United States Patent [19]

Mueller et al.

[11] **3,760,550**

[45] **Sept. 25, 1973**

[54] **COLLAPSIBLE TRUSS STRUCTURE**

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[73] Assignee: **Armco Steel Corporation,** Middletown, Ohio

[22] Filed: **Jan. 20, 1972**

[21] Appl. No.: **219,254**

[52] **U.S. Cl.** **52/641**

[51] **Int. Cl.** **E04b 7/16**

[58] **Field of Search** 52/641, 645, 640, 52/646, 67, 118, 648, 109, 108, 639; 182/149, 153, 155; 287/51.4, 3; 248/277, 439

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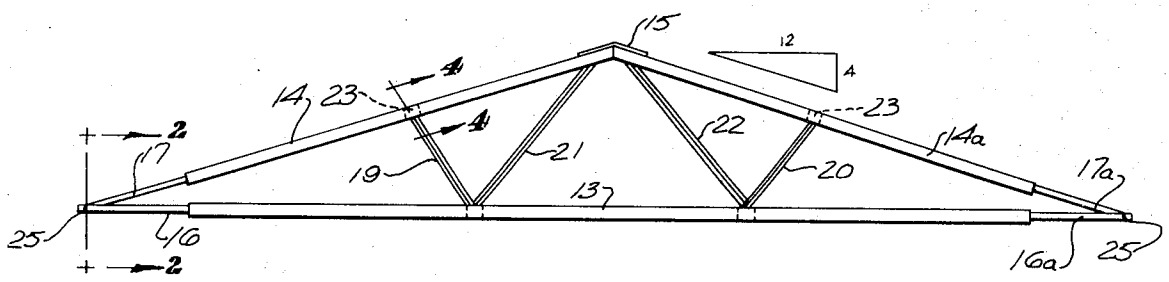
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Primary Examiner—Frank L. Abbott
Assistant Examiner—Carl D. Friedman
Attorney—John W. Melville et al.

[57] **ABSTRACT**

A metal truss structure is disclosed which is prefabricated and capable of being shipped in a collapsed condition in which it occupies a space on the order of four inches by four inches by twenty-eight feet, and which can be erected easily at the site into a roof truss capable of spanning all widths common in residential structures and some commercial structures, while maintaining a desired and predetermined roof pitch, as for example 4:12. A half truss suitable for panelized construction or for modular construction, and having many of the features of the basic truss structure, is also disclosed.

