Aug. 27, 1929. R. F. NORRIS 1,726,500

SOUND DEADENING CONSTRUCTION

Filed Feb. 25, 1929 2 Sheets-Sheet 1

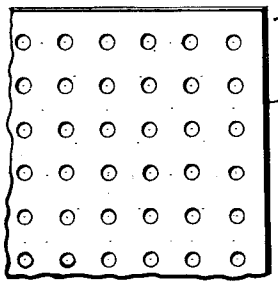


Fig. 1

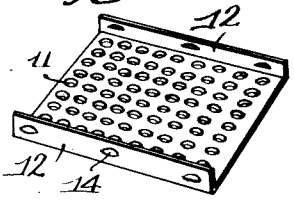


Fig. 2

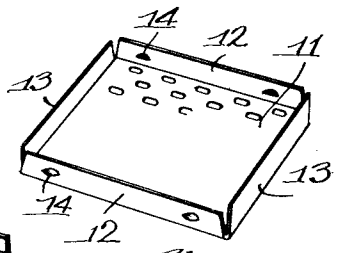


Fig. 3

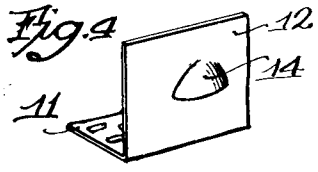


Fig. 4

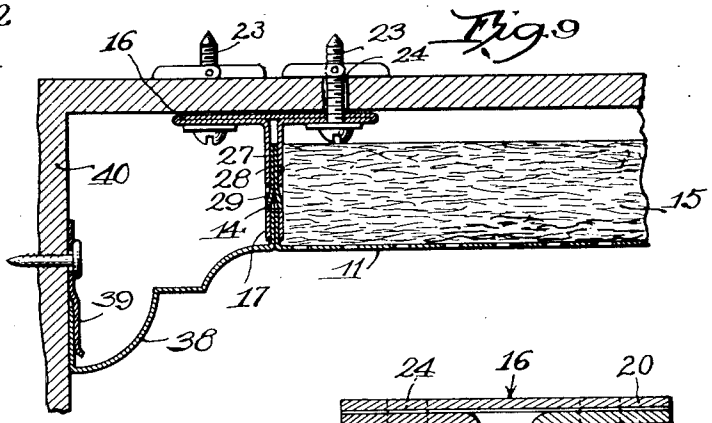


Fig. 9

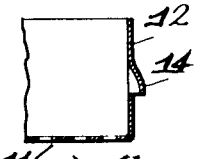


Fig. 5

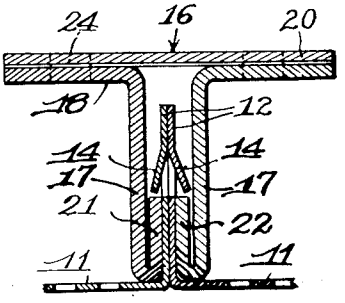


Fig. 8

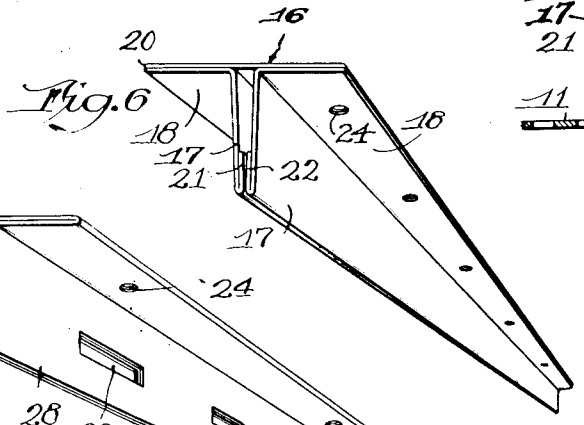


Fig. 6

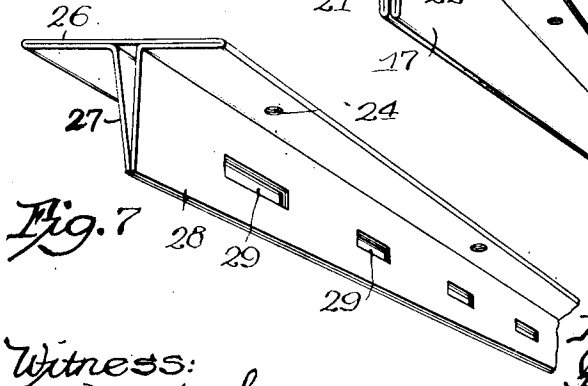


Fig. 7

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SOUND DEADENING CONSTRUCTION

