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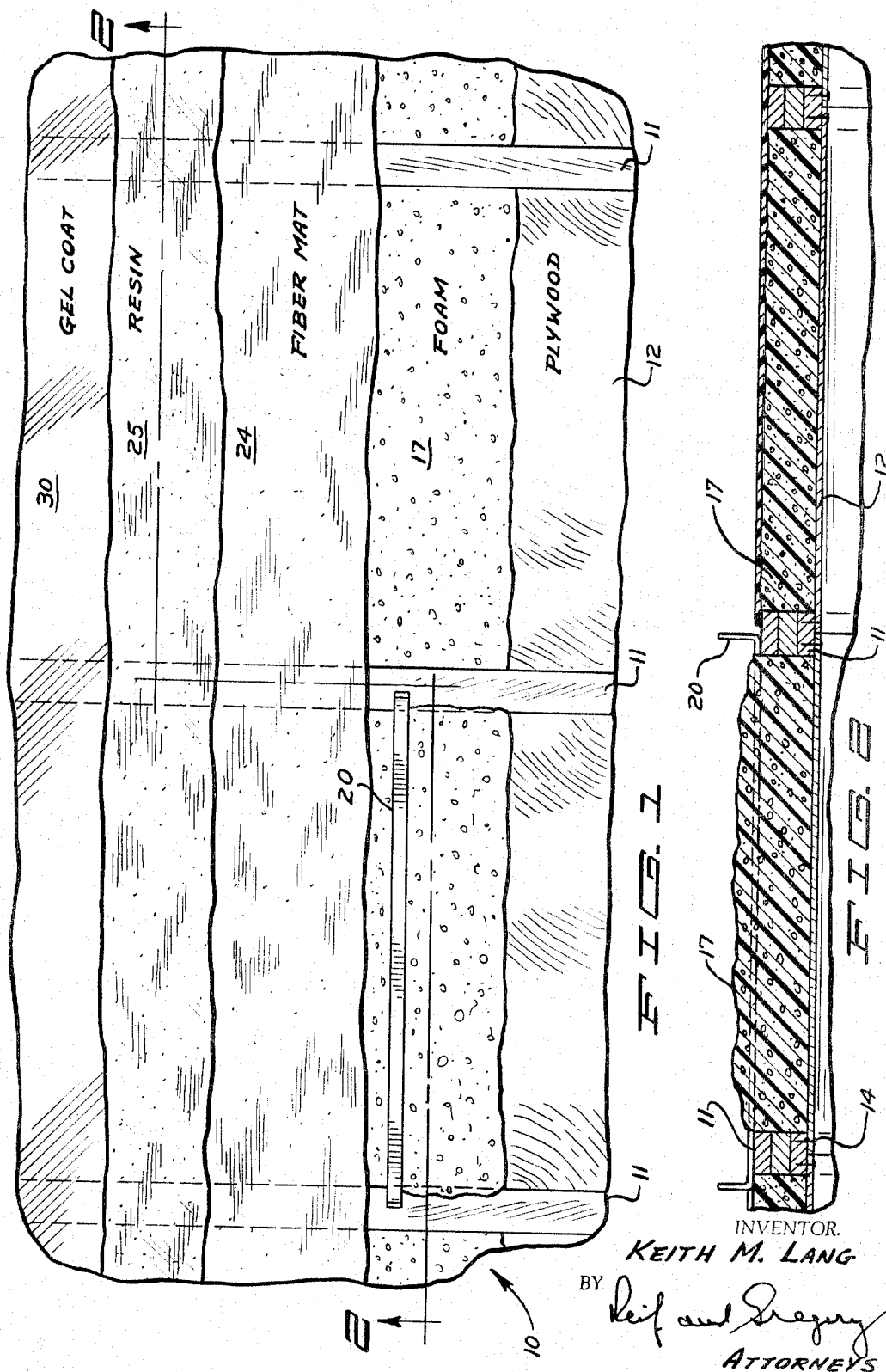
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METHOD FOR FORMING ROOF STRUCTURE

