July 11, 1933. A. O. MICKELSON 1,917,456

MULTI-PLY FIBROUS STRUCTURE

Filed April 29, 1929

Fig. 1.

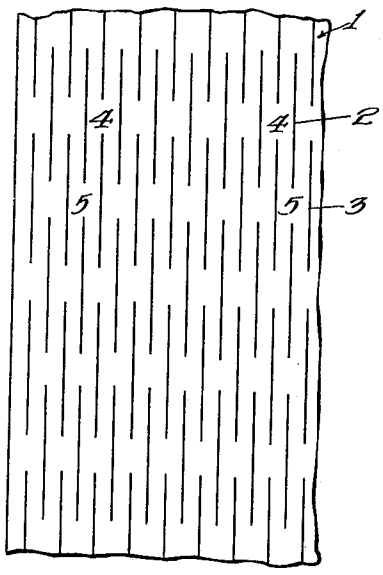


Fig. 2.

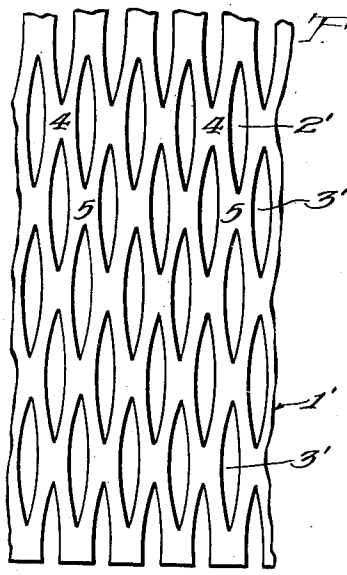


Fig. 3.

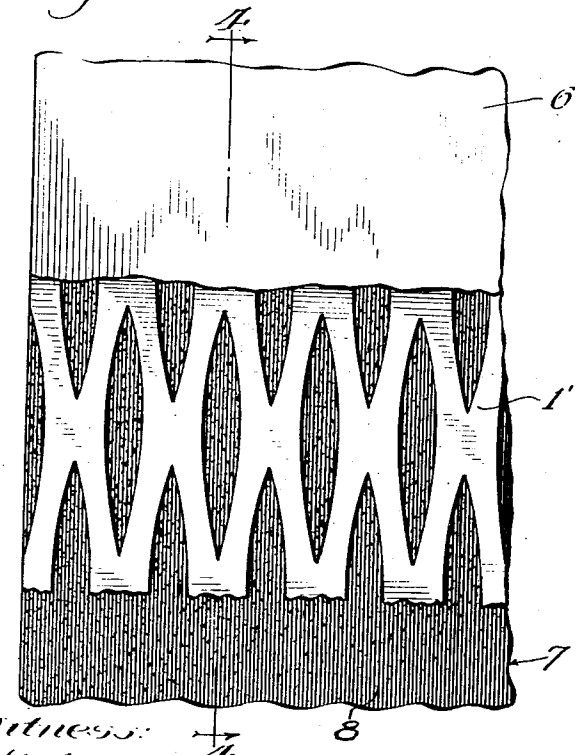
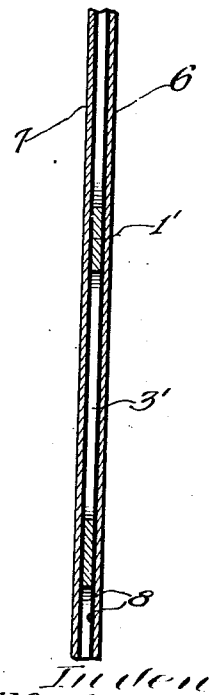


Fig. 4.



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UNITED STATES PATENT OFFICE

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MULTI-PLY FIBROUS STRUCTURE

Application filed April 29, 1929. Serial No. 358,895.

