are farther apart than the bottom ends of the vanes, the inner surfaces of the vanes defining a trapezoidal shape by encompassing two sides and the points of four corners of the trapezoid, each vane comprising a female sill and a female ledge, each female sill including, a front edge, and a load bearing inner surface, and each female ledge comprising an inner edge, and a load bearing inner face, the female sill extending from the face of the female base plate to the female ledge, rigidly connecting the two and supporting the female ledge and the female ledge extending inwardly from the front edge of the female sill in a plane essentially parallel to the plane of the base plate.

3. A connector assembly of claim 1, wherein the first male component and/or the second female component are each made of metal.

4. A connector assembly of claim 1 wherein the first female component and the second male component can be rigidly mated without tools by sliding them together, and unmated by reversing the process.

5. A connector assembly as in claim 2 wherein an integral ledger is incorporated on one or more top, bottom or side edges of each connector base plate, each integral ledger including an inner face, and inner edge, one edge of each integral ledger rigidly connected to a top, bottom or side edge of its male or female base plate and extending through the plane of the back of the base plate.

6. A connector assembly as in claim 2 wherein alignment tabs are situated on the female and male ledges, the alignment tabs on the female component situated at the bottom ends of the female ledges and bending backward toward the female face plate, and the alignment tabs on the male component situated at the top ends of the male ledges and bending backward toward the male base plate and by which the mated male and female ledges are held rigidly and precisely in position.

7. A connector assembly as in claim two wherein dimension control radii are employed at the corners of the joints where the female or male ledges join the male or female sills wherein the curvature radius of this joint is essentially equal to the thickness of the material from which the male or female connector components are fabricated and by which the mated male and female ledges are held rigidly and precisely in position.

8. A connector assembly as in claim 2 wherein the base plate and/or integral ledger of either or both the female and the male connector assembly is penetrated by mounting apertures through which fasteners may be inserted in order to fasten the connector assemblies to the structural parts that they will join and support.

9. A connector assembly of claim 3 wherein the male and female connector components incorporate a width web reinforcement bifurcating the connector vanes of the connector component.

10. A mounting skewer apparatus for mounting one or more connector assemblies on structural parts to be connected wherein the apparatus is made of a rigid material and includes a first end, a mid-portion, and a second end, each end thereof having a stem portion projecting within the same plane and through a plane parallel to the longitudinal axis of the mounting skewer, having affixed on the projected end of each stem, a male or female component of the connector assembly of claims 1 through 9, alternatively, such that the affixed component may mate with a corresponding, component of the opposite gender in order to precisely position that component for mounting on the first or second parts to be connected as described in claim 1.

11. A modular construction system for a knock down structure including one or more first parts and one or more second parts, the one or more first parts and the one or more second parts, all parts formed of a rigid material such as, illustratively, metal, plastic, fiberglass, or wood and each having connecting portions detachably secured to one another by connector

assemblies of claims 1 through 9, wherein the modular construction system allows a user to erect, without tools, a pre-designed structure that can be assembled without use of tools.

12. A modular construction system of claim 11 for a knock down structure comprising a residential deck system that includes a deck, stair and safety rail structure sufficiently strong to comply with load bearing requirements of in the International Residential Code 2000 RSC 2000 standards for residential structures.

13. A modular construction system of claim 11 for a knock down structure comprising a picnic table wherein all prefabricated structural components nest together for packaging and transport.

14. A modular construction system of claim 11 for a knock down structure comprising a workbench wherein all prefabricated structural components nest together for packaging and transport.

