April 30, 1940. A. J. EDGE ET AL 2,199,152

BUILDING CONSTRUCTION

Filed Jan. 27, 1937 4 Sheets-Sheet 1

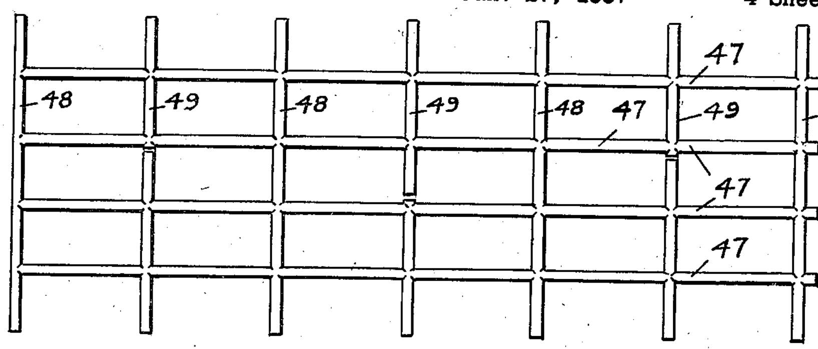


Fig. 1

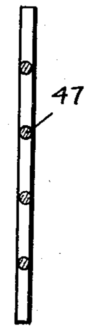


Fig. 2

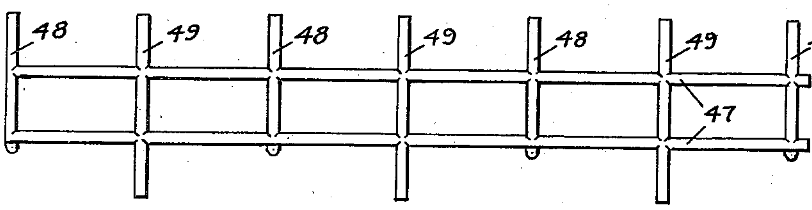


Fig. 3

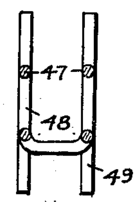


Fig. 4

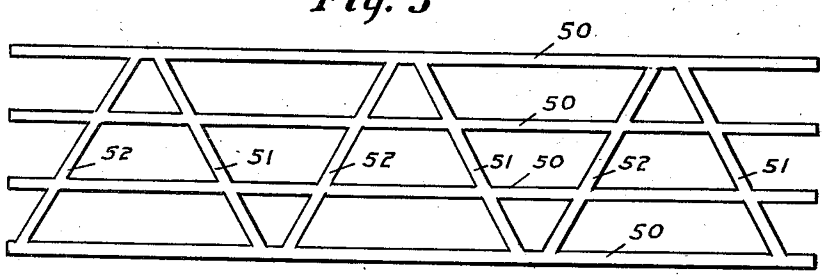


Fig 5

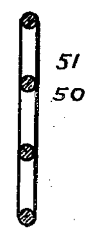


Fig. 6

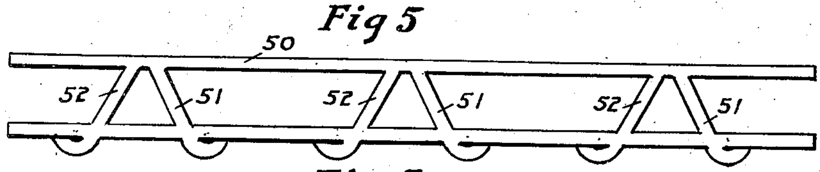


Fig. 7

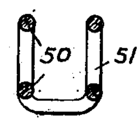


Fig. 8

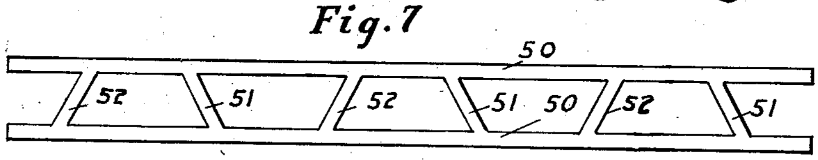


Fig. 9

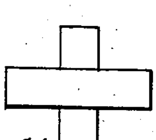

Fig. 1A

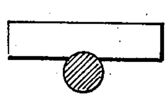

Fig. 2A

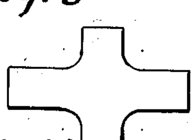

Fig. 3A

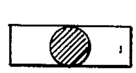

Fig. 4A

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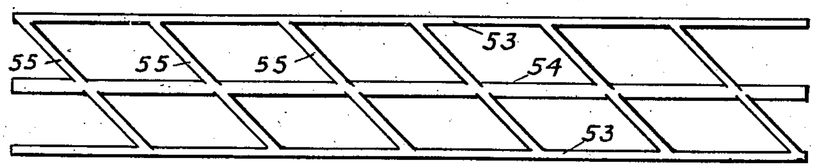


