

PATENT SPECIFICATION

(11) 1286 900

DRAWINGS ATTACHED

- (21) Application No. 61633/70 (22) Filed 29 Dec. 1970
(31) Convention Application No. 888717 (32) Filed 29 Dec. 1969 in
(33) United States of America (US)
(45) Complete Specification published 23 Aug. 1972
(51) International Classification B21D 47/00 B21K 25/00 B21D 39/00
E04C 3/04

(52) Index at acceptance

B3A 122D 122J 122K 122X 137

B3J 1B 2F 2G 7

E1K 1B1F 2B 3B



(54) IMPROVED STRUCTURAL UNIT, AND METHOD AND APPARATUS FOR PRODUCING SAME

(71) We, HUNTER DOUGLAS INTERNATIONAL N.V., a Dutch Body Corporate, of Handelskade 8, Willenstad, Curacao, Dutch Antilles, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

THIS INVENTION relates to a structural unit and to the method and apparatus for producing same. More particularly, this invention relates to an improved hollow metal building beam to be used for supporting patio covers, canopies, roofs or screened-in porches and outdoor rooms, carports, and like building structures.

According to a first aspect of the present invention there is provided a structural unit comprising opposed pairs of elongate structural members securely interconnected with each other into a unitary assembly; each member of a first pair of said pairs of members comprising a central web, opposed shoulder sections extending longitudinally of each such member along opposite margins of said web thereof, and slot structures interposed between and interconnecting said shoulder sections with said web margins, each of said slot structures including an elongate channel extending therealong; each member of the second pair of said pairs of members being positioned within and generally irremovably received within the respective slot structures of said first pair of members; and means securing opposite edge portions of said members of said second pair of members within said slot structures of said first pair of members, whereby a unitary structural assembly is provided therebetween, said means including sections of the members of at least one of said pairs of members which are deformed into locking engagement with the members of said other pair of members.

Further according to the invention there is provided a structural unit comprising opposed

pairs of elongate structural members securely interconnected with each other into a unitary assembly; each member of a first pair of said pairs of members being defined by a generally rigid metal extrusion and comprising a central web, opposed shoulder sections extending longitudinally of each of such members along opposite margins of said web thereof, and slot structures interposed between and interconnecting said shoulder sections with said web margins; each of said slot structures comprising a first wall portion between said web and an associated shoulder section, and a second wall portion depending from said shoulder section, said wall portions defining an elongate channel therebetween; each member of the second pair of said pairs of members being defined by a generally resilient sheet metal panel; the respective members of said second pair of members being received within the channels defined by the slot structures of said first pair of members; and means securing opposite edge portions of said members of said second pair of members in said slot structures of said first pair of members by clamping the same between the respective wall portions thereof, whereby an integral structural assembly is provided thereby.

According to a second aspect of the present invention there is provided a method of forming an integral structural unit from a plurality of discrete structural members, comprising providing first and second pairs of such structural members, the members of said first pair including preformed slot structures extending longitudinally along opposite margins thereof; bringing said pairs of members into contact with each other at an assembly station, inserting edge portions of said second pair of members into the respective slot structures of said first pair of members at said station; and deforming predetermined segments of the members of at least said second pair into locking engagement with the mem-

bers of said first pair to thereby lock said edge portions of said second pair of members within said slot structures of said first pair of members without requiring separate fastening means therefor.

5 A method of forming a structural unit in accordance with the present invention comprises providing first and second pairs of structural members, the members of said
10 first pair including deformable slot structures defined by opposed wall portions extending longitudinally along opposite margins thereof, the members of said second pair having edge
15 portions thereof receivable within said slot structures; inserting the edge portions of the second pair of members into the respective slot structures of the first pair of members; and deforming segments of one of the wall
20 portions as well as segments of the edge portions to clamp the edge portion of the second pair of members between the respective wall portions.

According to a third aspect of the present invention there is provided an apparatus for
25 forming a structural unit defined by opposed pairs of structural members, a first pair of which have preformed slot structures extending longitudinally along opposite margins thereof to receive therein edge portions of
30 the members of a second pair thereof; the apparatus comprising guide means for receiving the pairs of members from supplies thereof and orientating the members of each pair in opposed relationship to each other; means for drawing the aligned pairs of mem-
35 bers into engagement with each other and inserting edge portions of the members of the second pair into the slot structures of the first pair; and means for deforming segments
40 of the members of at least said second pair into locking engagement with the members of the first pair, whereby the pairs of members may be securely interconnected into an integral structural unit.

45 According to another aspect of the invention there is provided an apparatus for forming a structural unit defined by opposed pairs of structural members a first pair of which have preformed slot structures extending
50 longitudinally along opposite margins thereof to receive therein edge portions of the second pair thereof; said apparatus comprising guide means for receiving the pairs of members from supplies thereof and orientating the
55 members of each pair in opposed relationship to each other, means for drawing the aligned pairs of members into engagement with each other and inserting edge portions of the second pair of members into the slot structures of
60 the first pair of members; and means for deforming segments of the respective slot structures of the first pair of members and segments of the edge portions of the members of the second pair of members into locking
65 engagement with each other; whereby the

edge portions of the second pairs of members are securely clamped in the slot structures and the pairs of members are joined securely into an integral structural assembly.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a generally schematic view illustrating the assembly sequence by which one form of structural unit made in accordance with the present invention may be produced from a plurality of discrete structural members,

Figures 2, 3 and 4 are cross sectional views of the structural unit at various stages of the assembly procedure taken in the planes of lines 2-2, 3-3 and 4-4 respectively of Figure 1,

Figure 5 is a side elevational view of the machine for assembling the subject structural unit,

Figures 6, 7, 8 and 9 are vertical sectional views through the subject machine taken in the planes of lines 6-6, 7-7, 8-8 and 9-9 respectively of Figure 5,

Figure 10 is a horizontal sectional view through a portion of the machine taken in the plane of line 10-10 of Figure 8,

Figure 11 is a horizontal sectional view through a portion of the machine taken in the plane of line 11-11 of Figure 8,

Figure 12 is a plan view, partly in section, of a portion of the machine taken generally within the confines of line 12-12 of Figure 10 on an enlarged scale relative thereto,

Figure 13 is a sectional view through another embodiment of a structural unit made in accordance with the present invention showing the opposed pairs of structural members thereof interengaged prior to rigid interconnection thereof,

Figure 14 is an enlarged view of a portion of two interengaged structural members, one being shown in phantom lines, taken within the confines of line 14-14 of Figure 13 on an enlarged scale relative thereto,

Figure 15 is a sectional view corresponding generally to Figure 13 but showing the structural members rigidly and integrally interconnected,

Figure 16 is a horizontal sectional view through the assembled beam taken in the plane of line 16-16 of Figure 15,

Figure 17 is a horizontal sectional view through a portion of one of the side wall panels of the beam,

Figure 18 is a sectional view through a modified embodiment of the structural unit corresponding generally to the view shown in Figure 15,

Figure 19 is a view corresponding generally to that shown in Figure 14 but illustrating a further modified embodiment of the structural unit,

Figure 20 is an isometric view of a modi-



fied side wall structural member of the structural unit,

Figure 21 is a sectional view illustrating a building roof as cover assembly utilizing the modified side wall member of Figure 20,

Figures 22 and 23 are before and after views of a further modified embodiment of the structural unit,

Figure 24 is a vertical sectional view through a further modified embodiment of the structural unit and that portion of the apparatus designed to assemble the same,

Figure 25 is a horizontal sectional view through the modified embodiment of Figure 24 taken in the plane of line 25—25 thereof,

Figure 26 is an isometric view of an assembled structural unit of the type seen in Figure 15 showing a decorative cover panel attached therewith, and

Figure 27 is an isometric view of a beam of the type shown in Figure 15 with a decorative panel attached therewith.