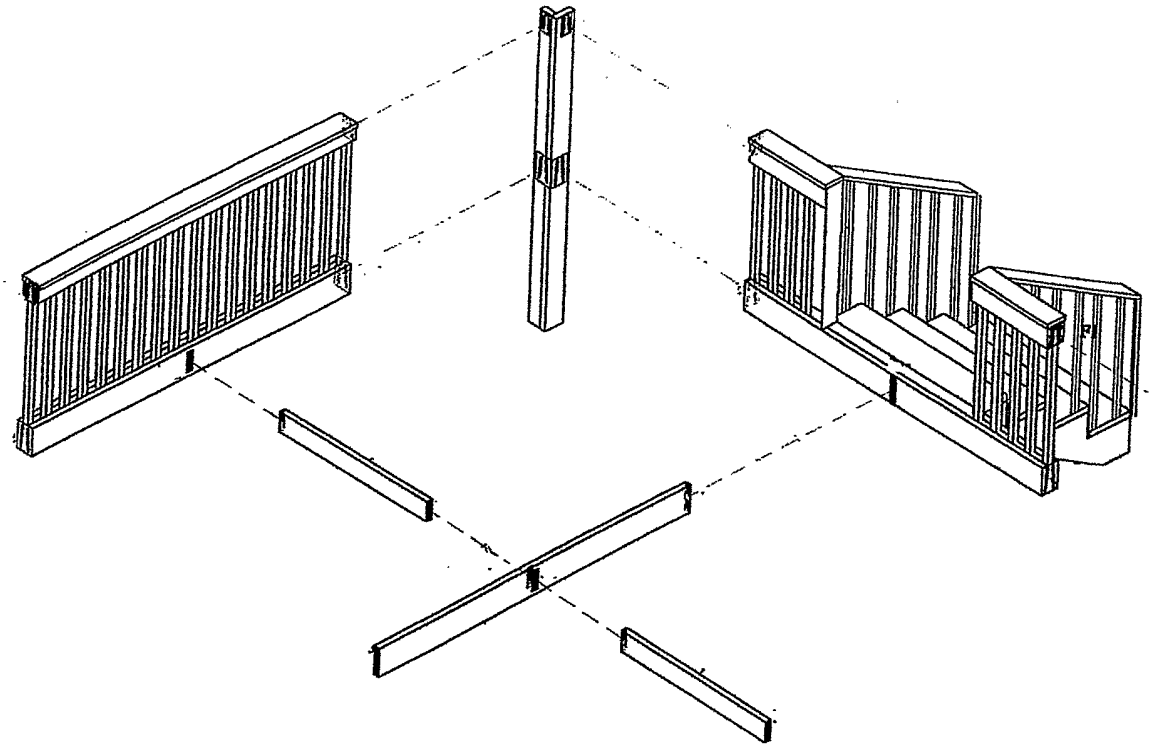


FIGURE 1

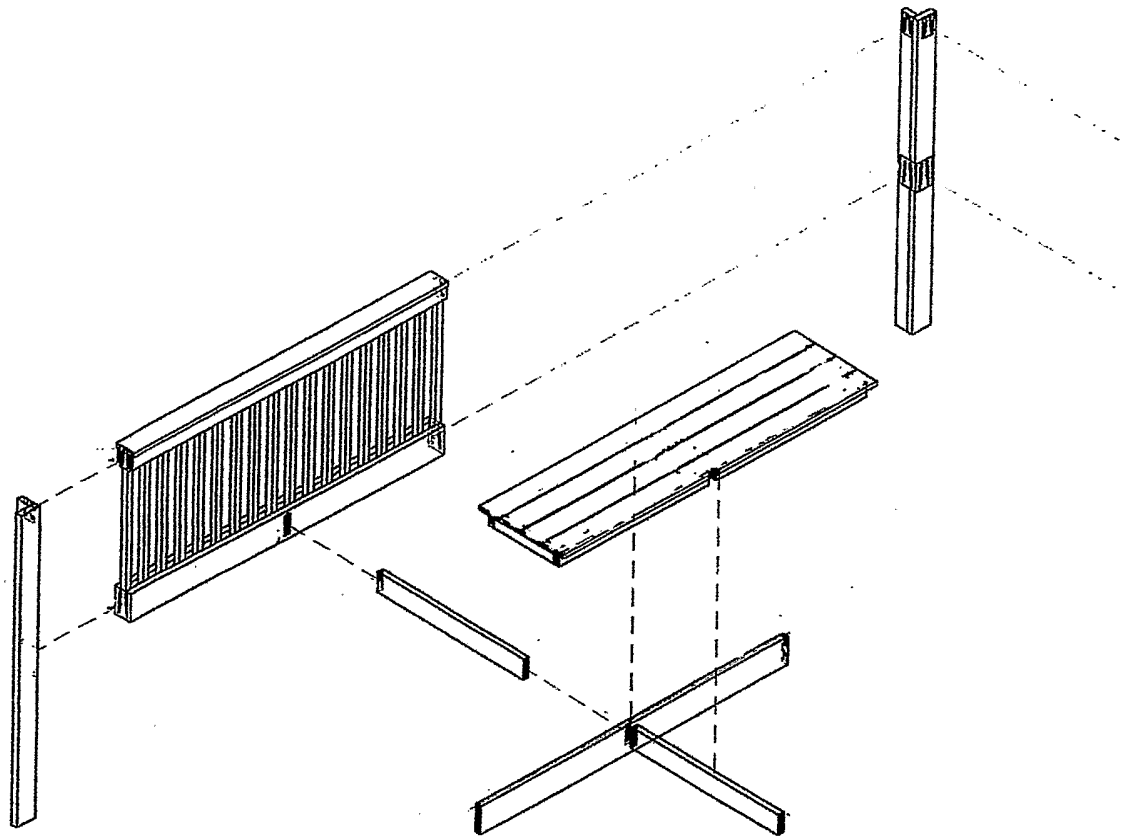


FIGURE 2

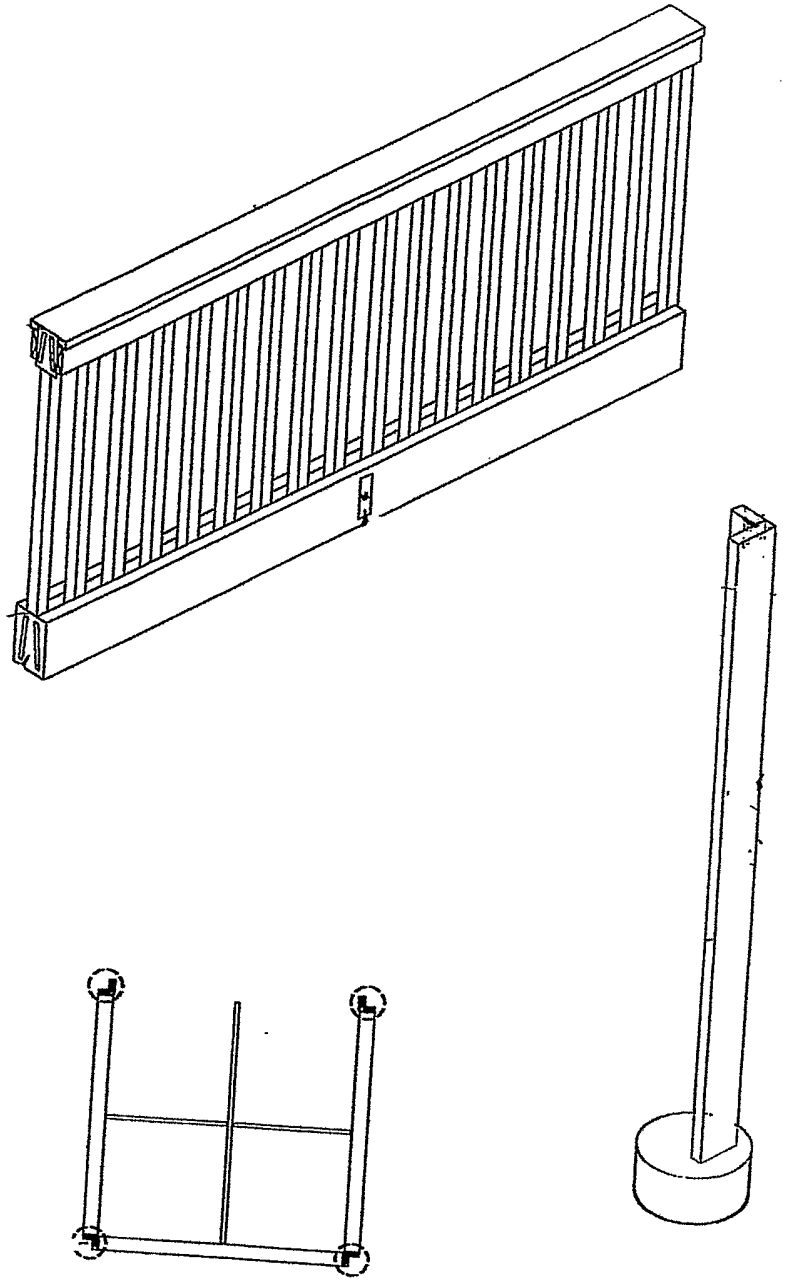