Filed Dec. 10, 1963

2 Sheets-Sheet 1



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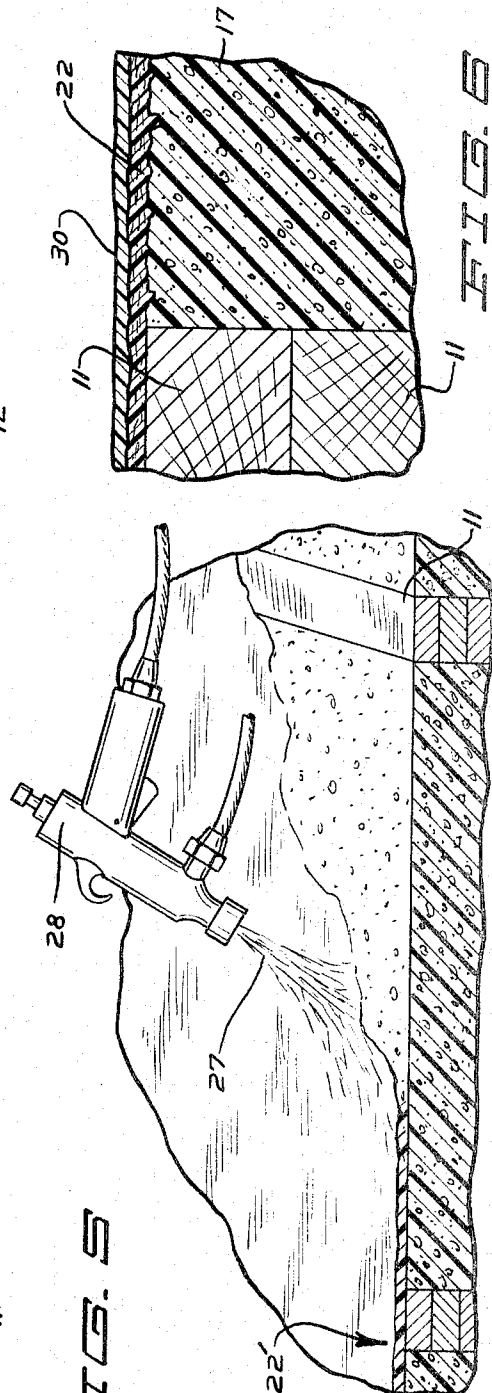
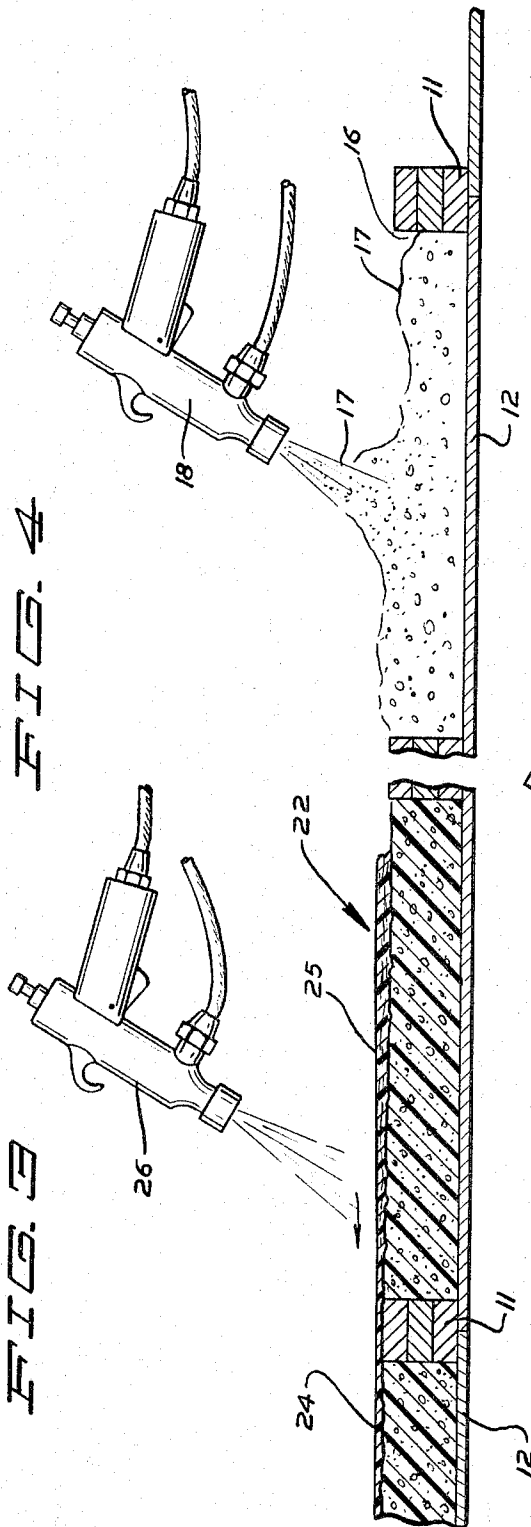
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METHOD FOR FORMING ROOF STRUCTURE

