June 16, 1936. G. B. BROWN 2,043,987

STRUCTURAL UNIT

Filed July 21, 1932

Fig. 1.

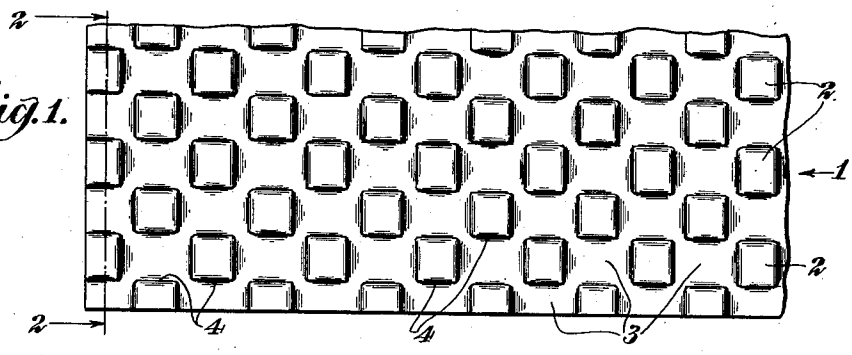


Fig. 2.

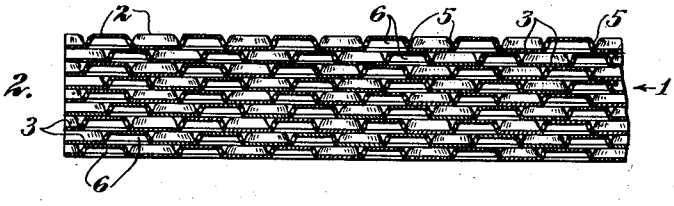


Fig. 3.

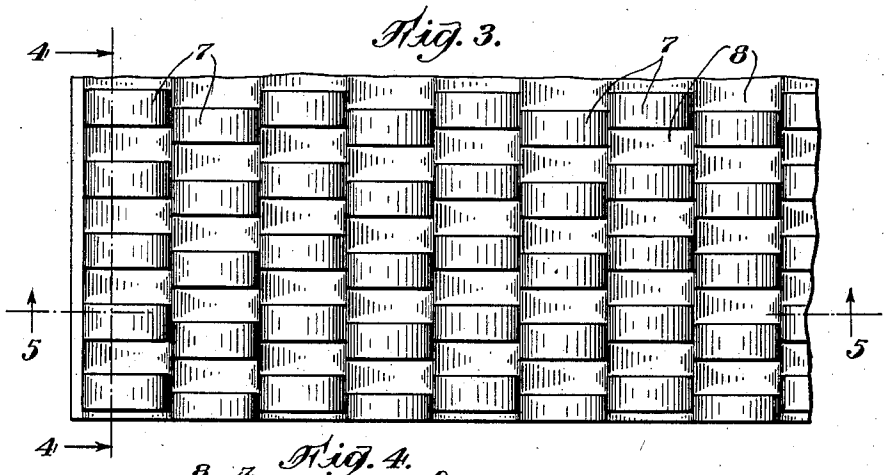


Fig. 4.

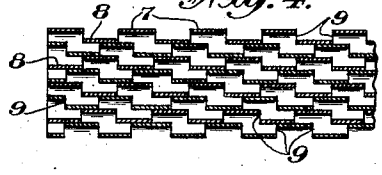


Fig. 5.



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STRUCTURAL UNIT

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Application July 21, 1932, Serial No. 623,731

6 Claims. (Cl. 154—44)

This invention relates to a sound absorbing unit and method of making the same. It relates especially to a composite of a plurality of sheets provided each with a multiplicity of closely spaced openings of substantial size, adapted to admit incident sound, disposed rearwardly with respect to imperforate forward portions of the sheet and largely concealed from view from a forward position.

The invention comprises a sound absorbing unit including a body member provided with sound absorbing spaces and an outer portion thereof, described herein, for convenience, as the facing element, of irregular surface having a multiplicity of openings extending at an angle, suitably at approximately a right angle, to the general plane of the facing element and adapted to admit incident sound to the sound absorbing spaces within the unit.

There is wide commercial use of acoustical structures consisting of sound absorbing pads provided with apertured facing elements, such as woven fabric or closely perforated metal sheeting. While such structures are very useful and advantageous, there is a field for a modified form of construction. In the type now in use, there is some difficulty due to closing of the openings in the facing element, when the facing element is painted or otherwise decorated, if the openings are very small. On the other hand, if the openings are large, they may be conspicuous and create an architectural effect that is not desired in certain installations. Furthermore, large openings may permit a small amount of dust from a fibrous backing material to fall downwardly through the openings, unless an additional fabric provided with small openings is installed between the perforated metal and the fibrous backing material. Also, there is some expense involved in perforating sheet material in a manner adapted to admit incident sound satisfactorily.

It is an object of the present invention to overcome the disadvantages in apertured facing elements of the kinds that have been mentioned, and to provide a novel type of acoustical unit that is inexpensive to manufacture, effective in sound absorption, and light in weight. Other objects and advantages will appear as the description of the invention progresses.