Filed Feb. 25, 1929 2 Sheets-Sheet 2

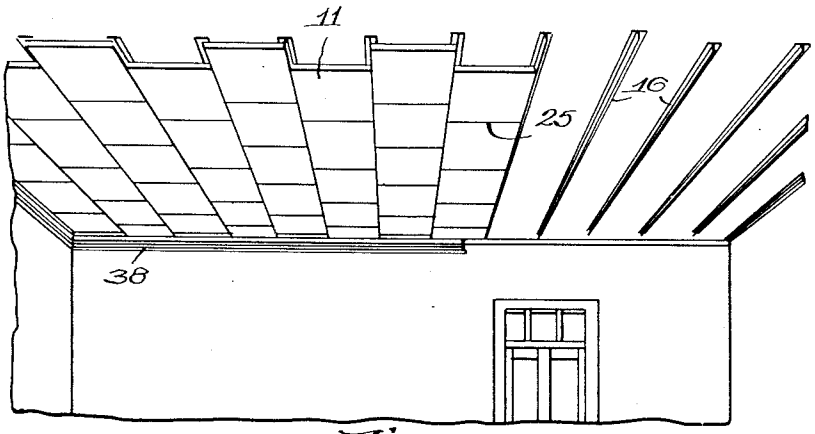
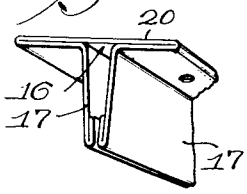


Fig. 10

Fig. 11



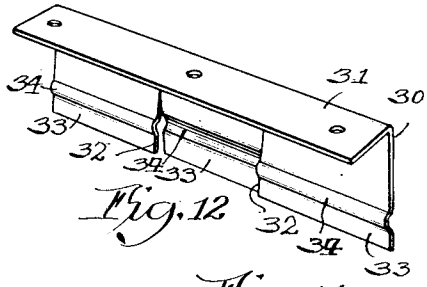


Fig. 12

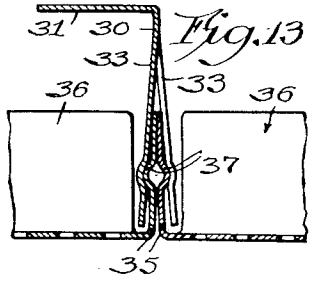
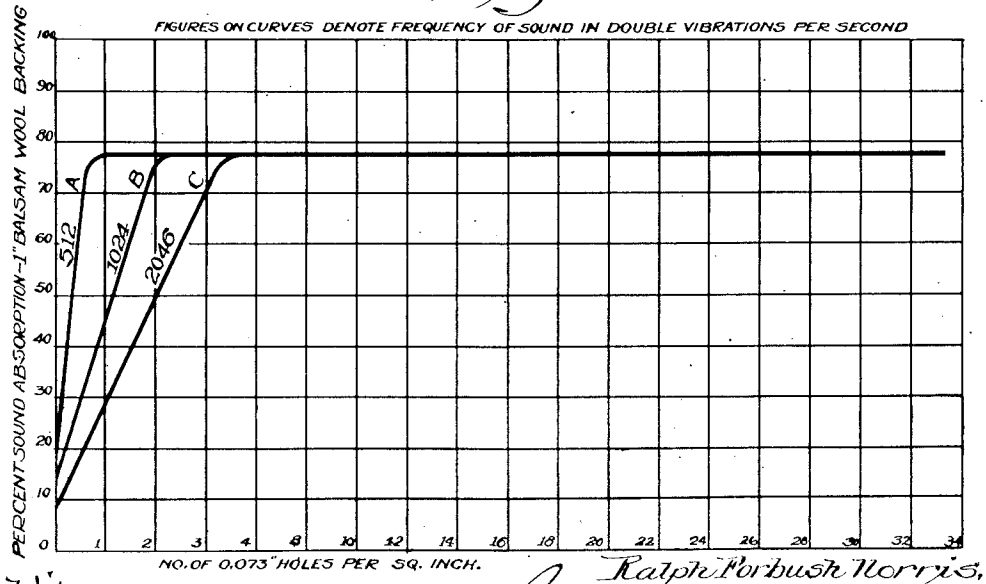


Fig. 13

Fig. 14



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Patented Aug. 27, 1929. 1,726,500

UNITED STATES PATENT OFFICE.