Fig. 10

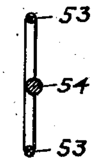


Fig 11

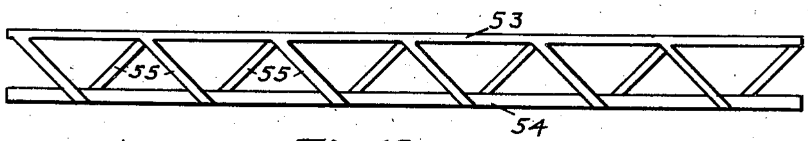


Fig. 12

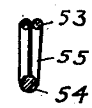


Fig. 13

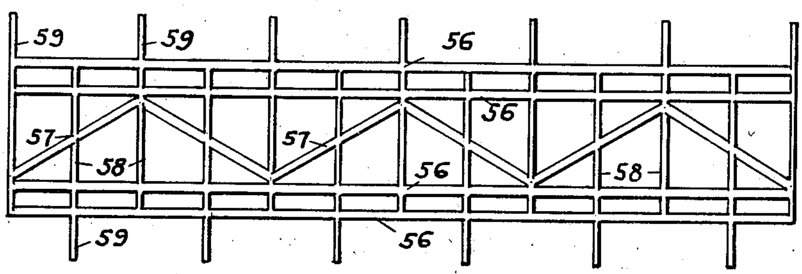


Fig. 14

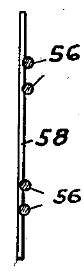


Fig. 15

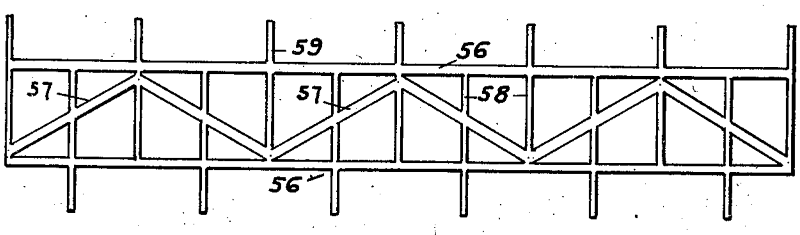


Fig. 16

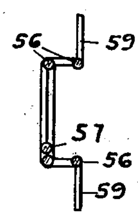


Fig. 17

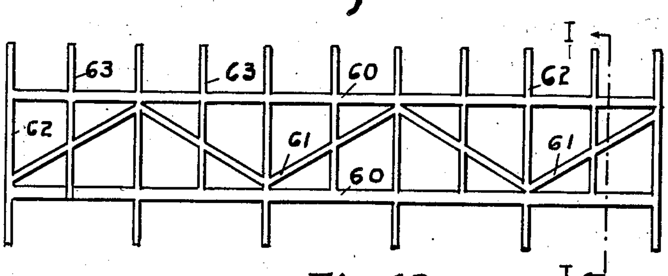


Fig. 18

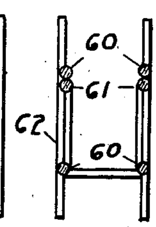


Fig. 19

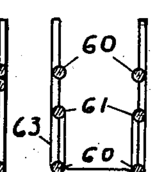


Fig. 20

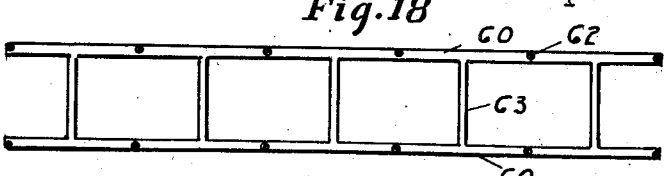


Fig. 21

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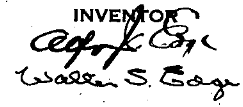


