

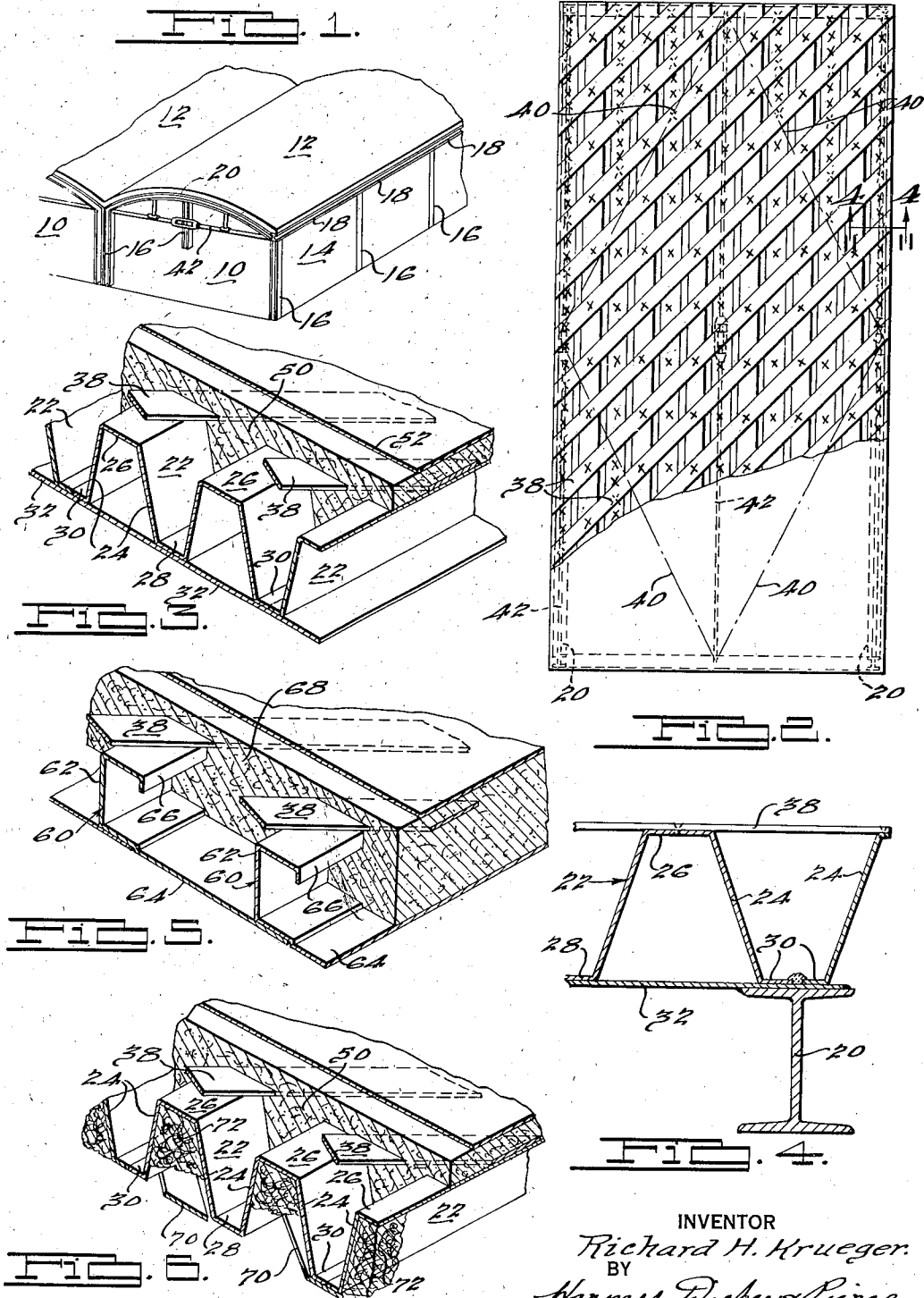
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ROOF STRUCTURE

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ROOF STRUCTURE

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This invention relates to roof structures and is particularly adaptable to that type of roof structure required to extend over and cover a relatively long span, the principal object being the provision of a structure of this type that is simple in construction, light in weight and economical to build.