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SOUND-DEADENING CONSTRUCTION.

Application filed February 25, 1929, Serial No. 342,337, and in Germany December 28, 1928.

My invention relates to improvements in sound deadening construction and embodies the use of foraminous or perforated metal sheets or other suitable foraminous rigid sheet material for facing sound-absorbing materials especially used in building construction. The invention also has reference to the construction used in mounting the sound absorber and perforated sheet.

One object of the invention is to provide a sound-absorbing installation which combines the high efficiency of the most effective types of loosely fabricated porous materials with the mechanical and decorative advantages of hard, stiff material, such as sheet metal, as a means of concealing the sound-absorbing material or as a means for supporting it as well.

In carrying out my invention, I employ a stiff perforated sheet metal plate, for example, having perforations therein of such size, number per square inch, and arrangement, as to bear a definite relation to the length and character of the average of the sound waves passing through it in a particular installation, whereby the use of a metal covering does not necessarily decrease the efficiency of the sound-absorbing material behind it, but provides a composite structure of unexpected utility and effectiveness.

A contributory object is to provide a facing for sound-absorbing materials which is durable, gives unlimited service, is easy to clean, decorate and redecorate or paint any number of times without interfering with its efficiency, is good looking, reflects light well, has a reasonable first cost with a minimum of upkeep, is fireproof, and is verminproof. It is a further object of my invention to provide a construction which may be removed and reinstalled in different locations, with the wasting or destroying of only a small amount of material. Other objects will become apparent in the following specification and appended drawings in which:

Fig. 1 is a perspective view of a rigid non-sound-absorbing perforated sheet used for facing sound absorbing material;

Fig. 2 illustrates in perspective one type of perforated sheet metal shaped to form a tile;

Fig. 3 is a modified form of sheet metal tile;

Figs. 4 and 5 are side and end views respectively showing the ears on the upturned portions on the edges of the metal tile of Figs. 2 and 3, by means of which the tile are removably attached to the supporting members;

Fig. 6 shows one type of T shaped furring member employed in supporting metal tile of Figs. 2 and 3;

Fig. 7 is a modification of the furring member;

Fig. 8 is a sectional view showing the metal tile in position on the T iron furring member;

Fig. 9 is a broken vertical sectional view of an installation showing the details of the metal tile and sound-absorbing material and the method of fastening the same to a ceiling or wall;

Fig. 10 illustrates a partially completed ceiling finished with my metal acoustical tile.

Fig. 11 illustrates a furring strip similar to that shown in Fig. 6, but having the legs integral with the back member.

Fig. 12 is a perspective view of a further modification.

Fig. 13 is an end view thereof; and

Fig. 14 is a curve illustrating certain tests.

Many buildings are found to have poor acoustics after being constructed, and other buildings and rooms, such as offices, are found to need acoustical correction or to have sound-deadening material installed because of the noises resulting from various sources such as typewriters, adding machines, and various other mechanical devices, and in restaurants, for example, the rattle of dishes is objectionable. It becomes necessary, therefore, to apply sound-absorbing material to the walls and ceilings of auditoriums and other rooms after a building is constructed. The walls and ceilings of buildings may also be treated acoustically during the initial construction. These installations have to be sightly and at the present time the most common method of treating finished surfaces is to install sound-absorbing felts or other acoustical materials and then to stretch over this material a sound-absorbing and transmitting fabric membrane which is either porous or has holes in it and which conceals the felt. This construction can be made to give a good appearance. The practice has certain inherent disadvantages, however. Many fabrics are "dirt catchers" and it is impracticable to wash them after installation. If the porous membrane is painted, it loses a portion or all of its porosity and sound-transmitting and absorbing properties and

the absorption of the membrane is materially reduced. Also punched fabric membranes are usually highly flammable and have a tendency to sag between adjacent supports and are affected to some extent by the humidity of the atmosphere. It has always been considered necessary to use a membrane which in itself had some sound-absorbing properties and therefore fabric membranes have been used since they also transmit the sound to the sound-absorbing backing material.