This invention relates to improvements in a multi-ply fibrous structure, and refers more particularly to a fibrous structure particularly adapted for use in building and refrigerator insulation, pipe coverings, container board, plaster base, and in general where efficient insulation is desired.

Among the objects of the present invention are to provide a multi-ply fibrous structure which, dependent upon selection of outer plies of suitable characteristics, may be flexible or rigid; to provide a multi-ply fibrous structure which may itself be used as a rigid board, or which may be used in combination with an extraneous rigid board for insulation purposes; to provide a multi-ply structure of the character described which is less expensive and lighter in weight than fibrous structures now conventionally used for the same purposes, while at the same time not sacrificing any needed strength.

Briefly, the structure of the present invention comprises two separate imperforate outer plies adhesively united together and enclosing an inner ply, or plies, of fibrous material having sealed dead air cells. The particular method of producing these confined and sealed cells within the structure of the inner ply, as well as the result produced thereby, comprises one of the novel features of the invention.

The utility of the invention as well as other objects and advantages thereof will be apparent from the following description.

In the drawing, Fig. 1 is a plan view of a ply adapted for use as an inner ply, illustrating regularly spaced lines of severance.

Fig. 2 is a view similar to Fig. 1 illustrating the form of the structure shown in Fig. 1 after having been spread or expanded by force applied thereto.

Fig. 3 is an enlarged fragmentary plan view of a three-ply structure, illustrating the outer imperforate covering plies and the expanded inner ply.

Fig. 4 is a view taken on line 4—4 of Fig. 3, looking in the direction of the arrows.

Referring more particularly to the drawing, 1 designates as a whole a molded or felted fibrous sheet of suitable thickness and weight. In one specific embodiment of the invention, this ply 1 may comprise cotton or wool felt as made on a conventional felting machine, and used, for instance, as a base in the manufacture of flexible roofing material. This sheet is subjected to an operation which produces within the structure thereof rows of regularly spaced cuts 2 and 3 of a predetermined length and spacing. These cuts 2 and 3 are preferably uniform in length and may be, for instance, from 1 to 4 inches, more or less. The cuts in row 2 are staggered relative to the cuts in row 3. In addition, the cuts in one row overlap at top and bottom the cuts of both adjacent rows, leaving interposed spaces 4 and 5 between the edges of adjacent cuts.

After the sheet 1 has been suitably severed in the manner illustrated in Fig. 1, force may be applied thereto to spread or expand the sheet to produce the confined elongated oval-shaped cells 2′ and 3′. In the expanding step, the unsevered areas 4 and 5 between longitudinally adjacent cuts function as connecting members. Care should be taken to prevent excess expansion such as would break the bond at the points of these connecting members 4 and 5. It may be that some of these connecting points 4 and 5 will rupture and break due to excessive strain on these particular points, or faulty material, but care should be taken to see that the majority of these connecting members are not broken during the expanding step. The force required in the expanding step should be applied for a sufficient time to see that the expanded sheet designated as a whole 1′ will permanently retain the structure illustrated in Fig. 2.

It is contemplated that the sheet 1 shall be expanded to substantially twice its area, but, of course, it is to be understood that I do not wish to limit myself to this particular amount of expansion, as it may be decreased or increased over this amount.

In manufacturing the expanded sheet 1′, a practical commercial way is to feed a continuous strip of material to a rotary cutting die which produces the cuts 2 and 3 transversely of said continuous sheet. The cut sheet may be then fed to a second rotary die, rotating at an increased speed relative to the first mentioned rotary die, which does the expanding and produces the cells 2′ and 3′ transversely of the sheet. The sheet is then severed transversely at desired points. While this is a practical commercial way of manufacturing the structure 1′ I do not wish to limit myself to this particular method, as the cuts 2 and 3 may be made longitudinally

of the sheet instead of transversely, in which event the sheet would be expanded transversely.