17 Claims, 23 Drawing Figures



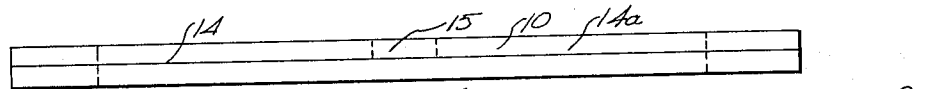


FIG 1

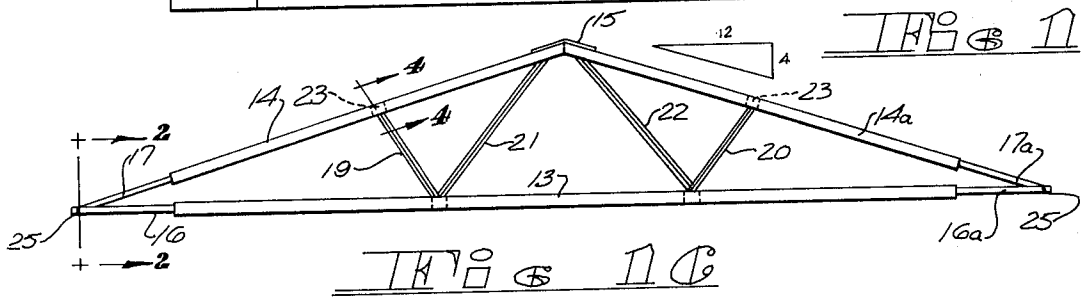


FIG 1C

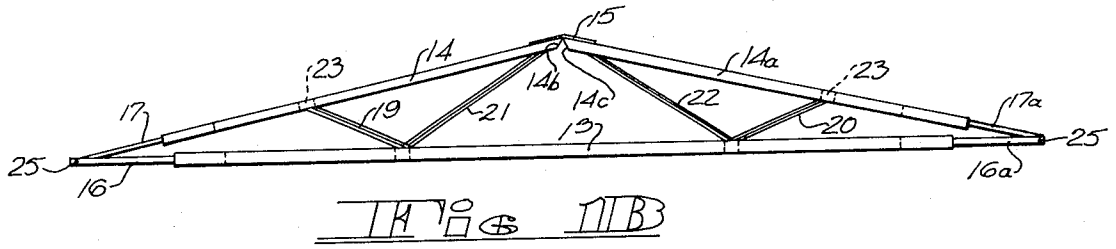


FIG 1B

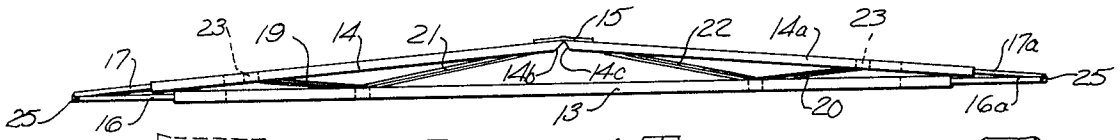


FIG 1A

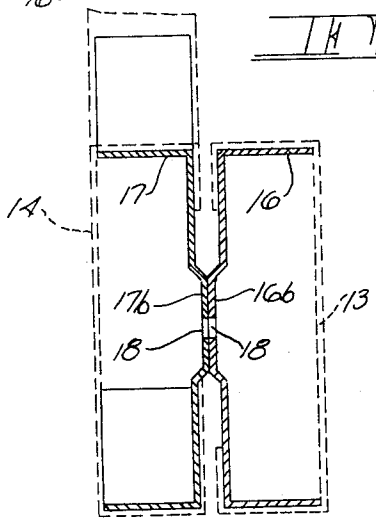


FIG 2

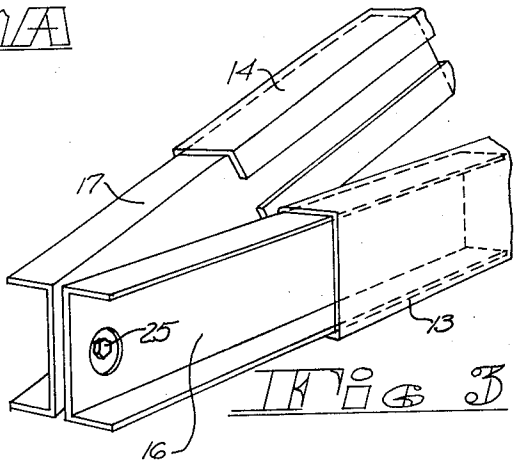


FIG 3

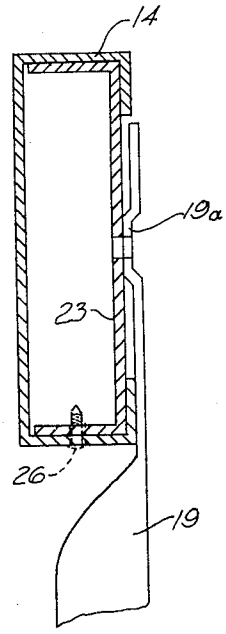


FIG. 4

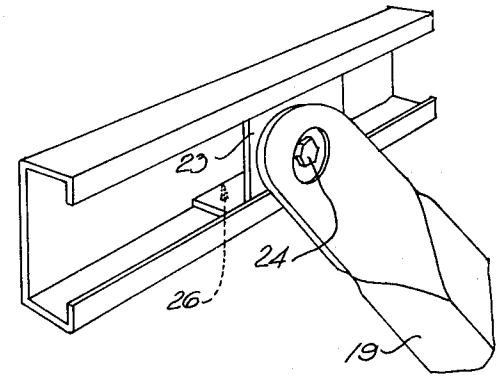


FIG. 5

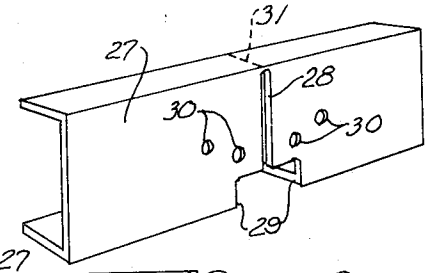


FIG. 6

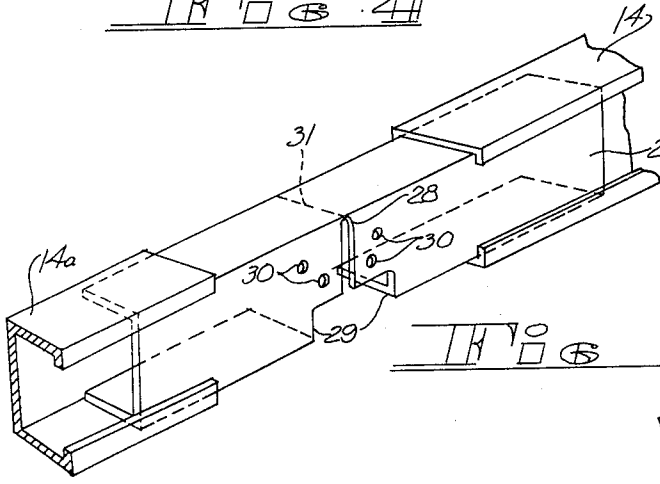


FIG. 7A

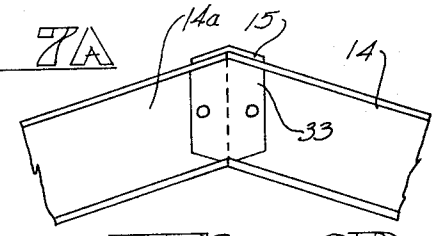


FIG. 8B

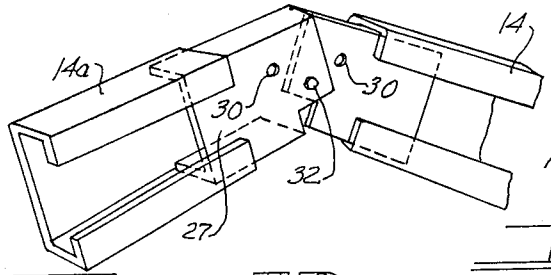


FIG. 7B

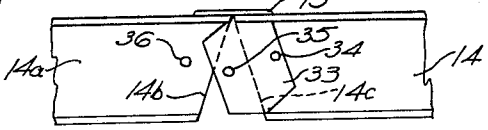


FIG. 8A

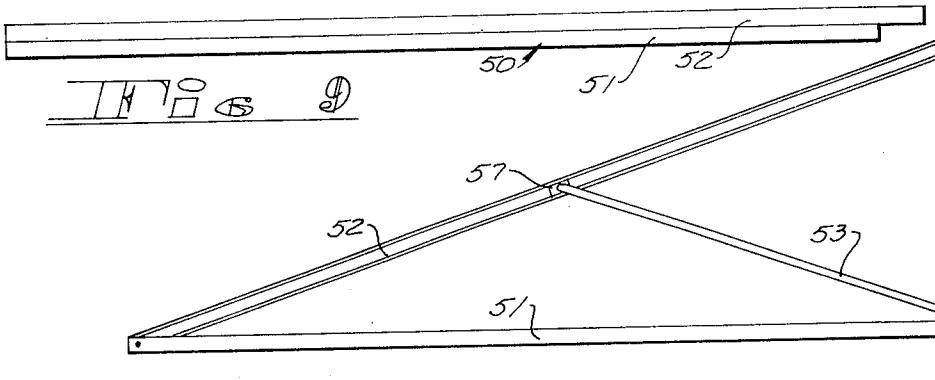


FIG 10

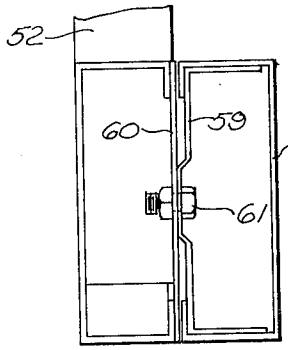


FIG 11

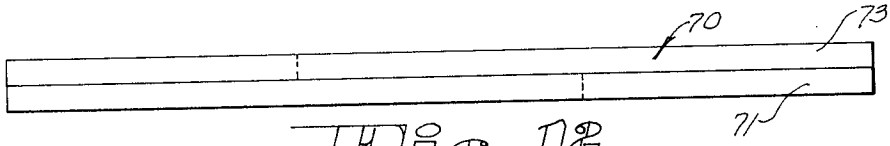


FIG 12

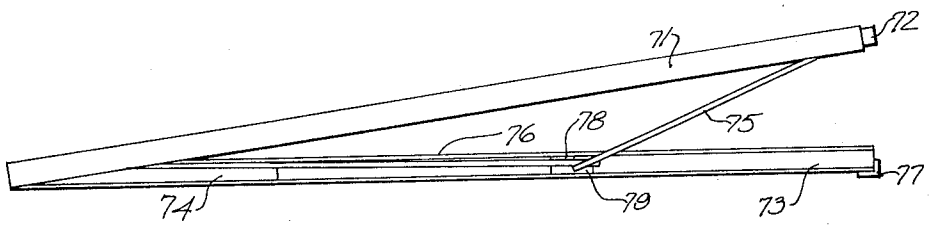


FIG 13

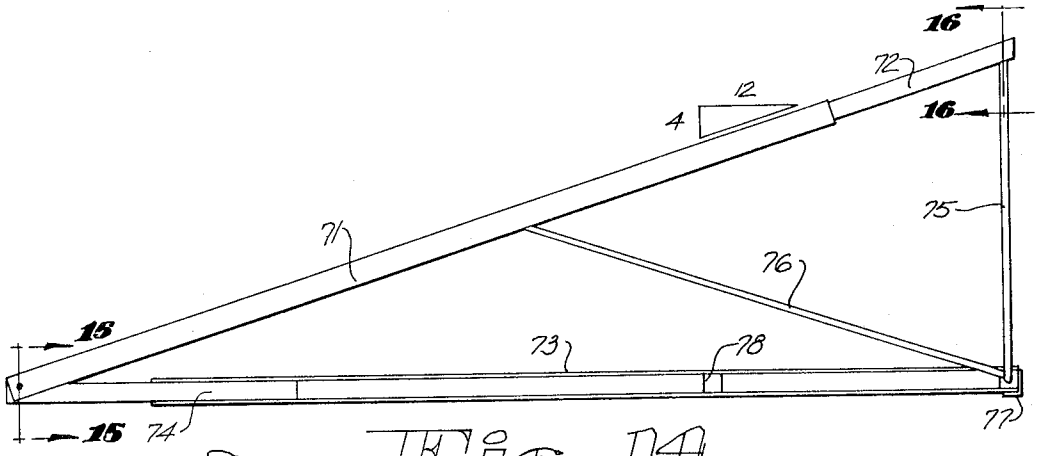


FIG 14

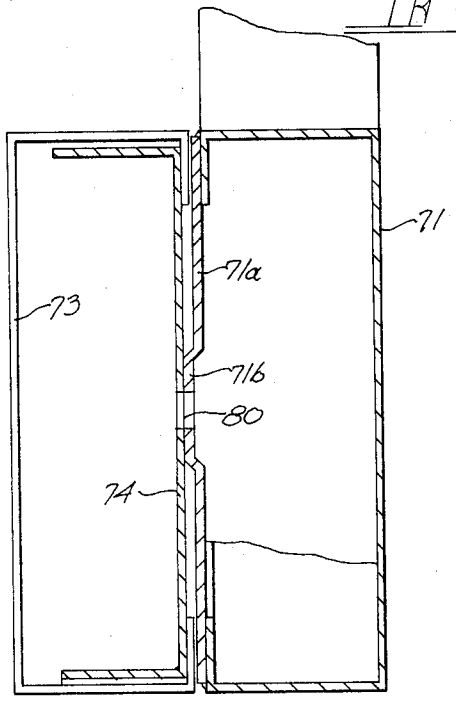


FIG 15

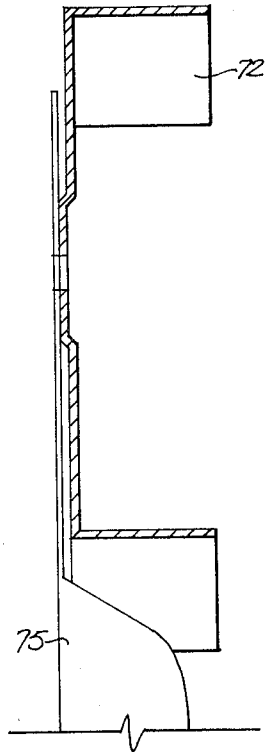


FIG 16

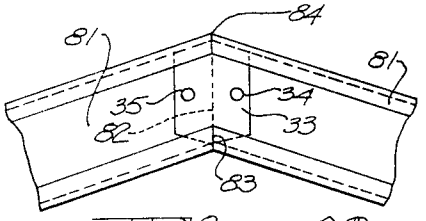


FIG 18

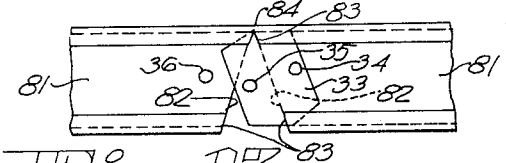


FIG 17

COLLAPSIBLE TRUSS STRUCTURE

BACKGROUND OF THE INVENTION

