July 10, 1956 R. K. McBERTY 2,753,962

METALLIC WALL AND ROOF JOINT

Filed Sept. 15, 1950 6 Sheets-Sheet 1

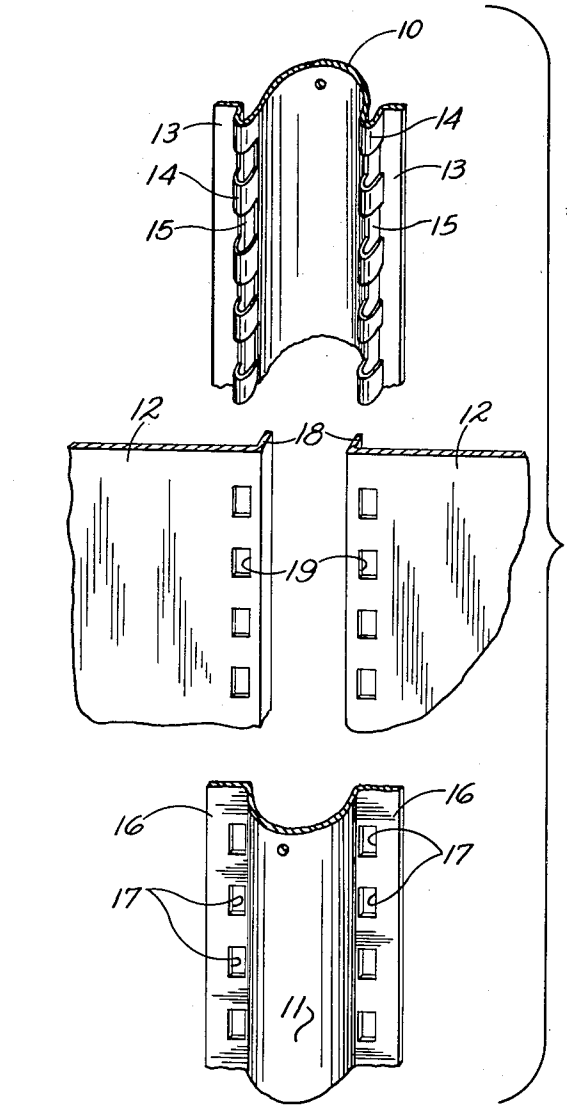

Fig. 1

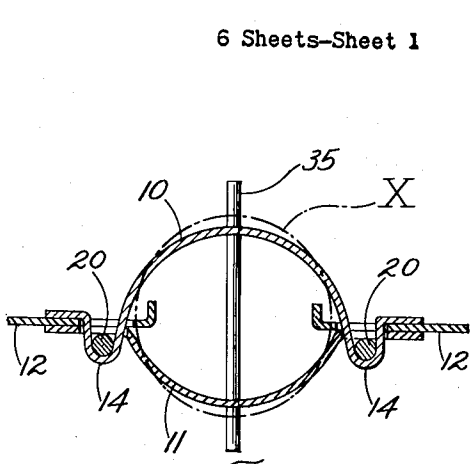

Fig. 3a

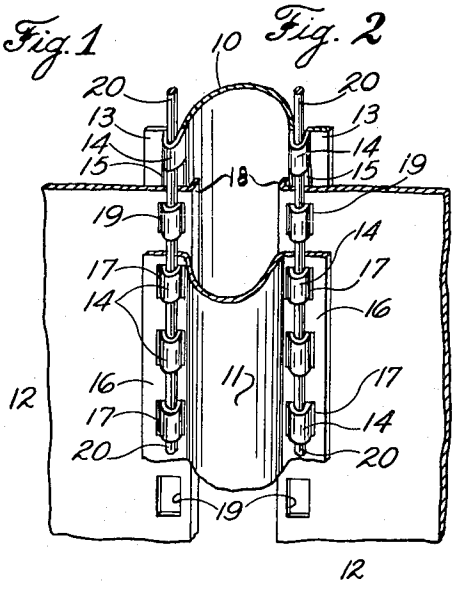

Fig. 2

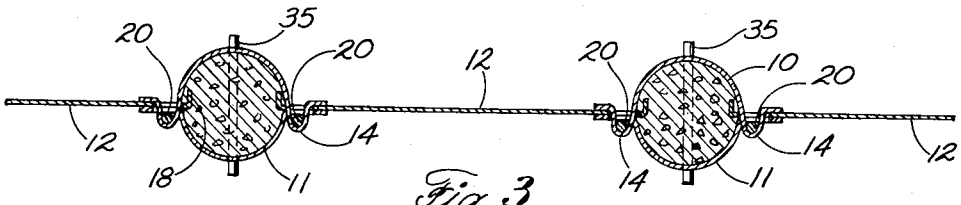

Fig. 3

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METALLIC WALL AND ROOF JOINT

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Fig. 4

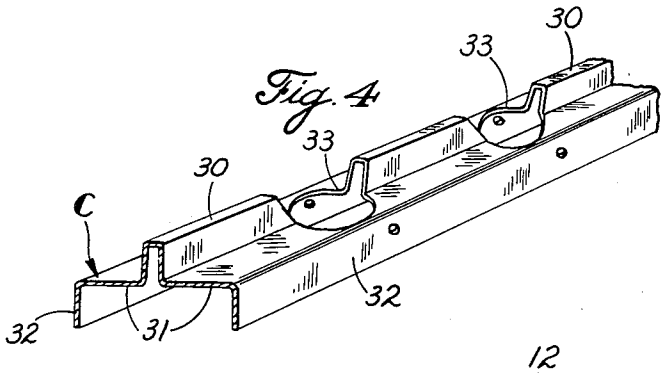
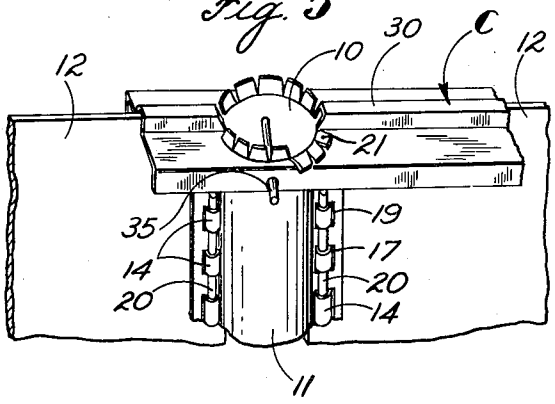


