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[54] **EASY-TO-ASSEMBLE STRUCTURE**

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[52] **U.S. Cl.** **297/440,** 52/36, 52/272, 52/486

[51] **Int. Cl.** **A47c 4/02**

[58] **Field of Search** 52/36, 127, 584, 27, 239; 24/DIG. 11; 248/DIG. 3; 297/443, 440; 312/263, 195; 108/159; 46/17, 21, 22; 272/9, 13

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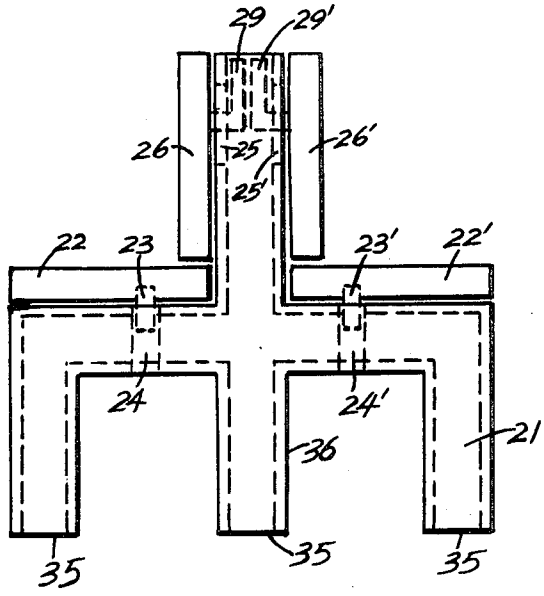
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Assistant Examiner—Henry Raduazo

[57] **ABSTRACT**

An easy-to-assemble structure is disclosed comprising at least a tubular metal frame for support. A first structural member is carried on a selected portion of the frame while a second structural member is to engage a different portion of the same frame. This second member is in gravity-controlled, locking engagement with the different portion by means of a special hook-and-slot system. The second member is also slidable against gravity along the different portion, to allow placement of the first member into its intended position and to complete the assembly of the structure. upon being assembled into this intended position, the first member prevents the second member from falling under gravity out of the engagement.