The structural unit to be described is in the form of a beam which is designed to be assembled in a factory or at the job site utilizing specially designed machinery to join together the respective structural beam member components in a fashion which precludes their disassembly without destruction thereof.

Although several embodiments of a structural beam unit will be described, it should be understood that each embodiment employs the concept of utilizing segments of the respective beam structural members as the means for rigidly and securely interconnecting opposed pairs of such structural members into a unitary strong and light weight assembly, whereby separate connecting fasteners are obviated.

Utilization of the beam made in accordance with the invention in a particular type building construction has not been illustrated herein. However, it should be understood that the same may be employed in any structural arrangement desired, such as to support a patio cover or canopy, carport, roof of an outdoor room or screened in porch, and the like, in known fashion, but without intending to be restrictive on such utilization thereof.

Before describing in detail the structural features of the subject beam and the machine for assembling the same, reference is directed to Figures 1 through 4 which illustrate general details of one embodiment of the beam and of the assembly machine in conjunction with a schematic showing of the method steps employed in forming a plurality of discrete structural members into an integral structural unit. In that regard, the illustrated embodiment of the beam, generally designated 1, comprises a pair of opposed structural members 2 and 3 which define the top wall and bottom wall of the beam, and a second pair of opposed structural mem-

bers 4 and 6 which define the opposite side walls thereof.

In the preferred embodiments disclosed herein, the top and bottom structural members 2 and 3 are defined by elongated metal extrusions, preferably of aluminum or a suitable aluminum alloy of a known type having sufficient strength to perform the purpose intended therefor. Such extrusions are generally rigid in the longitudinal and transverse directions and preferably are preformed to predetermined lengths in accordance with the overall length of the beam to be formed therefrom.

The side walls 4 and 6 of the beam preferably are formed from generally resilient panels of sheet metal, such as aluminum or aluminum alloy of a known type having strength sufficient to perform their intended function. To enhance the strength of the panels 4 and 6, the same may be provided with generally parallel corrugations of suitable size and spacing as will be described hereinafter, such corrugations preferably being arranged to extend vertically between the top and bottom members 2 and 3 to define rigid reinforcing channels which resist collapsing of the beam in the vertical direction.

As shown progressively from the illustrations of Figures 2 through 4, the opposed pairs of structural members are brought in converging paths into contact with each other so that edge portions of the side wall panels 4 and 6 are inserted into preformed slot structures provided along opposite margins of the extrusions 2 and 3. Upon such interengagement being effected, inward pressure is applied to the extrusions 2 and 3 to insure that the edge portions of the side wall panels 4 and 6 remain within the slot structures, as will be described hereinafter in greater detail. Then lateral pressure is applied to the members to deform predetermined segments of the members of at least one of said pairs into locking engagement with the members of the other of said pairs so that the edge portions of the side wall panels 4 and 6 are securely locked within the slot structures of the extrusions 2 and 3.

In the beam embodiment shown in Figures 2 through 4, the slot structures formed in the extrusions 2 and 3 are deformed together to clamp or lock the edge portions of the side wall panels 4 and 6 therein. In alternative embodiments also described herein, under certain circumstances the edge portions of the side wall panels 4 and 6 may be deformed, and in further alternative embodiments both the slot structures and the edge portions of the side wall panels may be deformed, depending upon the type of interlock desired between the respective structural members. In any event, however, upon such deformation being effected, the structural members are

securely interlocked together to define a strong, rigid, light weight beam having a generally rectangular cross section and hollow interior which is available to receive therein

5 electrical conduits and the like, depending upon the intended use of the completed beam.

Referring now to Figure 1, the principal components of the apparatus for assembling the beam will be described in conjunction with the schematic procedure shown in this drawing. The infeed end of the machine is defined by a supply station generally designated 7 from which the structural members 4, 6 are withdrawn in converging paths in accordance with a predetermined plan. Adjacent the supply station is a guide and assembly station generally designated 8 at which the opposed pairs of members are interengaged with each other in the manner shown in Figure 2. Adjacent the guide and assembly station 8 is a pressure station generally designated 9 at which inward pressure is applied to the respective components in the fashion shown in Figure 3 prior to passage of the interengaged components to a deforming station generally designated 10 at which the components are integrally locked with each other. A second pressure station generally designated 11 is provided adjacent the deforming station 10 to impart curvature to a completed beam if desired. Finally, a cut off station generally designated 12 is provided adjacent to the discharge end of the machine at which the various structural members of the beam withdrawn from a continuous supply may be severed to impart the beam with a predetermined length.

It will be noted from Figure 1 that the respective stations are positioned in line with each other so that the components may be successively formed from separate structural members into a unitary assembly which can be separated only by destructive distortion thereof.

It will further be noted from Figure 1 that the integral structural unit of this invention is formed by employing a method in which a plurality of discrete structural members of like opposed pairs are provided, the members of a first pair including preformed slot structures extending longitudinally along opposite margins thereof. Such opposed pairs of members are brought into contact with each other at a guide assembly station at which edge portions or margins of the second pair of members are inserted into the slot structures of the first pair of members at such station. The respective members are fed from supplies thereof with the extruded members 2 and 3 being drawn from precut lengths thereof while the sheet metal side wall members 4 and 6 are withdrawn from substantially continuous rolls 13 and 14 thereof.

After the respective structural members have been drawn into interfitting engagement

with each other, pressure is applied thereto to hold the members assembled, and thereafter the members are selectively deformed into locking contact with each other. In those embodiments in which it is desired to impart a curvature to the beam, this is done after interlocking of the members has been effected which results in a predetermined amount of arch being imparted to the completed beam. In that regard, while the amount of curvature may be varied selectively it has been found that some slight amount of curvature in all beams is preferred to compensate for loading of the beams when the same are utilized in building structures. In that regard, a curvature of deflection of approximately $\frac{1}{4}$ inch to $\frac{3}{4}$ inch for each 20 foot beam length is desirable. However, if additional curvature is desired for design appearance, for example to give a noticeable arched configuration to a roof or ceiling being supported by the beam, a curvature of from 5 to 6 inches for each 20 foot beam length can be effected.

Following assembly of a beam to its desired configuration, the same is cut to a predetermined length, generally determined in accordance with the predetermined length of the preformed structural members 2 and 3. In that regard, any suitable cut off mechanism, such as one or more reciprocally movable, rotary saw blades of the type illustrated schematically in Figure 1 at cut off station 12, may be employed.

It will additionally be noted from Figure 1 that an important feature of this invention which facilitates assembly of the structural members into interengagement with each other is the fact that the members are fed from the supplies thereof in converging paths which simplify introduction of edge portions of the side wall panels 4 and 6 into the preformed slot structures of the top and bottom wall structural members 2 and 3.

Having thus summarized the assembly method utilized for the various embodiments of the structural beam disclosed herein, reference is directed to Figures 5 through 11, taken in conjunction with the schematic showing of Figure 1, for a detailed description of the apparatus developed to assemble structural beams in the manner summarized above.

The preferred embodiment of the machine illustrated is generally designated 16 and comprises two operative sections, namely, a fixed lower section 17 and an operatively discrete upper section 18 which is adjustably movable relative to the lower section. Such adjustable capability permits the subject machine to fabricate beams of varying sizes, such as beams ranging, by way of example, from 5 inches to 12 inches in spacing between the planes of the top and bottom structural members 2 and 3 thereof.

