Oct. 24, 1933. G. M. THOMSON 1,932,359

SOUND ABSORBING MATERIAL

Filed Nov. 28, 1930

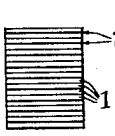


Fig.2.

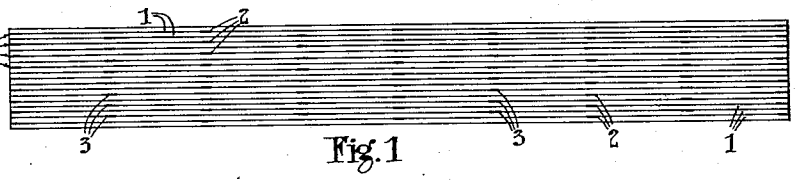


Fig.1



Fig.4.

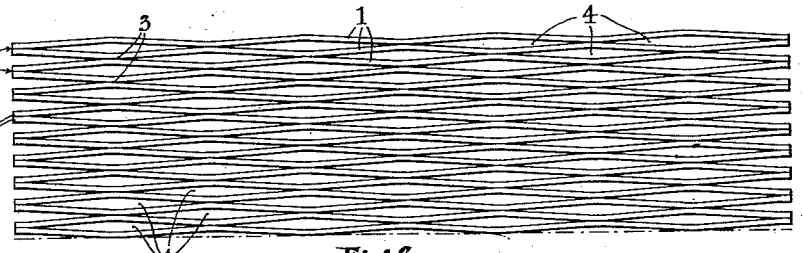


Fig.3.

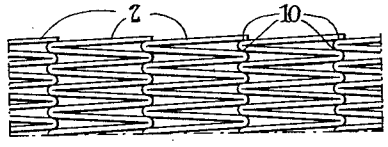


Fig.5.

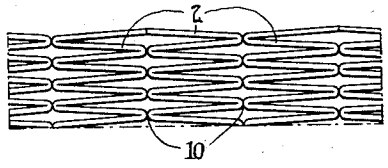


Fig.6.

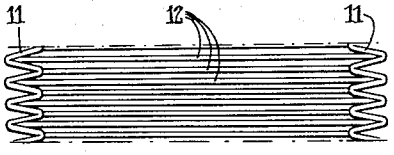


Fig.8.

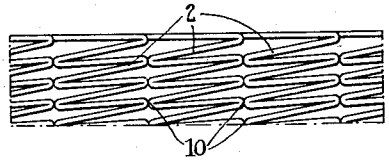


Fig.7.

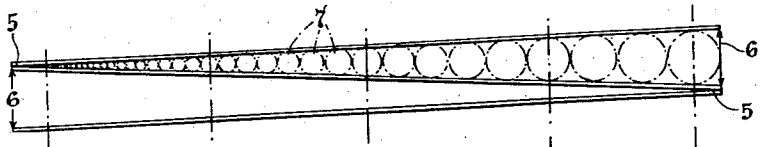


Fig.9.

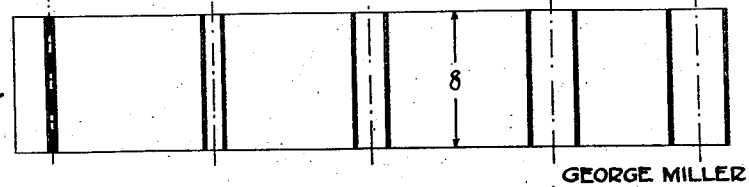


Fig.10.

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UNITED STATES PATENT OFFICE

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SOUND ABSORBING MATERIAL

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Application November 28, 1930
Serial No. 498,896

11 Claims. (Cl. 154—45)

This invention relates to products for absorbing sound for the purpose of improving the acoustical characteristics of enclosed spaces, such as rooms, halls, churches and the like. It is well known that in ordinary rooms sound is reflected from the walls, ceiling and floor, and travels back and forth, suffering a small diminution at each reflection, until it has been completely absorbed, transmitted or converted. Thus a listener may hear not only the initial sound, but various previously propagated reflected sounds, and the latter often confuse the former, so that hearing is rendered difficult.