FIGURE 3

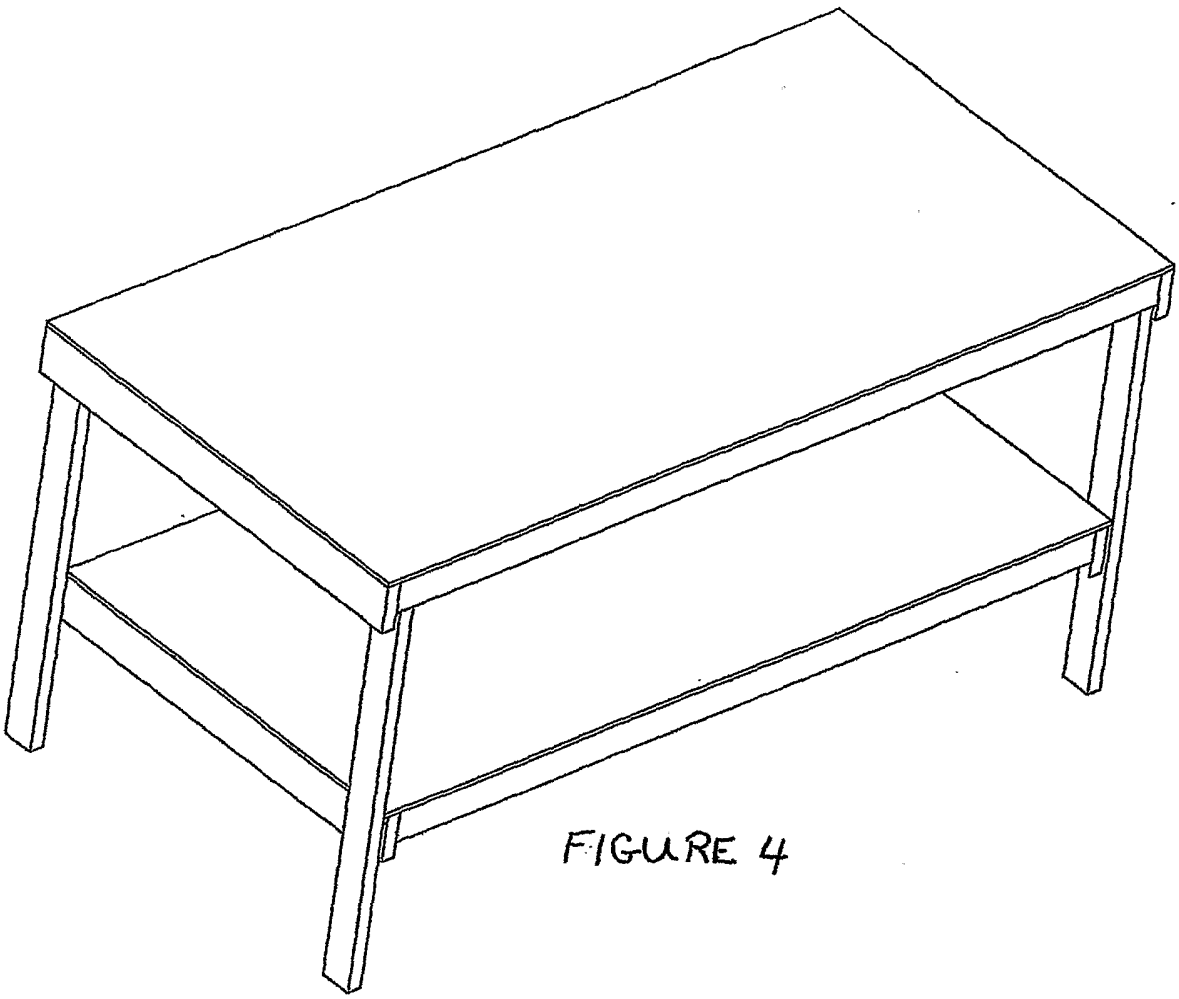
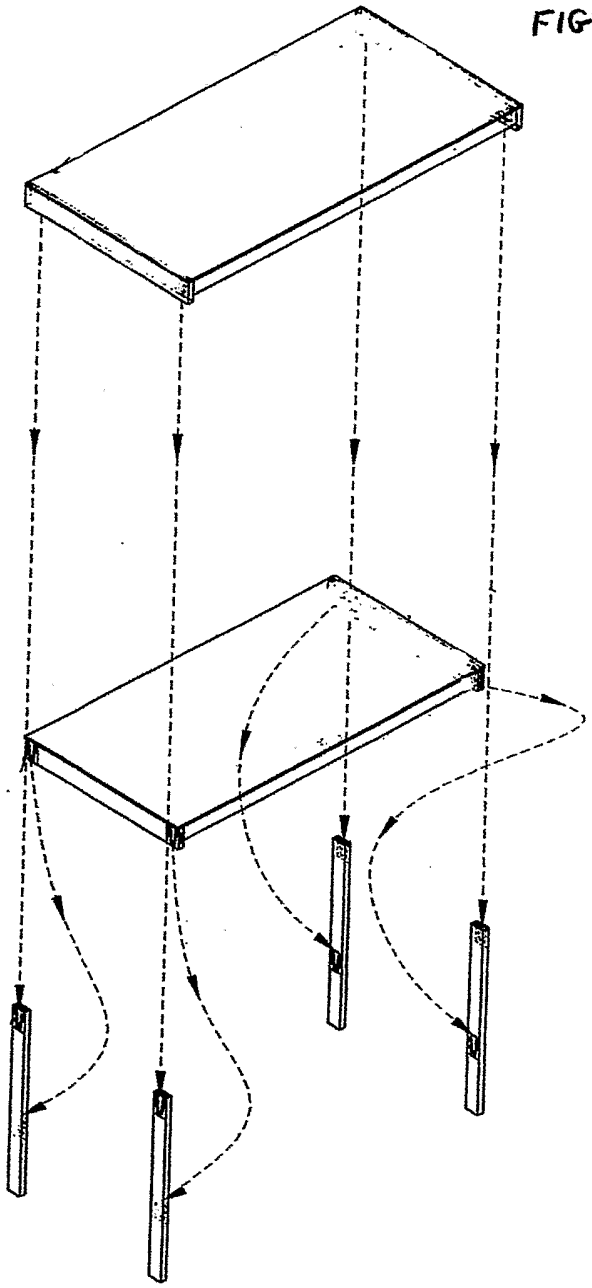
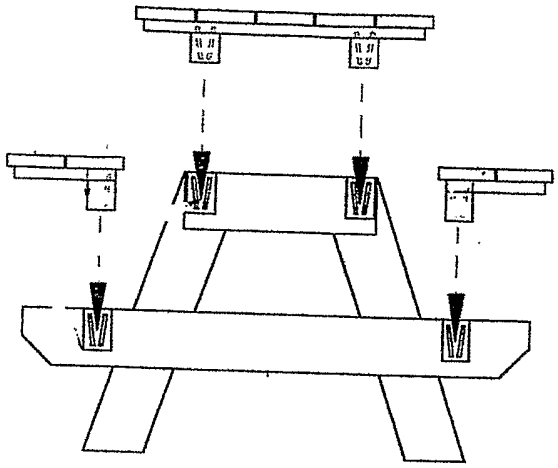