Another method of treating walls and ceilings has been tried which consists in fastening tiles or boards of fibrous material to the wall or ceiling surfaces. In one modification of this treatment closely spaced holes are bored in the material. The sound is absorbed largely in the holes. Unfortunately, this material, due to its hard board-like form, is not as absorptive as the acoustic felts and catches dust.

Acoustical plasters and acoustical ceramic tiles are also used, especially in new buildings, but have the disadvantages that their acoustical efficiency is low, their surface is necessarily rough and therefore they are "dirt catchers", and their efficiency is greatly reduced by painting.

I have been able by the present invention to overcome the difficulties encountered in the use of the fibrous products and fabric membranes previously used by employing a perforated rigid sheet membrane, such as a sheet metal membrane, which in itself does not absorb sound or only slightly at most but which is within the scope of the term "non-sound-absorbing" and is located between the source of sound and the sound absorbing material. Vulcanized fibre sheets, bakelized sheets, veneered wood sheets, and the like may be used instead of metal. Such a rigid perforated membrane 10 as shown in Fig. 1, provides a durable surface which may be washed and painted, may be fire proof and has many other advantages. It gives excellent acoustical results when used as a so-called facing material or screen for concealing suitable sound absorbers such as balsam-wool, hairfelt, porous ceramic products and similar materials, most of which are unsightly. The perforated rigid membrane 10 of Fig. 1 presents installation difficulties if a continuous surface devoid of screw heads and the like is required. Although I prefer a rigid membrane which is non-sound-absorbing, under certain conditions it may be possible to use a flexible non-sound-absorbing membrane.

I have discovered, however, an efficient method for installing such rigid perforated sheet material, especially when made of metal, at a minimum of expense so that the fastening means will not be visible. Furthermore, I have discovered how to install a metal sheet in the form of tile in such a manner that it may be readily removed to a different location with the wasting or destroying of only a small amount of material.

I prefer using a thin sheet metal membrane which may be composed of galvanized iron, tin or terne plate, ordinary black iron or stiff steel sheets. Other metals such as aluminum or duralumin sheets may be used for special locations. These sheets may be perforated in any suitable manner. The perforations may, for example, cover from 0.4% to 35% of the area of the metal or other rigid sheet although I do not limit myself to this range, and excellent results are obtained with a sheet in which about 16% of the surface is perforated. The perforating must be done with due regard to the size of perforation and also to the spacing between perforations.

The lower limit of size of the perforation usually is determined not by sound absorption considerations but by the difficulties resulting from the bridging over and closing of the perforation when the surface is painted. A round perforation 0.073 inches in diameter or any other shaped perforation having that minimum dimension is about the smallest that may be readily painted or enameled without plugging. The maximum size of a perforation is dependent upon the appearance of the tile and the tendency of the sound-absorbing material to project through it and be visible to the eye. I favor a hole less than .125 inches for its minimum dimension where elongated holes are employed. A round hole 0.125 inches in diameter has an area of .0123 square inches. Holes smaller or larger than the dimensions given may be used.

I have found that the spacing of the holes should be determined by the pitch of the sound which is absorbed. The lower the pitch of the sound, that is, the smaller the number of double vibrations per second and the longer the wave length, the greater may be the distance between the holes to secure the same absorption. Fig. 14 shows graphically the results of experiments on the spacing of the holes. The sound absorption of panels of perforated metal having a 1-inch balsam-wool backing was measured, this material when used without a facing having a sound absorption of about 74%. The number per square inch of round holes 0.073 inches in diameter was varied and the sound pitch varied. It will be noted that an unperforated metal diaphragm backed with balsam-wool absorbs from 10% to 18% of sound. The proportion of sound of 512 double vibrations per second, an average sound, which is absorbed, curve A, rises from about 18% with no perforations to 78% with 1 perforation per square inch. One .073 inch diameter hole per square inch is equivalent to about 0.0042 square inches or about 0.4% of the area. If the holes are evenly spaced over the entire

panel they are 1 inch apart at their centers. It will be noted that the sound absorption of the balsam-wool is actually increased by the perforated metal diaphragm. The curve further shows that any increase in the number of holes over 1 per square inch practically does not increase the sound-absorption of the sound absorber.