An embodiment of the invention that is now preferred is illustrated in the drawing in which

Fig. 1 shows a plan view of an acoustical unit provided with an improved outer sheet or facing element in which the openings adapted to admit incident sound are largely or wholly concealed from view from a forward position.

Fig. 2 shows a cross sectional view along the line 2—2 of Fig. 1.

Fig. 3 shows a plan view of a modification in which the sheets have an irregular surface that resembles in appearance a basket weave with the cross or filler bands omitted.

Fig. 4 shows a cross sectional view along the line 4—4 of Fig. 3, and Fig. 5, a similar view on line 5—5.

In the various figures like reference characters denote like parts.

Thus, 1 denotes a plurality of spaced sheets provided with irregularities of surface, including elevations 2, depressions 3, and intermediate areas 4 between the elevated or forward and depressed or rearwardly disposed portions, indicated, respectively, by the reference characters 2 and 3, The said intermediate areas or portions of the sheet, disposed rearwardly with respect to the forward portions, are provided with openings or apertures 5 (Fig. 2), of substantial size, adapted to admit incident sound. The various sheets of irregular surface are closely spaced and composited, in the assembled unit, and lie in planes that are generally parallel and define between them inner, sound absorbing spaces 6 that communicate with each other by means of the openings 5. The openings 5 in the various sheets are non-registering, and thus cause sound which passes into the unit to undergo numerous changes of direction, in a labyrinth of intercommunicating spaces.

In the modification shown in Figs. 3 and 4, the openings 9 between the elevated portions 7 and the lateral adjacent depressed portions 8 may be essentially cuts or slits of width extending approximately at a right angle to the general plane of the several sheets, to form a structure resembling a modified basket-weave. The said slits are sound-permeable, are adapted to admit incident sound, and lie in a plane that forms approximately a right angle with the general plane of the facing element.

The sheet material used in constructing the units of the types described may be a fire-resistant, felted product such as paper. The paper may comprise newsprint pulp, asbestos fibers, or the like. If the fibers composing the paper are combustible per se, they may be treated to make them fire-resistant. Thus, wood pulp may be made into paper with a suitable proportion of a fire-retarding substance, such as a hydrated

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chemical, as, for example, alum or hydrated magnesium ammonium phosphate.

The inner sheets constituting the body of the acoustical unit and the outer sheet or facing element may have the same or different compositions. The facing element may be of more rigid composition, in order to assist in maintaining an established shape of exterior of the block.

A method of making a structural unit in accordance with the present invention, is illustrated in the following example.

A fire-resistant paper is first made by a conventional method. The finished and dried paper is passed between dies or rollers in order to provide irregularities of surface of the paper. Rollers of a satisfactory type may be similar to those adapted to produce so-called indented paper, which is now in wide use as a component of thermal insulating articles, for example. Such rollers or dies have elevated portions of approximately flat surface and depressed portions of similar shape of surface and may have connecting portions or intermediate areas that extend more or less at a right angle to the planes of the flat surfaces of the elevated and depressed portions. The elevations on one roller mesh with the depressions on the other; the intermediate areas on one roller mesh also with those on the companion roller.

A departure is made from the usual process of making indent paper, in that provision is made for tearing or shearing the paper as it is indented, and, thereby, providing openings in aproximately predetermined areas. The paper before indenting may be moistened, as by being subjected to a steaming operation just sufficient to leave the paper somewhat brittle and not so readily deformable without tearing as would be the case if the paper were more thoroughly moistened. Also, the indenting rollers are set somewhat closer together than is the usual practice. Various settings may be used. I have used to advantage a setting so close that the clearance between the said intermediate areas of surface of the rollers, that is, between the side of a projection on one roller and the corresponding side of a depression in the companion roller, is slightly less than the thickness of the paper that is being indented, thereby causing a shearing action to form slits or openings.

When paper is passed between rollers set in this manner, there is a binding action on the paper in areas that are intermediate, that is, that occur between the raised and the depressed portions of surface, both of the rollers and also in the finished indented paper; the paper is torn in such areas to provide openings of substantial size, in approximately predetermined positions. Thus, these openings may be $\frac{1}{16}$ to $\frac{1}{8}$ inch in maximum length and width, and closely spaced, say about half an inch apart or less. Being in areas that are transverse, that is, disposed at an angle that is suitably approximately a right angle to the general plane of the sheet, and particularly to the plane connecting the high spots or forward portions of the sheet, as assembled in the unit, the holes also extend in one direction transversely, suitably at a right angle, to the plane of the forward portions.

After the paper issues from the indenting and tearing rollers, it is submitted to a coating and drying treatment, to maintain it in deformed and torn condition. Thus, it is coated with a stiffening chemical, as by being sprayed with a dilute, aqueous solution of sodium silicate or a dilute solution of bakelite and then passed through a steam heated drying chamber. This produces a more or less stiff sheet, in which the sodium silicate or phenol-aldehyde resin (bakelite) serves to maintain the form in which the sheet is dried.