Fig. 5



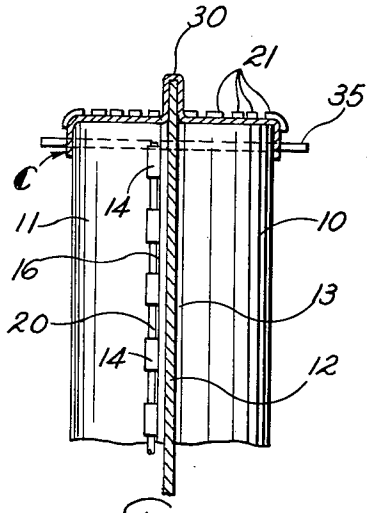


Fig. 6

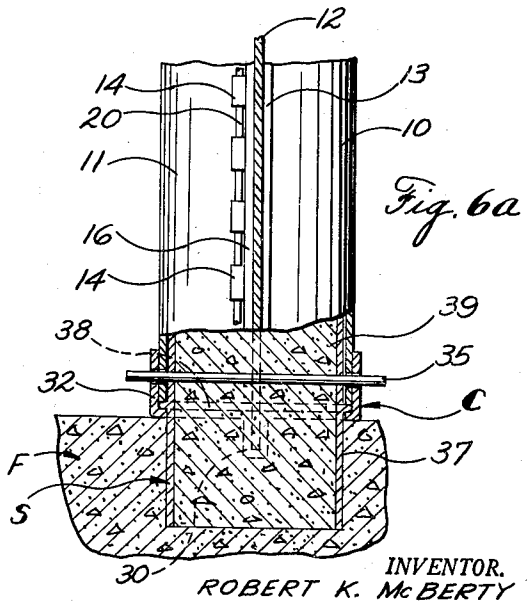


Fig. 6a

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METALLIC WALL AND ROOF JOINT

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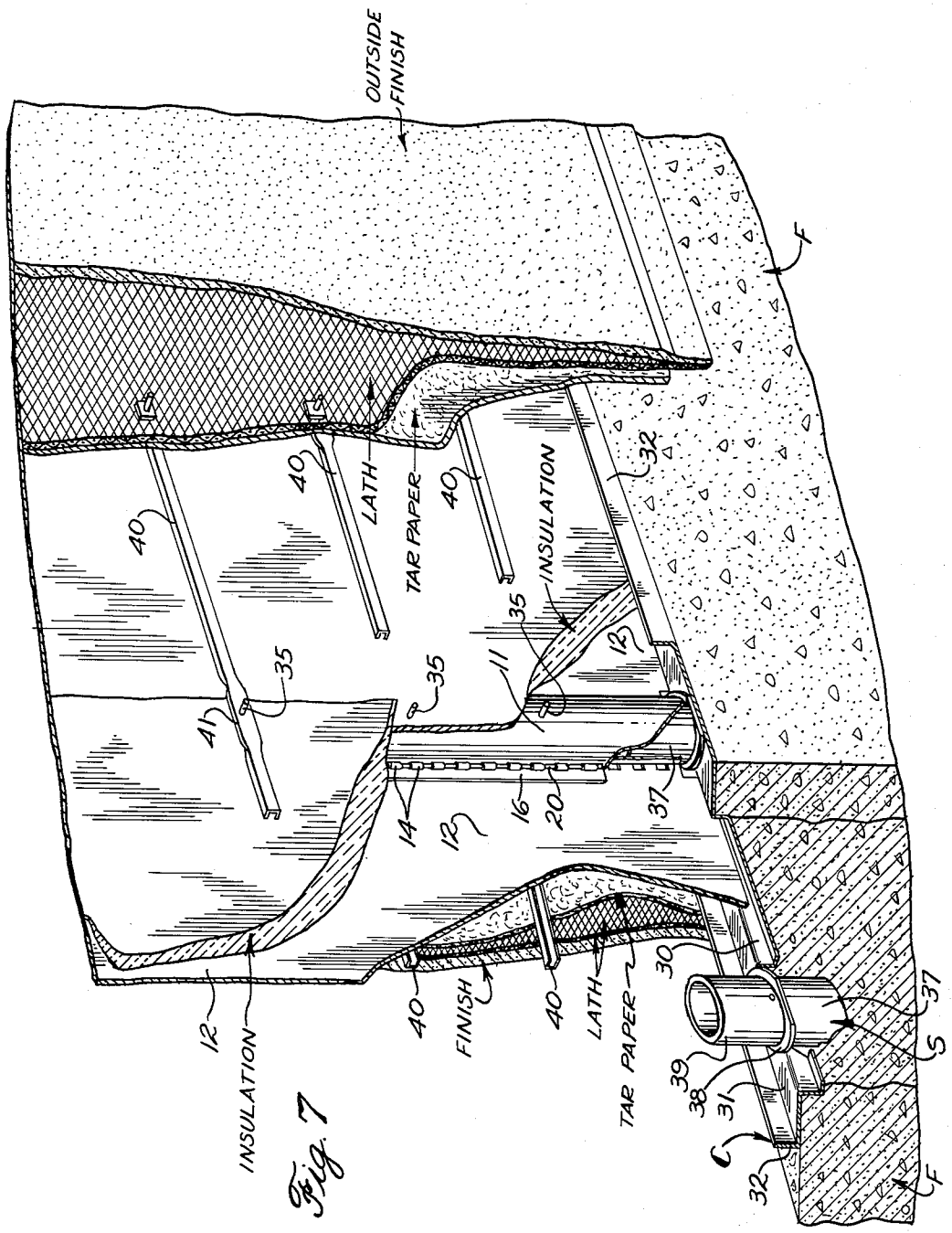