FIGURE 4

FIGURE 5





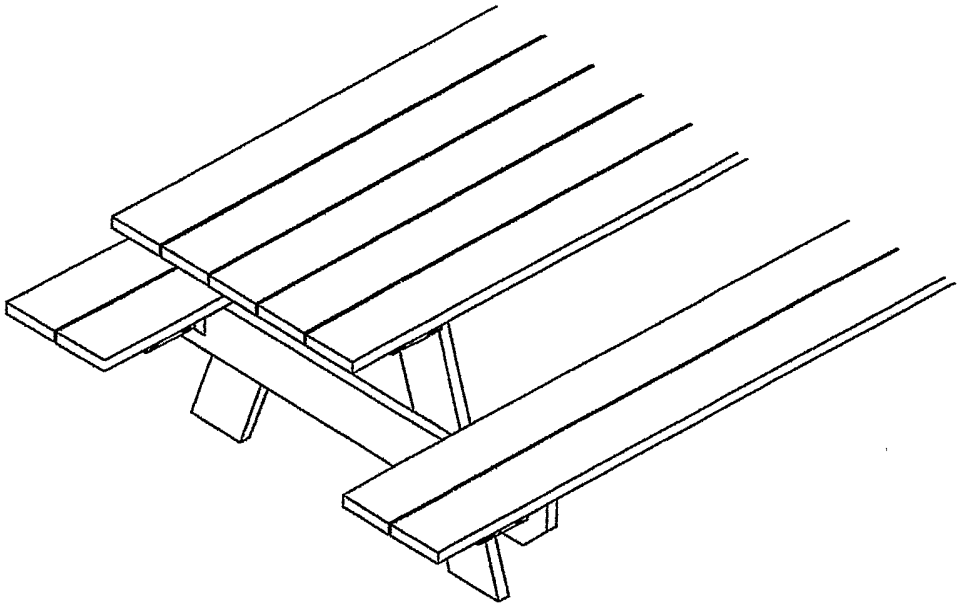


FIGURE 6

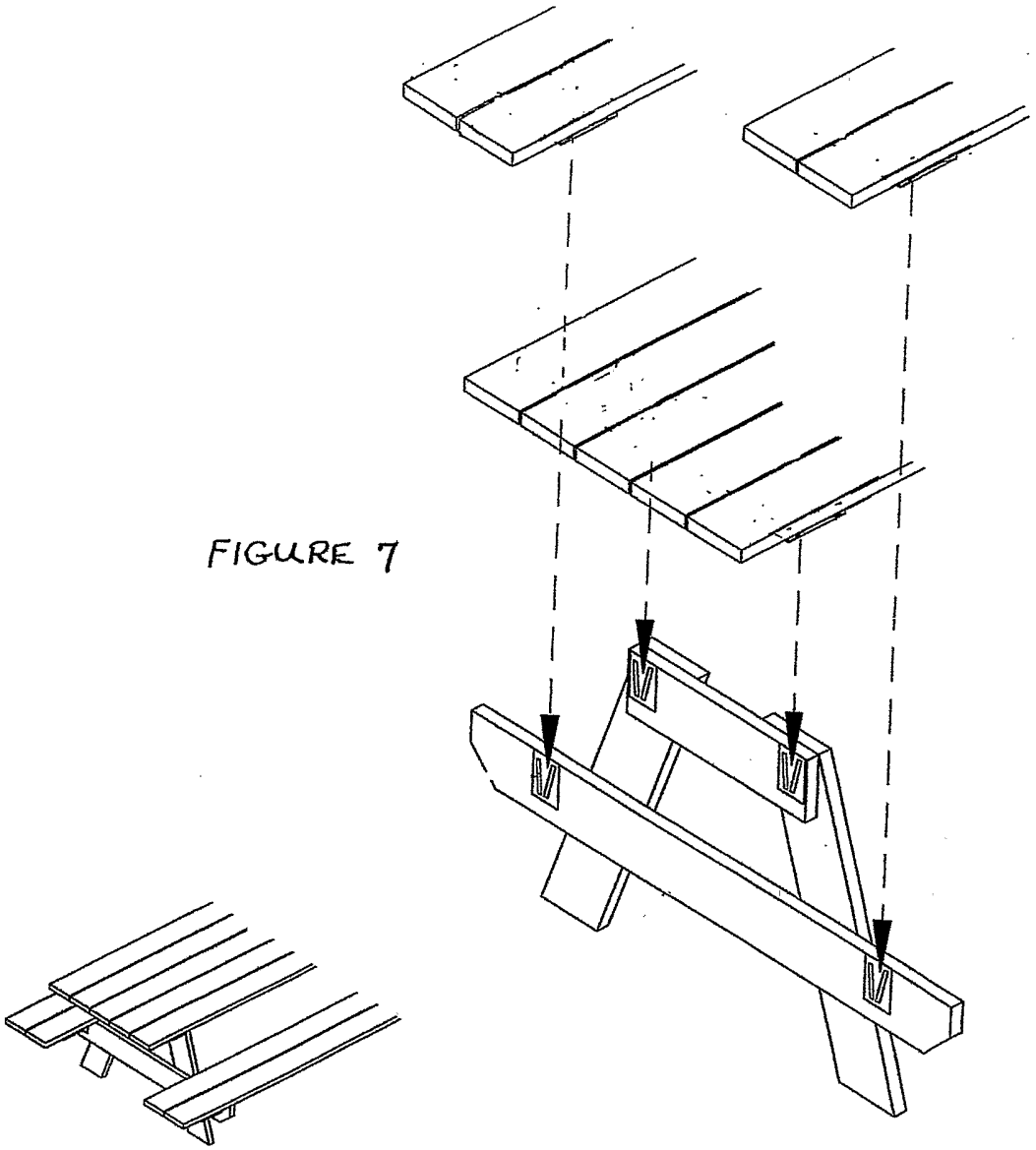