When the pitch of the sound is increased so that there are 1024 double vibrations per second about 13% of sound is absorbed (curve B) with an unperforated sheet metal having a 1 inch balsam-wool backing. The maximum absorption of about 78% is reached with about 2 holes per square inch. The holes are about 0.706 inches apart on centers with this spacing. At 2046 double vibrations the maximum absorption is reached at about 4 holes per square inch (curve C), these holes being ½ inch apart on centers. Unfortunately, the noises which are most distressing to the human being are the high pitched noises, some of which may have a frequency of as high as 10,000 double vibrations per second above which the sound is not audible to the human ear. Noises from typewriters, adding machines, dishes and the like are high pitched (about 4,000 double vibrations per second). The curve of Fig. 14 indicates that the number of holes per square inch must be increased beyond 4 per square inch if the high-pitched noises are to be absorbed. I have determined that a sound absorber backed perforated sheet metal with 16 holes per square inch, ¼ inch apart on centers gives maximum results for that absorber for most conditions, absorbing both the low and most high-pitched sounds. This spacing is for holes .073 inch in diameter. With this diameter the holes are on an average of .177 inch apart, measuring between nearest edges of holes. With holes of larger diameter or different shape the spacing may be changed so that the distance between the edges of the holes is approximately the same since the distance between the holes apparently is the determining factor. It is desirable to have the number of holes less than 16 per square inch as the cost of fabrication is smaller the fewer the holes, the metal tiles are stiffer and stronger, and the light reflection of the surface is increased. For special conditions where a low pitch sound is to be absorbed (under 512 double vibrations per second) it is possible to use a perforated metal containing less than 1 hole per square inch.

In situations where vibrations in the structure or other conditions may cause disintegration of the sound absorber, thereby causing particles of the absorber to fall through the perforations to the discomfort of the occupants of the room; or where it is desirable to use a loosely packed fibrous or granular substance as a sound absorber; or where it is desirable to increase the light reflection, I have found it advisable to lay or glue a sheet of porous, fibrous, or other absorbent material such as soft filter paper over the inside surface of the perforated metal sheet. This does not materially decrease the efficiency of the sound absorption. A stiff facing sheet such as sheet metal has several advantages over a fabric membrane. The rigidity of such a facing allows smaller perforations to be used and allows the closer spacing of the holes.

The fibers and threads of a fabric membrane must be continuous to have strength and prevent the fabric membrane from distorting and finally rupturing. Larger holes do not lend themselves to decorative possibilities as well as the smaller holes and also allow paint to enter and the sound absorber to show. A perforated sheet metal membrane may also be embossed with pleasing designs. In addition a rigid facing sheet provides a substantially flat surface as compared with the uneven surface which results from sagging fabric membranes. A metal membrane is fireproof and therefore is decidedly advantageous.

In the preferred type of construction shown in Figs. 2–10 inclusive the sheets or tile 11 of perforated metal have their lateral edges 12 preferably turned at right angles to a depth of about 1″. The two edges 12 of Fig. 2, may be turned leaving the ends open, or all four edges 12, 12 and 13, 13 of Fig. 3, may be turned forming a tray-like member. I prefer using the construction of Fig. 3 as the edges are stiffened thereby. The tile are preferably made about 24″ wide and about 24″ long to give a uniform appearance to the ceiling or wall although other sizes may be employed where desired. The turned edges 12, 12 and 13, 13 of the tile 11 are locked into steel furring strips as will be explained hereinafter.

At least two of the turned edges of the perforated metal tile 11 have projecting ears 14 struck up from the metal to rest on a ledge in the furring strip, as hereinafter explained. The sound-absorbing material 15 is located between the perforated metal tile and the wall or ceiling to absorb any sounds passing through the perforations. In some cases said sound-absorbing material need not cover all the holes in the metal, i. e., its area may be smaller than the area of the tile, thus enabling the rear surface of said material and the structure to which the tile is fastened, to absorb some of the sound. Also by leaving a burr or rim around the holes said sound absorbing material may be spaced from the metal.