Other objects of the invention include the provision of a roof structure capable of use over relatively long spans but which will be materially lighter in weight than conventional roof structures of an equivalent span and yet will be amply strong for the purpose required; the provision of a roof structure of the type described in which the principal elements consist of angularly sectioned sheet metal members extending longitudinally of the span; the provision of a roof structure of the type described in which the roof has a continuous thickness determined by the depth of the angularly sectioned sheet metal members extending longitudinally of the span; the provision of a roof structure of the type described in which both the outer and inner surfaces of adjacent angularly sectioned longitudinally extending members are rigidly tied together by metal members; the provision of a roof structure of the type described in which the outer faces of the longitudinally extending members are tied together by diagonally extending plates or strips preferably spaced from one another; the provision of a roof structure of the type described in which the various longitudinally extending angularly sectioned members are secured to each other and to a metallic inner covering in such a manner as to form the corner portion thereof into rigid and substantially unyielding sections serving to brace the edge portions of the roof structure between columns against bulging under excessive load; the provision of a construction as above described in which one face of the longitudinally extending members is completely closed by plates of metal co-acting with the longitudinally extending members to form box sections; the provision of a roof structure of the type described affording high insulation characteristics against loss of heat; and the provision of a roof structure as above described provided with means for reinforcing the longitudinally extending angularly sectioned metal members against deformation under load.

The above being among the objects of the present invention, the same consists in certain novel features of construction and combinations of parts to be hereinafter described with reference

to the accompanying drawing, and then claimed, having the above and other objects in view.

In the accompanying drawing which illustrates suitable embodiments of the present invention and in which like numerals refer to like parts throughout the several different views—

Fig. 1 is a fragmentary perspective view of a building provided with a roof constructed in accordance with the present invention;

Fig. 2 is an enlarged plan view of one of the sections of the roof shown on the building in Fig. 1, with a portion of the covering and filling material removed to better illustrate the construction;

Fig. 3 is an enlarged fragmentary, partially broken, partially sectioned perspective view of a portion of the roof structure shown in Figs. 1 and 2;

Fig. 4 is a still further enlarged fragmentary vertical sectional view taken on the line 4—4 of Fig. 2 and illustrating a preferred method of securing the longitudinally extending sheet metal members to a roof beam where the latter is employed;

Fig. 5 is a view similar to Fig. 3 but illustrating a modified form of construction; and,

Fig. 6 is a view similar to Fig. 3 but showing a still further modified form of construction.

Roof structures required to span a relatively great distance without support have, in accordance with conventional practice, involved a considerable amount of structural steel necessarily involving great weight and running into considerable cost in their construction. In addition, in conventional constructions when the space below the roof requires heating, it requires the application of insulating material to the roof which has no material value from the standpoint of increasing the strength thereof but serves primarily, from a structural standpoint, as an additional dead load which must be carried by the roof structure. It is the main purpose of the present invention to provide a roof structure in which the use of structural steel members is minimized to a great extent and may even be eliminated entirely, the structural steel members of conventional constructions being replaced by sheet metal members of angular cross-sectional configuration, together with inner and outer boundary members fixed thereto, the whole being so constructed and arranged as to provide a roof with ample factor of safety and yet weighing only a fraction of a corresponding roof constructed in accordance with conventional practice. Additionally, with the structure of the present invention heat insulating material may be

readily applied to the roof structure in a simple and economical manner and where such insulation material is of a desired type it actually serves to further stiffen the structure and increase the factor of safety thereof.

Although the present invention may be employed for roofs of either the flat or convexly curved or arched types, it is particularly adaptable to the latter type of roof inasmuch as in such cases all of its elements are constantly under a compressive stress, thus enabling the same depth and weight of structure to be employed for curved or arched roofs having greater spans than in the case of flat roofs. This latter type of construction is illustrated in the drawing by way of illustration and not by way of limitation as will be readily appreciated, although the application of the invention to the convexly curved or arched type of roof does include certain structural advantages as compared to a flat roof and which, accordingly, constitutes a more limited phase of the present invention.