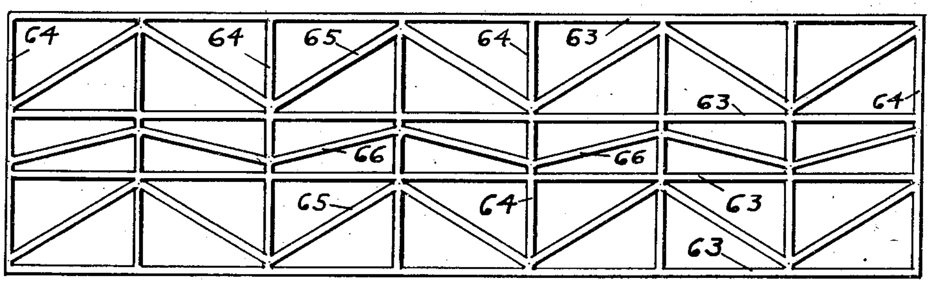



Fig. 22

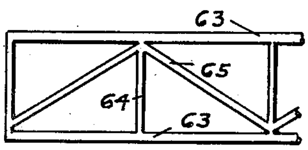



Fig. 23

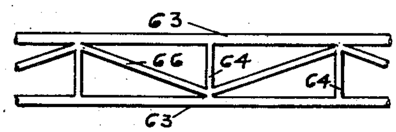



Fig. 24

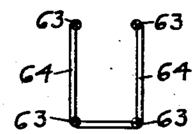



Fig. 25

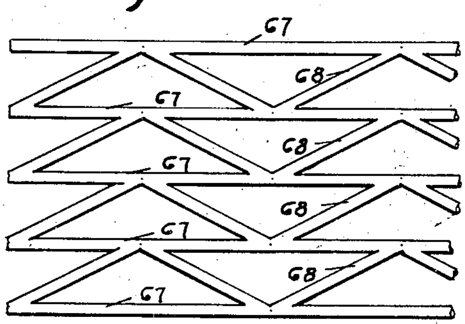



Fig. 26

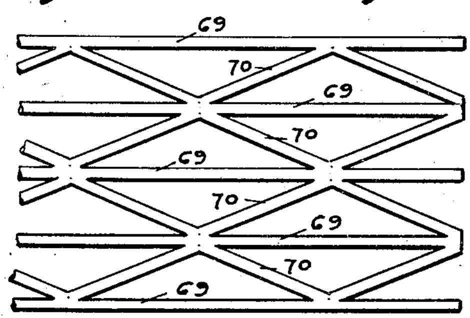
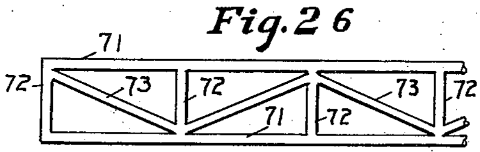



Fig. 27

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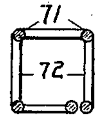


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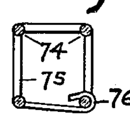