As best seen in Figure 5, the lower machine section 17 comprises a rigid supporting frame-

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work defined by a plurality of longitudinally spaced pairs of laterally spaced vertically extending legs 19 engageable with a suitable supporting surface 21 in a manufacturing factory or the like. The framework is completed by a series of laterally spaced longitudinally extending horizontal frame members 22, and horizontal extensions thereof 23 at the discharge end of the machine. The respective legs 19 and frame members 22 and 23 are joined together in any suitable fashion, such as by welding, into a rigid supporting framework upon which the operative components of the machine are mounted.

The upper section 18 of the machine includes a rigid unitary framework defined by a longitudinally extending horizontal frame member 26 which extends substantially the full length of the machine between the infeed end and discharge end thereof. The frame member 26 is mounted for vertical adjustable movement relative to the framework of the lower section 17 of the machine. Adjacent opposite ends of the frame member 26 are secured upwardly projecting vertical frame members 27 and 28 with which means for moving the upper section of the machine vertically relative to the lower section thereof are operatively connected as will be described.

Adjacent the infeed end of the machine, a vertical frame member extension 29 projects upwardly from the lower framework and is secured thereto by welding or the like, as seen in Figure 6. Positioned on the frame extension 29 adjacent its top is a collar 31 which surrounds the member 29 and is vertically slidable thereon. Projecting laterally from the collar and secured thereto by welding or the like is a connecting plate 32 which is secured, such as by a series of nut and bolt assemblies 33, to the upright frame member 27 mentioned previously. The vertical frame extension 29 thus serves as a guide for collar 31 so that the vertical frame member 27 and its associated frame member 26 may be moved vertically relative to the lower machine framework.

Adjacent the discharge end of the machine, the upper machine section 18 is supported for vertical adjustable movement by means of a transverse mounting plate 36 (Figure 8) secured in any suitable fashion to the underside of the upper frame member 26. Extending through plate 36 in a manner to be described in greater detail hereinafter are a pair of upright rotatable drive shafts 37 and 38 which also serve as guide shafts for the upper machine section. In that regard, bearings 39 and 41 respectively are secured to the mounting plate 36 and such bearings permit rotation of the respective shafts without interfering with longitudinal movement of such bearings and plate 36 and other structures supported thereby.

Adjustment means for moving the upper

machine section relative the lower section of the machine, identified 42 and 43 respectively, are provided adjacent opposite ends of the machine and are operatively interposed between the respective upright frame members 27 and 28 and the horizontal frame member 26. Such adjusting means are essentially identical and therefore the details of only one thereof will be described with similar reference numerals identifying similar parts of each. Taking reference to means 43 shown in Figures 5 and 8, such means comprise mechanism for drawing the horizontal frame member 26 towards or moving the same away from the lower framework of the machine. Such mechanism comprises an upright worm member 44 having mounting bearings 46 and 47 at opposite ends thereof. Lower bearing 47 is secured to a support plate 48 which is welded or otherwise secured to the frame member 26. Upper bearing 46 is mounted on a support plate 49 which is secured to and projects from the upright frame member 28.

Interposed between the opposite ends of the worm 44 is a bracket 51 secured to an upright extension 52 (Figure 8) of the lower framework of the machine. In the bracket are mounted a pair of spaced nut members 53 and 54 through which and with which the worm is threadedly engaged. Thus, upon rotation of the worm in one direction, the frame member 26 and the components supported thereby may be drawn downwardly; upon rotation of the worm in the opposite direction the frame member 26 and the components mounted thereon may be drawn upwardly.

The opposite adjusting means 42 is similarly constructed and is driven in conformity with operation of adjusting means 43 so that the upper section of the machine may be adjusted precisely and uniformly in complete parallelism as required to permit beams of predetermined dimensions to be accurately assembled. In that regard, drive means for simultaneously actuating the respective worm mechanisms 42 and 43 is provided which is driven from a central power source, such as an electric motor 56 secured to the frame member 28. By means of a pulley and belt assembly 57 the motor actuates an elongate drive shaft 58 which extends substantially the length of the machine and is journaled in the upright frame members 27 and 28.

The drive shaft 58 carries thereon spaced bevel gears 59 and 61 which mesh with other bevel gears 62 and 63 secured to the respective worm members of the adjusting mechanisms 42 and 43. The electric motor 56 possesses reversible capability which permits the drive shaft 58 to be rotated in a preselected direction to advance or retract the worm members to raise or lower the upper section of the machine on the guide means provided therefor. A suitable control,

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generally designated 66, is provided at an operator's station (Figure 5) for selectively actuating the motor 56 in the direction chosen in known fashion. Preferably such control includes fine adjustment capability which permits the worm mechanisms 42 and 43 to be precisely adjusted to the exact locations desired.

To provide additional support for the drive shaft 58, an upright mounting plate 67 (Figure 5) is provided having a bearing 68 therein through which the drive shaft rotates. The plate 67 is secured by means of braces 69 to the horizontal frame member 26 of the upper machine section.

When the upper machine section has been adjusted to the predetermined spacing required to effect assembly of a structural unit of predetermined size, the machine is ready to accept therein the opposed pairs of beam members 2, 3, 4 and 6 being assembled.

At the aforementioned supply station 7, as best seen in Figure 1, means are provided for supporting the respective beam components as they are being introduced into the machine. Each of the supporting means for the rolls 13 and 14 of the side panel members 4 and 6 comprises an upright standard 71 from which a vertical axle 72 extends through the core of the respective rolls. Such supporting means further includes rollers 73 and 74 vertically spaced from each other past which and in contact with which the respective top and bottom structural members 2 and 3 pass as they enter the machine. The rollers 73 and 74 are supported by standards of any suitable construction (not shown) in spaced relationship to each other to ensure a converging path of travel of the structural members 2 and 3 relative to each other as they enter the machine.

In that latter regard, at the guide and assembly station 8, structure is provided for receiving the respective pairs of structural members from the supplies thereof and bringing the same together in the converging path noted. Such guide structure, as seen in Figures 5 and 6, includes laterally spaced upper and lower pairs of guide tracks 76 and 77 respectively through which opposed upper and lower edge portions of the respective side wall panels 4 and 6 pass into the machine from their supply rolls 13 and 14. The respective guide tracks are defined by closely spaced guide plates defining a guide channel therebetween. The guide tracks are secured to the respective upper and lower sections of the machine by means of spaced mounting brackets 78 and 79 respectively which in turn are secured to upper and lower frame members of the machine section as perhaps best seen in Figure 6.

The guide tracks converge downwardly and inwardly relative to each other so that the side wall panels 4 and 6 are fed in the con-

verging path noted previously. In that regard, roller means are provided at opposite sides of the beam assembly being formed as seen in Figures 5 and 7 which engage the side wall panels 4 and 6 to further ensure intermeshing of the respective structural components of the beam. Such roller means comprise a pair of laterally spaced rubber or like rollers 81 and 82 adjustably mounted on a pair of upright supporting shafts 83 and 84 which in turn are supported at their lower ends by bearings 85 and 86 on mounting plates secured to the frame members 22 of the lower machine section. The outer peripheries of the respective rollers 81 and 82 as seen in Figure 7 are spaced from each other a distance corresponding to the dimension desired for the completed beam assembly.