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2 Sheets-Sheet 2



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METHOD FOR FORMING ROOF STRUCTURE
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This invention relates to an improvement in a roof structure for buildings and a method for forming the same.

It is desirable and an object of this invention to provide a relatively lightweight roof structure of simple construction having substantial strength and substantial weather resistant and insulating characteristics.

It is another object of this invention to provide a roof structure of cellular insulating material having a thin outer skin or coating surface.

It is a further object of this invention to provide a roof structure comprising a cellular foam material applied to open-faced cavities in a roof construction and a weather resistant surfacing material coating said foam material.

It is also an object of this invention to provide a roof structure comprising various degrees of curvature which may require different degrees of strength and/or rigidity in various portions thereof in connection with a beam structure of uniform cross sectional dimension.

It is a more specific object of this invention to provide a roof structure formed on the job at its place of installation comprising a skin underlying spaced beams forming open-faced cavities therewith, a cellular foam material filling said cavities, a variable density of said material relative to the strength required in said roof structure with relation to specific portions thereof, a reinforced plastic skin overlying said cellular foam material and a relatively smooth weather resistant skin overlying said reinforced skin.

It is also an object of this invention to provide a method for forming a roof structure as set forth in the preceding objects.

These and other objects and advantages of the invention will be fully set forth in the following description made in connection with the accompanying drawings in which like reference characters refer to similar parts throughout the several views and in which:

FIG. 1 is a broken view in plan of a section of a roof structure indicating in steps various stages of its construction and the materials used in connection therewith;

FIG. 2 is a view in vertical section taken on line 2-2 of FIG. 1 as indicated by the arrows;

FIG. 3 is a broken view in vertical section showing a step in construction;

FIG. 4 is a view similar to FIG. 3 showing another step in construction;

FIG. 5 is a broken view in perspective showing an alternate step in applicant's invention; and

FIG. 6 is a fragmentary view in vertical section on an enlarged scale showing a detail of construction.

It is to be understood that applicant's roof structure is formed in the process of the construction of a building.

Referring to the drawings, a fragmentary portion of a roof structure is shown in FIG. 1 being indicated generally by the character 10. Only a sufficient portion of the roof structure is shown as is adequate for a full disclosure of the applicant's invention. Beams or rafters 11 are indicated in spaced relation as usually positioned. Said beams may have various cross sectional configurations and may be formed of various materials, but for purpose of illustration here they are indicated as being of wood uniform in size and instead of being spaced at 16 inch intervals on center as is commonly done, they are preferably spaced at 4 feet intervals with respect to their centers as is hereafter indicated. Thus it is seen there re-

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sults a substantial reduction in structural weight by the use of a lesser number of beams.