Fig. 7

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METALLIC WALL AND ROOF JOINT

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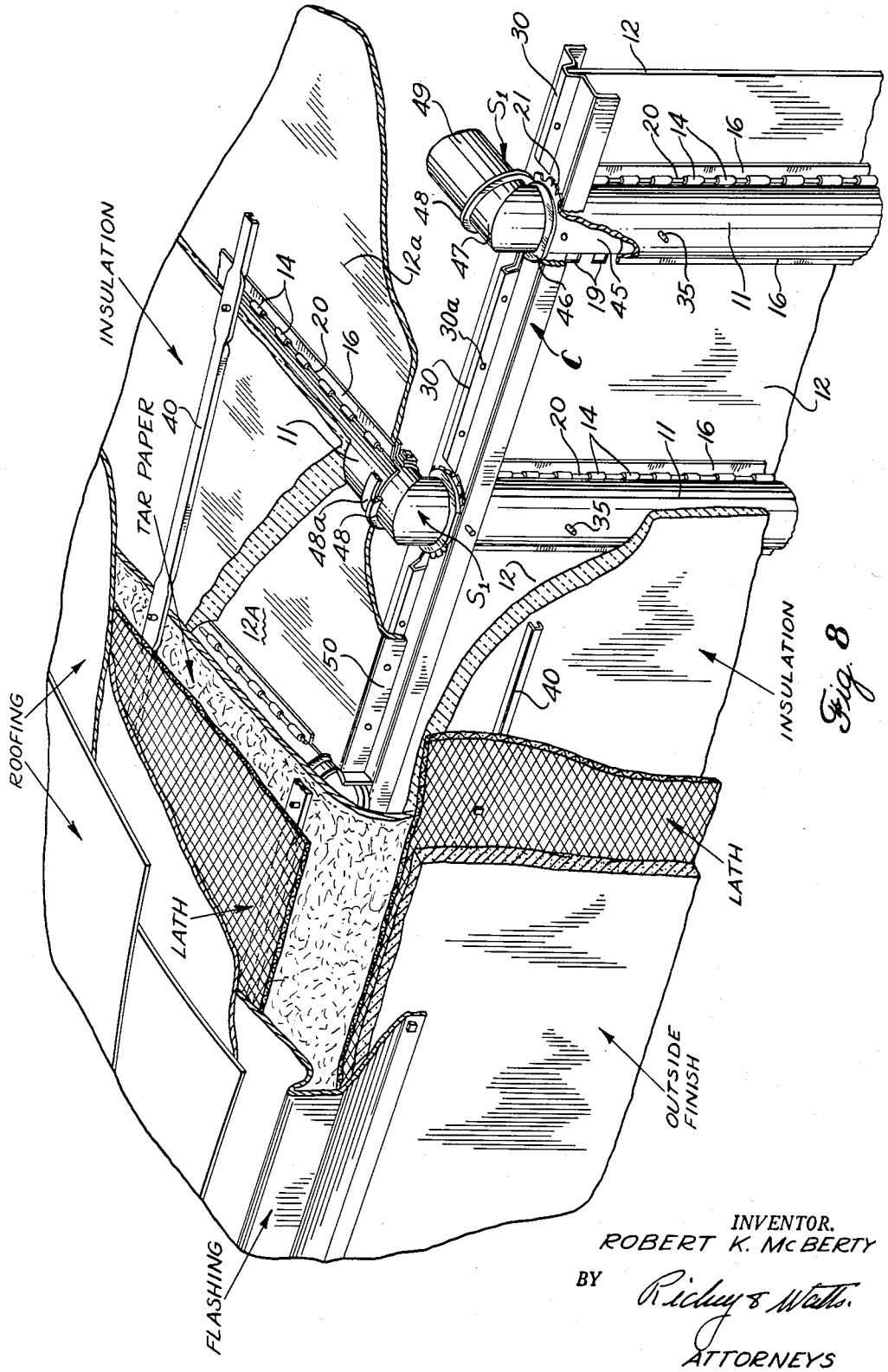

Fig. 8

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METALLIC WALL AND ROOF JOINT

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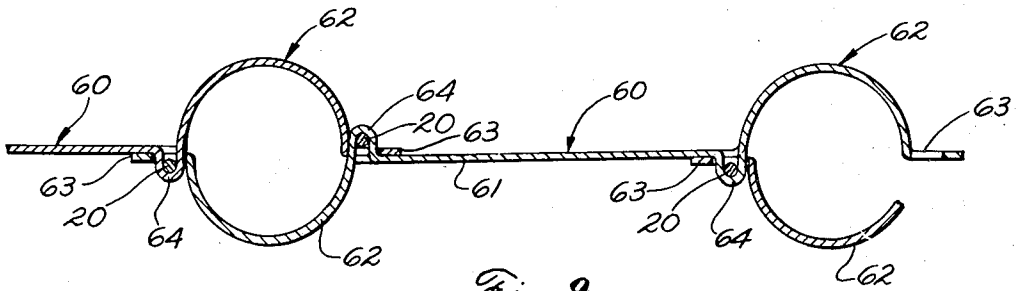