Referring to Fig. 1, a fragment of a building is there illustrated as comprising a plurality of adjacent sections or bays indicated generally at 10, each section or bay having its own convexly curved or arched roof indicated generally at 12. It will, of course, be understood that the equivalent of one section or bay 10 of one roof may, when provided with side and end walls, constitute an individual building all by itself, the multiple type being shown merely by way of illustration. In the particular building structure shown the type of structure includes a side wall indicated generally at 14, an open front which may or may not be closed by suitable walls, doors or the like, and being open on the side opposite the sides 14 into the next section or bay.

It may be assumed for the purpose of description that sections or bays 10 are of relatively great width, for instance in the neighborhood of 100 feet, and that no supporting columns are permitted between the side walls in the main portion of the same. Accordingly, along each side of each section or bay 10 columns 16 are provided. These columns are connected at the top by structural steel members such as channels 18 rigidly secured thereto. Although not necessary in the broader aspects of the present invention, it will sometimes be desirable that corresponding columns 16 on opposite sides of each section 10 be connected together by a structural steel member such as an I-beam 20 curved in conformance with the curvature of the roof. Accordingly, between each pair of adjacent structural members 20 a roof constructed in accordance with the present invention is provided.

In the preferred form of the structure illustrated in Figs. 2, 3 and 4 it will be noted that the roof is made up of a plurality of main longitudinally extending members indicated generally at 22 longitudinally curved into conformance with the desired curvature of the roof and arranged parallel with the corresponding structural members 20 at each side of the section. In referring to the members 22 as extending longitudinally it will, of course, be appreciated that by "longitudinally" is here meant longitudinally of the corresponding sections between column 16, for instance as illustrated in Fig. 2 and accordingly, they extend transversely of the roof structure as a whole in the construction illustrated in Fig. 1.

Each of the members 22 is formed from sheet metal, the gauge depending upon the span of the roof and the weight to be supported thereby, and

includes at least one inverted channel-shaped part having side walls 24 integrally connected together by a top wall 26. One or more of such channel-shaped elements may be included in a single longitudinally extending member 22, relatively deep sections, for instance between 18 and 24 inches in depth preferably including only one channel portion to each member, while shallower sections may have two or more channel portions to each member. In the particular construction it may be assumed that these channel portions are approximately one foot in depth in which case it is feasible to form each member to provide two of such channel members in which case two adjacent channel members have the marginal edge of their adjacent side walls 24 integrally connected together by a wall 28 parallel to the connecting walls 26 and of substantially the same width. The remaining margins of the channel-shaped portions are each provided with outwardly directed integral flanges 30 parallel to the walls 26 and 28 and of half the width of the wall 28.

Although these longitudinally extending members 22 may be arranged with the flanges 30 overlapping and fixed together by welding, riveting or the like, preferably they are arranged with the free edges of the flanges 30 in a common plane and abutting one another as illustrated in Fig. 3. They are secured together by means of longitudinally extending strips or plates 32 of sheet steel of suitable thickness which underlie the various walls 28 and flanges 30 and are suitably secured thereto as by riveting, welding, or any other suitable means. The plates or strips 32 are preferably of the same width as the longitudinally extending members 22 but in order to facilitate assembly of the structure and to render it more rigid generally, preferably one margin of each plate 32 is centrally aligned with the center of the wall 28 of each section so that the abutting or substantially abutting joint between each of the longitudinally extending members 22 is located centrally of each plate or strip 32.

Each longitudinally extending member 22 and a corresponding plate 32 is preferably assembled together before being applied to the roof structure so that when applied to the roof all that remains to do is to weld or otherwise secure the overlapping part of the adjacent longitudinally extending section 22 of each assembly to the projecting edge of the cooperating plate 32 of the next adjacent assembly. Additionally, in the manufacture of the longitudinally extending members 22 it is preferable that each is welded or otherwise fixed to a corresponding plate 32 in substantially flat or straight form and then the resulting assembly subjected to a suitable operation between rolls or the like to bring it to the curvature desired in the roof structure.

It may be noted at this point that seldom, if ever, will the entire length of the members 22, or the plates 32 for that matter, be formed from a single strip of metal for manufacturing reasons. They may be formed in suitable lengths as, for instance, twenty-five feet, and such lengths welded or otherwise secured together in end-to-end abutting relation to form the full length of the members 22. The plates 32 in such case are, of course, arranged in overlapping relation to the joints between sections and preferably such joints in adjacent members 22 are staggered to further enhance the rigidity of the structure.