The building of roof trusses on the building site in residential and in small commercial buildings is an expensive and time consuming operation. In addition, where a large number of such trusses need be built, they rarely turn out to be perfectly uniform. As a result, the building industry has gone to the prefabricated roof truss which eliminates the costly on-site labor time. When these prefabricated wooden trusses are completely assembled, a special truck is required for shipping them to the job site and one such truck can usually just about carry the number of trusses required for a single home. Because of the shape of the assembled trusses and the configuration of the special truck which must be used, it is impossible to carry any additional construction materials. Furthermore, such prefabricated trusses must be ordered to size for each individual structure. With trusses of longer spans the weight of the assembled wood trusses becomes excessive since it is necessary to use heavier wood members. In fact, the relatively few sizes of standard lumber available often results in a structure which is over-adequate for the intended purpose.

A complete truss according to the present invention occupies an area of about four inches by four inches by twenty-eight feet when fully collapsed, so that many such trusses can be stacked easily on an ordinary flatbed truck or trailer which may also be used for the delivery of bulk materials. Since the truss of this invention is capable of use for any commonly used span, such trusses may be ordered in large quantities and stockpiled for future use and need not be specially ordered and built for each particular building.

The use of trusses according to the present invention makes it possible to optimize the steel members which make up the truss for the load requirements involved and thus one is not limited to standard available sizes. This factor combined with the increased modulus and strength of steel over wood results in a noticeably lighter truss which is therefore easier to handle during erection.

Beyond the provision of collapsible trusses per se, the invention also contemplates a panelized construction and a modular construction. In a panelized construction a plurality of half trusses according to the invention are assembled with a roof decking or sheathing so that at the site the several trusses may be erected to provide a complete roof. In a modular construction, the half trusses are assembled with roof decking, a side wall, and half end walls; and plumbing, duct work, and electrical wiring are all installed at the factory. Thus, two such modular half buildings may be assembled at the site into a complete building.