The beam component guide means also includes guide structure for feeding the top and bottom structural members 2 and 3 in a converging path into engagement with the side wall panel members 4 and 6. In that regard, as seen in Figures 6 and 7, the latter guide structure includes a pair of generally U-shaped brackets 91 and 92 which respectively depend from the upright frame member 27 of the upper machine section and project upwardly from a transverse frame member 93 which extends between the longitudinal frame members 22 of the lower machine section. Such brackets are secured by bolting or the like to the frame members noted.

Secured by bolting or the like to the respective brackets 91 and 92 are elongated guide bars 94 and 96, of wood or other suitable material, which extend longitudinally of the machine into the beam being assembled. Such guide bars serve the dual purpose of preventing lateral movement of the side wall panels 4 and 6 inwardly relative to each other to an excessive amount while at the same time serving as guide surfaces over which the top and bottom structural members 2 and 3 may pass into contact with the upper and lower edge portions of the respective side wall panel members. Thus, as the aforementioned guide rollers 81 and 82 urge the side wall panels 4 and 6 inwardly towards each other, the guide bars 94 and 96 limit such inward movement in the manner best seen in Figure 7.

Following introduction of the opposed edge portions of the side wall members into the slot structures of the top and bottom structural members, the same are subjected to inward pressure generally in the vertical direction to hold such members assembled while they are passing from the aforementioned pressure station 9 to the deforming station 10. At the pressure station 9, means are provided for insuring secure interengagement of the respective structural members of the beam

assembly with each other, and the maintenance of such members interengaged until the same are rigidly interconnected at deforming station 10. In the embodiment shown, such means comprises a series of opposed pairs of upper and lower pressure wheels mounted on the respective upper and lower sections of the machine section.

As noted from Figures 1, 5 and 7, three such opposed pairs of pressure wheels are positioned to engage the respective top and bottom structural members of the beam. The pairs of pressure wheels at the top of the machine are designated 101, 102 and 103 while the pairs of pressure wheels at the bottom of the machine are designated 106, 107 and 108. As will be seen from Figure 7, each of the upper pairs of opposed pressure wheels are supported in depending relationship by a mounting bracket 109 secured to and depending from the top frame member 26 of the upper section of the machine. Similarly, the respective lower pairs of pressure wheels are supported by an upstanding mounting bracket 111 secured to the framework of the lower machine section. Such brackets 109 and 111 are secured to their respective frame members in any suitable fashion, such as by bolting. The spacing between the pressure wheels of each pair is such that a shoulder section of the structural member extrusions 2 and 3 which define the top and bottom members of the beam assembly may pass therethrough. The pressure wheels thus are positioned to exert pressure on the extrusions 2 and 3 to urge the same towards each other in the fashion shown in Figure 3 and to hold the components of the beam assembly interconnected as the same pass from the pressure station 9 to the deforming station 10.

It will be noted from Figure 1 that the respective opposed pairs of pressure wheels 101 and 106 are spaced vertically from each other a distance slightly greater than the corresponding spacing of the subsequent pairs 102, 107 and 103, 108 in accordance with the converging path followed by the extrusions 2 and 3 as the same enter the machine.

At the deforming station 10, lateral pressure is applied to the structural members of the beam to join such members together into a unitary assembly. As will be described hereinafter with respect to several embodiments of the beam disclosed herein, such lateral pressure may be applied in various fashions and at various locations, depending upon the particular configuration and construction of the components of the beam being assembled. At station 10, means is provided for deforming preselected segments of the respective structural members into locking engagement with each other.

In the embodiment of the machine shown in Figures 1 and 5 through 12, such de-

forming means is constructed to react with a particular configuration of the beam structural members of the type shown in Figures 13 through 15 of the drawings as will be described in greater detail hereinafter. With such an arrangement, the top and bottom structural members 2 and 3 are provided with preformed slot structures within which upper and lower edge portions of the side panel members 4 and 6 are received. Such slot structures are defined by spaced walls which together define an elongate channel therebetween. The deforming means provided for that purpose as seen in Figures 8, 10 and 12 comprises rotary mechanism for engaging each of the respective slot structures to deform the same into clamping or locking engagement with the edge portions of the side panels 4 and 6 received within the slot channels defined by the structures.

Referring to Figures 8 and 10, such rotary mechanism comprises pairs of opposed upper and lower jointing or stitching wheels 116 and 117 respectively which are mounted on the aforementioned guide shafts 37 and 38 upon which the upper section of the machine is slidably mounted. Such jointing wheels are secured by set screws or the like in predetermined positions on the shafts 37 and 38 in accordance with the dimension in the vertical direction of the beam being formed. Such set screws are received within suitable keyways formed longitudinally in the shafts 37 and 38, as seen in Figure 12, to permit the adjustment mentioned previously.

The shafts in turn are supported at their lower ends in suitable bearings 118 and 119 mounted on a supporting plate 121 extending between the frame members 22. A second supporting plate 122 is positioned above plate 121 and supports thereon sprocket wheels 123 and 124 by means of which the shafts 37 and 38 are rotated from a suitable power source to be described. Another supporting plate 126 is positioned above plate 122 and bearings 127 and 128 are mounted on the underside of such plate for providing additional support for the shafts 37 and 38.

As noted from Figure 8 the aforementioned plates 36 and 126 are secured to extend between upright supports 127 and 128 bolted or otherwise adjustably secured to the frame member extensions 23 of the lower section of the machine. The aforementioned jointing wheels 116 and 117, as also seen from Figure 8, are supported by braces 129 and the aforementioned plate 126 in vertically spaced relationship relative to each other in accordance with the size of the beam being assembled.

Interposed between such jointing wheels are pressure roll assemblies 131 and 132 respectively at opposite sides of the machine, each comprised of a pair of pressure wheels 133 and 134 (Figure 10) which are engaged

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with and urge inwardly the side wall panels 4 and 6 of the beam. Such pressure roll assemblies are mounted upon and supported by the frame members 127 and 128 in any suitable manner, such as by welding.

Each of the jointing wheels is mounted on the aforementioned upright shafts 37 and 38 for rotation therewith through a keyed interconnection thereof with such shaft. Each such wheel is provided with a series of protuberances or projections 141 provided to deform predetermined segments of the extruded structural members 2 and 3 into locking engagement with the side wall panels 4 and 6 of the beam in the manner described in more detail hereinafter. It will be noted that upon rotation of the shafts 37 and 38 in the direction noted the wheels will draw the interengaged components of the beam assembly through the machine while at the same time joining the same together into a unitary assembly.

Preferably means are provided to back up the pressure exerted by the jointing wheels and such means comprise a pair of spaced back-up wheels 142 and 143 positioned at opposite sides of the beam in alignment with each of the respective riveting wheels 116 and 117. The respective back-up wheels 142 are mounted as seen in Figure 8 to project from brackets 144 secured to the respective plates 126 and 36. To assure effective backing up during the riveting operation, two such back-up wheels are provided in operative alignment with each jointing wheel and are longitudinally spaced from each other as best seen in Figure 12.

Referring to Figure 11, means is provided for simultaneously driving at uniform speeds all of the jointing wheels 116 and 117. Such drive means comprises a variable speed reversible electric motor 151 mounted beneath the framework of the apparatus by means of mounting plate 152, as best seen in Figure 5. A belt and pulley mechanism 153 is utilized to transmit power from the motor 151 to a gear reducing unit 154. The gear reducer in turn is operatively connected by a pulley train defined by toothed pulleys 156, 157, 158 and 159 to the riveting wheels 116 and 117 mentioned previously. That is, each of the pulley wheels mentioned is engaged via its teeth with a drive chain 161 which passes over the respective pulleys in the fashion seen in Figure 11.