Fig. 9

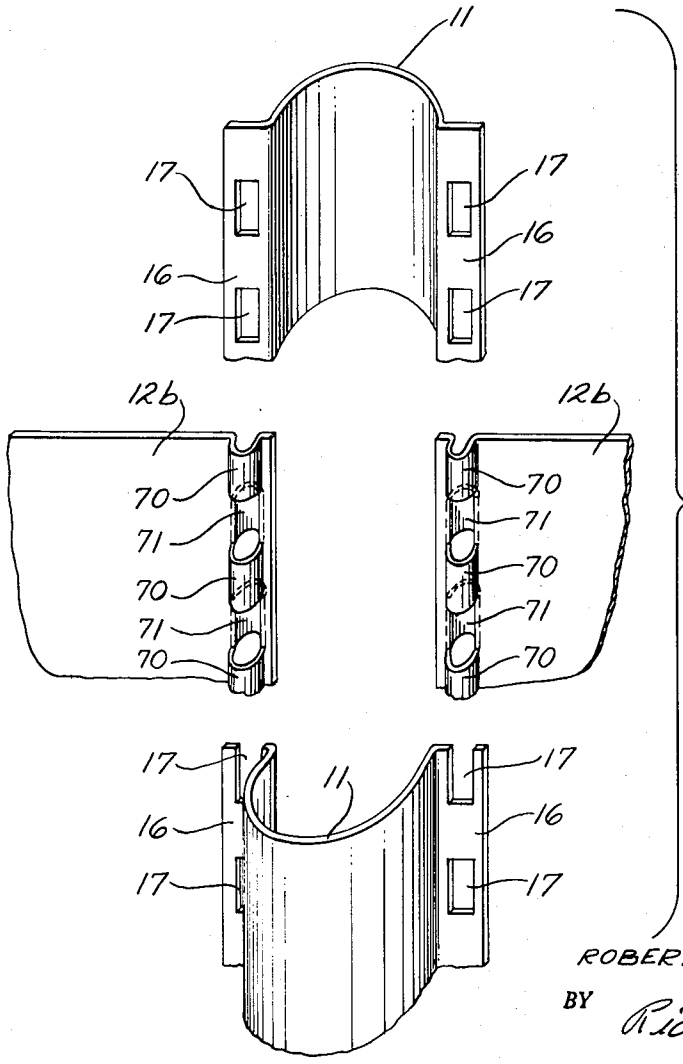

Fig. 10

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METALLIC WALL AND ROOF JOINT

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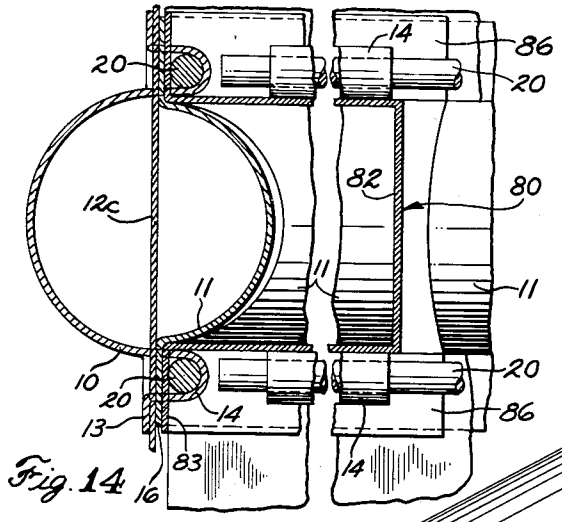

