PUBLISHED
APRIL 27, 1943.
BY A. P. C.

HANNS-HEINZ WOLFF

SOUND ABSORBING STRUCTURE

Filed Nov. 3, 1941

Serial No.
417,671

4 Sheets-Sheet 1

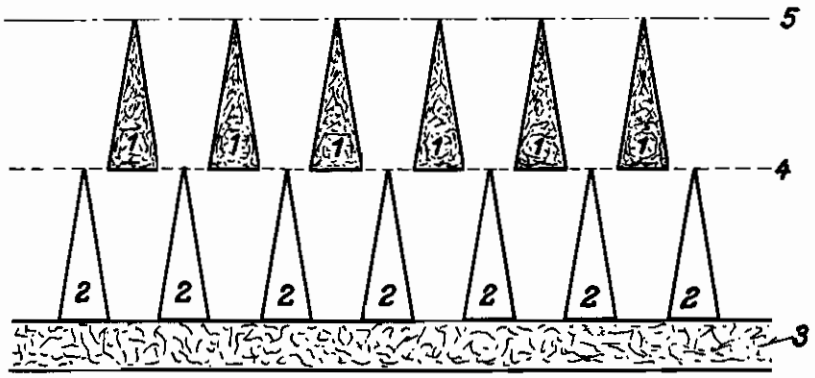

Fig. 1

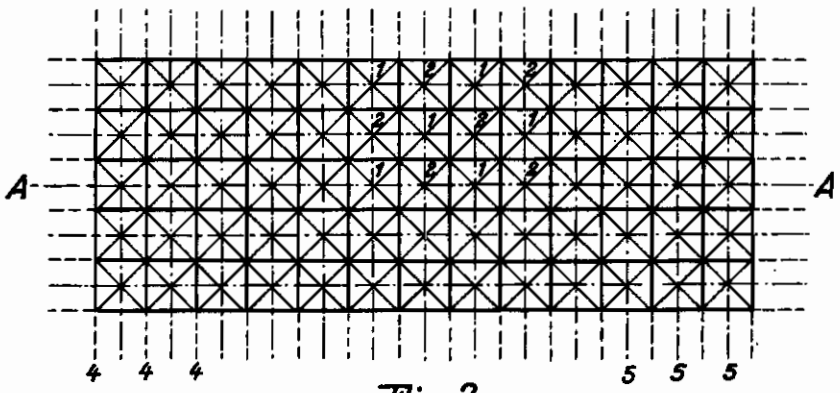

Fig. 2

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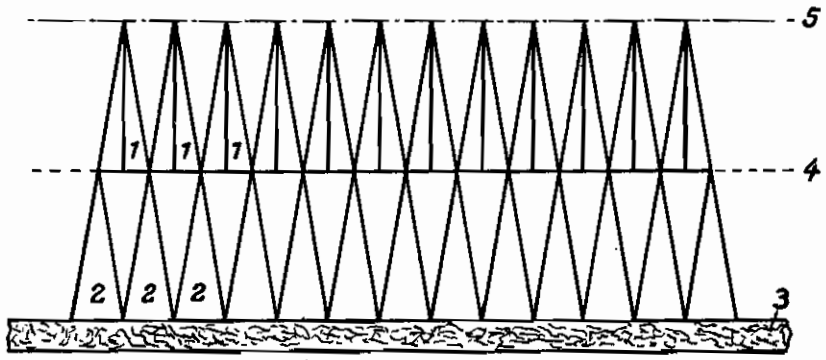

Fig. 3

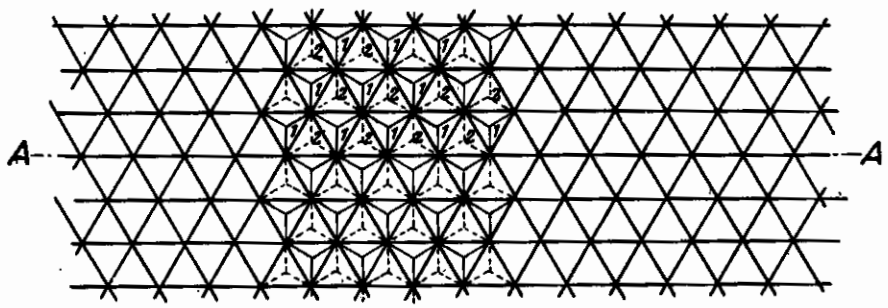

Fig. 4

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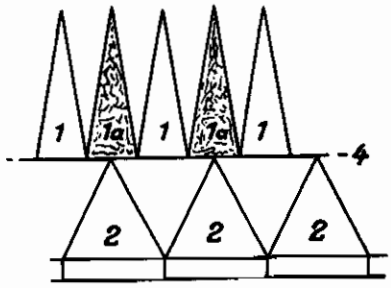