26 Claims, 5 Drawing Figures



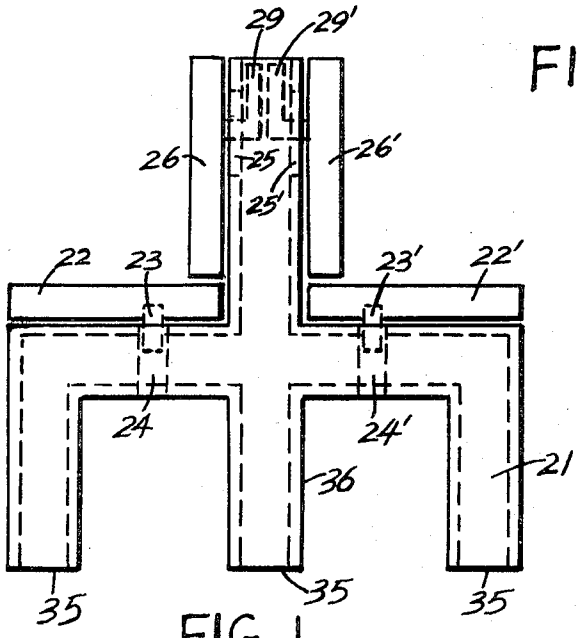


FIG. 1

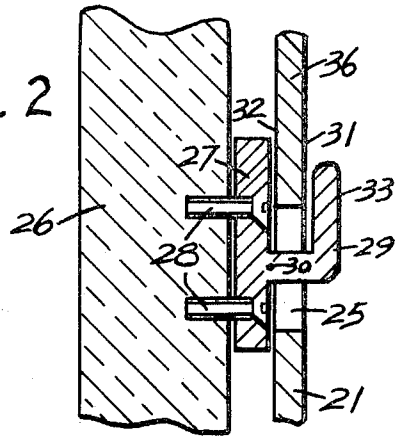


FIG. 2

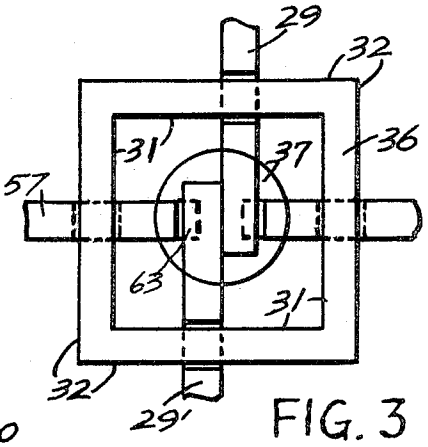


FIG. 3

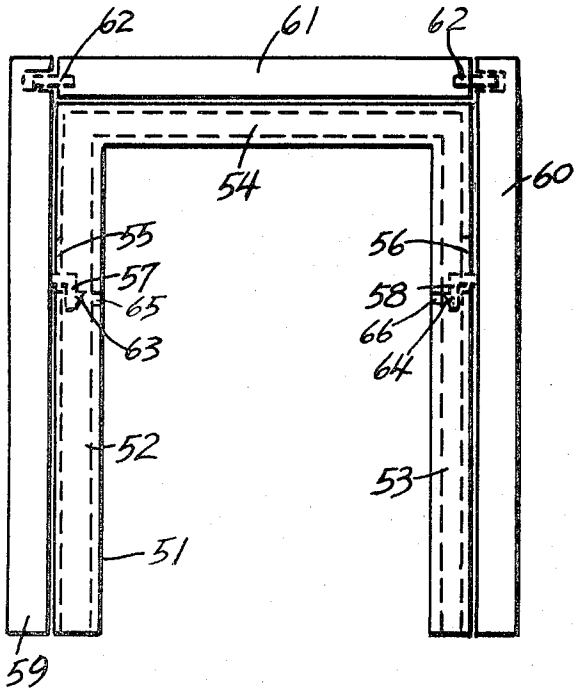


FIG. 5

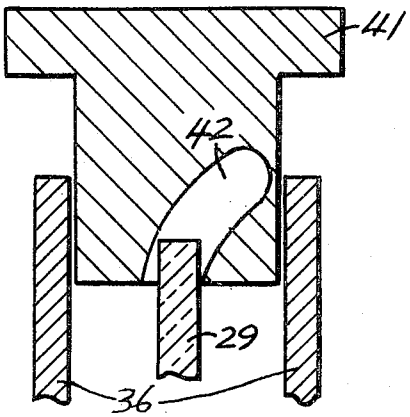


FIG. 4

EASY-TO-ASSEMBLE STRUCTURE

BACKGROUND OF THE INVENTION

The invention relates to easy-to-assemble structures, and more particularly to easy-to-assemble structures having gravity-controlled, locking engagements between their components.

The invention has wide educational, household, commercial, industrial, ... uses. While not limited thereto, it is herein described mostly in connection with a seat or bench, a (telephone or voting) booth, and a carrel-table assembly for the library study.

The ordinary library carrel-table assembly is very complicated in design but weak in structure. Usually the assembly is made of several pieces of three-fourth inch plywood assembled together by means of angle irons, brackets, tension bolts, nuts, wood screws, and the like arranged in unsightly manners. The number of these fastening devices is amazingly large. Not infrequently, there are over 60 or 85 screws or bolts to be meticulously assembled into the structure. The assembling operation typically takes two skilled persons approximately 1½ hours. Often, these persons have to spend several hours just to understand the assembly instructions alone.

The steel bolts and screws are by no means the best fastening devices for the purpose. The wood between the screw threads are easily stripped. The hole for a screw is often enlarged, thereby loosening the screw grip and hastening the stripping process. This condition soon renders the screw useless as an effective fastening device. Load on the structure is then shifted, with increasing intensity, to the other screws or bolts. Again and again, the loosening and stripping processes are reinitiated with increasing rapidity until complete failure of the carrel occurs.

Many of the screws are often located in hard-to-reach places. They are often designed to intersect the plywood surfaces at acute angles far from 90°. Such designs invariably result in weak structural joints. In addition, the many angle irons, screws, bolts, and nuts used on the ordinary carrel often protrude out of the plywood. They are thus unsightly and unsafe. The weight of the numerous fastening devices is often another undesirable factor to consider.

In summary, the conventional carrel is complicated in design, weak in structure, unnecessarily heavy in weight and, furthermore, unsightly to see, unsafe to use, time consuming to assemble, and costly to install.

SUMMARY OF THE INVENTION

Therefore, to overcome the above and other difficulties, the general object of this invention is to provide improved structures readily assembled from their components.