In constructing a roof as above described one section 22 with its corresponding plate 32 is

preferably positioned with one side margin thereof resting upon the upper surface of one of the curved structural members 20, as illustrated in Fig. 4, with the corresponding edge flange 30 overlying the upper flange of the structural member 20 and suitably welded thereto. In such case it is, of course, necessary to laterally extend the corresponding plate member 32 and terminate it along the edge of such flange 30 as indicated in Fig. 4. The opposite ends of the member 22 and its plate 32 are, of course, suitably fitted to and secured as by welding or the like to the corresponding structural members 18 at the ends of the roof section. After the first longitudinally extending member 22, together with its corresponding plate 32 is fixed to one of the structural members 20 as described, additional members 22 together with their plates 32 are then positioned in place one against the other and securely welded together and to the members 18 as previously described until the entire space between the structural members 20 has been filled, and the last longitudinally extending member 22 welded to the remaining structural member 20 as indicated in Fig. 4. The members 32 thus serve to provide a continuous and substantially smooth and flat or curved under-surface for the roof structure. By "continuous" is meant that adjacent plates substantially abut one another, and while such plates 32 are preferably imperforate for a reason which will hereinafter be more apparent, i. e. so as to act as a wall of a mould, where extreme lightness is desired holes may be punched in them to aid in attaining this result.

After the above has been accomplished, then the entire upper surface thereof is covered with diagonally extending metallic strips or flat bars 38 suitably secured in place to the wall portions 26 as by welding or the like. These bars 38 extend at preferably a 45 degree angle with respect to the longitudinally extending members 22 and are of heavier gauge than the members 22 and the plates 32 and are preferably spaced from one another by a distance at least equal to their width. The bars 38 in thus connecting the upper surfaces of the members 22 together transversely of the structure, act to impart a material amount of transverse rigidity to the structure.

In order to prevent possible bulging of the ends of each roof section as above described under abnormal load conditions I prefer, in accordance with a further phase of the present invention, to weld the corner portions of the structure, that is areas within lines such as the line 40 in Fig. 2, together at such frequent intervals as to render the corner portions substantially integral. This is illustrated in Fig. 2 by illustrating a greater concentration of X's, here employed to indicate relative points of welding between the members 22 and the plates 32, than in the remaining areas of the structure. Additionally, it will, of course, be understood that turnbuckle controlled tension members such as 42 may be stretched between the structural members 18 on opposite sides of the structure in line with the columns 16 and at any desired point intermediate the columns 16, as for instance in the center of each roof section as illustrated in Fig. 2, to provide the necessary resistance to spreading tendencies of the roof under load.

It will be observed from an inspection of Figs. 3 and 4 in particular that the plates 32 cooperate with the longitudinally extending members 22 to close each channel portion 24—26 into a box

section capable of withstanding a high degree of compressive stress without deformation. The entire structure is, therefore, built up of a plurality of adjacent box section girder-like members rigidly secured together at both top and bottom from which it will be apparent that an extremely stiff and rigid roof structure is provided. Calculations indicate that with this construction a roof structure equally as strong as those of conventional constructions yet weighing only a fraction of the weight of conventional constructions can be produced. The saving in weight is in and of itself an indication of the economy in providing a roof structure of this type as compared to conventional types of roof constructions, not only in itself but also in the columns, etc., required to support the roof. This is particularly true in the curved or arched type of roof to which the present construction is particularly adaptable in view of the fact that in such constructions all of the members are constantly subjected to compressive stresses only thus peculiarly adapting this structure to such types of roof construction.

After the roof has been constructed as thus far described it may, if desired, be covered in the state described with a suitable weather repellant covering or sheathing of any suitable or desirable type. However, in accordance with a further phase of the present invention it is preferable to fill the space between the channels 24 and 26 with some material 50 that may have either one or the other or both of two characteristics. One characteristic which such material 50 may have is the character of insulation against transfer of heat therethrough in which case the material 50 may be of any suitable or conventional heat insulating material capable of being readily applied between and over the channels 24—26 and may be either of a loose type of material or some type capable of being formed into a more or less integral mass. On the other hand, the material 50 may be of a character which will reinforce the members 22, 32 and 38 against buckling, warping or the like and in such case the material 50 may be concrete or the like simply poured or cast into place. The material 50 is preferably applied to a depth sufficient to imbed the members 38 a material distance therein as brought out in Fig. 3. It will be appreciated that where a material such as concrete or other cementitious material is employed the entire roof structure assumes the form similar to that of a reinforced concrete roof but including metallic members of a new form through which the principal strength of the roof is obtained. Concrete, of course, does not have a high degree of resistibility to transfer of heat through it and, accordingly, where concrete is employed some material of a higher insulating value is preferably provided over the upper surface of the same to enhance the heat insulation qualities thereof when desired.