Fig. 14

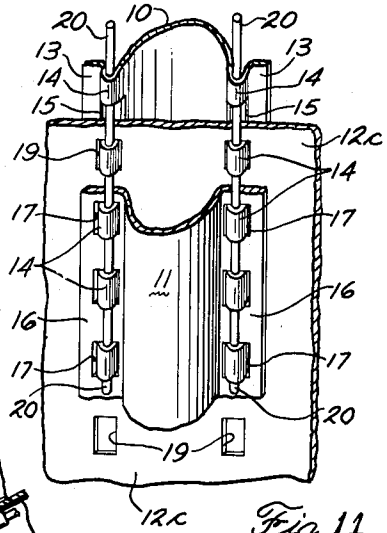

Fig. 11

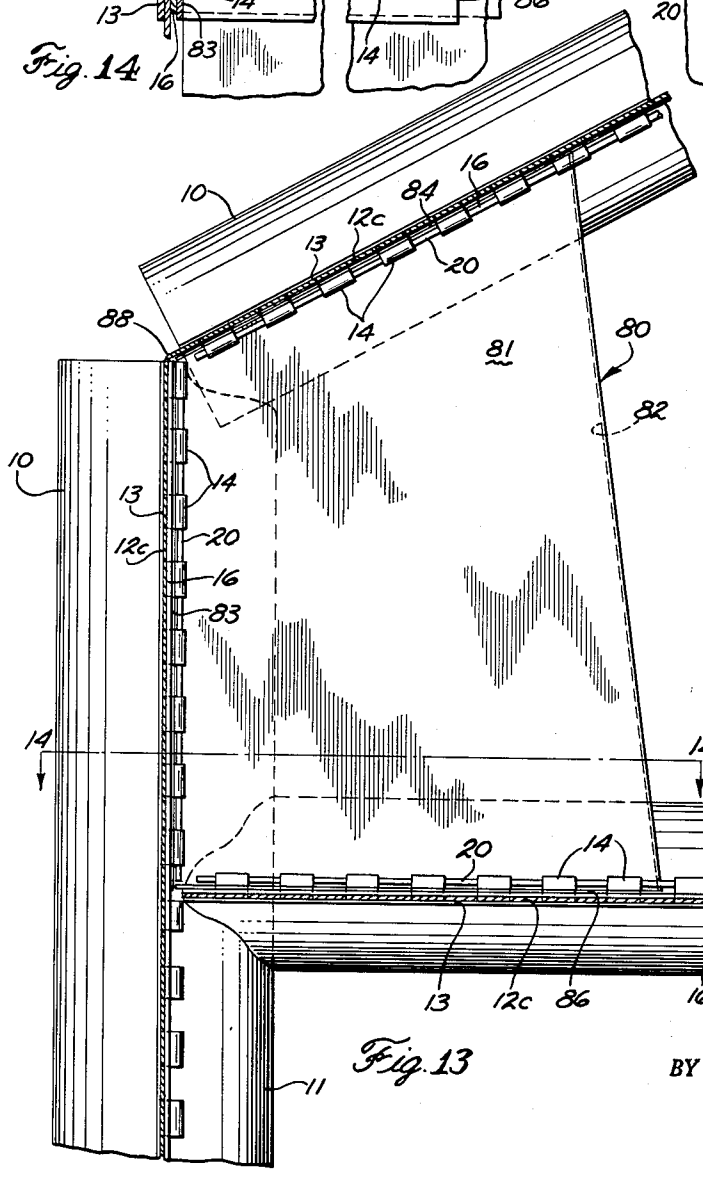

Fig. 13

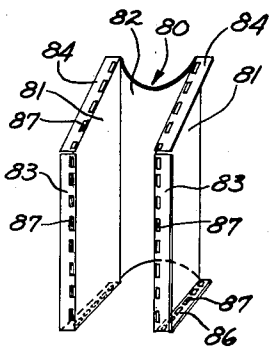

Fig. 12

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United States Patent Office

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METALLIC WALL AND ROOF JOINT

Robert K. McBerty, Galion, Ohio

Application September 15, 1950, Serial No. 184,929

3 Claims. (Cl. 189—1)

This invention relates generally to a building structure suitable for dwellings and other structures, as well as a method of producing the same.

Briefly, the essence of my invention resides in the provision of a readily assembled, self-trueing frame construction of sheet metal, adapted to be covered with insulation and weather-proof finish surfaces.

In its broadest and most basic aspects, a building constructed in accordance with my invention may be thought of as having for its fundamental structural and enclosing elements an enclosed box of relatively thin continuous sheet metal reinforced against stresses of tension and compression by having fastened thereto at spaced intervals sheet metal column members. The elements are arranged so that all parts are built up of duplicates of a few similar pieces, and are self-trueing and have tight, strong joints. This light, inexpensive, and readily-assembled basic structure serves to support, by means of the column members, the inside and outside insulation and finish layers, and due to the nature of the basic structure, virtually no metallic path for heat transfer between the outer and inner finish layers is provided.

Where the roof panels are formed in the manner of the wall panels, their junction may be braced by box-like members bridging the rafter and column elements.

More specifically, a wall framework built up in accordance with said preferred embodiment will comprise a series of tubes or hollow columns made up of relatively thin sheet metal and spaced about two feet apart by webs of thin sheet metal rigidly interlocked with said columns. The parts are adaptable and interchangeable and permit the production of a wide variety of architectural and structural designs without special engineering. I provide means whereby the central web and the columns may be assembled by lateral motion without relative axial sliding of said parts, there being locking means to fasten the columns and webs in assembled relationship that prevent relative axial sliding of the parts and so produce a rigid, self-trueing framework. No additional braces or supports are required during the assembly. I contemplate that the columns may be filled with cement, if so desired. Such a framework is not only novel in itself, but gives a foundation for construction of a wall having numerous advantages not found in the art.

Prior workers who have attempted to provide a building assembly of the type to which this invention relates, have been forced to employ one or more of several undesirable and expensive constructions in order to produce an adequately rigid composite building structure, one reason being that the proposed basic frameworks were inherently unsatisfactory and difficult to assemble.

For example, some workers have conceived forming framework of metal tubes or columns but have found it necessary to make the columns substantially contiguous

in order to obtain the desired strength and rigidity. This is not only an expensive construction but complicates the fittings of doors, windows, and the like.

Others have improved upon the above-mentioned structure by using spaced columns but have employed sheet metal members to form the inside and outside wall surfaces in order to impart the necessary accuracy and rigidity to the framework during assembly. This is not only an expensive construction, difficult to assemble, but it is subject to the serious disadvantage that there is excessive heat conduction from one sheet metal wall to the other wall.

Still others have attempted to provide column-like members with webs there between, but because the webs do not form a self-trueing rigid structure with the columns they have found it necessary to pour concrete between the columns, on at least one side of the web.

Accordingly, a primary object of my invention lies in making a readily assembled, self-trueing sheet metal framework of web-spaced columns, a preferred form of which requires neither inner nor outer wall members for its support and alignment to add weight and conduct heat. It is an object to provide a framework that requires no concrete between the columns, and which may be assembled into a rigid aligned structure without requiring relative axial sliding of the major components, springing of parts in place, etc. Still another object is to provide a simple readily-fabricated, strong, and easily assembled means and method for attaching sheets or webs together or to columns or reinforcing members formed of sheet material. These objects are attained and all of the aforesaid disadvantages of prior constructions I overcome in the preferred embodiment by forming cylindrical columns of thin sheet metal, preferably semi-cylinders that have side flanges with channel-shaped tongues supported at each side by the flanges. The flanges are interlocked with thin sheet metal webs by assembling the parts together laterally, no relative axial motion of the assembled parts being possible. In the preferred construction, the parts are permanently joined together by readily inserted axial keys, rods or other similar devices.

A further important object resides in the reduction of heat transfer between the inner and outer walls to a minimum. This I accomplish by fastening spaced narrow horizontal strips or channels of sheet metal to the tubes or columns, said strips serving the dual function of further reinforcing the wall and acting as mounting means for insulation, expanded metal lathe and the like. It is important to note that with this construction, the inner and outer wall supporting strips are narrow so that they have little more than point contact with the columns. This reduces heat conduction from the warm wall to the cold wall to a minimum and virtually eliminates cold spots in the warm wall because the only path for heat transfer is from a series of points at one side to opposed points on the other side. A construction of this type requires no stiffening and locating metal webs that extend laterally from wall to wall. Such webs, common in the prior art, facilitate heat transfer between the walls and produce cold spots on the inner wall in cold weather, and act as radiators in hot weather.