The furring strips are T shaped in cross section, as shown in Figs. 6 and 7. In Fig. 6 the furring strip 16 is a T shaped composite fabricated metal strip formed of two L shaped sections 17 placed back to back and spaced slightly apart at their bases 18, the

latter being welded to the backing strip 20. The ends 21 and 22 of the projecting legs of the L sections 17 are turned inwardly and doubled on the vertical legs so that a double ledge is formed on the inside of the legs. The doubled portions press together with spring pressure along the contacting portions. The furring strip may be fabricated in other ways well known to those skilled in the art and may be formed in one piece if desired, as shown in Fig. 11.

The furring strips 16 are fastened to the ceiling, as shown in Fig. 9, by means of toggle bolts 23 passing through holes 24, or by other means. To complete the ceiling facing, the perforated metal trays of Figs. 2 or 3 are slipped between the vertical portions 17 of the furring strip. The turned edges are pressed upward until the projecting ears 14 snap over the ledges as clearly shown in Fig. 8. Since there is a spring pressure between the doubled portions 21 and 22, the ears 14 are engaged by the edges of said portions and prevent the tile members 11 from slipping out vertically from between the projecting legs of the furring strip. The tiles may be slipped back and forth on the furring strips so that abutting tiles may be firmly pressed against each other to make a tight joint as at 25 of Fig. 10. After the perforated sheet metal tiles 11 have been put in place the sound-absorbent material may be positioned between the tile and the ceiling or wall, the tile serving as a perforated screen to conceal the sound absorbing material and constituting its sole support, in the case of a ceiling treatment, though this positioning may be done before the tiles are snapped into the furring strips. Also the sound absorbing material may be secured to the ceiling or wall, independently of the tiles, if desired, although such arrangement is less convenient and more expensive.

To dismantle an acoustical metal ceiling constructed with my improved perforated metal tile as above described, it is only necessary to destroy one tile, after which all of the tiles may be removed by merely springing open the projecting legs of the T shaped furring strips with any suitable tool.

In the modification of the furring strips 26 shown in Fig. 7, the legs 27 and 28 are not doubled as in Fig. 6 but holes 29 are cut at predetermined positions in the projecting legs which also press against each other with a spring pressure as in the above described embodiment of this invention. In the construction, the ears 14 snap into the opening 29 and are engaged by the lower ledges formed thereby. The perforated metal tiles 11 are therefore held in the same manner as in Fig. 6. Other variations which may be used will be apparent to those skilled in the art. The described construction may also be used in new buildings by fastening the furring strips to the joist, studding, or similar members in other types of construction.

In Figs. 12 and 13 is illustrated a somewhat different type of furring strip which comprises a member 30 having a flange 31 by means of which the strip can be secured to a wall or ceiling. The other flange of the member 30 has spaced slits 32 which form a number of legs 33, each of which is provided with a rib or bead 34, the said ribs or beads of alternate legs extending in opposite directions. The alternate legs are bent slightly into different planes as shown clearly in Fig. 13 to accommodate the flanges 35 of the perforated tiles 36, said flanges having inwardly directed ribs or beads 37 which are engageable by the beads 34 of the legs 33 of the furring strips, for supporting the tiles.

The corners of the room may be finished with suitable molding 38 fastened as by means of a mold clip 39 or other means through the plaster 40 as shown in Fig. 9.

In the finished construction the sound-absorbing material is disposed between the perforated sheet metal tile 11 and a wall or ceiling surface and thus prevents the reflection of sound which otherwise would occur, the perforated sheet metal being between the source of sound and the sound absorbing material and in that sense constituting a facing therefor. I define "wall or ceiling surface" as any wall or ceiling construction with or without lath and plaster or other surfacing material.

The perforated sheet metal may be decorated in any desired manner and is preferably treated by baking an enamel onto it prior to assembling in the ceiling or wall section. Various designs may be used. Such a ceiling may be washed and repainted at any time and without interfering with the acoustical efficiency.