BRIEF SUMMARY

According to the invention, a full truss comprises a bottom chord member, a top chord member, and two web members on each side of the middle. The chord members are steel channel members and have telescoping extensions at their outer ends. The telescoping extensions are pivotally connected. In a full truss, the upper chord member is provided in two pieces of half length which may be mitered at their adjacent ends to provide a desired pitch, say 4:12 for the roof; and they are held together by a strap of relatively thin bendable material. Extensions are provided for the chord members so the truss may be used for a variety of spans, while still maintaining the predetermined pitch. On each side of middle there are provided two web members in a V configuration. One arm of each V is pivotably secured at its upper end adjacent the inner end of the respective upper chord piece. The upper end of the other arm of the V is pivotably secured to an element which is slidable along the respective upper chord piece. The lower ends of the V's on each side are pivotably secured to each other, and to members slidable along the lower chord on each side of center. While the structure above outlined provides a symmetrical truss, it will be understood that for some structures it may be desirable to provide upper chord pieces of unequal length.

Thus, the complete truss may constitute in its collapsed condition a package having dimensions of about four inches by four inches by twenty-eight feet. By lifting up the adjacent inner ends of the top chord pieces, thereby bending the connecting strap, the web members adjust themselves by sliding along the upper and lower chords until the predetermined pitch is attained, and the extensions in the upper chord members also adjust themselves. In this manner, a truss of minimum span is produced. If a longer span is required, the extension members in the lower chord member are first extended equally from each end until the desired span is reached, and then fixed at these locations by suitable means, such as self-threading screws. Erecting into final condition continues as previously described, resulting in a truss having an increased span, but with the same predetermined and desired pitch. When the truss is thus fully erected, the several remaining slidable parts are also fixed in position by suitable means, as for example, self-threading screws.

The half truss, whether for use for the panelized construction or a modular construction as above outlined, is basically one half of a complete truss; and the half trusses for the two types of construction are basically similar, with minor variations.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a plan view of a full truss in fully collapsed condition.

FIG. 1A is an elevational view showing the truss in partially erected condition.

FIG. 1B is a view similar to FIG. 1A showing the truss in a further,but still partially erected condition.

FIG. 1C is an elevational view showing the truss in fully erected condition.

FIG. 2 is a cross sectional view on an enlarged scale, taken on the line 2—2 of FIG. 1C.

FIG. 3 is a fragmentary perspective view of the joint between the upper and lower chord extensions.

FIG. 4 is a fragmentary cross sectional view taken on the line 4—4 of FIG. 1C.

FIG. 5 is a perspective view of the structure shown in FIG. 4.

FIG. 6 is a perspective view of an insert which may be used at the joint between the two upper chords.

FIG. 7A is a fragmentary perspective view of the two upper chords with the insert of FIG. 6 in place, the truss being in its collapsed condition.

FIG. 7B is a view similar to FIG. 7A showing the condition when the truss is erected.

FIG. 8A is an elevational view of the two upper chords showing a modification, the chords being in collapsed condition.

FIG. 8B is a view similar to FIG. 8A showing the condition when the truss is erected.

FIG. 9 is a plan view of a half truss suitable for panelized construction, in collapsed condition.

FIG. 10 is an elevational view of the half truss in erected condition.

FIG. 11 is a fragmentary end elevational view of the connection between the upper and lower chords, as seen from the left of FIG. 10.

FIG. 12 is a plan view of a modified half truss, suitable for modular construction, in collapsed condition.

FIG. 13 is an elevational view of the half truss of FIG. 12 in partially erected condition.

FIG. 14 is an elevational view of the same half truss in fully erected condition.

FIG. 15 is a cross sectional view, on an enlarged scale, taken on the line 15—15 of FIG. 14.

FIG. 16 is a cross sectional view taken on the line 16—16 of FIG. 14.

FIG. 17 is a view similar to FIG. 8A, showing a modification.

FIG. 18 is a view similar to FIG. 8B, showing the same modification.

DETAILED DESCRIPTION

Referring first to FIGS. 1 to 8B which disclose a full truss according to the invention, the collapsed truss package is shown at 10 in FIG. 1. For most purposes, this package will be four inches by four inches by twenty-eight feet. It is assumed that the truss is designed for a conventional roof pitch of 4:12, but it should be noted that any pitch desired in the intended construction is possible. The progressive erection of truss from the condition of FIG. 1 to the condition of FIG. 1C is shown in FIGS. 1A, 1B and 1C.

Basically, the truss consists of a bottom chord indicated generally at 13 and an upper chord consisting of two pieces 14 and 14*a*. These chord pieces are all in the form of channel members having lipped or return flanges and the pieces 14 and 14*a* may be joined together at their adjacent ends by a strap member 15 of relatively thin bendable material.

In the embodiment shown, the bottom chord 13 is provided with the telescoping extensions 16 and 16*a* and the upper chord pieces 14 and 14*a* are provided with the telescoping extensions 17 and 17*a*, respectively. The extension members 16, 16*a*, 17, and 17*a* are in the form of plain channels without the lipped flanges. These members are disposed back-to-back and are dimpled at the center as indicated at 17*b* and 16*b* in FIG. 2 and they are secured together by means of a bolt 25 passing through the aligned openings 18. It will be understood that these members can also be fastened with rivets, or self-drilling screws. This is true for any bolted connection described herein.