FIGURE 7

FIGURE 8

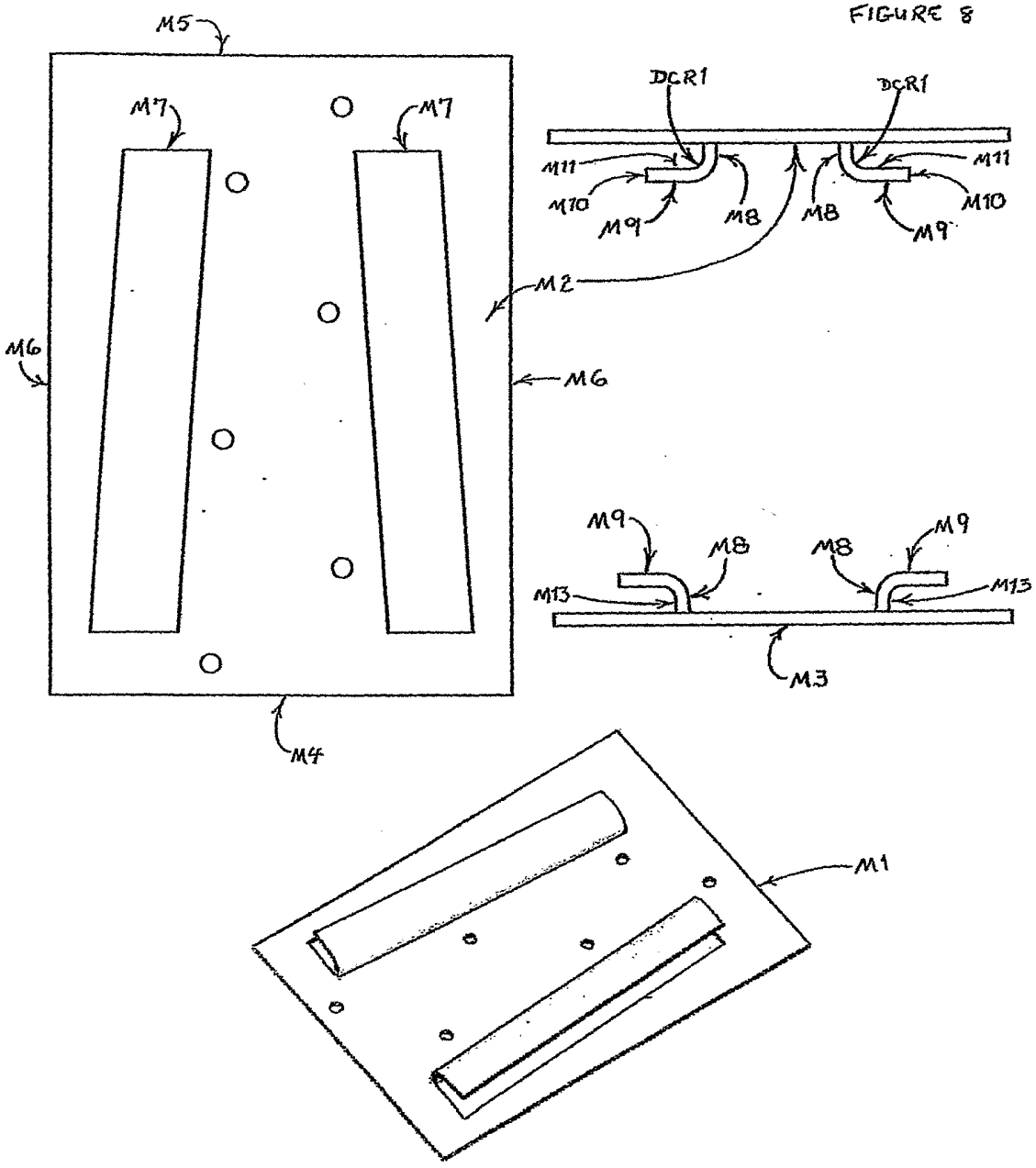
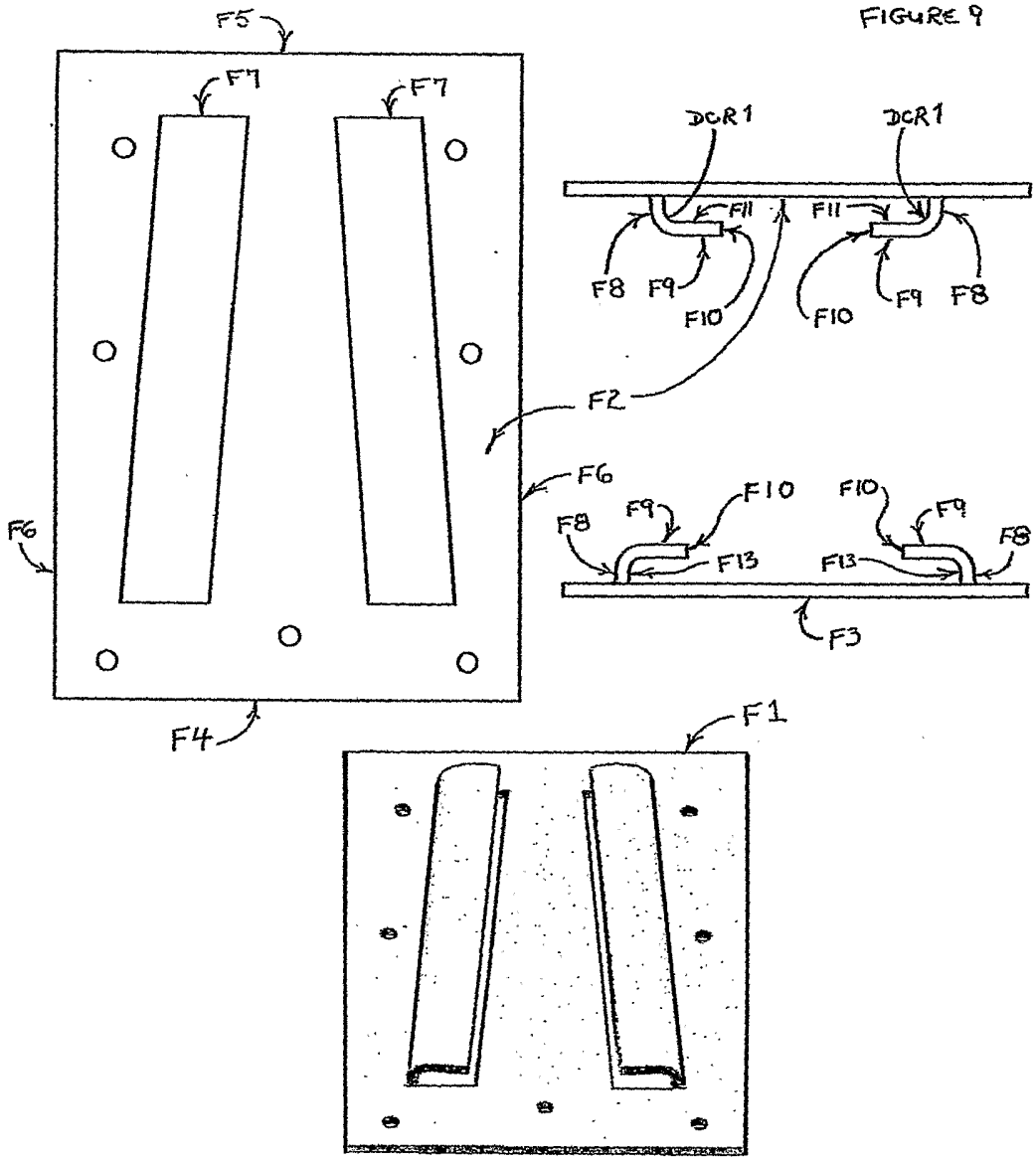