Pulley wheels 157 and 159 in turn form part of the aforementioned sprockets 123 and 124 with which the drive shafts 37 and 38 are secured as noted. Thus, upon actuation of motor 151, the drive shafts 37 and 38 are rotated in opposite direction to rotate the jointing wheels. In that regard, a suitable operator control 162 is provided at the operator's station as seen in Figure 5. Such control is electrically connected in known

fashion with the motor 151, such motor being of the reversible type so that upon actuation of the control 162 the beam being assembled may be drawn through the machine, or temporarily reversed in its direction of travel, as desired to meet particular manufacturing conditions.

As also seen from Figure 5, if desired, additional pairs of opposed pressure wheels 163 and 164 may be provided closely adjacent the jointing wheels to engage the extrusions 2 and 3 of the beam to ensure that all components of the beam are held tightly together while the same are being locked into engagement with each other.

Following passage of the beam in the assembled condition from the station 10, the same passes the second pressure station 11 at which curvature, if desired, may be imparted to the beam assembly. At station 11 are positioned a pair of laterally spaced vertically extending guide rolls 166 and 167 (Figure 9) between which the beam passes. Such rolls are mounted on suitable shafts which extend upwardly from bearings 168 and 169 mounted on the aforementioned horizontal frame member extensions 23.

Extending laterally between the frame member extensions 23 is a mounting plate 171 with which is adjustably connected a guide roll mounting bracket 172 (Figure 9) having slots therein through which bolt connectors 173 pass. The slot-bolt connections thus permit vertical adjustment of the bracket 172 relative to plate 171.

The bracket 172 supports thereon a rotatable guide roller 174 over which the base of the beam rides as the same is discharged from the machine.

Positioned oppositely from roller 174 is a pressure roller 176 which is supported by another mounting bracket 177 which in turn is connected by adjustable slot-bolt connectors 178 to a mounting plate 179 secured to the end of the upper frame member 26.

Normally the spacing between the peripheries of rollers 174 and 176 is such that a completed beam assembly may pass there-through. The spacing of such rollers relative to each other may be altered by the slot-bolt connections to accommodate therebetween beams of varying sizes. Also, the orientation of such rollers relative to the axis of the beam may be altered so that the rollers may be positioned somewhat offset downwardly relative to the longitudinal axis of the beam. By thus locating the upper pressure roller 176 in the downwardly offset position, pressure in the downward direction may be applied to the completed beam as the same exits from the machine. Thus, as the beam is being formed, curvature may be imparted thereto to the desired extent for the purpose of compensating for structural loading of the beam when the same is positioned in a building structure

or to impart architectural design curvature thereto.

5 Finally, as noted previously, at cutoff station 12 suitable cutoff means, such as one or more reciprocally movable, rotary knife members, designated 181 in Figure 1, may be positioned to sever the side wall panel members 4 and 6 of the beam, and the extrusions 2, 3 is desired, in accordance with the pre-determined length desired for the completed assembly. Such cut off means may be actuated selectively as needed when travel of the beam is temporarily halted, by any suitable power source.

10 While the machine has been described with respect to the assembly of one particular type of beam construction, it should be understood that, by selective modification of the various pressure means and riveting means, the machine may be adapted easily and readily to accommodate various beam constructions therein.

15 Reference is now directed to Figures 13 through 17, taken in conjunction with Figure 12 for an understanding of a preferred embodiment of the subject structural beam. In that connection, as noted previously, the beam is comprised of opposed pairs of structural members 2, 3, 4 and 6. As shown in Figure 17, preferably the side wall panels 4 and 6 are each formed with vertical corrugations positioned in parallel relationship to impart vertical rigidity thereto. The particular size and configuration of such corrugations may vary to meet particular structural needs.

20 It will be noted from Figure 13 that the extruded structural members 2 and 3 are identical, but oppositely oriented. Each member includes a central web 201 which separates and integrally interconnects opposed spaced shoulder sections 202 and 203. Such shoulder sections include slot structures 204 and 206 respectively which extend longitudinally along the shoulder sections. The shoulder sections also include outwardly extending flange portions 207 and 208 which terminate in projecting ribs 209 and 211.

25 The respective slot structures 204 and 206 are defined, as best seen with reference to slot structure 206 in Figure 14 by a first wall portion 212 which is interposed between and interconnects the central web 201 with its associated shoulder section 203. Such slot structure is further defined by a second wall portion 213, such wall portions defining therebetween an elongated channel 214 extending therealong.

30 It will be noted that the wall portion 213 is initially formed to extend out of parallel relationship with the inner wall portion 212 to facilitate insertion of the upper edge portion 216 of the associated side wall panel therein. The inner wall portion 212 as best seen in Figure 14 is also provided with an elongated groove 217 extending the length

thereof which preferably is undercut or dovetailed in configuration and communicates with and forms part of the slot structure channel. Additionally, outer wall portion 213 is provided with a pair of spaced guide ribs 218 and 219 which define a recess therebetween which is generally in alignment with the groove 217 in the inner wall portion.

35 As perhaps best seen from Figure 15 taken in conjunction with Figure 12, upon rotation of a jointing wheel 116 in engagement with the slot structures, the outer wall 213 of each slot structure is deformed inwardly and the projections 141 on such wheel form spaced deformed segments 220 in the wall portion 213 which are urged inwardly in the groove 217 formed in the inner wall portion 212. Such deformation is accompanied by deformation of similar segments of an edge portion 216 on the side wall panel engaged in the slot structure as seen in Figure 16. Thus, the respective components of the beam assembly are jointed or stitched together utilizing their own material so that the need for separate fasteners to effect a secure interconnection between the beam components is obviated.

40 As seen in Figure 15, a guide function is performed by the ribs 218 and 219 and 211 of the extruded structural members 2 and 3 as shown therein in conjunction with jointing wheel 117. The function of the back-up wheels 142 is also noted in that figure. It should also be understood that the projections 141 on the jointing wheels cause the beam components to be drawn physically through the machine past each of the stations noted.

45 Figure 18 shows a modification of the beam in which the upper beam structural member, designated 2', is modified in construction to provide a water trough in conjunction therewith. That is, such beam component comprises a deeply recessed central web 201' in which the wall portions 212' which connect the same to the shoulder portions 202 and 203 space the web a substantial distance therefrom. Partial overlying flanges 221 and 222 may be provided to partially close off the water receiving trough 223 defined by the central web 201' and the wall portions 212' thereof.

50 In assembling the embodiment shown in Figure 18, the aforementioned guide block 94 which spaces the side wall panel 4 and 6 from each other, as seen in Figure 7, is removed and the side walls 212' perform the function of such guide blocks as mentioned previously. The water trough is provided to carry off water from a roof structure when the beam is exposed to the elements of nature.

55 Figure 19 shows a further modification of a beam structure in which the extruded structural members 2 and 3 have their slot structures further modified by providing a longitudinal rib 226 along the inner surface of the outer wall portion 213 generally in alignment

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with groove 217 provided in the inner wall portion 212. The presence of such rib, whether longitudinally continuous or discontinuous, further ensures inward deformation of an edge portion 216 of a side wall panel of the beam construction into the receiving groove 217 to further ensure effective inter-connection between the beam components.

