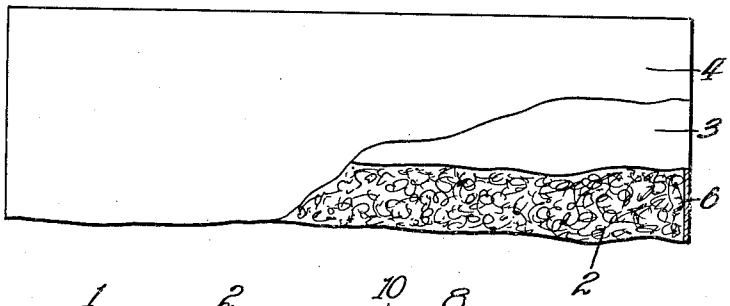
March 17, 1942. R. F. NORRIS 2,276,788

BUILDING CONSTRUCTION

Filed June 27, 1938

Fig. 1



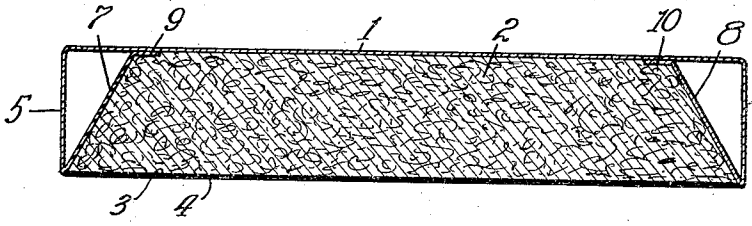


Fig. 2

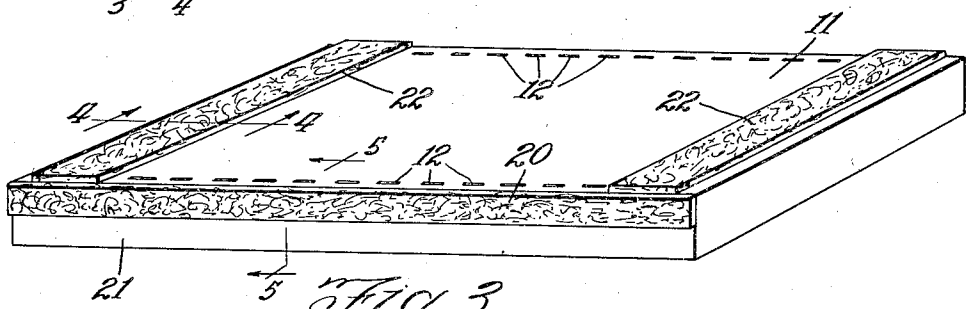


Fig. 3

Fig. 5

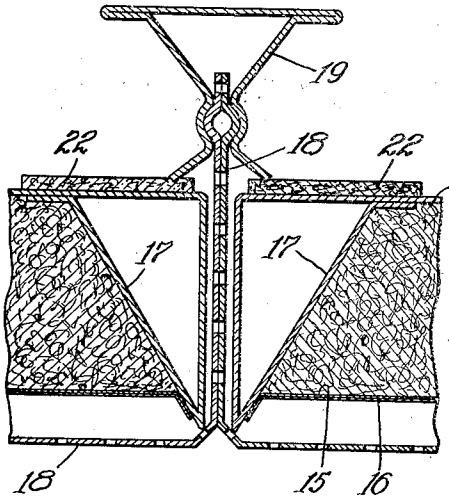
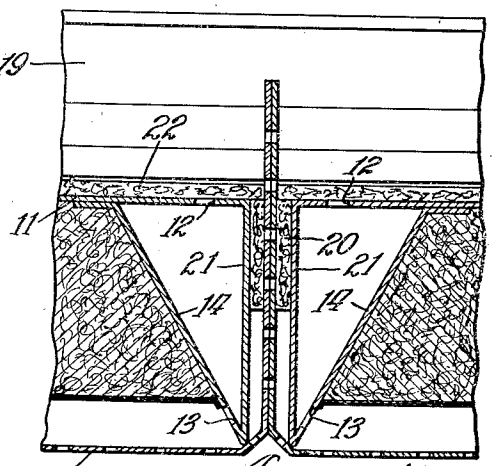


Fig. 4



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Patented Mar. 17, 1942

2,276,788

UNITED STATES PATENT OFFICE

2,276,788

BUILDING CONSTRUCTION

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Application June 27, 1938, Serial No. 215,981

6 Claims. (Cl. 98—40)

This invention relates to sound-absorbing constructions and particularly to a sound-absorbing unit which may be used to line the ceiling of a room whose sound reverberation time or noise level is to be reduced.

The object of this invention is to provide a low cost sound-absorbing unit or panel which has desirable acoustical characteristics in that it will absorb sounds within the ordinary audible frequency range with greater uniformity than is obtainable by means of presently available materials. Further objects include the production of an extremely light and simple construction which may be manufactured with uniformity and which may conveniently be handled and installed without excessive breakage and consequent waste.

A further object is to provide an efficient sound-absorbing unit equipped with air-distributing means whereby the acoustical construction may also be utilized to function as an air distributor for a ventilating system for the room acoustically treated.