A skin 12 is secured to the under side of said beams to underlie the same. Various specific underlying skins may be utilized. In a preferred embodiment in carrying out the applicant's invention, the skin 12 is here indicated as being formed of a suitable type of sheets of plywood of the usual 4 x 8 foot size secured to said beams by appropriate nails 14. Said beams will be spaced at four foot intervals on center in connection with said plywood sheets. It is satisfactory for said plywood to be on the order of 1/2" to 3/4" in thickness. An adhesive may be added to securely bond the plywood to the beams in order to develop full shear stress in the plywood.

Thus the skin 12 underlying said beams 11 forms therewith open-faced or relatively unrestricted cavities 16 providing restraint only at either side by said beams and at either end by appropriate end plates not here shown.

Said cavities are filled with a self curing cellular plastic foam material 17 of a suitable character. A plastic foam material which is preferable is Freon blown polyurethane foam applied in liquid form into said cavities, as indicated in FIG. 4, by a common type of applicator 18 here shown in the form of a gun having lines running to containers of the foam material not here shown.

The polyurethane foam material will include commonly used catalyst and resin materials well known in the art wherein the polyurethane material is converted rapidly on the order of an interval of five minutes from its liquid state into a substantially rigid closed cell cellular structure. Said foam mixture will be self bonding to the underlying plywood skin member and to said beams.

The use of open face cavities 16 is important to the successful development of applicant's roof structure. The open face cavities permit the foam material to rise freely and thus avoid distortion which otherwise is present in applying a foam material into a restricted cavity. As a result, in the instant application there is little if any internal stress, the foam material is uniform in cross section and the bonding of the foam material to the beams and to the underlying skin becomes very effective.

Said foam material after becoming rigid will be found to have a substantially uniform density or cross sectional character. The strength present in said foam material is in relation to its density. There is a great deal of flexibility present in the application of said foam material. In areas where higher compressive strength may be desired or required, the density of said foam material may be increased by appropriate change in the mixture of ingredients making up the liquid polyurethane foam material. Thus the density of said foam material may be increased to provide additional strength where required in lieu of varying the cross sectional dimension of the beams.

Said polyurethane foam in rising freely will extend above the beams 11. As soon as said foam has attained sufficient rigidity, the portion thereof extending above the upper surface of the beams will be trimmed off to make the upper surface of said foam material coplanar with the upper surface of said beams. The trimming of said foam material may be accomplished in various known ways. It may be trimmed off with a serrated bladed knife which is here indicated in the form of the cutting member 20, with reference to FIG. 2, or a hot wire or calrod unit may be used with effectiveness.

With said foam material 17 in a rigid condition and coplanar with the upper surface of said beams 11, a self bonding reinforced plastic skin 22 is next applied thereto to overlie said foam material and the exposed upper portions of said beams.

Said reinforced plastic skin in one embodiment is readily formed of fiber reinforced plastic mats 24, such

as Fiberglas mats. With the mats laid in position, a plastic resin 25, such as a polyester resin of a common commercial type, is sprayed thereon as by an applicator 26 communicating with a supply of said resin to saturate said mats and extend therethrough to bond said mats to said underlying foam material and beams and to provide an upper surface coating for said mats.

In the alternative, instead of separately laying a fiber reinforced mat as above indicated, plastic fiber reinforced skin 22' may be formed with a polyester resin 27 being used which is identical to the polyester resin 25 with the addition of chopped fibers thereto, such as glass fibers, and the mixture of said polyester resin and chopped fibers is applied as by the applicator 23, as indicated in FIG. 5. This mixture of chopped fibers and plastic resin forms its own integral bond with the upper surface of said polyurethane foam material 17 and said beams 11.