On the other hand the cement, such as Portland cement, may be mixed with a suitable material of high heat insulation qualities and be employed for the material 50, in which case the material 50 not only will reinforce the metallic portion of the structure against warping or distortion under load but will also serve as a heat insulation material for insulating the roof against transfer of heat therethrough. One material which is ideally suitable to mix with cement for this purpose is vermiculite which, when mixed with suitable quantities of Portland cement, may be cast into place and thereafter not only en-

hance the strength of the roof itself but, due to the air cells which the vermiculite causes to be distributed throughout the mixture, forms an excellent heat insulation for the roof.

In any event after the material 50 has been applied to the roof structure, its outer surface is then preferably covered by a suitable roofing material such as 52 applied in any suitable or conventional manner for protecting the material 50 against the effects of weather thereon.

It will be appreciated from the foregoing that the structure provided in accordance with the present invention enables a roof of extended span to be constructed with a relatively simple, efficient and unusually light and, therefore, economical manner, and that it may be easily and efficiently insulated against the transfer of heat therethrough.

Although the construction illustrated in Fig. 3 including the inverted channel-shaped portions which cooperate with the plates 32 to provide box-like sections is preferable, particularly where the spans are of great length, the construction illustrated in Fig. 5 will be found satisfactory, particularly where employed with shorter spans and usually will be found to be more economical to use and more easily fabricated. As will be noted from an inspection of Fig. 5 the construction is substantially the same as that illustrated in Fig. 3 except that the members 60, corresponding with the members 22 previously described, are of a different form and instead of embodying separate plate members 32 are constructed so as to provide their own plate members. In other words, in Fig. 5 each of the members 60 is formed from sheet metal and each includes a channel sectioned end portion 62 the channel of which opens laterally. The lower flange of each channel end 62 is integrally connected to a downwardly offset parallel plate portion 64, the amount of the offset being substantially equal to the thickness of the material from which the members 60 are constructed. The free edge of the upper flange of each channel end 62 is provided with a downwardly extending flange 66 for enhancing the rigidity thereof. In assembling the members 60 together the free marginal edge portion of the plate portion 64 of each member 60 is arranged in underlying relationship with respect to the lower flange of the channel end 62 of the adjacent member, as illustrated, and with the free edge of the plate portion 60 in substantially abutting relationship with respect to the shoulder formed between the lower flange of the channel end portion and the adjacent plate portion 64. The free marginal edge of the plate portion 64 of each member 60 is, of course, welded or otherwise suitably secured to the lower flange of the channel end 62 of the cooperating member 60 so as to rigidly secure the adjacent members 60 together. It will thus be appreciated that the plate portion 64 of each member serves the same purpose as the plate members 32 in the first described construction and the channel end 62 of each member serves the same purpose as the channels 24-26 of the first described construction. The same bars 33 are provided in this construction and in the same manner as in the previously described construction, that is they are diagonally disposed with respect to the length of the roof section and overlie and are suitably secured as by welding or the like to the upper flange of each channel end 62 over which they extend in the same manner as described in connection with the first described construction.

Suitable material 68 which may be the same as the material 50 previously described may fill the entire space between adjacent members 60 and extends upwardly over the diagonals 38 as in the previously described construction and thereby serve the same purpose and effect. The main difference between this construction and the previously described construction is, of course, that it does not provide for the box-sections provided for in the previously described constructions, but on the other hand is lighter and slightly more economical to build.