The thus stiffened sheet of stabilized irregularity of surface and tears is then composite with similar sheets, the alternating sheets being laid, suitably, in opposite directions or crossed, in order to minimize the likelihood of internesting of the irregularities of adjacent sheets. Before the sheets are stacked together, they are coated with an adhesive such as a solution of sodium silicate or glue, to provide a layer of adhesive over the high spots of the several sheets. The sheets with the thus applied adhesive are then composited and are pressed lightly together to cause adherence. The finished composite is then dried and may be trimmed to size.

The product has interesting properties, some of which have been indicated already. The product is inexpensive, particularly in comparison with other sound absorbing units now on the market. The overall density is low. Thus, a block of the type illustrated in Figs. 1 and 2, fabricated from asbestos paper weighing 6 lbs. per hundred square feet of area (before being indented), with 16 plies of indented paper per inch of thickness, has an overall density of approximately 1 pound per board foot. This block is also of satisfactory sound absorbing properties; it absorbs 77% of incident sound of a frequency of 512 cycles per second and 67% of frequency 1052 cycles. The voids defined between adjacent sheets in a composite of a plurality of indented sheets are limited on all sides at close intervals by the irregularities of the indented material; this limitation of the voids causes frequent reflection or change in direction of sound passing throughout the unit.

Because of the positions of the openings in areas that may extend approximately at a right angle to the general plane of the face of the unit, the openings may be largely concealed or invisible when viewed from a forward position but readily visible when viewed in perspective. A unit provided with a facing element having such openings may be painted and repainted over the forward positions, by brush or otherwise, without adversely influencing the permeability of the facing element to incident sound. The openings persist and are not bridged over by the application of even a large number of coats of paint. Because the plane in which the openings lie is more or less vertical, when the structure is used in a ceiling, the objectionable falling of dust through the holes in such an installation is reduced to a minimum. The forward or raised portions of the facing element are preferably impermeable to sound, as illustrated. The facing member is suitably inelastic.

The term "impermeable", as applied to penetrability to sound, refers to the condition of being not adapted to transmit sound to a substantial extent by air conduction. Thus, a continuous, unapertured sheet of metal would be considered "impermeable" to sound.

While the invention has been described particularly with reference to indented sheets, or basket-weave type of sheets, the invention is ap-

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plicable to other structures. Such a structure to which the invention is applicable is one comprising composited sheets of corrugated fire-resistant paper. Thus, asbestos paper may be slightly moistened with steam and passed between corrugating rollers provided with ridges on one roller that mesh with corresponding troughs in the companion roller. The rollers may be of such type and set so closely together that the clearance in areas in which it is desired to tear the paper is less than the thickness of the paper being corrugated. These areas may be those that are intermediate between the crests and the troughs in the corrugations, whereby the paper is torn in areas that are rearwardly disposed with respect to the forward portions of the corrugated sheeting. Corrugated sheets made as described may be composited with each other, in cross-wise relationship, or with alternating sheets of paper indented and torn as described above. Since the positions of tearing of the paper during corrugation are irregularly spaced, it is obvious that openings corresponding to the tears will be in non-registering relationship in the several composited sheets.

It will be understood that the details that have been given are for the purpose of illustration and not restriction and that many variations therefrom may be made without departing from the spirit and scope of the invention.

What I claim is:

1. A sound absorbing unit comprising in combination a composite of a plurality of spaced sheets provided each with a multiplicity of openings, a facing element of irregular surface, and apertured areas in the facing element extending approximately transversely to the general plane thereof, the openings in the said sheets and in the apertured areas in the facing element being closely spaced, whereby they are adapted to admit incident sound.

2. A structural unit comprising in combination a composite of a plurality of spaced sheets provided each with a multiplicity of openings, a facing element of irregular surface, and apertured areas in the facing element extending transversely to the general plane thereof, the said openings being in non-registering relationship in the several sheets.

3. A structural unit comprising in combination a composite of a plurality of spaced sheets of asbestos paper provided each with a multiplicity of non-registering openings, an asbestos paper facing element of irregular surface, apertured areas in the facing element extending approximately transversely to the general plane thereof, and a stiffening material coated over the said sheets and facing element with preservation of the permeability thereof to sound.

4. A structural unit comprising in combination a composite of a plurality of spaced sheets provided each with a multiplicity of openings, a facing element of irregular surface, and apertured areas in the facing element extending transversely to the general plane thereof.

5. Sound absorbing means comprising a body portion, including composited spaced sheets provided with perforations adapted to admit incident sound and a facing element adhered to the said body portion, the said facing element including laterally adjacent elevated and depressed portions and provided with sound-permeable slits between the said laterally adjacent elevated and depressed portions, the said slits lying in a plane that forms approximately a right angle with the general plane of the facing element.

6. A preformed sound absorbing unit comprising a plurality of composited indented sheets, alternating elevated and depressed portions thereof constituting irregularities of surface and defining, between adjacent sheets, voids limited on all sides and at close intervals by the said irregularities, and intermediate areas extending between the elevated and depressed portions and transversely with respect to the general plane of the elevated portions, the said intermediate areas being provided with openings adapted to admit incident sound.

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