On each side of the middle there are a pair of webs in a V configuration. Thus, there are the relatively short web members 19 and 20 and the relatively long web members 21 and 22. The upper ends of the web members 21 and 22 are pivotably secured to the respective upper chord pieces 14 and 14*a*. This connection is pivotable but not slidable. The upper ends of the web members 19 and 20 are pivotably connected to sliding channel elements 23 by means of bolts 24 as best seen in FIGS. 4 and 5, where a typical construction connecting the upper end of the web 19 is shown. The end of the web member 19 is dimpled as at 19*a* and the bolt 24 is passed through the openings in the member 23 and in the center of the dimple 19*a*. It will be understood that the construction shown in FIGS. 4 and 5 is found at the upper end of each of the webs 19 and 20.

The lower ends of the webs 19 and 20 are pivotably secured to a similar sliding channel member and to the lower ends of the webs 21 and 22 respectively.

From the foregoing description it will be clear that as the truss is erected from the condition of FIG. 1 to the condition of FIG. 1C, the strap member 15 is bent. It should also be noted that the inner ends of the truss pieces 14 and 14*a* may be mitered as shown respectively at 14*b* and 14*c*, so that the miter defines the limit to which the truss may be erected and defines the desired roof pitch. Another method of connecting truss pieces 14 and 14*a*, which does not necessitate mitering of the ends of the truss pieces, will be described hereinafter. As the truss is erected and as can be seen very clearly in the progression of FIGS. 1A, 1B, and 1C, the bottom of the V structure of the web 19, 21 and 20, 22 slides along the chord 13 and similarly the sliding members 23 at the upper ends of the webs 19 and 20 slide along the chord pieces 14 and 14*a*.

As described above the extension members 16, 17 and 16*a*, 17*a* are pivotably secured together by means of the bolts 25 and it will be understood that by extending the telescoping members 16, 17, 16*a*, 17*a* the height of the truss and the span of the truss are increased without disturbing the desired roof pitch. Thus, a truss according to this invention may be manufactured to serve for a variety of spans and in fact such a truss can be made to cover all of the commonly used spans which are found in residential and small commercial buildings.

Once the truss has been erected to the required span the various sliding elements are simply fixed in position by means of sheet metal screws or other suitable fastening. A typical fastening arrangement using sheet metal screws is shown at 26 in FIGS. 4 and 5. Similarly, of course, the extensions 16, 17, 16*a* and 17*a* will also be secured with sheet metal screws or the like and the sliding members at the bottom of the V configurated webs will be similarly fixed.

The ridge portion of the truss may be fixed and secured in several ways, two of which are shown in the drawings. In FIG. 6 there is shown a channel member 27 having its web centrally slotted at 28 and relieved at 29. It is also provided with the predrilled holes 30. The element of FIG. 6 is shown in position in the collapsed truss in FIG. 7A. When the truss is erected the insert member 27 bends along the line 31 and the adjacent portions of the web of the member 27 overlap each other as clearly seen in FIG. 7B. The two lower holes 30 coincide when the predetermined angular relation is established and a bolt 32 secures the upper chord pieces 14 and 14*a* in position. The remaining holes 30 serve to fasten the upper ends of the web members 21 and 22, respectively. It should be noted that in this embodiment the inner ends of the upper chord members 14 and 14*a* are separated, and are connected by means of the insert 27, so that mitering is unnecessary.

An alternative construction is shown in FIGS. 8A and 8B. Here a small plate 33 is provided which is bolted to one of the chord pieces, in this instance the piece 14

at 34. Thus, when the truss is erected the parts go from the position shown in FIG. 8A to the position shown in 8B and a bolt is then inserted through the holes 35 and 36 which will now be aligned. It should be noted that the inner ends of the chord members 14 and 14*a* are mitered, as shown respectively at 14*b* and 14*c*, so that the miter defines the limit to which the truss may be erected, and defines the desired roof pitch.

A still further embodiment is illustrated in FIGS. 17 and 18, wherein a one-piece upper chord is disclosed. The one-piece upper chord 81 has its web, lower flange and upper and lower lips cut out, as indicated at 82 and 83, leaving its upper flange only along the line 84. The angles of the cuts 82 may be such as to determine the roof pitch, or they may be greater, and a connector piece may be relied upon to determine the pitch. A connector such as that shown in FIGS. 8A and 8B may be used, either to determine the pitch and fix the truss parts in position, or simply to fix the truss parts in position.