Fig. 5

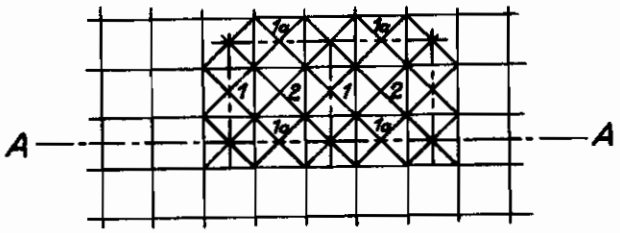

Fig. 6

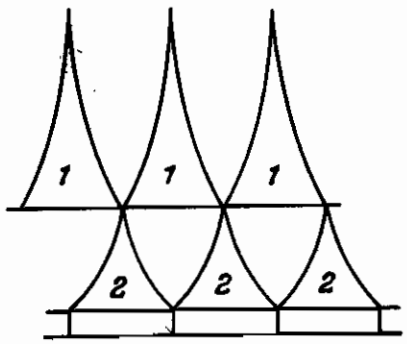

Fig. 7

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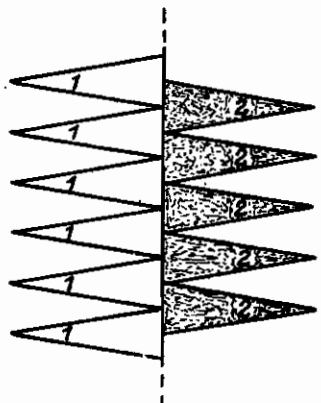

Fig. 8

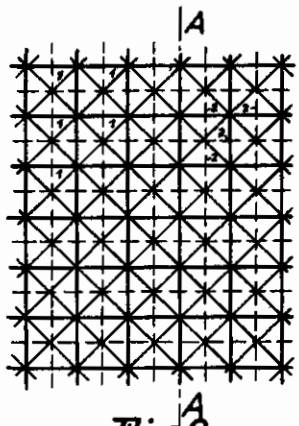

Fig. 9

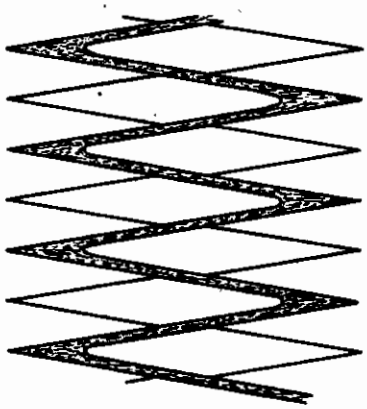

Fig. 10

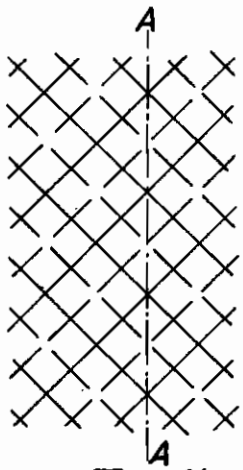

Fig. 11

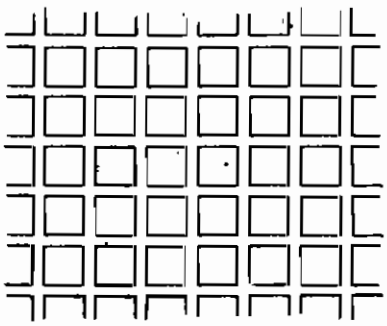

Fig. 12

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ALIEN PROPERTY CUSTODIAN

SOUND ABSORBING STRUCTURE

Hanns-Heinz Wolff, Berlin, Germany; vested in the Alien Property Custodian

Application filed November 3, 1941

The present invention relates to sound absorbing structures applicable to, or usable as, walls of rooms, such as laboratories for acoustic experiments, broadcast- or sound-film studios and the like, and adapted to prevent air oscillations produced within the room or, more generally, at the one side of the structure, from being rebounded thereby, and, preferably, also from penetrating therethrough. The general term "wall", in this connection, is intended to comprise not only the side walls but also the ceiling and the floor of a room.