It will be appreciated that unless the plates 32 of the construction illustrated in Fig. 3, and the plate portions 64 of the construction illustrated in Fig. 5, are formed to provide a plurality of holes through them and backed by suitable sound insulating material, or are covered on their lower side with suitable sound insulating material, they will serve to reflect sound waves and tend to make the building noisy. Where, of course, the plates 32 or portions 64 are formed to provide a plurality of holes therethrough and the open space above the plates filled with a suitable sound insulating material the reflection of sound waves will be materially lessened. However, where the sound absorbing qualities of the roof structure are important, the construction illustrated in Figs. 1 to 4, inclusive, may be readily modified to materially lessen its sound reflecting characteristics in the manner illustrated in Fig. 6. The construction illustrated in Fig. 6 is identical to the construction illustrated in Fig. 3 except in one particular and, accordingly, it will only be necessary to discuss this single change in order to fully disclose the construction.

The main difference between the construction illustrated in Fig. 3 and that illustrated in Fig. 6 is that in Fig. 6, instead of using the plates 32 as in Fig. 3, the plates 32 are replaced with bar members 70 which may be identical with the bar members 38 except that they extend in an angularly opposite direction to the bar member 38, perpendicular to the length of the bar members 38 where the bar members 38 are disposed at an angle of 45° to the members 22, and are welded to the lower walls 28 and flanges 30 of the members 22. Preferably the bar members 70 are spaced in approximate accordance with the spacing of the bar members 38 so as to provide a plurality of openings or spaces between the various bar members 70 opening upwardly into each of the downwardly facing channels of the members 22. The space between each downwardly opening channel 24-26 above the various bar members 70 is preferably partially or completely filled with a suitable sound insulation material such as 72. This sound insulating material may be of any conventional or suitable type such as the various fibrous materials conventionally used or, if desired, may be of the same type of material as previously described for the material 50 when desired to be of heat insulating characteristics, namely a mixture of cement and vermiculite as this mixture is not only a good heat insulating medium but also a good sound absorbing medium.

By employing the construction illustrated in Fig. 6 a roof of substantially the same strength for the same amount of material as the construction illustrated in Fig. 3 may be provided, the diagonally extending and oppositely directed bars 38 and 70 which are welded to the upper and lower faces respectively of members 22 serving to impart great rigidity to the structure. It will, of course, be appreciated that modifications in the

assembly of the roof structure as described in connection with the structure shown in Fig. 3 are necessary in assembling the roof structure shown in Fig. 6, it being necessary in the latter case to apply the bar members 70 independently of the roof members 22 instead of simultaneously therewith as is possible with the plates 32 in the construction illustrated in Fig. 3.

Formal changes may be made in the specific embodiments of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. A roof structure for buildings comprising a plurality of sheet metal members of angular section extending between opposite edges of said roof section, sheet metal plate means secured to the underface of said members in substantially unbroken relationship over the entire area thereof, and transversely extending metallic bars extending across and fixed to the upper surfaces of said members, said members serving as the major load carrying elements of said structure.

2. A roof section comprising, in combination, angularly sectioned sheet metal members of a depth substantially equal to the thickness of the roof extending from one edge thereof to an opposite edge thereof and provided with transversely extending surfaces at the upper and lower surfaces thereof arranged in parallelism with the general plane of the roof, metallic plate means rigidly fixed with respect to the lower surfaces of said members and forming a substantially continuous under-surface therefor, and spaced metal bar members overlying the upper faces of said first mentioned members in diagonal relation with respect to the length thereof and rigidly fixed thereto.

3. A roof structure for buildings comprising a plurality of sheet metal members of angular section extending between opposite edges of said roof section, sheet metal plate means secured to the underface of said members in substantially unbroken relationship over the entire area thereof, transversely extending metallic bars extending across and fixed to the upper surfaces of said members, said members serving as the major load carrying elements of said structure, and means filling the upwardly opening spaces between said members serving to reinforce said members against distortion.

4. A roof structure for buildings comprising a plurality of sheet metal members of angular section extending between opposite edges of said roof section, sheet metal plate means secured to the underface of said members in substantially unbroken relationship over the entire area thereof, transversely extending metallic bars extending across and fixed to the upper surfaces of said members, said members serving as the major load carrying elements of said structure, and means serving to reduce transfer of heat through said roof structure filling the upwardly opening space between said members.