If rigid or stiff sheet material other than sheet metal is used and is of such a nature that it cannot be bent or turned, the flat perforated sheets may be screwed, nailed, bolted or otherwise fastened to the joists, studding, beams, furring strips, or other supporting means and the sound-absorbent positioned behind it. This method of supporting the facing may also be used with perforated sheet metal but the installation does not present as pleasing an appearance as the metal tile since the fastening means will be visible. Rigid sheets with molded turned edges may also be used. Other methods of fastening such rigid perforated sheets will be apparent to those skilled in the art.

The perforated facing need not be flat, but may have any desired curvature either by bending or stamping, as in the case of metal, or by molding, as in the cast of certain other materials. Various other changes may be made, as will be apparent. The construction

described is adapted for use in aeroplane cabins to reduce the noise. Numerous other uses are contemplated.

The balsam-wool referred to herein as an efficient sound-absorbing material, is felted wood fibre.

This application is a continuation, in part, of my co-pending application 212,265, filed August 11, 1927, which earlier application has been abandoned.

What I claim is:

1. In the combination of sound-absorbing material and a facing therefor, a thin sheet of perforated metal forming such facing, the ratio of the unperforated area of said sheet to the openings therein being such as to expose an apparently substantially continuous surface to the sound waves.

2. In the combination of sound-absorbing material and a facing therefor, a thin sheet of perforated metal forming such facing, the perforations being substantially uniformly distributed over the area of said sheet and the average dimensions of the individual openings being less than the distance between the edges thereof.

3. In the combination of sound-absorbing material of high efficiency and means for confining and concealing the same, a thin layer of self-sustaining, non sound-absorbing perforated material constituting such means, the openings therein being widely distributed over the area exposed to the sound waves and small enough to substantially conceal the sound-absorbing material.

4. In the combination of sound-absorbing material of high efficiency and means for confining and concealing the same, a thin layer of self-sustaining, non-sound-absorbing perforated material constituting such means, the openings therein being widely distributed over the area exposed to the sound waves and the aggregate area of said openings totaling not more than about 16% of said first area.

5. Sound-absorbing means comprising, in combination, sound-absorbing material and a thin, stiff member contiguous thereto with a plurality of openings therein, the ratio of openings to the area of said member being such as to expose an apparently substantially continuous surface to the sound waves.

6. A sound-absorbing structure comprising sound-absorbing material and a thin, self-sustaining material concealing the same with a multiplicity of small openings therethrough of average dimensions greater than the thickness of said self-sustaining material.

7. A sound-absorbing structure comprising sound-absorbing material and a thin, self-sustaining material concealing the same with a multiplicity of small openings therethrough of average dimensions greater than the thickness of said self-sustaining material and spaced from each other a distance in excess of said average dimensions.

8. Sound-absorbing means comprising, in combination, thick porous material having high capacity for sound absorption, and a thin, dense, perforated material having less sound-absorbing capacity, the spacing of the openings in said perforated material, as specified herein, bearing such relation to the length of the sound waves passing therethrough as to provide a combined sound-absorbing efficiency as great as that of said high capacity sound-absorbing material.

9. The combination with a sound-absorbing material, of a thin, sheet metal facing therefor having a multiplicity of small openings therein and supported at its margins, said openings having dimensions several times the thickness of said sheet metal and spaced between edges a distance in excess of said dimensions.

10. The combination with sound-absorbing material having an efficiency in excess of 70%, of thin, dense, foraminous material having an efficiency less than 25%, forming a facing therefor, the openings in said dense material being spaced, as specified herein, to permit the transmission of sound waves in such manner as to result in an efficiency in the combined materials in excess of that of said sound-absorbing material.

11. Means for deadening sounds reflected from a hard surface, comprising a layer of sound-absorbing material between the source of sound and said hard surface, and perforated sheet metal adjacent said sound-absorbing material between it and said sound source, the openings in said sheet metal being substantially uniformly distributed over its surface and having a total area less than the unperforated area of said metal.

12. Sound-absorbing means as in claim 5, in which the area of the individual openings averages from .004 to .0123 square inches.

13. Sound-absorbing means as in claim 5, in which said openings have a minimum dimension less than .125 inch and are spaced at least about 0.177 inch apart at their minimum distance.