The invention consists essentially of a shallow box-like foundation structure of suitable rigid sheet material containing a sound-absorbing medium, said sound-absorbing medium being covered by a double diaphragm which serves as one of the broad sides of the box-like structure in place of the rigid material. A collection of such units is arranged on the ceiling of the room with the double diaphragm exposed to the sound waves to be attenuated. The air-distributing acoustical units are provided with a number of openings adapted to permit predetermined quantities fo air to pass into the room through the partition formed by a collection of these units from the plenum chamber between the wall or ceiling and said partition.

The invention is disclosed in detail in the following description with the aid of the drawing, in which

Fig. 1 is a fragmentary plan view of the sound-absorbing unit;

Fig. 2 is a sectional view of said unit;

Fig. 3 is a perspective view of an air-distributing acoustical unit;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 3 shown with a preferred supporting means; and

Fig. 5 is a sectional view taken on line 5—5 of Fig. 3 and also shown with the preferred supporting means.

The basic unit shown in Figs. 1 and 2 is composed of a box-like foundation 1 of thin, hard cardboard or chipboard substantially filled with a sound-absorbing material 2 and a double diaphragm 3, 4 which serves to close the box-like foundation structure and thus retain sound-absorbing material 2 within it. The foundation structure 1 may conveniently and economically be formed from a unitary sheet of material and bent to form side walls 5 and 6, the marginal zones being incompletely inwardly retroverted to provide bracing members 7 and 8. A rigid structure is then completed by cementing the edges of the sheet material to the broad backing member, as at 9 and 10. Shredded newsprint may be employed as the sound-absorbing material 2, or other well-known materials of this type may be used, such as exfoliated vermiculite, balsam wool, cotton linters or other vegetable fibers. Membranes 3 and 4 are preferably air pervious and should be flexible and capable of mutually independent vibration. Sheet material such as strong, than filter paper or artificially perforated creped or plain kraft paper is suitable for this purpose although a thin, air-impervious material, such as tissue paper, may be used. The membranes forming the double diaphragm 3, 4 are sound transparent whether constructed from the former or the latter class of materials. "Sound transparent" as used herein, is taken to designate the property of a given material to transmit a substantial proportion of sound waves incident upon one surface thereof regardless of whether such transmission takes place by direct passage of the sound waves through apertures therein or by vibration of the material itself.

The diaphragm membranes 3 and 4 may be mounted on the foundation structure after the sound-absorbing material has been arranged in it by cementing or otherwise fastening the edges to the sides thereof. These membranes are in loose contact with each other and are not stretched tautly in mounting but are loosely vibratile. All of the materials from which the unit is made are preferably pretreated in a well-known manner to render them flameproof or fireproof. The optimum thickness of the units from the acoustical standpoint is about 1½ inches. The other dimensions are determined partly by considerations of shipping convenience. Also, they should not be too large in at least one dimension as too great a span would result in excessive sagging of the diaphragm facing. A convenient size is about 12 x 24 inches. The units are very light in weight and may be readily mounted by cementing or otherwise affixing the backing element of the foundation structure

to the surface of the ceiling or the units may be cemented to suitably supported furring strips.

Sound waves impinging upon the exposed diaphragm facing 3, 4 are substantially absorbed by the combined operation of the sound-absorbing material 2 and the double diaphragm 3, 4. The sound-absorbing material within the structure effectively attenuates the sounds in the higher frequency range, these sounds being readily transmitted by the members 3 and 4. The sounds in the lower frequency range are substantially attenuated by the action of the double diaphragm and by the structure as a whole which functions as a resonator for this purpose. The mechanics of the cooperation between the sound-absorbing material and the double diaphragm 3, 4 in attenuating sound waves are not definitely known.

The air-distributing sound-absorbing unit shown in Figs. 3–5 is of fundamentally the same construction as that above described. The foundation structure 11 is provided with a series of openings 12 in the back portion thereof. A second set of openings 13 is provided along the lower edge of bracing members 14 as shown in Fig. 5. The double diaphragm is cemented at its edges to the bracing members 14 and 17 at a point just above openings 13. A passageway through which air may flow is thus provided by openings 12 and 13. When a collection of these units are arranged below the ceiling of a room to be acoustically treated and ventilated in spaced relation thereto and abutting each other in the form of a partition forming a plenum chamber between it and the ceiling into which ventilating air is continuously introduced, the ventilating air is caused to pass through openings 12 and 13 and into the room in quantities determined by the amount of open area provided by the openings. It will be seen that in this way the air may be caused to enter the room over a large area and without drafts. This type of air-distributing arrangement is disclosed in Norris Patent No. 2,172,771, dated September 12, 1939.