Another object is to provide inexpensive, easy-to-assemble structures.

Another object is to provide easy-to-assemble structures having gravity-controlled, locking engagements between the components.

A further object is to provide light but strong, easy-to-assemble structures which are simple in design and pleasing in appearance.

Another object is to provide interchangeable and intermixable structural components to greatly enhance design flexibility.

Other objects and advantages, and a more complete understanding of the invention will become apparent from the following descriptions and claims, taken in conjunction with the accompanying drawing.

DESCRIPTION OF THE DRAWING

For the purpose of illustrating the invention, there is shown in the drawing the forms which are presently preferred. It is understood, however, that this invention is not necessarily limited to the precise arrangements and instrumentalities here shown.

FIG. **1** shows a side view of a simple bench, or a back-to-back double bench according to the invention;

FIG. **2** shows some details of the counter-gravity locks used in the bench of FIG. **1**;

FIG. **3** is a top view of one of the tubular metal members, together with the metal hooks intruded from the sides into the tubular metal member and joined together by cement or other means;

FIG. **4** shows a bending die used to bend or twist the hooks, so as to secure permanent locking engagement of the structural components;

FIG. **5** is a front view of a telephone booth showing the use of a gravity-locking engagement.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** shows a side view of an easy-to-assemble bench. Here, a rigid framed supporting device **21** is first placed with its feet **35** on the ground but its vertical column or columns **36** (about 50 inches high) in upright positions. One or more of the feet **35** may have height-adjusting mechanisms, such as screws with bottom pads, to insure leveling of the bench. Preferably, the frame is made of rectangular or square metal tubes, such as 1½ × 1½ inch, **14** gauge cold-rolled, tubular steel. A horizontal seat member **22** made of plywood three-fourth inch thick by 18 inches wide is to be placed on the top surface of the seating portion of the frame (at about 17 inches from the ground). This horizontal member **22** is prevented from moving horizontally, particularly away from the vertical columns **36,** by a dowel or dowels **23,** about three-eighth inch in diameter by three-fourth inch long built into the underside of the horizontal member **22.** The dowels **23** are adapted to engage matching holes **24** on the supporting device **21.** Each of the vertical columns **36** has at least one vertical, narrow slot **25** made by punching, slitting, or other means (see FIG. **2**). A vertical member **26** forming the back support of the bench and also made of three-fourth inch plywood is next mounted in a vertical position against the column.

As shown in the enlarged view of FIG. **2,** the vertical member **26** has one or more metal plates **27** (e.g., **12** gauge cold-rolled steel) secured to its back side by glueing, or factory-inserted screws **28.** Hooks **29** are partially cut or stamped out of the metal plates **27,** and bent 90° at their bases **30,** which are still connected to the metal plates **27.** The **90°** bending provides, for a given metal plate and tubular column, much greater steel-to-steel bearing surfaces and better joint strength than otherwise possible.

The hooks **29** in FIGS. **1** and **2** have open ends pointing upward, and are positioned to be all inserted simul-

taneously into the matching slots **25.** Further, the hooks **29** and slots **25** form counter-gravity locking engagements to secure, against gravity, the vertical member **26** to the columns **36.** By inserting the hooks **29** into the slots **25** and lifting the vertical member **26** relative to the frame **21,** the rear part of the horizontal seat member **22** may be inserted directly below the lower edge of the vertical member **26** and, simultaneously, properly dowelled with the dowels **23.** The insertion of the horizontal or seat member **22** prevents the vertical member **26** from falling under gravity out of the locking engagement and instantly completes the assembly of the structure. These simple procedures take two men only a few minutes' time to complete the assembly of the sturdy bench structure.

It is to be particularly noted that the hooks **29** have generally vertical sides to match the inside wall **31** and outside wall **32** of the tubular vertical columns **36.** Further, there are substantial contacting regions (over at least three-eighths inch high) between the hooks **29** and tubular metal walls **31** and **32.** This insures a strong locking engagement. The thickness of the hooks **29** is less than the width of the matching slots **25,** preferably by only a few mils or less, so as to achieve high joint strength. The hooks **29** may even be thinner at their entrance edges **33,** but thicker at their bases **30,** than the matching slots **25,** so as to achieve interference fits. For this last application, the metal of the vertical columns **36** should preferably be strain-hardenable, such as iron, steel, or aluminum, in order to strain-harden and strengthen the metal around the slots **25** near the bases of the intruding hooks **29.**