Fig. 30

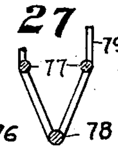


Fig. 31

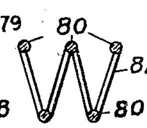


Fig. 32

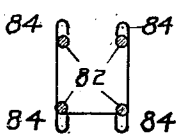


Fig. 33

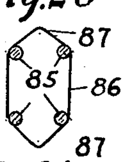


Fig. 34

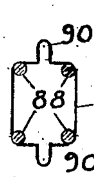


Fig. 35

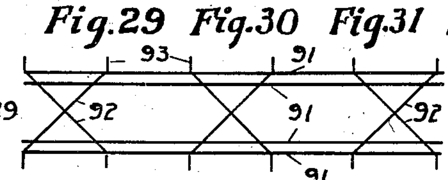


Fig. 36

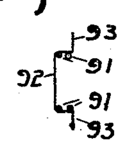


Fig. 37

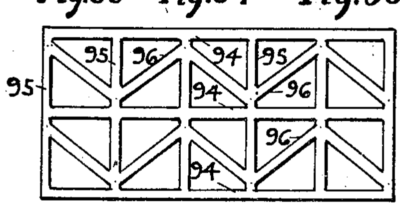


Fig. 38

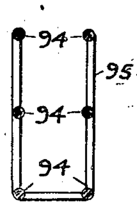


Fig. 39

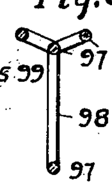


Fig. 40

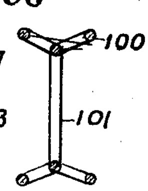


Fig. 41

INVENTOR

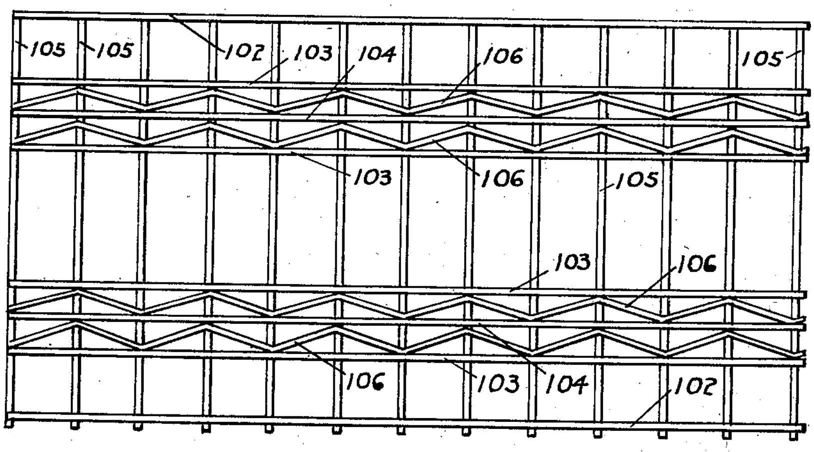


Fig. 42

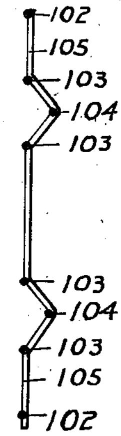


Fig. 43

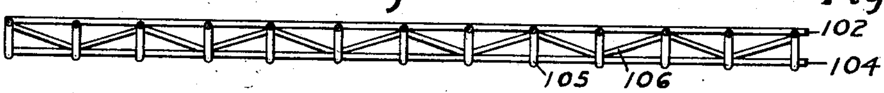


Fig. 44

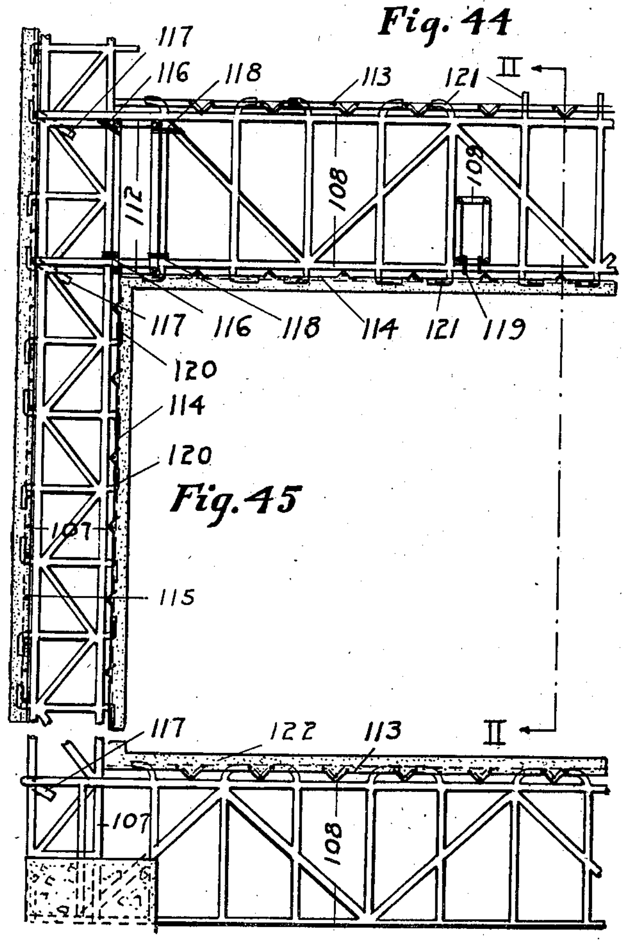


Fig. 45

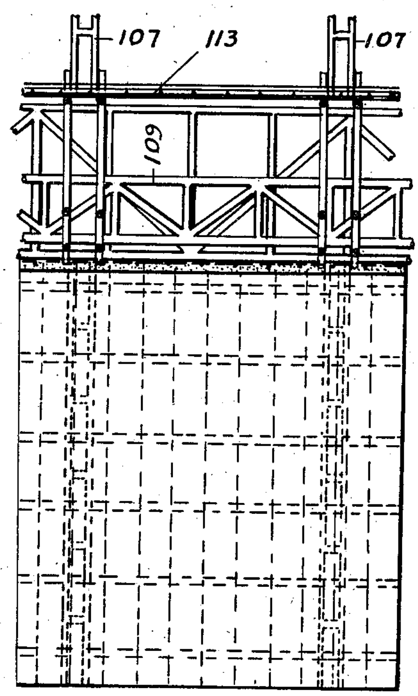


Fig. 46

INVENTOR
Walter S. Edge

Patented Apr. 30, 1940 2,199,152

# UNITED STATES PATENT OFFICE

2,199,152

## BUILDING CONSTRUCTION

Alfred J. Edge, Savannah, Ga., and Walter S. Edge, Pittsburgh, Pa.

Application January 27, 1937, Serial No. 122,638

1 Claim. (Cl. 29—155)

Our invention relates to the framing for structures such as posts, poles, bridges, buildings of various kinds, but its greatest use, we think, lies in small low cost dwellings. Apparently, it may be economically used as a substitute for wooden timber for many purposes.

One object of our invention is to produce structural members of very high efficiency.

Another object is to produce structural framing members of very light weight.

Another object is to produce a framed structure with self contained connections provided for interior or exterior coverings or both, greatly facilitating its rapid erection.

Another object is to produce structural members which lend themselves to very easy erection and very simple and strong field connections.

Another object is to produce a structural frame which provides the maximum facility for the running of electric ducts, pipes, etc., in walls or floors.

Another object is to produce structural members which, when combined with cement stucco, plaster or a concrete floor, will act with the same to carry stress as combination members, thereby, greatly increasing the efficiency of construction. This is not true of many forms of combined steel and cement construction now in common use.

We are aware that many attempts have been made and are being made to produce the, so called, low cost steel house and we are familiar with many of these designs, but, so far as we know, no one has succeeded in producing a satisfactory steel house at a cost equal to or lower than a similar house could be built out of wood in the same locality.

By the use of the designs and methods of manufacture herein disclosed, coupled with the special combination of materials which we employ, we are able to produce fireproof construction at a cost considerably below the cost of standard wood construction. Our materials weigh less and require less labor for their erection. As a typical example, we are producing metal beams as a substitute for wooden beams, having equal strength, weighing one fifth and costing one half as much as wood.

In the design of structural steel beams and welded joists (electrically welded assemblies of steel parts), unit tension and compression stresses of 16,000 to 18,000 pounds per square inch are commonly employed. This is due to the fact that the elastic limit of the steel of which they are made may be as low as 32,000 pounds per square inch and a higher working stress would reduce the factor of safety too much. With such low working stresses, steel cannot compete with wood in cost except possibly in longer spans.