Coming now to a description of a half truss and particularly a half truss suitable for use in a panelized construction, reference is made to FIGS. 9 to 11 inclusive. Again, the half truss 50 is shown in a collapsed condition in FIG. 9. It consists of a bottom chord 51 and a top chord 52. It should be noted that in FIGS. 9 to 11, no extension members are shown for the chord pieces 51 and 52 but it will be clear that they may be added in the same manner as disclosed in connection with FIGS. 2 and 3. The web members are shown at 53 and 54. Again the web member 54 is pivotably bolted to the end of the upper chord 52 at 55 and the lower ends of the webs 53 and 54 are pivotably secured to each other and to a sliding member at 56. The upper end of the web member 53 is secured to a sliding member 57 in the same manner as was described in connection with FIG. 5. A web stop is provided at the inner end of the lower chord 51 at 58. Since the channels constituting the chords 51 and 52 open toward each other in order to provide the tracks in which the sliding pieces 56 and 57 travel, an insert 59 is secured within the channel 51 and a plate 60 is secured to the channel 52 so that the channels 51 and 52 may be pivotably connected to each other. The parts are connected together by a bolt 61. In this way a neat boxlike structure is provided for the collapsed half truss.

When the half truss is collapsed, the sliding member 57 slides toward the left in the upper chord 52 and the sliding connection at the bottom of the webs 53 and 54 slide toward the left in the chord 51.

In a panelized construction roof decking or sheathing is applied to a plurality of such half trusses and thus a half roof may be shipped direct to the site in collapsed condition. When such a half roof arrives at the site, the plurality of half trusses having the roof decking attached thereto are erected to the position of FIG. 10 with the sliding connection at the lower ends of the webs 53 and 54 abutting against the web stop 58. The parts are then fixed in position as described in connection with the full truss and a half roof including truss and decking is provided.

The building industry is now coming to a modular construction wherein substantially a half building is prefabricated including a side wall, two ends walls, half roof trusses, and roof decking, and with duct work, plumbing, and electrical work already installed. For such a purpose, the structure of FIGS. 9 to 11 is slightly modified. Again, the collapsed half truss for modular use is shown in FIG. 12 at 70. FIG. 13 shows the half truss in a partially erected condition for a purpose to be described later, and FIG. 14 shows the half truss in its fully erected condition. In this instance, the upper chord consists of a main portion 71 and a telescoping extension 72 at its upper end. The lower chord consists of a main portion 73 and a telescoping extension 74 at its outer end. It should be noted that these telescoping extensions 72 and 74 are at opposite ends of the respective chord members.

The web members 76 and 75 may be in all respects just like those indicated at 53 and 54 respectively in connection with FIGS. 9 to 11. Again, an end stop is provided at 77 and an intermediate stop is provided at 78 in the lower chord.

With the half truss in the condition of FIG. 14, all of the assembly work at the factory is done. The side wall and end walls of the building are attached and the various elements of duct work, electrical, and plumbing work are installed.

Difficulty is encountered when such a module is to be shipped from the factory where it is assembled, to the building site. This invention makes it possible to partially collapse the assembled half roof truss and to make it narrower and lower for shipment purposes. Thus, when the extensions 72 and 74 are telescoped respectively into the members 71 and 73 and the web members 75 and 76 are caused to move to the left as described above, the half truss may assume the position shown in FIG. 13 where the connection between the web member 75 and 76 to the sliding member 79 abuts against the intermediate stop 78 to hold the partially collapsed half truss in the condition of FIG. 13. In this condition, it may be seen that the half truss is substantially narrower and lower than in its erected condition and is in fact no longer than it was in its fully collapsed condition of FIG. 12. The state of the half truss in FIG. 13 does not interfere with duct work and piping and the like installed under the roof and yet the half truss is now of small enough size that it can be handled with presently available trucks without violating laws in regard to width and height of loads traveling over highways.

Again, as shown in FIG. 15, the members 71 and 73 are disposed with their openings facing each other and for this reason the member 71 is provided with a plate 71*a* having the dimple 71*b* so that the connection between the upper chord 71 and the lower chord extension 74 can be made by means of bolting through the opening 80. The connection between the upper chord extension 72 and the web 75 is shown in FIG. 16.

It will be seen that the construction of FIGS. 9 to 11, which has been described for a panelized construction and the construction of FIGS. 12 to 16 which has been described as for a modular construction, are in reality very similar, and there will undoubtedly be instances where either construction may be used. An additional advantage of both constructions is that they may be erected from the right hand end as seen in these Figures, thus permitting workmen to effect erection from outside the construction. In connection with a modular construction, this is of great importance.

It will be understood that numerous modifications may be made in details of the construction without departing from the spirit of the invention. No limitation

not specifically set forth in the claims is intended and none should be implied.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A roof truss comprising an upper chord and a lower chord, each constituted by channel members having lipped flanges, and a pair of web members extending therebetween, said web members at their lower ends being pivotably connected together and to an element slidable along said lower chord, one of said web members, at its upper end, being pivotably connected to said upper chord adjacent the inner end thereof, and the other of said web members, at its upper end, being pivotably connected to an element slidable along said upper chord, said slidable elements being plain channel pieces slidable within said lipped channel members, whereby said truss, in collapsed condition, presents a long, thin and narrow package, and is capable of being erected, with said slidable elements adjusting themselves along the respective chords, said slidable elements then being secured in fixed position.

2. A truss according to claim **1,** wherein said upper and lower chords are provided with extensions telescopingly arranged with respect to said chords, and said extensions, at their outer ends are pivotably connected together.