If required, the above bench can be extended to any length by lengthening the supporting device **21,** the horizontal seat member **22,** and the vertical member **26.** Alternately, the seat and vertical members, **22** and **26,** can each be made of several segments of plywood pieces 6 or 8 feet in length. For a short bench, say less than two feet, only one dowel **23** and a single locking engagement from a pair of slot and hook is needed. In this case, the vertical member **26** is adequately secured to the frame **21** by this locking engagement and also by having its lower edge bearing on the horizontal seat member **22.** This seat member **22,** meanwhile, is held in position by the vertical member **26** and dowel **23.**

In most cases, however, two or more dowels **23** and hook-slot pairs are needed. It may even be desirable, particularly with tall vertical members **26,** to have the hook-slot pairs arranged in two or more horizontal rows. The details of this arrangement can be readily designed by any skilled persons in the art.

The rigid and self standing, framed supporting device **21** may be made of a single plastic or cement piece, with short pieces of slotted metal tubes molded or cast in place to form the needed slots **25** at a given height level and specified horizontal distances apart. The same supporting device **21** can also be made of metal tubes joined together by, e.g., welding or brazing. This same device can even be made of two or more parallel, similar and spaced apart tubular frames. Each frame has at least one slot **25** for engagement by a hook **29** secured on the vertical member **26,** and also has a hole **24** for engagement by a dowel **23** secured on the horizontal members **22.** Upon the completion of these engagements, these frames **21,** the vertical member **26,** and the horizontal seat member **22** are all assembled together into a strong, unitary bench structure.

Notice that in assembling the above bench, there are no screws or bolts to be selected, positioned, aligned, turned, ... There are certainly no protruded bolts, nuts, or angle irons. There are also no metal parts, except possibly for portions of the supporting frame, to be seen or to cause personal injury, at least on the critical front side. The outer surfaces of the vertical member **26** and horizontal member **22** are not damaged or changed in the slightest manner. Artistic designs or color patterns on these surfaces will therefore be uninterrupted by screw holes, nuts, bolts...

As shown on the right side of FIG. **1,** a second seat or bench arranged back-to-back to the previous seat may also be assembled on the same but extended supporting device **21.** Needed here are only an additional horizontal seat member **22'** with its attached dowel **23'** to fit into hole **24',** and another vertical member **26'** with its attached hook **29'** to engage with its matching slot **25'** in the same vertical columns **36.**

The hooks **29** and **29'** may extend from opposite sides into the tubular columns **36** no further than the center of the tubes, so as to avoid possible interference during assembly (see horizontal hooks in FIG. **3**). The same hooks **29** and **29',** however, may be purposely extended farther than the center of the tubular columns **36** and horizontally offset to a degree so that they physically contact each other (See the two hooks **29** and **29'** in FIG. **3**). This condition strengthens the assembled bench structure. To further increase the strength of the structure, the contacting edges on the hooks **29** and **29'** may be positively joined together by means of a cement blob **37.** According to one aspect of the invention, a cement consisting of an epoxy and a hardener is used. The contacting surface of one hook, e.g., hook **29,** is coated with a layer of the hardener while the contacting surface of the other hook, i.e., **29',** is coated with a layer of the epoxy. Such coated surfaces can be stored without change almost indefinitely, particularly if the cement components are surface sealed by very thin layers of plastics or metals. Upon assembly of the bench structure, however, these coated surfaces contact each other, the epoxy and hardener are mixed, and a strong cement joint is formed. The surface of the hooks **29** and **29'** contacting the inside wall **31** and outside walls **32** of the tubular columns **36** can be similarly coated with an epoxy, while the surfaces of the walls **31** and **32** coated with the hardener, so as to achieve further strengthening of the assembled structure.

Another way to achieve a permanently assembled structure is to twist or bend the hooks **29** and **29',** after they are inserted through the slots **25** and **25'** into the tubular columns **36.** The bending or twisting can be accomplished by means of a screwdriver or a pair of pliers. A more uniform and reliable way is to insert a bending die **41** into the vertical column **36.** The die **41** fits snugly inside the tube and has, on its lower end, one or more special slots **42** to engage with the hooks **29** and **29',** preferably simultaneously. When the top of the bending die **41** is hit, e.g., by a hammer, the hook **29** is twisted into the required shape in accordance to the design of the slot **42** and selection of the hook material. Once bent or twisted, the hooks **29** and **29'** can no longer be taken out of the thin slots **25** and **25'.** It is even possible to design an unbending die with special slots of a different shape to straighten the twisted hooks **29** or **29'** for their removal from the slots **25** and **25'** and for disassembly of the structure.