It has already been proposed to produce highly effective sound absorbing surfaces by composing them of a plurality of bodies made of sound absorbing materials and arranged closely adjacent to one another, the bodies consisting of a prismatic portion, preferably having a quadratic base, and an adjoining pyramadic (or conical) portion. A structure composed of such bodies allows to obtain very high sound absorption coefficients, if the pyramadic portions of the single elements have a sufficiently large absolute height and a sufficiently small side length of the base, the prismatic portions of the single elements being fitted snugly side by side. To quote an example, elements having a base of 12:12 cm., a height of the prismatic portion of 14 cm., and a height of the adjoining pyramidic portion of 60 cm. and more have proved to be particularly suitable.

The total depth of a sound absorbing structure, however, which results in accordance with the above given particulars, is so large that an enormous space is required for the construction of walls, ceilings, and floors, which, in the case of rooms of small or medium size, amounts to more than 50% of the total space.

It is the object of the present invention to improve the sound absorbing properties of a structure of given dimensions, or, in other words, to reduce the space required for a sound absorbing structure having a prescribed absorption coefficient.

According to the invention, at least a part of the outer face of a sound absorbing structure made of sound absorbing material is composed of a plurality of tapering elements, and the elements are arranged in at least two groups, the tops of the elements of each group lying in surfaces substantially parallel but displaced with respect to one another in the direction of the axes of the elements.

In a preferred embodiment of the invention the tapering elements have the shape of pyramids, but it should be kept in mind that cones are to be considered as substantially equivalent to pyramids.

Mostly, the structure will be mounted in such a way that the subdivided part of its surface is arranged opposite to the source of the sound oscillations.

Further, the surfaces defined by the tops of the pyramids will ordinarily be parallel to the surfaces formed by the bases of the pyramids, but the case may be that the bases of pyramids, the tops of which lie in one and the same surface, do not lie all on the same level.

The term "parallel" surfaces, in connection with this invention, should be understood to comprise also, for example, the surfaces of concentric cylinders, and, more generally, all surfaces, the homologous points of which have equal distances from one another.

The invention will be more fully understood with the aid of, and further features of the invention will be apparent from, the following more detailed description and the accompanying drawing. In the drawing, in a purely diagrammatic fashion and by way of example

Figs. 1 and 2 illustrate a fragmentary side view and a corresponding ground plan, respectively, of a sound absorbing structure according to the invention, the view of Fig. 1 being taken from the plane A—A of Fig. 2. According to this embodiment of the invention, the sound absorbing structure is composed of a plurality of equal bodies having square bases, two groups of bodies being arranged one behind the other.

Figs. 3 and 4, in a manner similar to that of Figs. 1 and 2, show a sound absorbing structure composed of bodies having triangular bases.

Figs. 5 and 6 represent a modification of the invention where the size of the bodies belonging to the one group is different from the size of the bodies belonging to the other group, while

Fig. 7 illustrates a modification where the side faces of the pyramidic portions are concave. According to the embodiment of the invention illustrated by

Figs. 8 and 9, two opposite sides of the structure which may be used as a sound separating wall, are composed of pyramidic elements.

Figs. 10 and 11 show a modification of an arrangement substantially according to Figs. 8 and 9, the sound absorbing structure being composed of hollow bodies, while

Fig. 12 represents a frame work for supporting an arrangement preferably according to Figs. 10 and 11.

According to Fig. 1, the sound absorbing struc-

ture is composed of a plurality of elementary bodies of equal size which are made of sound deadening material. The bodies have the shape of pyramids and are arranged in two groups 1 and 2, one behind the other. The elementary bodies of the one group are displaced with respect to the elementary bodies of the other groups in the direction of the axes of the pyramids to such an extent that the plane surface formed by the bases of the pyramids of group 1 substantially coincides with the plane surface defined by the tops of the pyramids of group 2. Further, the groups are so mounted with respect to one another that the sound energy still penetrating through the first group is absorbed by the second, the arrangement being preferably such that the sound energy, which is still reflected by the second group is absorbed by the rear-side of the first.

For this purpose, as may be seen from Figs. 1–4, the first group is so mounted that the single sound absorbing bodies are not arranged closely side by side, but that free spaces are left between them, through which the sound is guided into the second sound absorbing set.