In our studies to develop a lower cost material for housing and other structures, we were led to consider the superior properties of cold drawn wire and cold rolled steel. It is easy to produce a low carbon steel wire having an ultimate tensile strength of 115,000 pounds per square inch with an elastic limit very close to the ultimate. By increasing the carbon and manganese, we have produced wire whose ultimate strength is close to 400,000 pounds per square inch and a strength of 220,000 pounds per square inch is being obtained commercially as an every day matter.

High carbon hot rolled steel can be produced, having a high tensile strength. It is frequently lacking in uniformity, is apt to be brittle and is not so reliable as hot rolled structural grade steel and is difficult to work. Wire, however, by its very nature and process of manufacture, is much more uniform and reliable.

In order to take advantage of the superior properties of wire, it must be assembled into structural units and this we have done in a number of ways, as this application will disclose. Resistance welding, similar to that now in common use, was employed, but we found that it would not give the results necessary to insure success. A long series of experiments were undertaken to find a cure for this trouble. We finally succeeded in perfecting a method and an apparatus which gave us the desired results and this forms the basis for another application for a patent, Serial No. 122,880, filed January 28, 1937.

Another weakness of assemblies made by ordinary welding was the eccentricity of all connections, which produced high secondary stresses in members of the unit which, of course, greatly reduced its efficiency. This weakness has also been overcome by our welding process.

We have also taken advantage of the different qualities possessed by different kinds of steel wire, which was first disclosed in application 94,985 by Walter S. Edge, filed August 8, 1936 (now Patent 2,103,897).

Our basic idea in the production of low cost structural members of high efficiency is to first, weld or otherwise assemble them into flat sheets which may be wound into coils for convenience in handling. Standard welding machines of the type now in use will not perform this function satisfactorily. The method of welding must be changed and, for the most efficient type of structural members, certain of the longitudinal wires, which would normally remain parallel to the rest, are moved back and forward to produce certain patterns which are required.

The pattern of the mesh, which will be normally assembled on the machine, will be a multiple of the fabric required for any specific member. As it passes through the machine, the stay or connecting wires between adjacent members, will be cut so that the result will be a number of strips or rolls, each one being equivalent to a structural member, but, of course, in an unfinished form. These individual strips or rolls will then be cold formed into the final shape required, either by cold pressing or cold rolling, and be cut into convenient lengths. Painting or galvanizing or other suitable methods may be employed as a protection against corrosion.

In said Patent 2,103,897 a product known as a "plaster ground" or "plaster base" was described. The structural members herein described are designed to work with this product and others similar to it. The projecting ends of wires shown on many of the structural members in this present application are provided as a support and anchorage for the plaster base, etc. When the structural members are erected in their final position, the plaster base sheet is simply pressed against the protruding ends of the wires, forcing them through the backing sheets and the projections are then bent over to engage the wires of the plaster base and thus firmly lock the whole together without the need of any other fastening means. The subsequent coating of plaster, stucco or concrete, as the case may be, produces a completely bonded structure. When the structural members, herein described, are used in floor construction, in combination with a concrete floor slab, the projecting vertical wires at the top of the beam extend up into the concrete floor slab and thoroughly bond the steel beam to the concrete, thereby producing a very efficient T beam of comparatively small dead weight. Where a plastered ceiling is used on the underside of the beam, the plaster base is locked on by bending the ends of the vertical wires which project from the underside of the beam. When the ceiling has been plastered, the lower sides of the steel beams are thoroughly braced against buckling and their efficiency is much increased.

In the accompanying drawings, Figure 1A is a plan view of a typical commercial resistance weld as made with soft wire and Figure 2A is a side view of the same weld. In Figure 3A is shown a plan view of a weld made by bringing together a hard drawn wire and a soft wire and welding them by our process and Figure 4A is a side view of the same weld. Figure 1 is a plan view of one of the simplest forms of structural members and Figure 2 is an end elevation of it. Figure 3 is a side view of the structure shown in Figure 1 after it has been pressed or formed into its final shape and in Figure 4 is shown an end view of Figure 3. Figure 5 is a plan view of another form of structural member and Figure 6 is an end elevation of it. Figure 7 is a side view of the structure shown in Figure 5 after it has been pressed into its final shape and Figure 8 is an end view of Figure 7. Figure 9 is a bottom plan view of the structure shown in Figure 7. Figure 10 is still another form of structural member and Figure 11 is an end view of it. Figure 12 is a side view of the structure shown in Figure 10 after it has been pressed into its final form and Figure 13 is an end view of Figure 12. Figure 14 is still another form of structural member which is shown in an end elevation in Figure 15. In Figure 16 is shown a side view of the structure shown in Figure 14 after it has been formed into its final shape and Figure 17 shows an end view of Figure 16. In Figure 18 is shown a side view of a structural beam of a U shaped cross section. In Figure 19 is shown an end elevation of it. Figure 20 is a section on line I—I and Figure 21 is a bottom plan of the structure shown in Figure 18. In Figure 22 is shown still another type of a structural member. In Figure 23 is shown a partial side view after it has been formed into its final shape. Figure 24 shows a partial plan view of the bottom of the structure shown in Figure 23 and Figure 25 is an end view of the structure shown in Figure 23. Figure 26 shows another type of structural member and Figure 27, still another, both of which are adapted to be formed into members having a U or V or a "box" cross section. In Figure 28 is shown a side view of a beam or column section and Figures 29 and 30 show typical cross sections of such a beam or column. Figure 31 shows a cross section of a beam having a V cross section and Figure 32 is a section showing another modification of this idea.