3. A truss according to claim **2,** wherein said chords are constituted by channel members having lipped flanges, and said extensions are plain channel pieces slidable within said lipped channel members.

4. A roof truss comprising a one-piece lower chord and an upper chord composed of two portions secured together at the middle of the truss, a pair of web members on each side of the middle, each pair of web members at their lower ends being pivotably secured together and to an element slidable along said lower chord, one of the web members of each pair, at its upper end, being pivotably connected to the respective upper chord portion adjacent the middle of the truss, and the other web member of each pair, at its upper end, being pivotably connected to an element slidable along the respective upper chord portion, whereby said truss, in collapsed condition, presents a long, thin and narrow package, and is capable of erection by raising the middle of the upper chord, with said slidable elements adjusting themselves along the respective chords, said slidable elements then being secured in fixed position.

5. A truss according to claim **4,** wherein said upper chord portions at their adjacent ends, are mitered to provide a desired, predetermined roof pitch, and are held together by a strap of thin bendable material.

6. A truss according to claim **5,** wherein a connector element is provided to secure said upper chord portions in the position providing said desired roof pitch.

7. A truss according to claim **4,** wherein the inner ends of said upper chord portions are spaced apart, and connected together by a channel shaped insert engaging in and secured to, the proximate ends of said chord portions, said insert having its web slotted, and having its lower flange and the lower portion of the web relieved, whereby during erection of the truss, the portions of the insert web separated by said slot overlap each other, a hole in said web on each side of said slot, said holes being located such that they will coincide when the desired roof pitch is attained, and may be fixed in position by fastening means passing through said aligned holes.

8. A truss according to claim **4,** wherein said chords are constituted by channel members having lipped flanges, and said slidable elements are plain channel pieces slidable within said lipped channel members.

9. A truss according to claim **4,** wherein said upper and lower chords are provided with extensions telescopingly arranged with respect to said chords.

10. A truss according to claim **9,** wherein said extensions are provided at the outer ends of the upper and lower chords, and said extensions, at their outer ends, are pivotably connected together.

11. A truss according to claim **9,** wherein said chords are constituted by channel members having lipped flanges, and said extensions are plain channel pieces slidable within said lipped channel members.

12. A half roof truss comprising an upper chord and a lower chord, each constituted by channel members having lipped flanges, and a pair of web members extending therebetween, said web members at their lower ends being pivotably connected together and to an element slidable along said lower chord, one of said web members, at its upper end, being pivotably connected to said upper chord adjacent the inner end thereof, and the other of said web members, at its upper end, being pivotably connected to an element slidable along said upper chord, said slidable elements being plain channel pieces slidable within said lipped channel members, and stop means for said first named slidable element at the inner end of said lower chord, whereby said half truss, in collapsed condition, presents a long, thin and narrow package, and is capable of being erected, with said slidable elements adjusting themselves along their respective chords, said slidable elements being then secured in fixed position.

13. A roof truss according to claim **4,** wherein said upper chord is a one-piece member, said chords being constituted by lipped channel members, said upper chord having its web, its lower flange and lip, and its upper lip relieved, and its upper flange having a line of weakness transversely of the length of said chord, whereby said upper chord may be bent along said line of weakness to provide a ridge, and a connector element to secure the relieved parts together in an angular relation.

14. A truss according to claim **12,** wherein said upper and lower chords are provided with extensions telescopingly arranged with respect to said chords, and said extensions, at their outer ends are pivotably connected together.

15. A truss according to claim **14,** wherein said chords are constituted by channel members having lipped flanges, and said extensions are plain channel pieces slidable within said lipped channel members.

16. A truss according to claim **12,** wherein each of said chords is composed of a major piece and a minor extension piece in telescoping relation, the combined length of each major piece and minor extension, when extended, constituting the length of said upper and lower chords respectively, the upper chord having its extension piece at its inner end, and the lower chord having its extension piece at its outer end, the outer end of the major piece of said upper chord being pivotably secured to the outer end of the extension piece of the said lower chord, a pair of web members extending between said chords, said web members, at their lower

ends, being pivotably connected together and to an element slidable along the major piece of said lower chord, one of said web members, at its upper end, being pivotably connected to the end of the extension piece of the said upper chord, and the other of said web members at its upper end being pivotably connected to an element slidable along the major piece of said upper chord, and stop means at the inner end of the major piece of said lower chord, whereby said truss in fully collapsed condition presents a long, thin and narrow package and is capable of being erected with said first named slidable element resting against said stop means, and said extension pieces fully extended, said second named slidable element adjusting itself along said upper chord, and said truss also being capable of being partially collapsed, there being an intermediate stop member in the major portion of said lower chord whereby said truss may be partially collapsed and the telescoping extensions withdrawn to present a relatively low and relatively narrow package for shipment.

17. A truss according to claim **16,** wherein the major pieces of said chords are constituted by channel members having lipped flanges, and said slidable elements and extension pieces are plain channel pieces slidable within said lipped channel members.

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