FIG. 5 shows a front view of a telephone booth comprised of two parallel, front and rear planar frames **51** made of 1½ × 1½ inches cold-rolled steel tubes. Each frame has two vertical columns **52** and **53** joined at their tops by a horizontal member **54.** The vertical columns **52** and **53** have four vertical slots **55** and **56** (two on the front frame and two on the rear frame) for engagement with four hooks **57** and **58.** These hooks are secured to the three-fourth inch plywood, side panels **59** and **60.** A horizontal top cover **61** made also of three-fourth inch plywood is designed to rest on the horizontal members **54.** The cover **61** also has four dowels **62** (two in the front and two in the rear) to engage into holes drilled into the two side panels **59** and **60.** The four hooks **57** and **58** here are similar in design to those of FIGS. **1** and **2** except that the four hooks are of the gravity-locking type. That is, the weight of the side panels **59** and **60** causes the hooks **57** and **58** to engage more closely with the slots **55** and **56,** while simultaneously holding the top cover **61** in its proper position with the aid of the four dowels **62.**

In assembling our telephone booth, the two tubular frames **51** are first set up, one at the front and one at the rear at a specified distance apart. The top cover **61** and the two side panels **59** and **60** are guided to come together with the dowels **62** halfway in their matching holes, and positioned relative to the frames **51** so that the top member **61** is assembled at the same time as the two side panels **59** and **60** are pushed down and locked by the hooking engagements.

The top members **54** of the frames **51** should be about 7½ feet high and the horizontal distance between the two vertical columns **52** and **53** of the frames **51** should be about 2½ feet, to accomodate comfortably a standing person inside the assembled telephone booth. This horizontal distance should be increased to 5 or 6 feet if the assembled structure is to be used as a voting booth instead of as a telephone booth. The top members **54** may be lowered to about 30 inches if the structure is to be used as a table, with the side panel **59** and **60** standing either flush with the top table member **61** or a few feet higher to provide privacy for the person using the table. Similarly, the horizontal members **22** and **22'** of the bench in FIG. **1** can also be raised from 17 inches to about 30 inches to provide a single, or double table.

This new table of FIG. **1** can even be combined with the boothlike structure of FIG. **5** to form a library carrel having two divided tables (i.e., the horizontal members **22** and **22'**), a common book shelf (i.e., the top cover member **61**), and two tall side panels **59** and **60** for privacy. Further, in this new library carrel only a single supporting device, rather than two, is needed. For example, only the two end frames **51** are needed each with two vertical columns **52** and **53.** Each of these columns is provided with three vertical slots on its three sides for the hooks **29, 29',** and **57** or **58.** These hooks can also be inserted into the metal tubes to be bent or cemented together therein. Notice that the hooks **57** and **58** have fish-hooked tips with one-eighth inch lips **63** and **64** (see FIG. **3** and **5**). When the sid panels **59** and **60** are pushed down, these lips overjump the hooks **29** and **29',** and lock them firmly in position (See FIG. **3**). To release the hooks **29** and **29'** from the lips **63** and **64,** rods must be inserted through the holes **65** and **66** to push back the lips, and the side panels must be lifted simultaneously.

The assembly of the structures according to our invention takes two men only a few minutes. This represents savings in labor costs of over 90 percent. Further, in our units there are no angle irons, and no tension holding members which are weak and unreliable. Instead, most loads are now carried by the widely spread-out, bearing or compressive contact forces, either wood on wood or steel on steel. The gravity-controlled, locking engagements are particularly useful in our structures. Even the dowels do the job of both dowelling and locking.

It is easy to see that the gravity-controlled, hook-and-slot system of this invention can be used not only for such structures as chairs or benches, tables, telephone or voting booths, library carrel-table assemblies, shelves, movable furniture; but also for wall panelling, elevator interior panelling, partitions, home construction, fences, signs, and snow drift fences. In fact, the use of our novel structures is indeed very far-reaching.