In Figure 33 is shown a cross section of a structural beam in which the projecting members at top and bottom are bent into loops or eyes to serve as an anchorage for other structural material. Figures 34 and 35 show other modifications of the same idea. In Figure 36 is shown a structural member adapted to be formed into a partition stud and Figure 37 shows a cross section of the structure shown in 36 after forming into its final shape. In Figure 38 is shown a side view of a structural beam of still a different pattern. Figure 39 shows an end view of Figure 38. In Figures 40 and 41 are shown sections of other forms of structural members which can be readily formed from welded structures in a similar manner. In Figure 42 is shown a plan of a structural fabric in which trussed beams of a V cross section are incorporated to stiffen the structure (see application 94,985 by Walter S. Edge, filed, August 8, 1936) which gives a structure suitable for a base for floor construction or a plaster base. Figure 43 is an end view of Figure 42 and Figure 44 is a side view of Figure 42.

In Figure 45 is shown a sectional view of a portion of a building showing how the structural members, shown in previous figures, are used and combined to form a complete structure and how the plaster base and floor base described in other applications by Walter S. Edge, are combined with the structural beams to finish the structure. In Figure 46 is shown a sectional view on line II—II in which other details are made clear.

Referring now to the figures in detail, it will be seen that Figure 1 consists of a fabric or grille made up of parallel spaced members, **47**, intersected by and rigidly connected to transverse spaced members **48** and **49**. Members **47** are preferably of high strength material such as high elastic limit steel, for example, hard drawn wire or cold rolled steel, and may be any cross section, round, flat or deformed. Members **48** are shown to be continuous from side to side but members **49** are cut at certain points. When the structure, shown in Figure 1 is formed into the U cross section shown in Figures 3 and 4, the cuts in members **49** allow portions of these members to protrude below the bottom of the structural beam. These projections from the top and bottom of the beam serve to provide a very excellent means for attaching other structural material such as plaster base, etc., to the structural framework. Members 48 and 49 are preferably made of a ductile material such as soft steel. Not only will this material withstand the stresses due to cold forming to shape better, but a better weld results from the combination of a hard drawn steel with a soft steel. The connections between members 47, 48 and 49 are described as rigid. Ordinary commercial welding will not produce this result with the steels which we prefer to use. Not only should the welds be strong enough to develop the full strength of the members, but there should be as little eccentricity as possible at the connections. By the method of welding which we have developed, the connections will develop the full strength of a high tensile wire, not only at the weld but for a length including a number of welds and eccentricity at the connections is eliminated. This invention forms the subject of another patent application by us, Serial No. 122,880, filed January 28, 1937.

As set forth in said application, wires or rods are assembled in superposed relation as shown in Figs. 1A and 2A for example, whereupon welding heat and pressure are applied, the heat and the pressure being continued until the two members occupy a common plane, as shown in Figs. 3*a* and 4*a*, for example.

A structural beam such as the one shown in Figures 3 and 4, will show a surprising amount of strength and stiffness but of course, is not as efficient as one in which diagonal bracing is introduced. By using welds of the type shown in Figures 3A and 4A, the resisting moment at the welded joints is doubled and by still further flattening the weld at the instant of welding, while the metal is still hot, the strength of the joint is still further increased in the plane of the fabric without weakening the structural members between the joints in any respect. By this means, the rigid frame type of structural member can be made quite efficient.

In Figure 5 we show a plan view of a structural member in which one form of diagonal or web bracing is introduced. In Figures 5, 6, 7, 8 and 9, longitudinal members 50 are straight, spaced and parallel and are preferably of high tensile material such as hard drawn wire or cold rolled steel. Intersecting them at regular intervals are transverse members 51 and 52 respectively. When the structure shown in Figures 5 and 6 is folded around the two interior members 50, a section of U form is produced (see Figure 8), which is quite well braced in two planes at right angles to each other. This design is really a compromise between a real truss and a rigid frame but our tests give it quite a good rating for efficiency. Obviously, here, strength of connections and freedom from eccentricity are important. In this design members 51 and 52 should preferably be of a comparatively soft material such as soft wire.

In Figure 10 is shown still another type of structure in which 53 and 54 are parallel spaced members, preferably made of hard drawn wire while members 55 are parallel and spaced and intersect 53 and 54 at an oblique angle and are rigidly connected at their intersections. When this structure is folded about member 54, a unit having a V shaped cross section results and if the folding is completed, the section shown in Figure 13 is obtained. If such a beam is used in floor construction, for example, and members 53 are bonded into a concrete floor slab, the unit will develop high efficiency. On the other hand, members 53 may be rigidly connected at two or more points and an efficient Warren truss is obtained.