Various remedies have been proposed including the placing of felt or soft textile materials on the walls or ceiling, or the lining of the surfaces with perforated or grooved boards. Lord Rayleigh in his "Theory of Sound", published in 1896, imagined a wall surface "perforated by a great number of similar narrow channels uniformly distributed, and bounded by surfaces everywhere perpendicular to the face of the wall." The present invention has for its object to provide a sound absorbing material which is broadly based on Lord Rayleigh's proposal, but which embodies a number of related improvements which render the abstract proposal commercially practicable.

As will be described more fully hereinafter, the invention comprises substituting wedge-shaped cells for narrow channels, whereby any predetermined range of frequencies can be absorbed.

The invention also comprises the provision of wedge-shaped cells arranged in staggered relationship so that the narrow end of each cell is disposed adjacent the wide end of the neighbouring cells, whereby the absorption of high and low frequencies is distributed uniformly over the surface of the material. That is to say, the material does not merely absorb low frequencies at one point and high at another, but absorbs both high and low frequency components substantially uniformly.

The invention also comprises making the material in an expansible form, which is a great manufacturing convenience in that it renders possible the production of any desired cell opening from a single stock of material.

The invention consists in the combination and arrangement of parts hereinafter fully described and more particularly pointed out in the appended claims.

Referring now to the accompanying drawing, which illustrates, diagrammatically and by way of example, several embodiments of the invention:

Figure 1 is a plan view of a preferred form of the invention when in collapsed or contracted condition;

Figure 2 is a side elevation of Figure 1;

Figure 3 is a plan view of the same form of the invention when in open or expanded condition;

Figure 4 is a side elevation of Figure 3;

Figures 5, 6, 7 and 8 are fragmentary plan views of modified forms of the invention;

Figure 9 is a diagrammatic plan view of two adjoining cells on an enlarged scale, and

Figure 10 is a diagram indicating several sections of one of the cells shown in Figure 9.

The product shown in Figures 1 to 4 comprises a stack of strips 1 of flexible material preferably of a fibrous nature, such as asbestos paper, which has the additional advantage of being fireproof. Each strip is connected to the one above it at suitably spaced points 2 and to the strip below it at the points 3, the points or lines of connection 2 being staggered with respect to the connections 3, preferably by an amount equal to one half the distance between the connections 2 or 3. The product thus formed can be expanded into the condition shown in Figure 3 to produce staggered rows of cells 4, the walls of which are perpendicular to the outer face of the product. Each cell is of a double wedge shape, that is to say, in transverse cross section it has at all points the shape of an elongated diamond.

Referring now to Figure 9, which shows one half of two adjacent cells, it will be seen that the width of each cell gradually increases from nothing, at 5, to a maximum at 6. Theoretically, this wedge-shaped cell may be regarded as being made up of a series of parallel, adjoining tubes or pipelets, indicated in dotted lines at 7, which gradually increase in diameter from an infinitely small diameter at 5 to a maximum diameter at 6. According to applicant's theory there is a direct relationship between the width of cell, such as 6, and the frequency of the sound wave which the cell will most completely absorb, and also a direct relationship between the depth

8 of the cell and the amplitude or loudness of the sound wave which the cell will most completely absorb. That is to say, the narrower the cell the more effectively will it absorb wave components of high frequency, and the wider the cell the more effective it will be for absorbing wave components of low frequency. Each cell of the improved product thus makes provision for the most effective absorption of a range of frequencies, from the highest to the lowest, including all intermediate frequencies. The depth 8 of the cell may be selected according to the loudest sound which it will ordinarily be required to absorb, and the louder the sound to be absorbed the greater will be the depth of cell required.

Figure 5 shows a possible alternative construction comprising a series of zigzag strips 2, the narrow ends of the bends acting as spacing means for the adjacent strips. The strips are connected at the points 10. This modification has single wedge-shaped cells and is not expansible.

The modifications shown in Figures 6 and 7 both comprise zigzag strips 2 connected at 10 to provide double wedge-shaped cells, and, like the form shown in Figures 1 and 3, are expansible and contractible to vary the range of frequencies which it is desired to absorb.

According to the products above described it will be noticed that the narrower portions of the cells are disposed adjacent the wider portions of neighbouring cells, and thus the absorption of the high, intermediate and low frequencies is distributed as uniformly as possible over the face of the material.