M5
M7
M7
M6
M6
M4
DCR1
DCR1
M11
M11
M10
M10
M9
M9
M8
M8
M2
M9
M9
M8
M8
M13
M13
M3
M1

FIGURE 9


F5
F7
F7
DCR1
DCR1
F11
F11
F8
F9
F10
F10
F9
F8
F2
F6
F6
F10
F10
F9
F9
F8
F8
F13
F13
F3
F4
F1

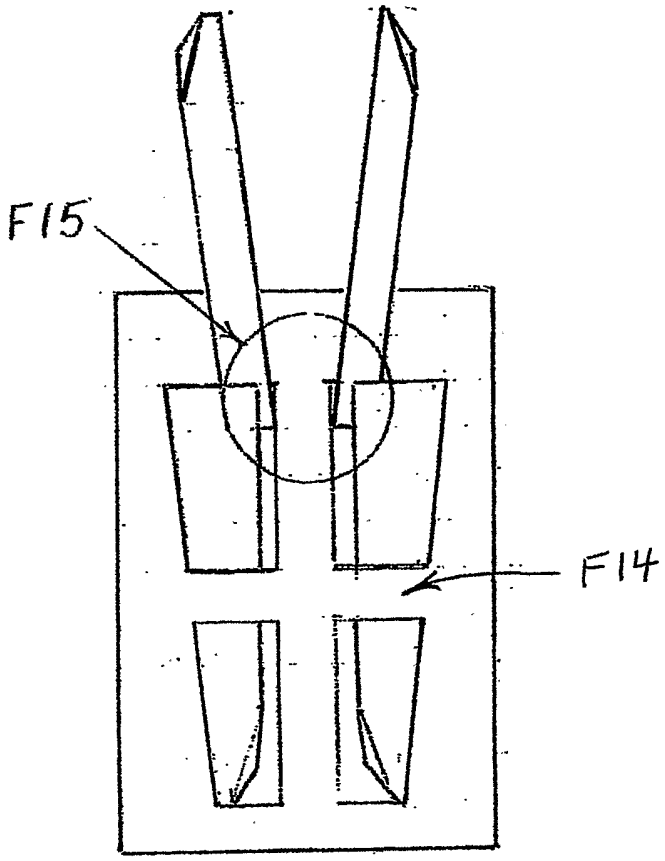


FIGURE 10

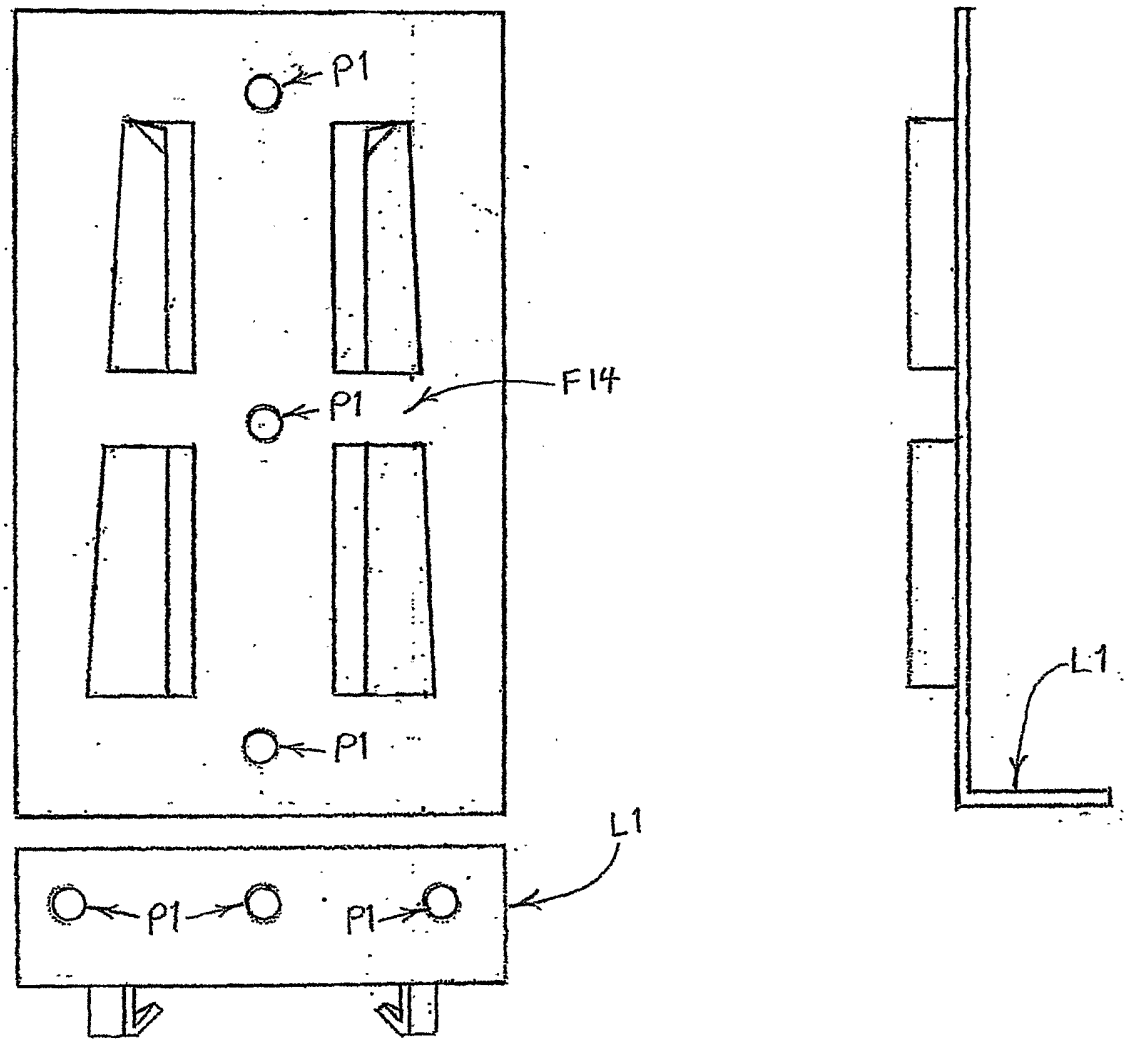
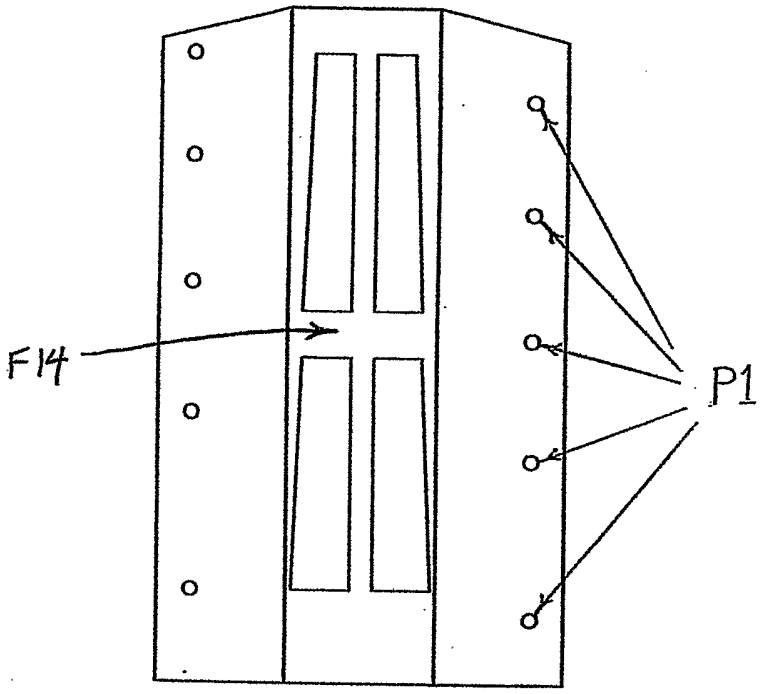
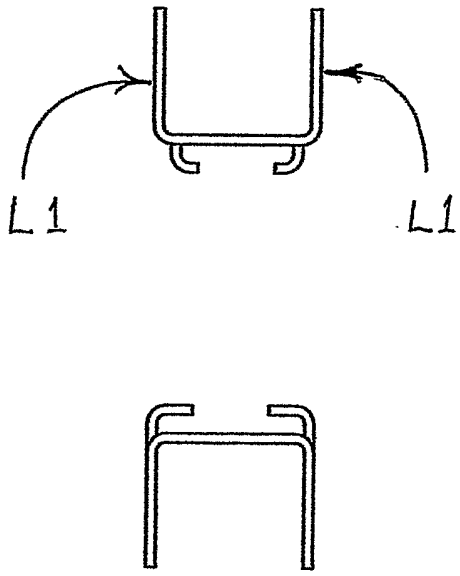