The invention is not to be constued as limited to the particular forms disclosed herein, since these are to be regarded as illustrative rather than restrictive.

We claim:

1. An assembled structure comprising:

a rigid and self-standing supporting device including at least one hollowed post that contains therein wall means defining at least an elongated slot, and having a generally vertical supporting surface and also having a different supporting surface in angular relation with the vertical supporting surface;

a first structural member having an upper surface and a lower surface with the lower surface resting in bearing engagement with the different supporting surface;

a second structural member having a front major surface and a rear major surface with at least a portion of the rear major surface bearing against the vertical supporting surface so as to have a prescribed spatial relation relative to the first member, the second member also having a lower edge resting in weight-supporting, bearing contact with the top surface of a selected portion of the first member placed thereunder; and

locking means for securing the second member in counter-gravity locking engagement with the vertical supporting surface, the weight of the second member tending to cause the second member to slip out of the locking engagement but being prevented from doing so by the selected portion placed underneath the second member;

said locking means comprising hook means attached to the second member and having an arm projecting rearwardly from the rear major surface, the arm turning upwardly and terminating into a generally vertical portion, the arm and the vertical portion having a total height less than the height of the slot so as to allow their insertion into the hollowed post through the slot to achieve the locking engagement,

the height of the slot being greater than the thickness of the selected portion with the positive difference therebetween being less than the total height whereby the second member is movable against gravity to allow placing the first member thereunder for instantly completing the assembly of the structure but once so placed, the first member

through the selected portion thereof prevents the second member from moving sufficiently downward to allow the hook means to be disengaged from the slot; and whereby the assembled structure can be disassembled by first elevating the second member sufficiently to allow removing the first member from underneath the second member thereby permitting the second member to be lowered before the hook means can be disengaged from the slot.

2. The structure of claim **1** wherein the device comprises a portion of metal having walls therein defining the elongated slot, and

the locking means comprises at least one metal hook secured to the second member and insertible in locking fit into the slot when aligned therewith.

3. The structure of claim **1** wherein the device comprises a tubular metal frame having a front and a rear vertical supporting surfaces, and the locking means secures the second member in counter-gravity, locking engagement with said front vertical supporting surface;

the first member upon being engaged with the different supporting surface preventing the second member from falling under gravity out of the locking engagement.

4. The structure of claim **3** wherein the tubular metal frame has on the front side walls defining two generally vertical slots located at approximately the same height level but at a prespecified horizontal distance apart, and the locking means comprises two metal hooks secured to the second member at the same horizontal distance apart and insertible into the slots when aligned therewith so as to form the locking engagement between the second member and the vertical supporting surface.

5. The structure of claim **4** wherein the rear side of the frame has walls defining two generally vertical, similar slots located at approximately the same height level and at the same horizontal distance apart as the slots on the front side of said frame, and including a third structural member carried on the rear side and engageable with a third supporting surface on the frame in a manner generally similar to the first member on the front side,

a fourth structural member engageable with the frame in a back-to-back arrangement relative to the second member while resting on an adjacent area on the third member,

and a second set of metal hooks secured to the fourth member at the same horizontal distance apart and insertible into the similar slots to also form locking engagement between the fourth member and a fourth supporting surface on the frame.

6. The structure of claim **5** wherein all the hooks extend sufficiently outwardly from the second and fourth members, and the slots on the front side and the similar slots on the rear side are so offset horizontally that the hooks inserted through the slots into the metal tube physically contact their respective matches, thereby strengthening the assembled structure.

7. The structure of claim **5** including means for joining the hooks inside the metal tube to their respective matches.

8. The structure of claim **7** wherein the joining means comprises a cement having epoxy and hardener as its two components,

each set of the two contacting hooks having epoxy on the contacting surface of one hook and hardener on the contacting surface of the other so that upon assembly of the structure the epoxy is mixed with the hardener and hardened to effectively join all the matched, contacting hooks.

9. The structure of claim **1** wherein the first and second members have such a prescribed spatial relation relative to each other that part of the second member rests on the first member and the weight of the second member pressing on the first member in its intended position enhances the engagement of the first member with the different supporting surface.