A preferred supporting apparatus is shown in Figs. 4 and 5. This apparatus is also disclosed in the above referred to patent application as well as in Norris Patent No. 1,726,500, dated August 27, 1929. A pan or shallow flanged receptacle 18 of perforated sheet metal or equivalent material is provided to receive a sound-absorbing unit and adapted to be supported, in turn, by furring strips 19 as shown. The furring strips may be spaced below the ceiling and supported by suitable stringers not shown. Felt or sponge rubber strips 20 may be provided along sides 21 of the foundation structure 11 to air seal the joint between the sound-absorbing unit and the adjacent flange of pan 18. This arrangement is shown in Fig. 5. Similar strips 22 may be arranged along opposed edges of the broad back surface of foundation structure 11. These strips serve as air seals between the furring strip 19 and the sound-absorbing unit as shown in Fig. 4. A more satisfactory air flow control is obtainable when these air seals are provided since all of the air flowing from the plenum chamber into the room must flow through the openings specially provided therefor.

Obviously, the sound-absorbing unit of Figs. 1 and 2 may be used with the supporting means shown in Figs. 4 and 5. However, it is preferable that the membranes forming the double diaphragm facing for the sound-absorbing material be attached to the foundation structure at approximately the position shown in Figs. 4 and 5 so that the lower diaphragm will be spaced above the exposed surface of the supporting pans. This is desirable from the standpoint of appearance of the assembled structure and also to prevent closing of the perforations in the sheet metal when the latter is painted. When the unit is used as an air distributor as well as an acoustical treatment, the space between the diaphragm facing and the perforated sheet metal permits an expansion of the air entering it through openings 13 and thus permits the ventilating air to enter the room through substantially all of the perforations on this exposed surface of the perforated metal supporting pan. It is thus seen that the perforated metal itself forms a part of the air-distributing apparatus.

The economic advantages of the invention are obvious. The improved acoustical characteristics whereby absorption of sound in the 200–500 cycle range is greatly increased over that obtainable by means of a sound-absorbing material alone are highly desirable. The relatively uniform absorption achieved by the unit throughout the ordinarily troublesome frequency range (256–2048 cycles per second) together with low manufacturing cost make the construction commercially important.

I claim:

1. A sound-absorbing unit of the type described comprising a foundation structure formed from a single piece of self-supporting material, said structure having a broad back surface, relatively narrow sides and means for bracing said sides relatively to said broad back surface, said means comprising bracing members formed by incompletely retroverting the marginal zones of said sheet inwardly and fastening the edges thereof to said back surface, sound-absorbing material disposed within said structure, and a sound-transparent facing diaphragm spanning the area between said sides and enclosing said sound-absorbing material within said structure.

2. A sound-absorbing unit of the type described comprising a foundation structure formed from a single piece of self-supporting material, said structure having a broad back surface, relatively narrow sides, and bracing members formed by incompletely retroverting the marginal zones of said sheet inwardly and fastening the edges thereof to said back surface, sound-absorbing material disposed within said structure and a sound-transparent facing diaphragm spanning the area between said bracing members and enclosing said sound-absorbing material within said structure, said diaphragm joining said bracing members along a line spaced inwardly from said sides of said structure.

3. An air-distributing and sound-absorbing unit comprising a box-like foundation structure formed from a single sheet of material, said structure having a broad back surface, relatively narrow sides, and bracing members, openings in the marginal portion of said back surface establishing communication between the space adjoining the exterior side of said back surface of said structure and the space bounded by the sides, bracing members and said marginal portions of said back surface, openings along the lower edge of at least one of said bracing members, and a sound pervious diaphragm spanning the area between said bracing members above said openings therein, said diaphragm enclosing said sound-absorbing material within said structure.

4. The construction of claim 3 in which said bracing members are formed by incompletely retroverting the marginal zones of said sheet inwardly and fastening the edges thereof to said back surface.

5. In a combined air-distributing and acoustical construction for a room, a perforated sheet metal pan, means for supporting said pan below the ceiling of said room in spaced relation thereto, and an air flow control and sound-absorbing unit disposed within said pan, said unit comprising a box-like foundation structure having a broad back surface and relatively narrow sides, said structure having enclosed ducts interiorly adjacent at least one side thereof, openings in said back surface establishing communication between the space adjoining the exterior side of said back surface and said duct, openings in the wall of said duct opposed to the contiguous side of said structure along the edge thereof remote from said back surface, sound-absorbing material within said structure, a sound-transparent diaphragm spanning the open area of said box-like structure and enclosing said sound-absorbing material therewithin, said diaphragm joining the inner wall of said duct above said openings and being in a plane substantially parallel with said back surface, and air seal means for preventing the flow of air between said unit and the sides of said perforated sheet metal pan, said unit being disposed within said pan with the diaphragm exposed to the interior of said room through the perforations in the sheet metal of said pan.

6. An air-distributing and sound-absorbing unit comprising a box-like foundation structure formed from a single sheet of self-supporting material, said structure having a broad back surface, relatively narrow sides, and bracing members formed by incompletely retroverting the marginal portions of said sheet inwardly and fastening the edges thereof to said back surface, openings in a marginal portion of said back surface establishing communication between the space adjoining the exterior side of said back surface of said structure and the space bounded by the sides, bracing members and said marginal portion of said back surface, sound-absorbing material disposed within said structure, and a sound-transparent facing diaphragm spanning the area between said bracing members and enclosing said sound-absorbing material within said structure, said diaphragm joining said bracing members along a line spaced inwardly from said sides of said structure, said bracing members having openings therein below the line of juncture of said facing diaphragm therewith.

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