A further object of this invention is the employment of relatively thin metal for the column and webs together with an exceptionally easily manufactured and assembled locking means, which firmly join the parts and makes a rigid structure. With the joints and self-supporting channel-like tongues employed in my invention, the advantages of economy and ease of fabrication attendant with the use

of thin metal are had without sacrifice of strength and rigidity. In order to attain self-trueing and rigidity of structure when using thin sheet metal for the framework, it is highly important that the fastening means for the column and webs prevent relative axial movement of those parts. This construction has an important advantage in that the sheet metal components may be made of relatively thin material without danger because the tongues are supported at two sides by their flanges. This construction is superior to prior arrangements wherein rivets, bolts, or free tabs are used to fasten the parts because in the prior arrangements the fasteners must be extremely close together or the base metal quite thick to prevent tearing of the base metal.

Another object resides in increasing the strength and rigidity of the building structure where the rafters join the walls. This is accomplished by providing box-like brace members connected to the columns and to the rafters. Preferably the intermediate sheet metal webs are bent to extend continuously over the corner at the roof.

It is also desirable, and an object of the invention, to place the webs in tension so that they form an integral unit structure with the columns. To this end I form the thin sheet metal columns so that their dimension across the wall is less than that in the wall, such as an oval section. Thus, if concrete is poured into the columns, the hydrostatic pressure of the liquid aggregate tends to expand the columns in a direction normal to the wall and contract them in the plane of the wall, for example if the columns are elliptical, their minor axes will be elongated. This draws up on the webs and removes clearances in the joints, the resulting structure being remarkably strong and rigid even though quite thin metal be employed. Although concrete or the like is an excellent medium to elongate the minor axes of the columns, similar results will be obtained by using structural members slid into place after assembly, such as sheet metal webs.

Other objects and advantages reside in the provision of novel base assemblies for the columns and webs, effective and simple cap structures for the wall, means whereby the roof section may be built according to the principles of the invention and joined to the wall section, and provision of a framework which is adapted for the reception of insulating material, or of heat or cooling pipes, water conduits and the like. It is a feature of the invention that warmed air may be circulated within the walls, ceilings, and floors for heating purposes. The provision of a structure made up of readily-fabricated repetitive parts that can be adapted or even made up in part on the job, using relatively simple breaks, hand tools, shears and punches.

The manner in which the aforesaid objects and advantages may be attained will appear more fully in connection with the following detailed description of the preferred embodiment of my invention accompanied by illustrated drawings thereof.

In the drawings:

Fig. 1 represents an exploded partial view of the basic elements that go to make up the wall framework of the preferred embodiment;

Fig. 2 shows the same elements assembled with portions broken away for clarity;

Fig. 3 is a horizontal section through a wall section;

Fig. 3*a* is a horizontal sectional view of the wall columns and illustrates the deformability of the columns upon being filled with concrete.

Fig. 4 is a perspective view of the longitudinal cap member which may be assembled at the top or bottom of the wall structure;

Fig. 5 illustrates how the cap member may be fastened to the column member;

Fig. 6 is a vertical section through the wall framework intermediate the column;

Fig. 6*a* is a similar section with the lower section broken away to show how the columns are set into the foundation;

Fig. 7 is a partial perspective view of the building with various portions broken away to show how they are assembled;

Fig. 8 is a similar view shown when the roof structure may be assembled with the wall structure;

Figs. 9 and 10 illustrate modified forms of wall structure;

Fig. 11 shows a modified form of web and column assembly wherein the web is uninterrupted at one or more columns;

Fig. 12 shows a box-like reinforcing member for use between the columns of the wall and roof;

Fig. 13 shows a modified form of wall and roof juncture; and,

Fig. 14 is a section taken on **14**—**14** of Fig. 13.

Basic wall structure

As is best seen in Fig. 1, the preferred basic wall structure is composed of three fundamental elements. These elements are a semi-cylindrical column member **10**, a similar member **11**, and an intermediate web structure **12**. Because of the novel way in which my building is constructed and assembled, these basic members may be made of quite thin sheet metal. These elements may be either prefabricated or made up on the job, providing the proper breaks and shears are at hand. The column member **10** has side flanges **13**, which are joined to the body by channel-like tongues **14**, preferably shaped in the form of a U, which tongues may be formed by pressing out the base metal or by forming channels and punching out metal between the tongues as at **15**. Column member **11** has side flanges **16** which are punched out at **17** for reception of the tongues **14**. The sheet metal webs **12** have flanges **18** to assist in initial locating of the parts and are punched out at **19** to receive the tongues **14**, the tongues and recesses being axially complementary and providing abutment surfaces in planes generally normal to the column axes. The manner in which the parts are assembled is clearly illustrated in Fig. 2. The parts may be assembled laterally so that tongue **14** extends through aperture **19** in the panel and apertures **17** in member **11**, whereupon they form aligned small channel-like parts that in effect form a single long channel. The parts are so proportioned that a key rod **20** may be forced through the apertures or channel formed by tongues **14**, to securely lock all parts together. Since both legs of the U-shaped tongues **14** are supported by or extend from the flanges they will not tear loose even though the base metal is relatively thin. The webs may be apertured or relieved to provide for the fitting of window frames, door frames, cabinets or the like.

Due to friction that resists thrusting rod **20** through a long row of loops **14**, the fit must be reasonably loose. If the pieces are held reasonably in line near the upper end, and if the rod has a slightly tapered end, once the rod is started through the first of a row of loops, the other loops in order are brought in line and pulled through the slots, as the end of the rod advances, much as a zipper tab pulls the parts together.

The locking rod may be forced through a series of loops by pressure, by twisting, in which case a coarse thread on the rod may be an advantage, or by pressure with vibrating pulses along the major axis, such as may be produced by a vibrating tool. The upper edges of the loops may be belled out to facilitate insertion of the rod.

It can be seen that this basic wall structure has several advantages. First, due to the abutments between the loops and the edges of the recesses the wall is self-

trueing in that no relative axial movement or canting of the parts is possible, and the keys positively prevent relative lateral motion. Next, the parts are readily assembled by being brought into engagement laterally, as opposed to a construction where columns and webs are assembled by axial sliding of one element into the other which becomes almost impossible unless parts are either very loose or perfectly aligned. Also, the tongues **14** are connected to the associated column member **10** at both ends, rather than at one end. This greatly adds to the strength of the assembly and permits the use of thin metal.