A modified embodiment of the side wall panels desirably employed in the subject beam construction is shown in Figures 20 and 21 in which a modified means for interconnecting such side wall panels with the metal extrusions is provided. Such arrangement is well suited for use with the extrusion constructed as in Figure 19 but its use is not restricted to such a combination. In that connection, adjacent the upper margin of the modified side wall panel, designated 231, is formed an expansible elongated male rib 232 which is accordion on M-shaped in cross section as shown in Figure 20. Upon pressure being applied to the base of rib in the direction of the arrow shown in Figure 20, the same may be expanded laterally outwardly. Thus, upon such rib being inserted in a groove 217 formed in the wall portion 212 of an extrusion and pressure applied thereto in the manner shown in Figure 21, such rib may be expanded into such groove to securely lock the side wall panel 231 in place. Such expansion is readily effected by forcing a rib 226 into engagement with the expansible rib 232, such rib 226 being provided as part of the slot structure and being formed therein in alignment with the groove 217.

The arrangement shown in Figures 20 and 21 further includes an improved construction by means of which the subject beam employing such side wall panels 231 may be employed to support ceiling structure to be supported by the beam. In that regard, an elongated groove 233 also is formed in the side wall panel member 231 parallel to and spaced inwardly from the expansible rib 232. Thus, as seen in Figure 21 when a beam employing such a side wall panel structure is utilized to support a roof structure, generally designated 235 in Figure 21, a space to receive insulating material or the like may be provided below the under surface of the roof 235. That is, by providing a support member 236 having an expansible rib 237 corresponding in configuration to the aforementioned rib 232, such support member 236 may be secured to the side wall member 231 of the beam by expanding the rib 237 in the groove 233 provided therefor. Thus, by securing the opposite end of the support member 236 in any suitable fashion at its opposite edge, such as by engaging the same in another side wall panel of a similar beam structure, a space is provided between the under surface of the roof and the support member which may

be filled with insulating material and the like as illustrated at 238 in Figure 21.

Figures 22 and 23 show another modified arrangement similar to that shown in Figure 20 in which a side wall panel member 241 may be secured to an extruded beam structural member by providing the upper margin of the side wall panel 241 with a generally Z-shaped male expansible rib 242 which may be expanded by applying pressure thereto in the general manner shown by the direction of the arrow in Figure 23. Such pressure may be applied by a smooth periphery jointing wheel shown in dotted lines at 243 in Figure 23. With the arrangement shown, an inner wall portion 213 of the receiving slot structure may be omitted as shown, with the groove 217 thus forming the slot structure channel.

Figures 24 and 25 show a further modification utilizing a male expansible rib of the type shown at 232 in Figure 20 which is expanded by utilizing a modified riveting wheel 246 as shown in Figure 25 in conjunction with a modified back up wheel 247. The modified riveting wheel includes projections 248 at spaced locations on the periphery thereof which deform segments of the rib 232 into the groove 217 of the slot structure of the beam extrusion. In that regard, it will also be noted that the outer wall portion 213 of such slot structure is omitted from the arrangement shown in Figures 24 and 25 so that the jointing wheel 246 may come in direct contact with the male expansible rib as shown.

In addition to the projections 248, the modified jointing wheel further includes a continuous projecting band 251 from which such projections 248 extend. Thus, the projections 248 as shown in Figure 25 deform segments of wall portions 212 and of the expansible rib 232 at spaced locations, and the band 251 also deforms the expansible rib 232 into the receiving groove 217 continuously along its length into the groove 217. To accommodate such inward deformation caused by the projections 248, the modified back up wheel 247 is provided with suitably spaced recesses 252 to receive therein the deformed segments of the wall portion 212 and rib 232 as seen in Figure 25.

Thus, it is seen that the structural members of a beam embodying this invention may be interconnected in secure engagement by deforming wall portions of the slot structures to clamp a portion of the side wall panels therein in the fashion shown in Figures 13 through 21 or, alternatively, the side wall panels of the beam may be deformed directly into the channels of the slot structures of the extruded structural members in the fashion shown in Figures 22 through 25.

Preferably the side wall panels of the beam are provided with a decorative motif, such as a wood grain effect available on aluminum

sheet metal rolls on the market today. To further enhance the decorative appearance of a beam utilizing such a decorative motif, a harmonizing pattern may be applied to an extruded member 2 or 3 by utilizing a decorative cover panel thereon. Such a panel, designated 256, may be slidably received or positioned to cover the metal extrusion with which the side wall panels are engaged as seen in Figure 26. By utilizing one or more decorative panels 256, all visible areas of a beam when the same is positioned in a building structure may be made to harmonize in design motif to produce a very attractive assembly.

Similarly, as seen in Figure 27, for those ends of the beam which may be visible in a given building structure, an end cap, designated 261, may be positioned in engagement with the side wall panels of the beam. Such an end cap may be formed from a suitable section of metal extrusion which is positioned over and interengaged with the end margins of the respective side wall panels 4 and 6 to close off the end of the beam. a section of metal extrusion is normally required to adapt the same to fit in place, but such trimming may be easily effected at the job site to produce the finished decorative effect desired.

WHAT WE CLAIM IS:—

1. A structural unit comprising opposed pairs of elongate structural members securely interconnected with each other into a unitary assembly; each member of a first pair of said pairs of members comprising a central web, opposed shoulder sections extending longitudinally of each such member along opposite margins of said web thereof, and slot structures interposed between and interconnecting said shoulder sections with said web margins, each of said slot structures including an elongate channel extending therealong; each member of the second pair of said pairs of members being positioned within and generally irremovably received within the respective slot structures of said first pair of members; and means securing opposite edge portions of said members of said second pair of members within said slot structures of said first pair of members, whereby a unitary structural assembly is provided therebetween, said means including sections of the members of at least one of said pairs of members which are deformed into locking engagement with the members of said other pair of members.

2. A structural unit according to Claim 1, in which each of the slot structures of the members of said first pair comprises a first wall portion extending between the central web thereof and the shoulder section associated therewith, and a second wall portion depending from such shoulder section, said

wall portions defining said elongate channel of each said slot structure therebetween.

3. A structural unit according to Claim 2, in which the said means securing the pairs of members together comprises segments of the second wall portions of the respective slot structures of the members of the first pair of members which are deformed into locking engagement with the first wall portions thereof and with the edge portions of the members of the other pair of members.

4. A structural unit according to Claim 3, in which each of the first wall portions of the respective slot structures includes a groove extending longitudinally thereof, the deformed segments of the second wall portions of the respective slot structures being received in the respective grooves of the first wall portions along with segments of said edge portions of the members of said second pair of members deformed therewith.

5. A structural unit according to Claim 4, in which each of the second wall portions includes an elongate rib extending longitudinally thereof and aligned with the groove in the first wall portion associated therewith, the rib ensuring deformation of said segments of said edge portions into said groove.

6. A structural unit according to Claim 1 in which each of the slot structures of the members of the first pair comprises a wall portion extending between the central web thereof and the shoulder section associated therewith, and an elongate groove extending longitudinally of said wall portion, and in which the deformed sections of the members of the second pair of members are received in the grooves of the respective wall portions of such members.

7. A structural unit according to Claim 6, in which said deformed sections of said members of the second pair comprise expansible ribs formed on such members which are expanded into locking engagement within said respective grooves.

8. A structural unit according to any one of claims 1 to 7, in which each of the members of said first pair are defined by elongate metal extrusions.

9. A structural unit according to any one of claims 1 to 8, in which each of the members of said second pair are defined by sheet metal panels.

10. A structural unit according to Claim 9, in which each of the sheet metal panels includes an elongate groove formed therein and extending longitudinally thereof, each such groove being adapted to receive an expansible rib of an associated supporting structure therein.