Thus the efficiency of the structure is greatly increased and, of course, the more, the smaller is the angle at the top of the tapering elementary bodies, and the larger is the number of groups or sets.

The reference numeral 1 denotes the sound absorbing bodies of the first group or set, the reference numeral 2 those of the sound group or set, and by 3 is denoted a base layer which preferably is also made of sound absorbing material.

The fastening of the sound absorbing bodies 2 to the base layer 3 does not make any difficulty. Between the sound absorbing bodies 1 and the sound absorbing bodies 2 there is mounted a wire net 4 which, on the one hand, supports the sound guiding bodies 1 and, on the other hand, if suitably designed, may be used for holding the tops of the bodies 2 in their correct position. The tops of the sound absorbing bodies 1 may be fixed, if required, by a wire net 5.

In the arrangement illustrated by Figs. 1 and 2 the sound absorbing bodies have substantially quadratic bases.

The arrangement according to Figs. 3 and 4 is quite similar to that illustrated by Figs. 1 and 2, but is modified insofar as the bases of the pyramids have the shape of (equilateral) triangles. Again, Fig. 3 is a side view taken along the line A—A of Fig. 4, and the same reference numerals are used as in Figs. 1 and 2. The plan of the bodies 2 is represented by dotted lines for better designation.

Of course, it is possible to employ sound absorbing bodies having other forms of bases, though the quadratic, at least the rectangular form, and the triangular form are particularly simple and suitable for the assembly of the structure.

Another modification of the sound absorbing structure according to the invention is obtained when the sound absorbing bodies of the two sound absorbing sets are given unequal heights. Further, it is easily possible to provide a structure in which the two groups of sound absorbing bodies have different angles at the tops of the pyramids.

An arrangement of this type is shown in Fig. 5, the ground plan of which is illustrated by Fig. 6. This structure is distinguished by a particularly small sound reverberation, because the shape and arrangement of the sound absorbing bodies of the two groups is adapted to produce a guiding of the sound energy within the absorbing wall, which is similar to the sound guiding produced by sound absorbing bodies, the side faces of which are concave.

A structure of the last mentioned kind making use of pyramids with concave side surfaces is illustrated by Fig. 7. The sound absorbing bodies may be arranged as shown in Figs. 1 and 2. Also by this modification a further, though relatively little improvement of the sound absorbing properties of the structure is obtained.

Sound separating walls, for example such as required between different sound-film studios, are suitably constructed as illustrated by Figs. 8 and 9. Fig. 8 is a section along line A—A of Fig. 9. The pyramids of the two groups of sound absorbing bodies are turned away from one another. Each group of sound absorbing bodies may again be subdivided into several sets which are arranged one behind the other, and, preferably, are displaced with respect to one another. Ordinarily, however, it will be useless to provide more than two or three sets.

The height of the cones or pyramids, in all cases, depends on the required sound absorption coefficient and may be reduced, if the demands are not too high.

A separating wall as represented by Figs. 10 and 11 is particularly advantageous. The arrangement is a modification of the embodiment shown in Figs. 8 and 9, the solid cones or pyramids being replaced by hollow bodies. Evidently, the effective height of the pyramids of the one group is increased by the cavities of the pyramids of the other group, the inner surfaces of the latter being, in a sense, a prolongation or continuation of the external surfaces of the former. The hollows are suitably given a parabolic outline.

In the just mentioned case a plurality of bodies of each group may be designed to form an integral portion. Similarly, in the above described cases, a certain number of pyramids or cones, preferably of the same group, may be united to form structural units. The whole sound absorbing structure is then obtained by joining a sufficient number of such portions or units.

In many cases, especially for constructing a sound absorbing wall according to Figs. 10 and 11, it will be convenient to make use of a framework, substantially as illustrated by Fig. 12, to which the single (hollow) cones or pyramids are fixed, for example by sewing. Also the above mentioned portions or units may be fastened to a framework.

The sound absorbing bodies preferably consist of fire-proof material, such as glass- or slag-wool, or of other fire-proofed felt- or wadding-like substances. In order to facilitate the forming and mounting, the sound absorbing bodies may be covered with or enveloped in a suitable, for example woven, material.

The sound absorbing bodies are fastened to the ceiling of a room preferably by hanging them up by wires. Distortions of the bodies may be prevented by a net of threads consisting, for example, of silk.

The above described sound absorbing structures may be used for all purposes where it is desired to obviate rebound or escape of sound.

HANNS-HEINZ WOLFF.