Plate and cap structure

Another feature of my invention resides in the unusually simple and effective means provided for supporting the wall on the foundation. As seen in Figs. 6*a* and 7, I may place an inverted cap member C in the foundation before the concrete hardens to form a plate. Member C has lateral flanges **31**, depending flanges **32** and is formed with a central channel **30** for reception of panel or web members **12**, it being noted that the panels preferably protrude past the column members. Guide or pilot sleeve members are inserted in the foundation before the concrete hardens, the plate member C being apertured as at **33** to receive the sleeves. Pilot sleeve S includes extension **37** which reposes in the concrete, an intermediate collar **38**, and an upper extension **39** which telescopes within the associated column member. Thereupon, the wall segments may be progressively assembled with each column surrounding a sleeve member, and the key rods **20** driven home. Next, as seen in Figs. 5, 6 and 8, a cap member C, like that reposing on the foundation, is laid across the tops of the column and panel members, with the panels extending upward into the channel **30** of the cap. I prefer that the column members protrude through apertures **33** so that the upper ends may be cut to form ears **21** which are bent over to firmly assemble the parts. This is best seen in Fig. 5. A series of studs, pins or other fastening devices **35** are inserted through apertures in the column members and serve as hangers or fastening means for other parts of the building structure. At this point, and if so desired, concrete may be poured into each column member, which can be readily accomplished because the upper ends are open.

Roof structure

After the column and webs are assembled together to form the walls of the building, the roof structure will most likely be added. Fig. 8 illustrated how the principles of the invention just described may be carried forward to produce the roof structure. It is to be understood that my invention is not limited to the use of a roof structure shown in Fig. 8, but my wall structure is adapted to receive the roof structure therein illustrated. An elbowed guide sleeve S_1 may be provided for the upper end of each column member. Such a sleeve may have a pilot portion **45** telescoped within the column, it being understood that if concrete fills the columns the sleeve would be fitted before the concrete hardened. A collar **46** locates the sleeve, and an elbow section **47** is formed to provide the proper pitch for the roof. The members corresponding to the conventional rafters may be made up of column members **10** and **11** fastened to panels **12***a* by keys **20**, such members following the principles of construction just described. The columns are assembled to telescope over pilot portion **49** on the sleeves S_1 and will be axially located by collars **48**. Strap or clamp members **48***a* may be added to strengthen this part of the assembly. The intermediate webs **12***a* are assembled with the rafter members as described where they join the wall they may be flanged as at **50** and fastened to channels **30** of cap member C. Such channels are apertured as at **30***a*, and suitable fastening employed for attachment of the panels. With the construction outlined, the sheet metal may be quite thin, in the nature of 1/16" stock, although if the columns are not filled with concrete thicker metal may be desirable.

Insulation

As seen in Figs. 7 and 8, the insulation should be next to the outside surface of the webs and columns, and may be either loose fill of porous material, blanket-like organic or inorganic fibers, or sheets of insulating boards, or combination. The blanket-like material as prepared may be wrapped over the outside of the steel frame, and by use of waterproof adhesive, seal the walls from the outside air. It is to be understood that electric conduits and heating or cooling pipes may run vertically between the columns.

Furring strips

A feature of the invention is the provision of narrow horizontal channels **40** of sheet metal which are fastened to the columns by means of studs or pins **35**. These preferably take the form of channels flattened at the columns so that they do not materially increase the overall thickness of the wall. I prefer that these strips be long enough to span at least two or more columns in which case they stiffen and strengthen the structure even though the columns and webs are fabricated of quite thin sheet metal. These strips may then act as furring strips and may support sheets of tar paper, expanded metal lathe, or any intermediate finishing material characteristic of the type of construction desired. Alternately the furring strips may be prefastened to sheets of wallboard, plywood, Transite, or the like in an aligned relationship such that each assembly of furring strips and board is readily attached to the columns as a unit.

The preferred outside finish is cement, sprayed onto a backing of expanded metal lath, with tar paper in back of that. This finish, approximately one-inch thick is adequate in strength, and of good appearance. Alternatively, plywood, Masonite, Cellotex, asbestos-cement sheets, tiles, bricks, or other organic or inorganic material may be used for the outside finish. Metal sheets may also be used, being bolted to the upright columns, and the horizontal furring strips and cap and plate members.

Reduction in heat transfer

As mentioned previously, one of the objects of this invention resides in the elimination of cold spots in the wall due to heat conduction from one wall to another. It will be noted that although a rigid self-aligning structure is produced, the only horizontal elements extending laterally from wall to wall are the cap members C. But these are either at the foundation or at the roof of each story, and, since in the completed building neither of these areas are physically opposite occupied parts of the building (because of the floor and coiling structures), the heat transfer due to the cap members can be ignored. Between the roof and ceiling, the only lateral path for heat conduction is at the fastening pins **35** and these points form an insignificant portion of the total wall area. The strips **40** make substantially point contact with the columns and so that very little heat is conducted to or from such strips. Furthermore, these strips may overlie the insulation so that heat must pass through pins **35**. The columns themselves are insulated from the outside of the wall by the tar paper, lathe and finish coats of material and even so they make little more than point contact with the metal furring strips which support those walls. Furthermore, even from said points of contact the heat must traverse a relatively long path to pass from one wall to another by means of the thin columns, thus, despite the fact that the basic framework of the building is of metal, and of a rigid construction, the heat conduction between walls by the metallic members is, to all practical purposes no greater than that which would

occur if the conventional wooden framework were employed.