11. A structural unit according to any one of Claims 1 to 10 in which the central webs of the members of the first pair of members are spaced inwardly from their associated shoulder sections and connected therewith by

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sheet metal rolls on the market today. To further enhance the decorative appearance of a beam utilizing such a decorative motif, a harmonizing pattern may be applied to an extruded member 2 or 3 by utilizing a decorative cover panel thereon. Such a panel, designated 256, may be slidably received or positioned to cover the metal extrusion with which the side wall panels are engaged as seen in Figure 26. By utilizing one or more decorative panels 256, all visible areas of a beam when the same is positioned in a building structure may be made to harmonize in design motif to produce a very attractive assembly.

Similarly, as seen in Figure 27, for those ends of the beam which may be visible in a given building structure, an end cap, designated 261, may be positioned in engagement with the side wall panels of the beam. Such an end cap may be formed from a suitable section of metal extrusion which is positioned over and interengaged with the end margins of the respective side wall panels 4 and 6 to close off the end of the beam. a section of metal extrusion is normally required to adapt the same to fit in place, but such trimming may be easily effected at the job site to produce the finished decorative effect desired.

WHAT WE CLAIM IS:—

1. A structural unit comprising opposed pairs of elongate structural members securely interconnected with each other into a unitary assembly; each member of a first pair of said pairs of members comprising a central web, opposed shoulder sections extending longitudinally of each such member along opposite margins of said web thereof, and slot structures interposed between and interconnecting said shoulder sections with said web margins, each of said slot structures including an elongate channel extending therealong; each member of the second pair of said pairs of members being positioned within and generally irremovably received within the respective slot structures of said first pair of members; and means securing opposite edge portions of said members of said second pair of members within said slot structures of said first pair of members, whereby a unitary structural assembly is provided therebetween, said means including sections of the members of at least one of said pairs of members which are deformed into locking engagement with the members of said other pair of members.

2. A structural unit according to Claim 1, in which each of the slot structures of the members of said first pair comprises a first wall portion extending between the central web thereof and the shoulder section associated therewith, and a second wall portion depending from such shoulder section, said

wall portions defining said elongate channel of each said slot structure therebetween.

3. A structural unit according to Claim 2, in which the said means securing the pairs of members together comprises segments of the second wall portions of the respective slot structures of the members of the first pair of members which are deformed into locking engagement with the first wall portions thereof and with the edge portions of the members of the other pair of members.

4. A structural unit according to Claim 3, in which each of the first wall portions of the respective slot structures includes a groove extending longitudinally thereof, the deformed segments of the second wall portions of the respective slot structures being received in the respective grooves of the first wall portions along with segments of said edge portions of the members of said second pair of members deformed therewith.

5. A structural unit according to Claim 4, in which each of the second wall portions includes an elongate rib extending longitudinally thereof and aligned with the groove in the first wall portion associated therewith, the rib ensuring deformation of said segments of said edge portions into said groove.

6. A structural unit according to Claim 1 in which each of the slot structures of the members of the first pair comprises a wall portion extending between the central web thereof and the shoulder section associated therewith, and an elongate groove extending longitudinally of said wall portion, and in which the deformed sections of the members of the second pair of members are received in the grooves of the respective wall portions of such members.

7. A structural unit according to Claim 6, in which said deformed sections of said members of the second pair comprise expandable ribs formed on such members which are expanded into locking engagement within said respective grooves.

8. A structural unit according to any one of claims 1 to 7, in which each of the members of said first pair are defined by elongate metal extrusions.

9. A structural unit according to any one of claims 1 to 8, in which each of the members of said second pair are defined by sheet metal panels.

10. A structural unit according to Claim 9, in which each of the sheet metal panels includes an elongate groove formed therein and extending longitudinally thereof, each such groove being adapted to receive an expandable rib of an associated supporting structure therein.

11. A structural unit according to any one of Claims 1 to 10 in which the central webs of the members of the first pair of members are spaced inwardly from their associated shoulder sections and connected therewith by



opposed side walls defining a recessed open channel therebetween, the web of one of such members being spaced a greater distance from its associated shoulder sections than the spacing of the web of the other of such members from its associated shoulder sections, said one web and its associated side walls providing a drainage trough extending longitudinally of said structural unit.

12. A structural unit comprising opposed pairs of elongate structural members securely interconnected with each other into a unitary assembly; each member of a first pair of said pairs of members being defined by a generally rigid metal extrusion and comprising a central web, opposed shoulder sections extending longitudinally of each of such members along opposite margins of said web thereof, and slot structures interposed between and interconnecting said shoulder sections with said web margins; each of said slot structures comprising a first wall portion between said web and an associated shoulder section, and a second wall portion depending from said shoulder section, said wall portions defining an elongate channel therebetween; each member of the second pair of said pairs of members being defined by a generally resilient sheet metal panel; the respective members of said second pair of members being received within the channels defined by the slot structures of said first pair of members; and means securing opposite edge portions of said members of said second pair of members in said slot structures of said first pair of members by clamping the same between the respective wall portions thereof, whereby an integral structural assembly is provided thereby.

13. A structural unit according to Claim 12, in which the means securing the pairs of members together comprises segments of the second wall portions of the respective slot structures of the first pair of members deformed into locking engagement with said edge portions of the other pair of members and with the first wall portion of such slot structures.

14. A structural unit according to Claim 13, in which each of the first wall portions of the slot structures of the first pair of members also includes a groove extending longitudinally thereof, the deformed segments of said second wall portions of the slot structures being received in the grooves of the first wall portions along with segments of the edge portions of the other pair of members deformed therewith.

15. A structural unit according to Claim 14, in which a rib is provided on the inner surface of each of said first wall portions of the respective slot structures, said ribs being aligned with the grooves in said second wall portions of such slot structures, said ribs ensuring deformation of said segments of said

edge portions of said second pair of members into said respective grooves.

16. A structural unit according to Claim 14 or 15, in which each of the panels of said second pair of members includes an expansible rib extending therealong and expanded into an associated groove for locking engagement therein.

17. A structural unit according to any one of Claims 12 to 16 in which each member of the first pair of members further includes a flange projecting from and extending along each of said shoulder sections thereof, and a pair of spaced guide ribs extending along each of the second wall portions of the respective slot structures thereof, the guide ribs being formed on the respective outer surfaces of said first wall portions; the guide ribs and the flanges together defining guide means for tools to be employed in clamping the second pair of members in the slot structures of the first pair of members.

18. A method of forming an integral structural unit from a plurality of discrete structural members, comprising providing first and second pairs of such structural members, the members of said first pair including preformed slot structures extending longitudinally along opposite margins thereof; bringing said pairs of members into contact with each other at an assembly station, inserting edge portions of said second pair of members in the respective slot structures of said first pair of members at said station; and deforming predetermined segments of the members of at least said second pair into locking engagement with the members of said first pair to thereby lock said edge portions of said second pair of members within said slot structures of said first pair of members without requiring separate fastening means therefor.

19. A method according to claim 18, further including feeding lengths of said pairs of structural members from a supply thereof to the assembly station; and joining together said pairs of members substantially simultaneously at the station.

20. A method according to claim 19, further including feeding the members of at least one of said pairs of members from substantially continuous supplies thereof; and severing the structural unit from such supplies when said unit has been formed from said pairs of members into a unitary assembly of predetermined length.