In Figures 14, 15, 16, and 17 is shown a type of structural member, well adapted to serve as a partition or exterior wall stud. Here, longitudinal members 56 are preferably of a strong and stiff material such as hard drawn wire and diagonal bracing members 57 may be of the same material. Transverse members, 58 should be of a relatively softer material. They may either extend beyond the outside of the members 56 at alternate ends as shown at 59 or they may extend at both ends or they may be cut flush with the edge, if desired. Again the projecting ends may be bent into loops or eyes (see Figures 33, 34 and 35), to better serve as an anchorage for other structural material such as a plaster base or floor base. Figures 16 and 17 show the completed form of this stud and it is at once apparent, as our tests have shown, that it is very efficient, acting as a beam in the plane of its greatest dimension. Here again the efficiency of the connections is very important.

In Figures 18, 19, 20, and 21 are shown views of a finished structural beam which may be formed from a flat fabric by cold pressing or cold rolling. The top may be open as shown in Figures 19 and 20 or it may be closed to form a box section, if required. When used in floors and walls, the other structural material closes the open side of the U but when used as a column, the box section may be necessary. In Figures 22, 23, and 24 and 25 is shown a design in which this feature is covered. In Figure 22 is shown a flat sheet of welded fabric which the finished structural beam is to be formed from. This fabric can be made on welding machines, now in common use, with certain mechanical changes and with a complete change in the welding mechanism. The machine can either turn out a single width suitable for a single beam or any practicable multiple of this, cutting the fabric as it makes it into the proper width and winding it into coils of convenient size, as is now common manufacturing practice. These coils of fabric may then be taken to a press and pressed into the desired form, or a better method appears to be to form them into the desired section by the continuous cold rolling or forming process, cutting them to length either before or after forming. The stresses set up by this process, in the fabric structure are considerable but the softer metal used in the connecting members 64 of Figures 22, etc., can easily withstand this kind of treatment.

In Figure 26 is shown still another type of structural member in which longitudinal members 67 are preferably of stiff material and diagonal members 68 are of softer material. Members 68 are rigidly connected to members 67 and this may be done by bringing one above the other, as shown, and welding them or one may be brought against the side of the other and welded as shown in Figure 27. While these patterns are the only ones shown, a number of other combinations and arrangements are evidently possible and we do not wish to be limited only to these designs.

In Figure 28 we show a side elevation of a beam or column which is shown in section in Figure 29 and an alternate design in Figure 30. Here longitudinal members 71 and 73 are preferably of a stiff material such as hard drawn wire while cross members 72 are of softer material. The structure here shown is a closed or box section, is thoroughly braced and showed under test a very high efficiency. In Figure 29 is shown the cross section resulting from folding a flat structure such as was shown in Figures 26 and 27. A simpler and better column section is formed by omitting one longitudinal, 74, Figure 30, and tying or welding members 75 to member 74 as shown at 76.

In Figure 31 is shown a sectional view of a beam having a V cross section which might be formed from the structure shown in Figure 10. Such a beam will prove quite efficient when the projecting ends of the cross members are locked into a concrete floor or plastered wall. Obviously, bottom member 78 may be made larger in size than the two upper longitudinal members 77.

In Figure 32 we show a further modification of this idea in which two or more V sections are combined. The same requirements apply here as in the other designs.

In Figure 33 is shown a beam in cross section in which four longitudinal members 82 are used, one in each corner and certain of the cross members are cut at the bottom to form projections which are then bent into the form of loops or eyes, 84. The same procedure is followed in regard to the projections of the same members at the top of the beam. The result is a beam which is easy to handle or ship and which lends itself very well to the attachment of other structural members such as paper backed plaster base or floor base. In Figure 34 is shown a modification of the same idea in which more gradual bends 87 are provided in the cross members 86 to serve the same purpose as the loops 84 in Figure 33. In Figure 35 is shown a further modification of the same idea. When a sheet of plaster base is forced against the projection loops, 90 of Figure 35, they are pushed through the paper backing of the plaster base sheet and the insertion of a nail or straight piece of wire through the loop locks the sheet in position.

In Figure 36 is shown another design suitable for a partition stud in which four longitudinal members 91 are used in much the same way as in other designs already disclosed. The transverse members 92 are arranged to furnish X bracing and are rigidly connected to the members 91 and to each other where they cross. They may have projections 93 extending beyond the outside of the stud. In Figure 37 is shown an end view of this stud after forming to final shape. The X bracing members may be spaced a distance apart equal to the depth of the stud and still give quite satisfactory results.

In Figure 38 we show the side elevation of a structural beam in which a different system of bracing is used. The same beam is shown in end elevation in Figure 39. It will be seen that not only are longitudinal members 94 used at the four corners of the section, but an additional member is used on either side along the neutral axis.

Each diagonal bracing member 96 extends only half the depth of the beam. While this design may appear complicated, it has certain very definite advantages from a manufacturing standpoint.

In Figures 40 and 41 are shown two other possible sections into which beams may be formed. Other sections are quite possible and we naturally do not wish to be only limited to those which we have shown. The most practical sections for our use seem to be the V, U and the "box" section. In this case the U really includes the channel section.