FIGURE 11

FIGURE 12





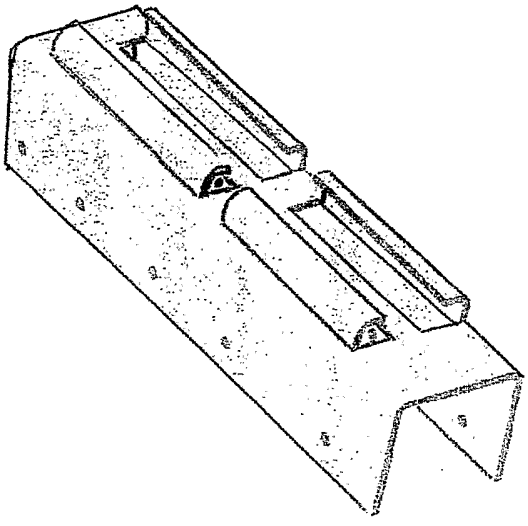
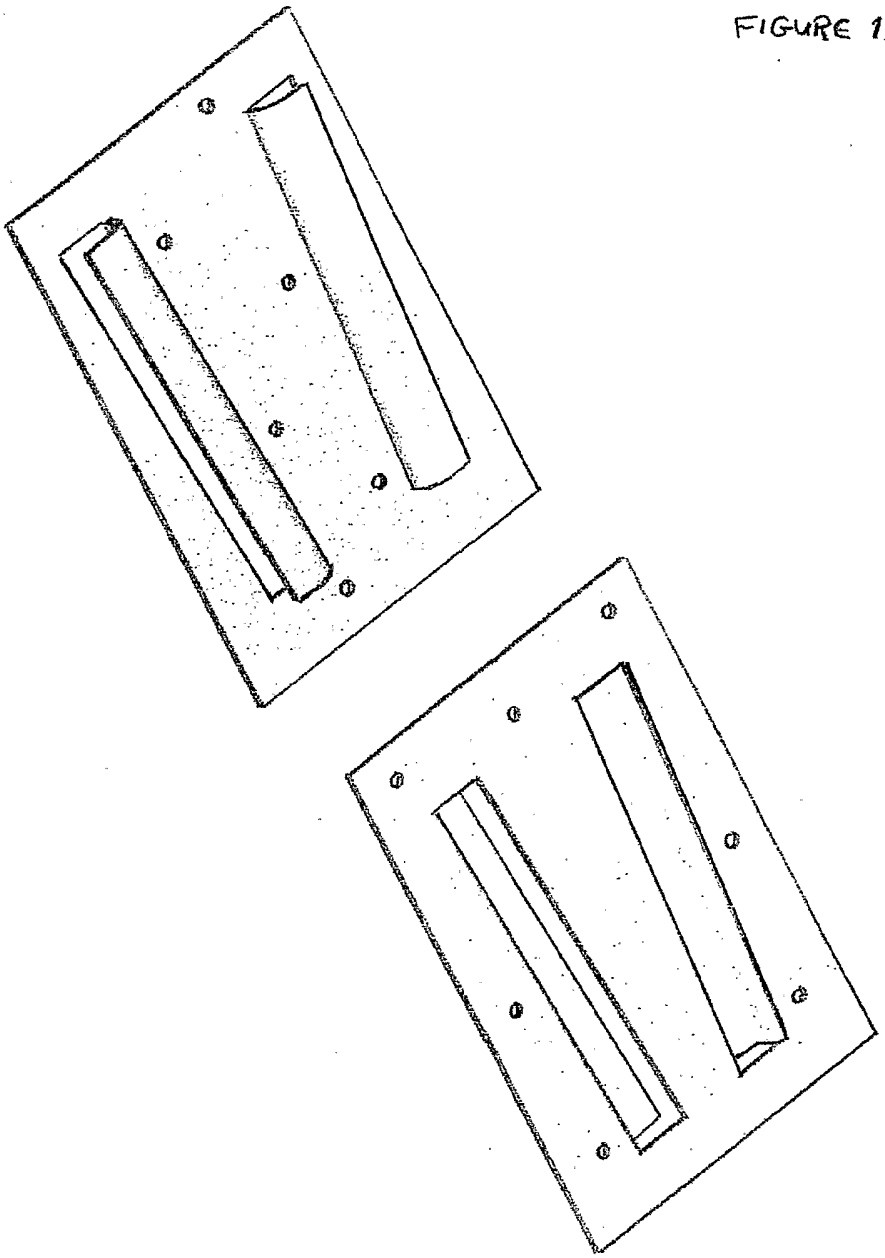
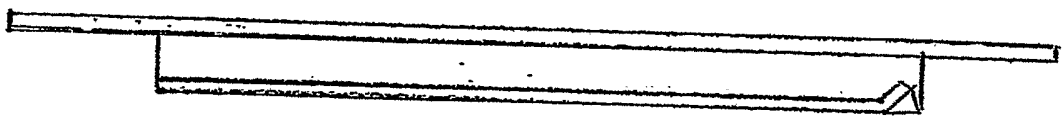