5. A roof section comprising a plurality of sheet metal elements extending from one edge of said section to an opposite edge thereof in generally parallelism to each other, each member comprising an angularly sectioned portion and a transversely directed plate-like portion fixed to the lower portion thereof in offset relation with respect to said angularly sectioned portion, the plate-like portion of one of said members overlapping the angularly sectioned portion of another

of said members and rigidly fixed thereto so as to form a substantially continuous plate-like surface for the lower surface of said section, and transversely directed spaced metal members overlying the upper surface of the first mentioned member and rigidly fixed thereto.

6. A roof section comprising a plurality of sheet metal elements extending from one edge of said section to an opposite edge thereof in generally parallelism to each other, each member comprising an angularly sectioned portion and a transversely directed plate-like portion fixed to the lower portion thereof in offset relation with respect to said angularly sectioned portion, the plate-like portion of one of said members overlapping the angularly sectioned portion of another of said members and rigidly fixed thereto so as to form a substantially continuous plate-like surface for the lower surface of said section, and a plurality of spaced parallel diagonally arranged metallic bar members extending diagonally across the upper surfaces of the first mentioned members and rigidly fixed thereto.

7. A curved or arched roof section comprising, in combination, a plurality of longitudinally arched sheet metal members arranged in parallel and adjacent relationship and extending between opposite sides of said section, each of said members comprising one or more angularly sectioned portions provided with laterally directed top and bottom surfaces, plate means fixed to the lower laterally directed surfaces of said member and cooperating to form a substantially continuous bottom surface for said section, and a plurality of spaced parallel bar members extending diagonally over the upper laterally directed surfaces of said members and rigidly fixed thereto.

8. A curved or arched roof section comprising, in combination, a plurality of longitudinally arched sheet metal members arranged in parallel and adjacent relationship and extending between opposite sides of said section, each of said members comprising one or more angularly sectioned portions provided with laterally directed top and bottom surfaces, plate means fixed to the lower laterally directed surfaces of said member and cooperating to form a substantially continuous bottom surface for said section, a plurality of spaced parallel bar members extending diagonally over the upper laterally directed surfaces of said members and rigidly fixed thereto, and heat insulating material filling the space between adjacent angular sections of said members.

9. A curved or arched roof section comprising, in combination, a plurality of longitudinally arched sheet metal members arranged in parallel and adjacent relationship and extending between opposite sides of said section, each of said members comprising one or more angularly sectioned portions provided with laterally directed top and bottom surfaces, plate means fixed to the lower laterally directed surfaces of said member and cooperating to form a substantially continuous bottom surface for said section, a plurality of spaced parallel bar members extending diagonally over the upper laterally directed surfaces of said members and rigidly fixed thereto, and a substantially rigid mass filling the space between adjacent of said angularly sectioned portions and extending above and imbedding said bar members therein serving to reinforce said members against distortion under load.

10. A roof section comprising, in combination, a plurality of load sustaining members extending between opposite sides thereof formed from

sheet metal to present downwardly opening channel sections, substantially flat plate means extending between and fixed to the lower faces of said members whereby to cooperate therewith to form said members into box-like sections, and a plurality of spaced parallel metallic bar members overlying the upper surface of said members and extending diagonally with respect to the length thereof and rigidly fixed thereto.

11. A roof section comprising, in combination, a plurality of load sustaining members extending between opposite sides thereof formed from sheet metal to present downwardly opening channel sections, substantially flat plate means extending between and fixed to the lower faces of said members whereby to cooperate therewith to form said members into box-like sections, said plate means projecting laterally beyond at least one edge of a channel section of its corresponding member in overlapping relationship with respect to the next adjacent channel section of the next adjacent member and rigidly fixed thereto, and a plurality of spaced parallel metallic bar members overlying the upper surface of said members and extending diagonally with respect to the length thereof and rigidly fixed thereto.

12. A roof section comprising, in combination, a plurality of load sustaining members extending between opposite sides thereof formed from sheet metal to present downwardly opening channel sections, substantially flat plate means extending between and fixed to the lower faces of said members whereby to cooperate therewith to form said members into box-like sections, a plurality of spaced parallel metallic bar members overlying the upper surface of said members and extending diagonally with respect to the length thereof and rigidly fixed thereto, and means filling the space between said channel sections serving to retard the transfer of heat therethrough.