10. The structure of claim **1** wherein the supporting device comprises a generally vertical, hollowed post having wall means therein defining the slot,

the slot having an inside wall and an outside wall on the surrounding material thereof; and

wherein the locking means comprises a metal hook secured to the second member and having an open end with two vertical, parallel inner hooking sides or edges thereon engageable with the inside and outside walls,

the open end of the hook being insertible into the slot when in registration therewith and being also relatively movable along the length of the slot after its insertion into the slot when the second member is shifted against gravity in a specified manner,

the inner vertical sides of the hook open end being separated at such a distance apart that upon the shifting and subsequent placement of the first member into its intended position these sides become engaged over substantial contact regions with both the inside and outside walls around the slot thereby achieving a strong locking engagement.

11. The structure of claim **1** wherein the supporting device comprises a framed structure having metal portions thereon, the metal portions including wall means defining a number of elongated slots arranged according to a prescribed geometrical pattern, and

the locking means comprises the same number of metal hooks secured to the second member and arranged according to the same geometrical pattern,

all the hooks being simultaneously insertible into the corresponding slots when aligned therewith but becoming non-removable therefrom when the first member is engaged with the different supporting surface in its intended position.

12. The structure of claim **1** including means for preventing the first member from moving out of engagement with the different supporting surface so as to maintain the locking engagement of the second member with the vertical supporting surface.

13. The structure of claim **1** wherein the first and second members are made of plywood at least three-fourth inches in thickness.

14. The structure of claim **1** wherein the first member is a generally horizontal member and the second member is a generally vertical member, and including holding means for preventing the first member from moving horizontally out of engagement with the different supporting surface,

the lower edge of the second member bearing on the top surface of the first member while the first mem-

ber is held in position by the second member and the holding means.

15. The structure of claim **2** wherein the metal hook is insertible into the slot in a first position of the second member relative to the supporting device,

the second member being relatively shiftable against gravity to a service position thereby preventing withdrawal of the metal hook until the second member is returned to the first position,

the placement of the first member into its intended position putting the second member into the service position thereby preventing the second member from returning to the first position and from being disengaged from the vertical supporting surface.

16. The structure of claim **2** wherein the device comprises a tubular column having an open top end thereon, and

including a top, hook-twisting member fitting snugly inside the open top end and having at the lower end thereof slotting wall means defining a hook-twisting slot that is engageable with the hook after its insertion through the slot into the tubular column,

the hook-twisting slot twisting the inserted portion of the hook into a prespecified shape when the top hook-twisting member is pressed downward into its intended position inside the tubular column,

once so twisted the hook becoming incapable of being disassembled from the slot thereby achieving a substantially permanently assembled structure.

17. The structure of claim **2** including means for joining the hook, after its insertion into the slot, to the metal surrounding the slot.

18. The structure of claim **2** wherein the supporting device comprises a tubular frame,

the first member is a generally horizontal member,

the second member is a generally vertical member, and

including wall means defining a hole in the tubular frame under the horizontal member, and also

including dowel means fixed onto the underside of the horizontal member and insertible into the hole when in alignment therewith,

by inserting the hook into the slot and lifting the vertical member relative to the tubular frame, the rear portion of the horizontal member may be inserted directly below the lower edge of the vertical member and, simultaneously, the dowel means may be inserted into the hole to dowel the horizontal member onto the tubular frame,

the weight of the horizontal member making it more difficult for the dowel means to be removed from the hole and causing the horizontal member to stay in place so that the vertical member is prevented from falling under gravity out of the locking engagement.

19. The structure of claim **1** wherein the two supporting surfaces are planar surfaces.

20. The structure of claim **1** wherein the different and vertical supporting surfaces are planar surfaces oriented substantially normally of each other.

21. The structure of claim **1** wherein said first and second structural members have different widths and the bearing contact between the first and second members extends across the entire width of the narrower of the two members.

22. The structure of claim **1** wherein the hook means is a metal hook formed out of a 90° bent-out portion of a metal plate secured to the second member.

23. The structure of claim **1** wherein the slot has a substantially constant width, and the arm and the vertical portion have the same thickness which is less than the substantially constant, slot width.

24. The structure of claim **23** wherein the same thickness of the arm and the vertical portion is less than the substantially constant slot width by no more than a few mils.

25. The structure of claim **1** wherein the hook means is thinner in the vertical portion but thicker in the arm than the width of the slot so as to achieve interference fitting.

26. The structure of claim **25** wherein the material of the hollowed post surrounding the slot is strain-hardenable so as to be strengthened upon the thicker arm of the hook means being forced into the slot.

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