Alternate form of wall and roof construction

As seen in Fig. 11, I may make the webs **12***c* wide enough to extend completely past one or more of the column members so that the webs are uninterrupted at such members. The construction is otherwise like that shown in Figs. 1 and 2 wherein the column members are formed up of channels **10** and **11**, each channel being flanged and the channel **10** having tongues **14** struck therefrom that extend through apertures in the web and in the flanges of the other channel **11**, the parts being located together by rods **20** essentially as described.

In some structures where rigidity of the joint between the roof and the wall is of importance, the construction shown in Figs. 12 to 14 may be employed, and in many respects this is the preferred construction. A plurality of sheet metal box-like bracing members are formed having side walls **81**, an inner or back wall **82**, front flanges **83**, top flanges **84** angled to correspond to the pitch of the roof, and bottom flanges **86**. The various flanges are punched or cut as at **87** to receive the tongues **14** on the channel members **10**. The assembly of the box member **80** with the wall columns and rafters appears clearly in Figs. 13 and 14, and it will be noted that the member is readily attached into the framework at the same time the other assemblies are attached by simply sliding rods **20** through the tongues. Thus, the box members are firmly connected to the wall, to the roof, and to the beam member extending between the walls, thereby forming with these parts a very rigid braced corner. This construction facilitates making the web continuous at the corner because the web **12***c* need only be bent as at **88** and may be continued along as part of the joint between the parts.

Additional features

As seen in Fig. 3*a*, in forming the column members I make them so that they cooperate to form an oval or elliptical cross-section with the long axis in the plane of the web members. With this construction, when concrete is poured into the columns, the walls having the least spacing tend to spread and those in the plane of the webs tend to approach one another. In other words, the cross-section of the columns tend to assume the circular form indicated at X, which draws up on the joints and tensions the parts with a considerable increase in rigidity of the parts. The same result may be attained by sliding in sheet metal pieces disposed along the minor axis of the columns.

As in wooden construction, it will be obvious to those skilled in the art that if additional rigidity is required, one or more column members may be inclined to form a braced construction, which provides an exceptionally rigid structure. Likewise, one or more members **40** may be widened and fastened at two or more places to each column, to provide additional bracing. Furthermore, it will be obvious that some members **40** may be applied diagonally to augment the rigidity of the structure.

The column and wall structure described previously is a preferred embodiment of the invention, but Figs. 9 and 10 illustrate modifications which have the same mode of operation and advantages as the preferred embodiment. In Fig. 9 the column and intermediate walls are of a two-piece rather than a three-piece construction. For example, in Fig. 9 each section **60** has a wall or web part **61** integral with oppositely disposed semi-column members **62**. These column members terminate in flanges **63** which flanges are apertured to receive punched out tongue members **64**, as shown. Key rods **20** fasten the parts together in the manner previously described.

Fig. 10 illustrates a modification similar to the structure shown in Fig. 1. Two sections **11** are employed and tongues are all formed in the webs B. It will be seen that the tongues **70** and **71** are struck from the webs in opposite directions. A pair of key rods **20** will be required for each side of the column in this construction. The mode of operation in this modification is like that previously described and it offers all the advantages thereof.

It will be understood that regardless of the nature of the locking means employed, webs between the column may be cut away to provide for windows, doors, cupboards, and the like. An important advantage of the construction is that although the sheet metal components are relatively thin and light, the accuracy of the finished assembly inherent when the invention is practiced permits the use of prefabricated window and door frames, wallboard sections, etc. with a minimum of cutting and fitting on the job. Also, some saving in materials could be effected by forming the webs as vertically-spaced sections to provide for door and window frames. For example, narrow webs could be fastened to the columns at the top and bottom of a given panel or wall section at a saving of material, the only criterion being the strength and rigidity desired.

Although I prefer to connect the webs to the columns in the common midplane of the latter, it will be obvious that many of the advantages and features of the invention will be effected if the webs are connected tangent to the columns at one side thereof. A building constructed in accordance with this invention is readily heated without requiring heating pipes or conduits, because warmed air may be circulated within the confines of the walls, the ceiling, and the floors to provide an effective and economical heating system.

Having completed a detailed description of my invention and a preferred embodiment thereof, it will be understood by those skilled in the art that various modifications having the mode of operation of the invention may be made, and, accordingly, I contemplate that the appended claims and not the aforesaid embodiment be determinative of the scope of my invention.

What is claimed is:

1. In a building wall and roof construction, a plurality of aligned column and rafter members, said members comprising spaced thin sheet metal tubular elements connected at their midplane to thin sheet metal web elements, locking means on said elements connecting said web elements and said tubular elements, said locking means providing engaging abutment surfaces generally normal to the axis of said tubular elements making said assembly rigid and self-trueing and preventing axial motion between said column members and said web elements, and box-like members bridging said column and rafter members at their junction, said box-like members having flanges along the sides thereof fastened to said column and rafter members and said web elements by said locking means.

2. In a building wall and roof construction, a plurality of aligned column and rafter members, said members comprising thin sheet metal tubular elements connected at their mid-plane to thin sheet metal web elements, locking means on said elements connecting said webs and tubular elements, said locking means providing engaging abutment surfaces generally normal to the axis of said tubular elements making said assembly rigid and self-trueing and preventing axial motion between said tubular elements and said web elements and box-like members bridging said column and rafter members at their junction, said box-like members having flanges along the sides thereof fastened to said tubular and web elements by said locking means, said web elements of the wall and roof being continuous and extending across the joint at the contiguous ends of the columns and rafters.

3. In a building, a wall comprising a plurality of spaced thin sheet metal column elements connected at their common mid-plane by thin sheet metal web elements, locking means on said elements connecting said web and column elements, said locking means providing engaging abutment surfaces generally normal to the axes of said columns making said assembly rigid and self-trueing and preventing axial motion between said column elements and web elements, key means engaging said locking means and fastening said elements together, a roof having rafters extending from said column elements with said rafters joined by web elements in the manner just defined and box-like brace elements joined to and extending axially along said column elements and rafters at their junction, said brace elements having flanges on the sides thereof retained against said wall and roof by said key means.

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