21. A method according to claim 20, in which the members of said first pair are defined by metal extrusions which are fed in sequence from supplies of predetermined lengths thereof, and in which said members of said second pair are defined by sheet metal panels which are fed from rolls thereof; a plurality of the structural units being formed in sequence by feeding successive pairs of such first pair of members into contact with



the supplies of the second pair of members, and severing the second pair of members in accordance with the predetermined lengths desired for successive units formed from the pairs of members.

22. A method according to claim 19, 20 or 21, further including feeding said lengths of the pairs of members in converging paths to the assembly station; and guiding the members of the second pair into the slot structures of the first pair while the pairs are converging and prior to deformation of such members to lock the pairs of members together.

23. A method of forming a structural unit, comprising providing first and second pairs of structural members, the members of said first pair including deformable slot structures defined by opposed wall portions extending longitudinally along opposite margins thereof, the members of said second pair having edge portions thereof receivable within said slot structures; inserting the edge portions of the second pair of members into the respective slot structures of the first pair of members; and deforming segments of one of the wall portions as well as segments of the edge portions to clamp the edge portions of the second pair of members between the respective wall portions.

24. A method according to claim 23, further including providing a groove in the other wall portion of each of said slot structures of the members of said first pair; and deforming segments of each of said one wall portions and their associated edge portions into such groove.

25. A method according to Claim 23 or 24, further including feeding predetermined lengths of said pairs of structural members from supplies thereof to an assembly station; and joining together said pairs of members substantially simultaneously at said station.

26. A method according to Claim 25, in which the pairs of members are fed from the supplies thereof toward the assembly station in converging paths to facilitate interfitting together thereof prior to joining the same into a unitary assembly at the station.

27. A method according to claim 24, 25 or 26 in which the segments of the respective wall portions and edge portions are deformed at longitudinally spaced locations along the length of the respective structural members.

28. An apparatus for forming a structural unit defined by opposed pairs of structural members, a first pair of which have preformed slot structures extending longitudinally along opposite margins thereof to receive therein edge portions of the members of a second pair thereof; the apparatus comprising guide means for receiving the pairs of members from supplies thereof and orientating the members of each pair in opposed relationship

to each other; means for drawing the aligned pairs of members into engagement with each other and inserting edge portions of the members of the second pair into the slot structures of the first pair; and means for deforming segments of the members of at least said second pair into locking engagement with the members of the first pair, whereby the pairs of members may be securely interconnected into an integral structural unit.

29. An apparatus according to claim 28, further including first means for supporting predetermined lengths of the members of the first pair of said members, and other means for supporting substantially continuous supplies of the members of the second pair of the members; the respective supporting means being positioned in advance of the guide means.

30. An apparatus according to claim 28 or 29, in which the means for deforming the member segments comprises rotary mechanism for substantially simultaneously engaging said members to be deformed.

31. An apparatus according to claim 30, further including backup means positioned on opposite sides of said members to be deformed relative to said rotary mechanism.

32. An apparatus according to claim 30 or 31 in which the rotary mechanism comprises a plurality of rotating wheels positioned to engage said respective members to be deformed, each of the wheels having projections thereon for engaging the members to be deformed to effect such deformation.

33. An apparatus according to claim 32, in which each of the wheels has peripherally spaced projections thereon, whereby the members are jointed together by spaced segments deformed therefrom as the wheels rotate thereagainst.

34. An apparatus according to any one of Claims 28 to 33 in which the guide means includes guide structure for receiving the pairs of members from supplies thereof and bringing the same together in a converging path to facilitate interfitting edge margins of the second pair of members into the slot structures of the first pair of members.

35. An apparatus according to Claim 34, further including pressure means for positively retaining the members interfitted as they pass from the guide structure to the means for deforming the segments.

36. An apparatus for forming a structural unit defined by opposed pairs of structural members a first pair of which have preformed slot structures extending longitudinally along opposite margins thereof to receive therein edge portions of the second pair thereof; said apparatus comprising guide means for receiving the pairs of members from supplies thereof and orientating the members of each pair in opposed relationship to each other; means for drawing the aligned pairs of members into



engagement with each other and inserting edge portions of the second pair of members into the slot structures of the first pair of members; and means for deforming segments of the respective slot structures of the first pair of members and segments of the edge portions of the members of the second pair of members into locking engagement with each other whereby the edge portions of the second pairs of members are securely clamped in the slot structures and the pairs of members are joined securely into an integral structural assembly.

37. An apparatus according to claim 36, further including first means for supporting predetermined lengths of the first pair of the members, and other means for supporting substantially continuous supplies of the members of the second pair of said members; the respective supporting means being positioned in advance of said guide means.

38. An apparatus according to claim 36 or 37, in which the deforming means comprises rotary mechanism for substantially simultaneously engaging the respective slot structure of said members of the first pair and deforming the same inwardly at predetermined locations therealong.

39. An apparatus according to Claim 38, in which the rotary mechanism comprises a plurality of rotating wheels positioned to engage the respective slot structures simultaneously as the pairs of members pass through the apparatus, each of the wheels having projections thereon, the projections deforming the slot structures at the predetermined locations to clamp the members of the second pair in the slot structures of the members of the first pair.

40. An apparatus according to Claim 39, in which the projections of the wheels are peripherally spaced from each other, whereby the slot structures are deformed at spaced locations therealong.

41. An apparatus according to Claim 39 or 40 in which back-up means are orientated to support the respective slot structures from the sides thereof opposite from the respective wheels during deformation of such slot structure.

42. An apparatus according to any one of claims 28 to 41 further including pressure means adjacent the discharge end of the apparatus against which a completed length of a structural unit passes, the pressure means applying pressure to such completed unit to impart a predetermined amount of curvature thereto.

43. An apparatus according to any one of claims 28 to 42, further including cut-off means adjacent the discharge end of the apparatus for severing the structural members of the second pair after assembly of the

pairs of members into a structural unit, whereby such unit may be discharged from said apparatus in a predetermined length. 65

44. A structural unit substantially as hereinbefore described with reference to Figures 2 to 4 of the accompanying drawings.

45. A structural unit substantially as hereinbefore described with reference to Figures 13 to 16 of the accompanying drawings. 70

46. A structural unit according to claim 45, modified substantially as hereinbefore described with reference to Figure 17 of the accompanying drawings. 75

47. A structural unit according to Claim 45, modified substantially as hereinbefore described with reference to Figure 18 of the accompanying drawings.

48. A structural unit according to claim 45, modified substantially as hereinbefore described with reference to Figure 19 of the accompanying drawings. 80

49. A structural unit substantially as hereinbefore described with reference to Figures 20 and 21 of the accompanying drawings. 85

50. A structural unit substantially as hereinbefore described with reference to Figures 22 and 23 of the accompanying drawings.

51. A structural unit substantially as hereinbefore described with reference to Figures 24 and 25 of the accompanying drawings. 90

52. A method of forming an integral structural unit from a plurality of discrete structural members substantially as hereinbefore described with reference to Figures 1 to 12 of the accompanying drawings. 95

53. A method according to claim 52, modified substantially as hereinbefore described with reference to Figures 13 to 16 of the accompanying drawings. 100

54. A method according to claim 52, modified substantially as hereinbefore described with reference to Figures 20 and 21 of the accompanying drawings. 105

55. A method according to Claim 52, modified substantially as hereinbefore described with reference to Figures 20 and 21 of the accompanying drawings.

56. A method according to claim 52, modified substantially as hereinbefore described with reference to Figures 24 and 25 of the accompanying drawings. 110

57. An apparatus for forming a structural unit defined by opposed pairs of structural members substantially as hereinbefore described with reference to Figures 1 and 5 to 12 of the accompanying drawings. 115

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