FIGURE 13





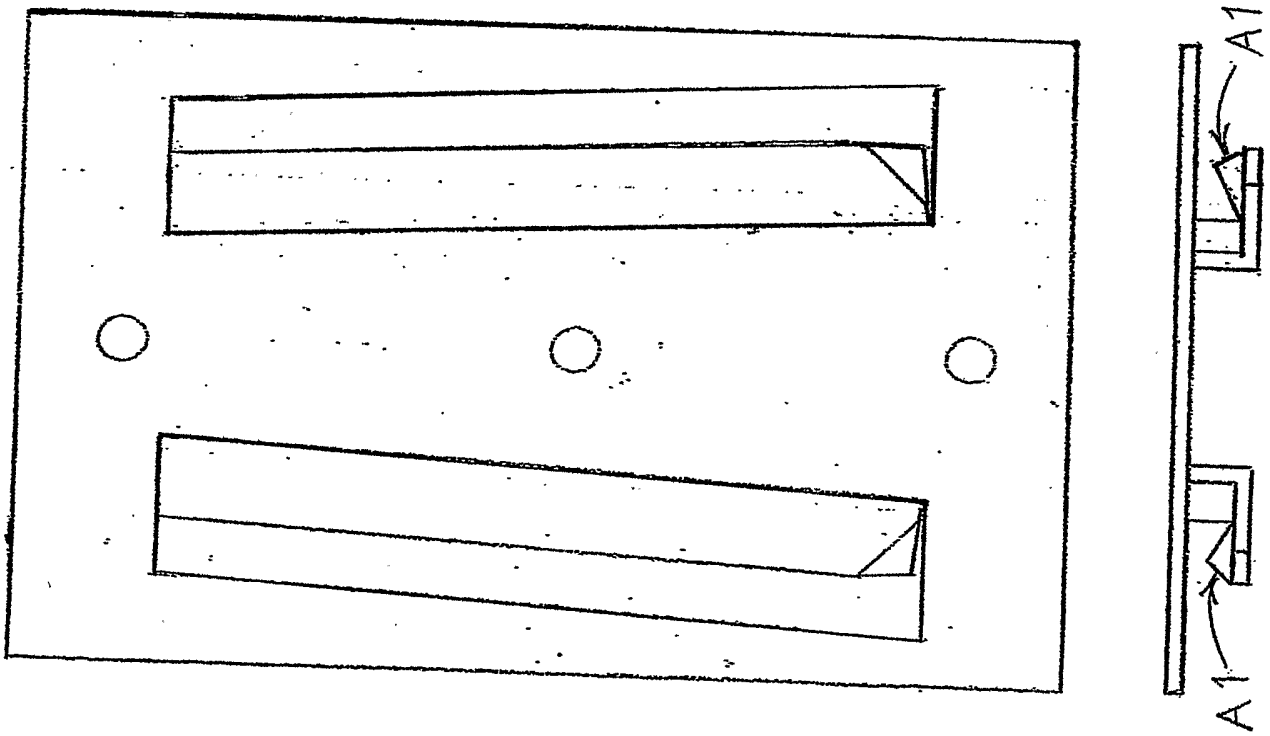


FIGURE 14

FIGURE 15

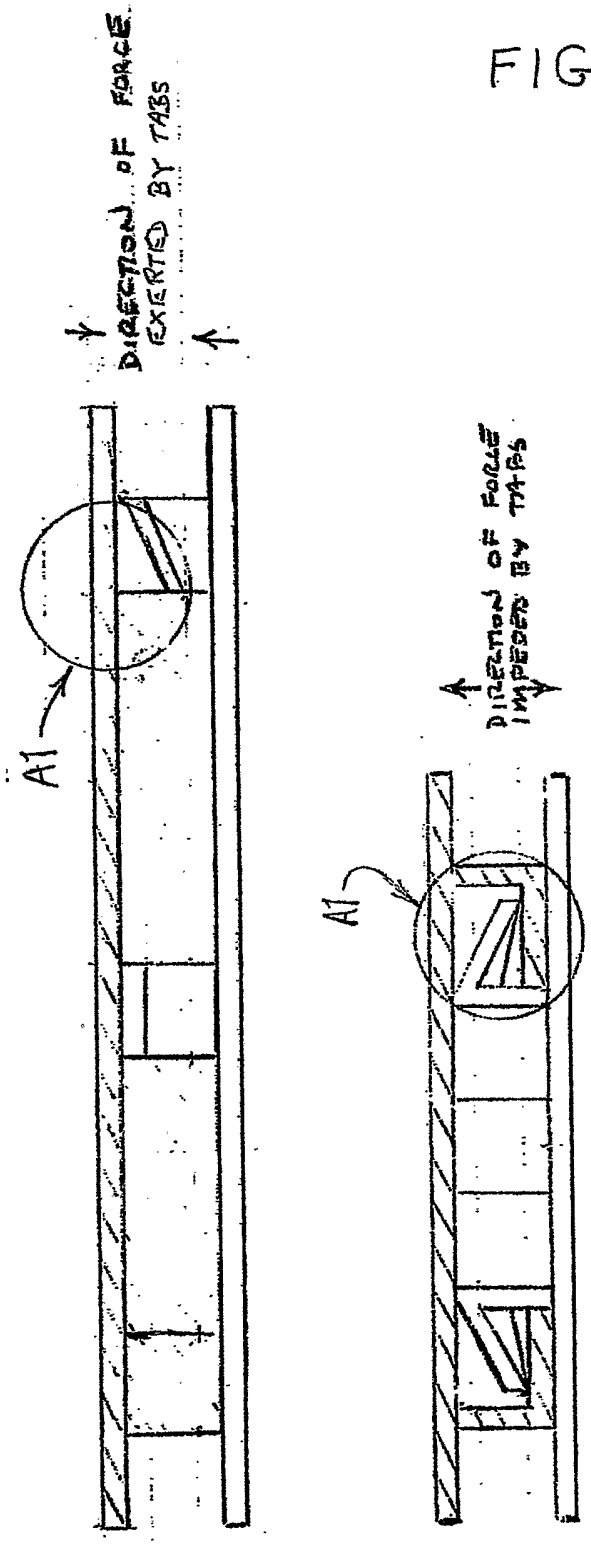
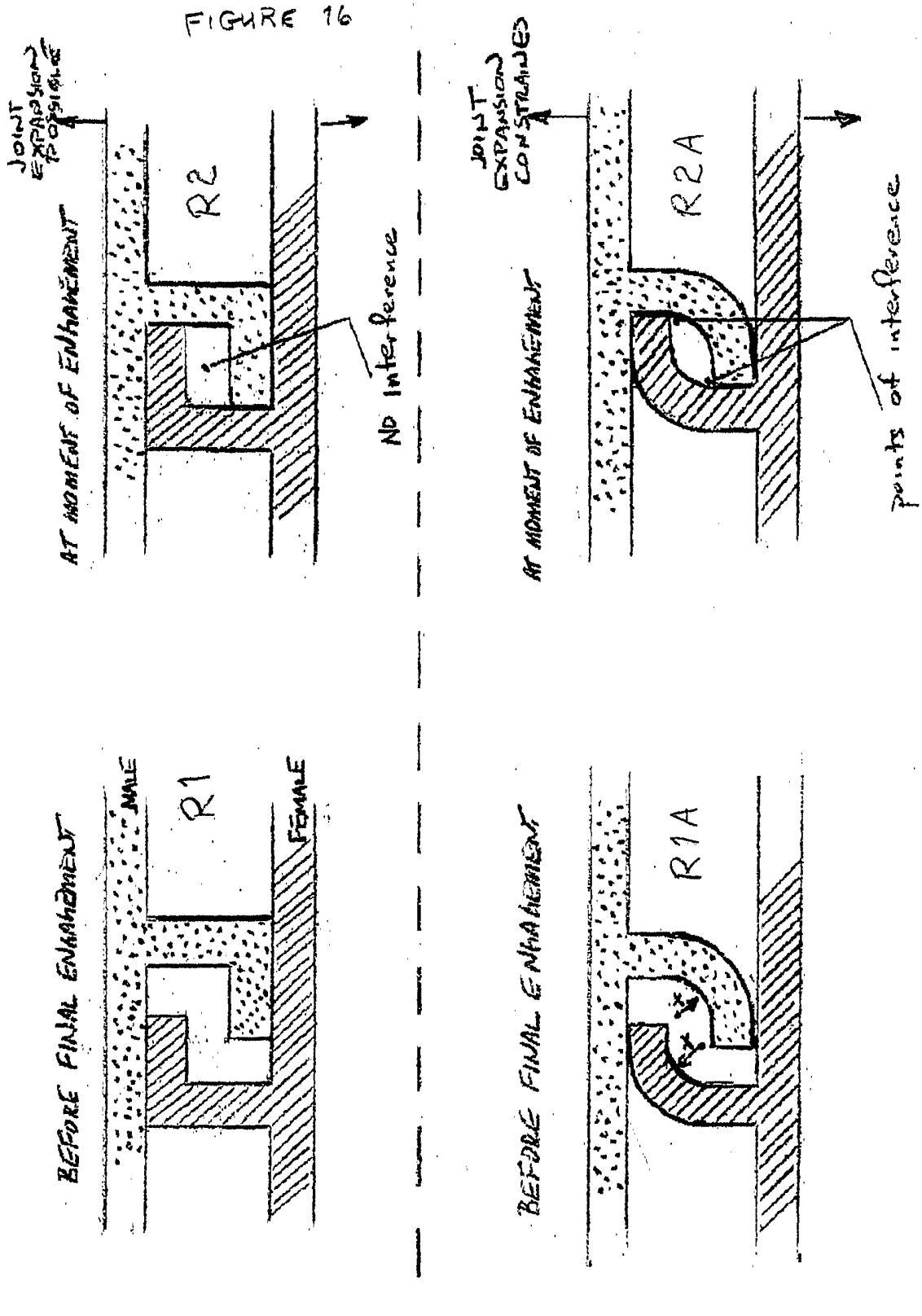
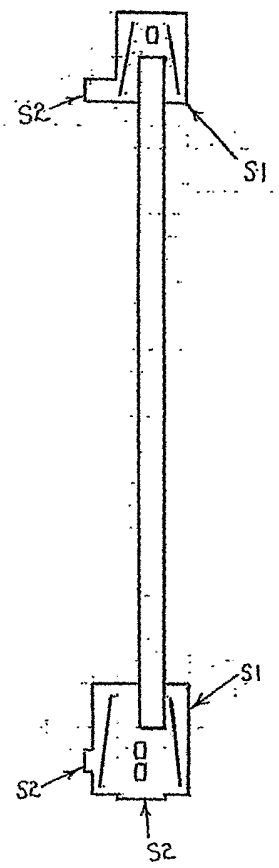
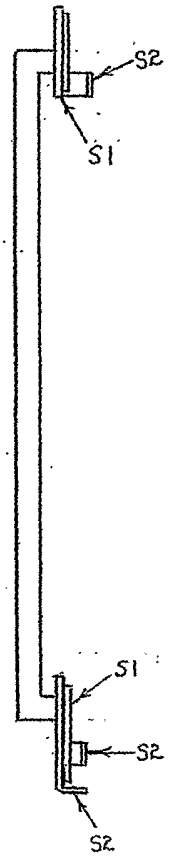

DIRECTION OF FORCE EXERTED BY TABS
A1
DIRECTION OF FORCE IMPEDED BY TABS
A1

FIGURE 16


JOINT EXPANSION POSSIBLE
AT MOMENT OF ENHANCEMENT
R2
NO Interference
JOINT EXPANSION CONSTRAINED
AT MOMENT OF ENHANCEMENT
R2A
points of interference
BEFORE FINAL ENHANCEMENT
MALE
R1
FEMALE
BEFORE FINAL ENHANCEMENT
R1A
X = MATERIAL THICKNESS


S2
S1
S1
S2
S2


S2
S1
S1
S2
S2