In either case whether mats are separately laid and sprayed to form the surface 22, or a fiber loaded plastic resin is sprayed directly to form the surface 22', the resulting surface structure is substantially the same. In either case the layer of surfacing material thus formed is preferably rolled to assure the removal of all air bubbles and to produce a uniform layer. This rolling process embodies no unobvious element of novelty, is of simple execution, and is not believed to require any illustration.

Where the roof structure comprises various degrees of curvature rather than being just simply curved or flat, higher rigidity and/or strength may be required at various areas in said roof structure. These varying needs in structural rigidity and/or strength are readily provided by simply increasing sufficiently the thickness of the fiber reinforced skin or upper surface layer 22 or 22' in said areas to form the necessary cross sectional area therein. This is in lieu of attempting to fabricate beams of variable cross section and results in a less expensive structure.

The mixture of fibers with the polyester resin or the fiber mats impregnated with the polyester resin generally results in some fibers being exposed to the atmosphere. A small projection of a fiber, such as a glass fiber, tends to create a wicking effect wherein moisture from the atmosphere is drawn inwardly along the exposed fiber and this adversely affects the bond between the fiber and the resin.

To assure a non-wicking outer surface and/or to provide a smooth outer surface, it is preferable to apply a final outer plastic gel coat 30 comprising a polyester resin similar to said resin 25 but preferably having a higher acrylic content. This provides a very substantial protective coating having very effective resistance to weather conditions in general and to the effects of heat and sunlight. The final gel coat thus completely seals any otherwise exposed fiber of said fiber loaded resin layer 22 or 22'.

It is here noted that in lieu of a roof structure which with respect to the average house would weigh on the order of ten to fifteen pounds per square foot, the applicant provides an improved roof structure weighing on the order of from five to six pounds per square foot. Thus it is shown that I have provided a simply constructed improvement in a roof structure which is formed at the

site. The method of construction is believed to be obvious from the description given.

It will of course be understood that various changes may be made in the steps and sequence of steps of the method without departing from the scope of applicant's invention which, generally stated, consists in a method capable of carrying out the objects above set forth, such as disclosed and defined in the appended claims.

What is claimed is:

1. The method of forming a roof structure consisting of
 - spacing supporting beams,
 - overlying one side of said beams with a rigid skin forming open face cavities with said beams,
 - filling said cavities with a self bonding, self curing freon blown polyurethane foam material,
 - trimming off said foam material flush with said beams,
 - overlying said foam material and beams with fiber reinforced mats,
 - applying a self bonding polyester resin to coat said mats and impregnate the same to bond said mats to said underlying foam material and beams, and
 - applying a polyester resin of high acrylic content to seal coat said last mentioned coat.
2. The method of forming a roof structure consisting of
 - spacing supporting beams,
 - overlying one side of said beams with a rigid skin forming open face cavities with said beams,
 - filling said cavities with a self bonding, self curing blown foam material,
 - overlying said foam material and beams with fiber reinforcement material,
 - applying a self bonding polyester resin to coat said reinforcement material to impregnate and bond the same to said underlying foam material and beams, and
 - applying a seal coat to said last mentioned coat.

References Cited by the Examiner

UNITED STATES PATENTS

2,858,580	11/1958	Thompson	296—31
2,896,271	7/1959	Kloote	52—512
2,908,602	10/1959	Collardeau,	
2,981,308	4/1961	Thompson.	
3,007,208	11/1961	Urban	161—150
3,080,268	3/1963	Bjork	161—159 X
3,122,073	2/1964	Masse	52—515
3,122,860	3/1964	Schulze	52—309
3,176,055	3/1965	Loos	156—79
3,194,708	7/1965	Fourcade	161—161
3,197,352	7/1965	Coates	156—242
3,199,261	8/1965	Soddy	161—161

OTHER REFERENCES

Polyesters and Their Applications by Bjorksten Research Lab., page 31, published in 1956 by Reinhold Publishing Corp.

Modern Plastics, October 1963, page 165.

FRANK L. ABBOTT, *Primary Examiner*.

JOHN E. MURTAGH, *Examiner*.