The modification shown in diagram in Figure 8 comprises two zigzag strips 11 which are connected by parallel strips 12 forming parallel cells which are adjustable in width. The ends of the cells are wedge-shaped but the cell walls are parallel for the greater part of their length. This form of the invention might be advantageously employed when the sound wave to be absorbed is mainly or wholly composed of low frequency components.

The invention thus comprises three important novel features, namely (*a*) the provision of a material having cells which vary in width from infinitely small to a maximum, (*b*) the arrangement of the cells whereby absorption of high and low frequencies is evenly distributed over the material, and (*c*) the adjustability of the material whereby it is necessary to make only one stock of material which can be expanded to form cells of the most effective width to suit the range of frequencies to be absorbed.

When the preferred, expansible material is employed it is expanded or opened to the necessary extent to suit the requirements of the enclosure which is to be equipped with it, and the edges of the strips 2 on one side of the material are then preferably mounted by adhesive, plastic or other suitable means on a backing or base indicated at 13 in Figure 4, and all the cells are thus secured at the desired degree of opening. In this way sound absorbing tiles or panels can be readily fabricated to suit the scientifically determined requirements of any particular enclosure, and the actual mounting of the tiles on the walls or ceiling of the enclosure can be effected by relatively unskilled labour. The mounting of the tiles may be effected by nailing, gluing or otherwise. If desired, the expanded material might be mounted directly on the walls or ceiling, without a backing, but this would call for greater skill.

The material is preferably made from strips of asbestos paper which is fireproof, and provides a material having a surface which can be attractively decorated by brushing or suitable decorating material may be applied.

It will be understood that, for purposes of illustration, the opening or width of the expanded cells as shown in the drawing is greatly exaggerated above what would ordinarily be required.

The invention may be employed in many different forms within the scope of the appended claims, the foregoing description and accompanying drawing being given merely by way of example.

It is obvious that mineralized fabric or thin metal may be used instead of asbestos paper or the like.

What I claim is:

1. Sound absorbing material comprising a tile or slab having therein cells which are wedge-shaped in the direction of their length, said cells being open at the front of the slab and of substantially uniform cross section in all planes parallel to the front and rear surfaces of the slab.

2. Sound absorbing material comprising a tile or slab having therein cells which are double-wedge-shaped in the direction of their length, said cells being open at the front of the slab and of substantially uniform cross section in all planes parallel to the front and rear surfaces of the slab.

3. A sound absorbing material having open-ended cells of substantially uniform cross section in all planes parallel to the front and rear surfaces of the material extending perpendicular to the front face of the material and each varying in width from infinitely small to a predetermined maximum.

4. A sound absorbing material having open-ended cells of substantially uniform cross section in all planes parallel to the front and rear surfaces of the material extending perpendicular to the front face of the material and each varying in width from infinitely small at each end to a predetermined maximum intermediate the ends.

5. A sound absorbing material as claimed in claim 4, wherein the predetermined maximum width is midway between the ends of each cell.

6. A sound absorbing material having open-ended cells extending perpendicular to the front face of the material and each varying in width from infinitely small to a predetermined maximum, the narrowest portion of each cell being adjacent the widest portion of the neighbouring cells.

7. A sound absorbing material having rows of uniform open-ended cells extending perpendicular to the front face of the material and each varying in width from infinitely small at each end to a predetermined maximum midway between the ends, each row of cells being staggered with respect to adjacent rows by an amount equal to half the length of a cell.

8. A sound absorbing material comprising a plurality of open-ended cells extending perpendicular to the front face of the material said material being expansible or contractible to vary the volume of said cells.

9. A sound absorbing material comprising a plurality of interconnected strips of flexible, fibrous, non-inflammable material, expanded to form a honeycomb formation of open-ended cells

of predetermined width, and backing means engaging the rear edges of said strips for holding said material in said expanded condition.

10. A sound absorbing tile or panel consisting of a plurality of zigzag strips of asbestos paper connected to one another at the crests or ridges and a backing or base on which the rear edges of said strips are mounted.

11. A sound absorbing material comprising a body having a multiplicity of interfitting cells open at the front face of the body, said body being adapted to expand and contract to vary the width of the opening of the cells to accommodate sound waves of various frequencies, and means for securing said body to maintain a predetermined width in the opening of the cells.

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