13. A roof section comprising, in combination, a plurality of load sustaining members extending between opposite sides thereof formed from sheet metal to present downwardly opening channel sections, substantially flat plate means extending between and fixed to the lower faces of said members whereby to cooperate therewith to form said members into box-like sections, a plurality of spaced parallel metallic bar members overlying the upper surface of said members and extending diagonally with respect to the length thereof and rigidly fixed thereto, and a substantially rigid mass filling the space between said channel sections and serving to reinforce said members against distortion.

14. A roof section comprising, in combination, a plurality of load sustaining members extending between opposite sides thereof formed from sheet metal to present downwardly opening channel sections, substantially flat plate means extending between and fixed to the lower faces of said members whereby to cooperate therewith to form said members into box-like sections, a plurality of spaced parallel metallic bar members overlying the upper surface of said members and extending diagonally with respect to the length thereof and rigidly fixed thereto, and a substantially rigid mass including a mixture of Portland cement and vermiculite completely filling the space between adjacent channel sections whereby to reinforce said members against distortion and to minimize the transfer of heat therethrough.

15. A roof section comprising, in combination, a plurality of sheet metal members extending be-

tween opposite sides thereof, each of said members comprising a laterally opening channel sectioned end portion and a laterally extending plate portion secured to the lower flange of each channel end portion, said members arranged with the free marginal edge of each plate portion in underlying relation with respect to the lower flange of the channel end of the next adjacent member and rigidly fixed thereto, and a plurality of spaced parallel metallic bar members arranged in overlying relationship with respect to the upper flange of the channel end portion of each of said members and extending transversely with respect thereto and rigidly fixed thereto.

16. A roof section comprising, in combination, a plurality of sheet metal members extending between opposite sides thereof, each of said members comprising a laterally opening channel sectioned end portion and a laterally extending plate portion secured to the lower flange of each channel end portion, said members arranged with the free marginal edge of each plate portion in underlying relation with respect to the lower flange of the channel end of the next adjacent member and rigidly fixed thereto, a plurality of spaced parallel metallic bar members arranged in overlying relationship with respect to the upper flange of the channel end portion of each of said members and extending transversely with respect thereto and rigidly fixed thereto, and means filling the space between said channel sections serving to retard the transfer of heat therethrough.

17. A roof section comprising, in combination, a plurality of sheet metal members extending between opposite sides thereof, each of said members comprising a laterally opening channel sectioned end portion and a laterally extending plate portion secured to the lower flange of each channel end portion, said members arranged with the free marginal edge of each plate portion in underlying relation with respect to the lower flange of the channel end of the next adjacent member and rigidly fixed thereto, a plurality of spaced parallel metallic bar members arranged in overlying relationship with respect to the upper flange of the channel end portion of each of said members and extending transversely with respect thereto and rigidly fixed thereto, and a substantially rigid mass filling the space between said channel sections and serving to reinforce said members against distortion.

18. A roof section comprising, in combination, a plurality of sheet metal members extending between opposite sides thereof, each of said members comprising a laterally opening channel sectioned end portion and a laterally extending plate portion secured to the lower flange of each channel end portion, said members arranged with the free marginal edge of each plate portion in underlying relation with respect to the lower flange of the channel end of the next adjacent member and rigidly fixed thereto, a plurality of spaced parallel metallic bar members arranged in overlying relationship with respect to the upper flange of the channel end portion of each of said members and extending transversely with respect thereto and rigidly fixed thereto, and a substantially rigid mass including a mixture of Portland cement and vermiculite completely filling the space between adjacent channel sections whereby to reinforce said members against distortion and to minimize the transfer of heat therethrough.

19. A roof structure for a building comprising

a plurality of sheet metal members of angular section extending between opposite edges of said roof section, metal bar members arranged in generally spaced and parallel relation with respect to each other and extending diagonally with respect to the length of said sheet metal members rigidly fixed to the lower faces thereof and forming a substantial lining for the entire under-surface of said roof structure, and additional metal bar members overlying the upper surface 10

of said sheet metal members and arranged in spaced parallel relation with respect to each other, said last mentioned metallic bar members extending diagonally with respect to the length of said sheet metal member but in a direction 5 opposite to the direction of angular extension of the first mentioned bar members and rigidly fixed to said sheet metal members.

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