Referring now to Fig. 3, the expanded sheet shown in Fig. 2 is interposed between two imperforate sheets 6 and 7. The inner surfaces of the sheets 6 and 7 may have applied thereto a suitable adhesive 8 which may also be a waterproofing material, such, for instance, as asphalt or the like. The three sheets 6, 7 and 1′ are then united into a composite multi-ply fibrous structure comprising the two outer imperforate sheets 6 and 7 and the inner expanded sheet 1′. The cells 2′ and 3′ are confined and sealed within the multi-ply structure so as to provide dead air spaces therein, which is the most effective means of insulation known at the present time.

While I have illustrated in Figs. 3 and 4, and have described a three-ply sheet, it is to be understood that the invention contemplates a five-ply, seven-ply, nine-ply, or multiple ply construction. In a five-ply structure, for instance, a second expanded sheet 1′ would be applied by means of an adhesive to the sheet 6 or 7 and an outer imperforate sheet adhesively united to said second expanded sheet so that in a five-ply structure the two outer plies and the central ply would be imperforate, being separated by two separate expanded sheets.

It will be appreciated by those skilled in the art that not only do I obtain all of the desirable benefits of insulation through the provision of the sealed dead air cells, but I secure these benefits by the provision of a structure which is less expensive and lighter in weight compared with other structures for similar purposes. This is obvious, since the amount of material used in the expanded ply 1′ may be one-half or less relative to conventional sheets used for the same purpose. In other words, as heretofore pointed out, the expanded sheet may cover twice the area of the unexpanded sheet 1.

The multi-ply fibrous structure of the present invention is of particular advantage when used as a plaster base, due to the fact that the inner ply permits any required expansion or contraction to take place. The advantage of this will be appreciated when compared with conventional plaster bases in which the base frequently is rigid and has a different co-efficient of expansion and contraction than the plaster, thus resulting in the breaking of the bond between the plaster and the base and nullifying its use as a plaster base.

I claim as my invention:

1. A multi-ply fibrous structure comprising spaced surface sheets having interposed therebetween, and adhesively united thereto, an inner ply of expanded fibrous material having elongated sealed dead air cells.

2. A process which comprises severing a sheet of fibrous material along regularly spaced lines of uniform but limited length, thereafter expanding said sheet to produce apertures therein, in thereafter interposing said expanded sheet between unexpanded surface plies and adhesively uniting the plies together to produce a multi-ply structure in which said cells are sealed within the structure to produce sealed dead air cells.

3. A multi-ply fibrous structure comprising spaced surface sheets having interposed therebetween, and adhesively united thereto, an inner ply of expanded fibrous material having spaced apertures, said apertures being of greater central width than of end width, said apertures being in staggered relation in the sheet of the inner ply and having their lengths located with respect to each other with an appreciable overlap.

4. A multi-ply fibrous structure comprising spaced surface sheets having interposed therebetween, and adhesively united thereto, an inner ply of stretched fibrous material having spaced apertures, said apertures being defined by opposed intersecting arcuate lines, the intersection of the arcs of one aperture being appreciably within the lines joining the adjacent intersections of the arcs of the apertures adjacent on either side of said first aperture.

5. A process which comprises forming cuts in the body of a sheet of fibrous material along laterally spaced like extending lines of limited length, the ends of each line being adjacent the middle portion of the length of the adjacent laterally spaced lines, expanding the sheet to expand said cuts to form apertures in the sheet, and interposing said sheet between cover sheets in close contact therewith to produce a plied structure in which said apertures form closed cells between the cover sheets.

6. A structure composed of a plurality of plies of sheet material comprising outer surface sheets and an inner sheet of expanded fibrous material between and in close contact with the outer sheets, said inner sheet having elongated openings therein in staggered but like extending arrangement with the ends of each elongated opening adjacent the middle of the length of the adjacent openings, the fibrous material surrounding each opening being that of adjacent portions of the body of the sheet before expansion without substantial removal of material of said body.

In testimony whereof I affix my signature.

ALFRED O. MICKELSON.