In our system of construction, there is a very definite need for a floor base or combined floor form and steel reinforcement as well as a plaster and stucco base as in said Patent 2,103,897. In Figure 42 is shown a plan of one design of ribbed or stiffened mesh suitable for a plaster base but really designed for the heavier duty required in a floor base. Figure 43 is an end view and Figure 44 is a side view of the fabric shown in Figure 42. This design is well adapted to be combined with a backing sheet of water proofed paper or the like to facilitate the casting of a concrete floor around the mesh reinforcement. Referring to Figure 42, the mesh is seen to consist of a series of straight spaced longitudinal members, 102, 103 and 104 intersected by transverse members 105 which are crimped to form V bends at certain points. Longitudinal members are preferably of a comparatively stiff material such as hard drawn wire while transverse members should be a softer material. Longitudinal members 102 lie in the general plane of the fabric. Members 104 are located in the bottom of the V crimp as will be seen in Figure 43. Between members 103 and 104 are located diagonal bracing members 106, which, in common with the other longitudinal members, are rigidly connected at their intersections to transverse members 105. It will be seen that this construction gives a fabric reinforced by trussed V ribs at frequent intervals and so great is its stiffness that when made out of comparatively small diameter wire and fastened to floor joists, it will carry the weight of a man walking over it without injury to the fabric.

In Figure 45 is shown a sectional elevation of a portion of an exterior wall and floor of a building showing how the various structural elements described in this application are combined to form a complete structure and Figure 46 is a partial section on line II—II which makes the details of construction more clear. The sidewall is seen to be made up of studs 107 which may be approximately 2 x 4 inches in size for ordinary residence construction, may be spaced 16 inches on centers and extend two stories in height, if desired. At the floor line is fastened a horizontal beam 112 which is securely tied with special wire ties 116 to the 2 x 4 inch studs 107. These ties develop more than 2000 pounds tensile strength and are easily and quickly applied. The floor beams 108 which may be 2 x 8 inches in section are framed into beams 112 and studs 107. Upper and lower chord members of beam 108 are carried over corresponding members in beam 112 and are bent around vertical members in studs 107 at 117. Vertical members in 108 are then tied to beam 112 at 118 and the resulting connection is actually stronger than present standard wood construction at the same point. When floor beams are erected, small beams 109, which may be 2 x 4 or 2 x 6 inches in section are inserted through the floor beams 108 and are tied at 119 to the lower chord to serve as bridging to distribute concentrated floor loads. It should be noted that studs 107 and floor beams 108 are provided with projecting members 120 and 121 respectively on both sides to facilitate the anchoring of other structural material to the frame. Next the floor base 113 is placed on top of the floor beams and locked by bending down the projecting members 121 above referred to. The same procedure is followed in applying the sheets of plaster base 114 to ceiling and interior side walls and a similar material 115 is secured to the outside of the structure in the same way, to serve as a base for Portland cement stucco. A thin layer of rich Portland cement concrete, 122 (made with a fine aggregate) is next placed on top of the floor base 113, leveled off and finished. On account of the close spacing of ribs and well distributed reinforcement, which we employ, this floor slab need not be more than one inch thick at its thinnest points to provide all the structural strength required. The walls and ceilings are next plastered in the usual way and the exterior walls are finished with Portland cement stucco or with any other exterior finish desired.

The exterior walls lend themselves readily to "rock wool" or other types of insulation. It is evident that the problems of plumbing and of electric wiring are greatly simplified. As compared to wood, the labor of erection will be greatly reduced because the framing will weigh about one fifth as much as its equivalent in wood. Welding may be employed in erection but is not necessary and we believe that our present method of tying is better as it permits a small amount of movement to permit temperature adjustment.

Obviously a fabric similar to that shown in Fig. 10 could have been produced by welding members 55 at right angles to members 53 and 54 and then deforming the completed fabric in the plane of the members to produce an arrangement similar to Fig. 10. This pattern or any multiple of it could be easily produced in this manner and while the diagonal members would not be quite as straight as they are shown in Fig. 10 they would nevertheless function quite satisfactorily in the finished structural member. This method of producing a trussed unit has certain practical advantages from a manufacturing standpoint, and by it multiples of the sections shown in Figs. 12, 13, 31, and 32 could be easily produced. The structure shown in Figs. 36 and 37 could also be partially produced by this means. Other possible applications of the same idea are obvious.

If two series of spaced members such as 55 and 53 and 54 in Fig. 10 are welded together at right angles, and then the welded frame is distorted to produce an arrangement similar to Fig. 10 and then another series of members 55 are welded into the structure at right angles to 53 and 54 at certain points it will be possible to produce an arrangement of members which will closely resemble a Pratt truss and which will function in the same manner under exterior loads which may be applied to it. Such a fabric could also be formed into a structural member as previously described.

Having thus described our invention, what we claim is:

The method of forming structural units which consists in welding one series of spaced, parallel members and a second series of members of a sinuous outline disposed between certain members of the said first series to a third series of spaced members which intersect the first and second series, cutting the members of the third series at certain points, on lines parallel to the first-named series, to produce elongated units whose axes are parallel to the first-named series, and bending the third-named series of each unit along lines spaced laterally of the first-named lines, to form a structural shape.

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