14. A sound absorbing structure as in claim 6, in which the openings cover about .4% to 35% of the total area.

15. A sound absorbing structure as in claim 6, with the addition of an absorbent sheet between said sound absorbing material and said self-sustaining material to prevent particles from passing through said openings.

16. As an article of manufacture, a sheet metal pan having a multiplicity of small perforations therein, of average dimensions greater than the thickness of said sheet metal, and a pad of sound-absorbing material fitting the same, the edges of said pan having means adapted for engagement with a support.

17. As an article of manufacture, a sheet metal pan having a multiplicity of small perforations therein of average dimensions greater than the thickness of said sheet metal, and sound-absorbing material within the same, the edges of said pan having means adapted for engagement with a support.

18. In a building structure, the combination with a wall or ceiling surface of a room, of an exposed perforated metal sheet having angularly disposed edges, some of said edges having projections, a sound-absorbing material between said perforated sheet metal and said wall or ceiling surface, means for supporting said sheet metal in spaced relation and adjacent to said surface, said supporting means comprising parallel furring strips, each of said furring strips comprising two members spaced slightly apart with means thereon on which said projections are adapted to rest.

19. In a building structure, the combination with a wall or ceiling surface of a room of an exposed perforated metal sheet having angularly disposed edges, sound-absorbing material between said perforated sheet and said wall or ceiling surface for absorbing sound within the room, means for supporting said sheet in spaced relation and adjacent said surface, said supporting means comprising parallel furring strips of composite fabricated sheet metal each formed of two L shaped sections placed back to back and spaced slightly apart at their bases, a backing strip to which said sections are welded, the free edge of each leg of said L sections being turned inwardly to form a double portion which presses against the other double portion with a spring pressure and being adapted to engage an angular edge of the sheet.

20. In a building structure, the combination with a wall or ceiling surface of a room, of an exposed perforated metal sheet having angularly disposed edges, sound-absorbing material between said perforated sheet metal and said wall or ceiling surface for absorbing sound within the room, means for supporting said sheet metal in spaced relation and adjacent to said surface, said supporting means comprising parallel furring strips of composite fabricated sheet metal T shaped in cross section, each strip being formed of two L shaped sections placed back to back and spaced slightly apart at their bases, a backing strip to which said two L sections are fastened, the ends of the projecting legs of said L sections pressing together with spring pressure at the contacting portions, and means on said projecting legs for engaging said angular edges for holding said perforated sheet in position.

21. In a building structure, the combination with a wall or ceiling surface of a room, of an exposed perforated metal sheet having angularly disposed edges, a sound-absorbing material between said perforated sheet and said wall or ceiling surface whereby sound within said room is absorbed, means for supporting said sheet in spaced relation and adjacent said surface, said supporting means comprising parallel furring strips of composite fabricated sheet metal T shaped in cross section, each strip being formed of two L shaped sections placed back to back and spaced slightly apart at their bases, and means on the projecting legs of said L sections for holding said perforated sheet in position.

22. In a building structure, the combination with a wall or ceiling surface of a room, of an exposed perforated metal sheet having angularly disposed edges, sound-absorbing material between said perforated sheet and said wall or ceiling surface whereby sound within said room is absorbed, means for engaging said edges to support said sheet in spaced relation and adjacent said surface, said supporting means comprising parallel furring strips of sheet metal T shaped in cross section.

23. In a building structure, the combination with a wall or ceiling surface of a room, of an exposed foraminous rigid non-sound-absorbing sheet spaced therefrom, a sound absorbing material between said sheet and said wall or ceiling surface and concealed by the former, and means for supporting said sheet in said spaced relation and adjacent to said surface, the ratio of the exposed area of the sheet to the openings therein being such as to provide a substantially continuous decoratable surface.

24. A supporting structure for sound-deadening material comprising furring strips each having a pair of resilient members, and foraminous sheets having portions formed for engagement between the resilient members of adjacent strips.

25. In a building structure the combination with a wall or ceiling surface, of a plurality of furring strips adapted to be secured to either or both such surfaces in parallel relation, said strips each having a pair of resilient legs provided with tile-supporting ledges, and tiles adapted to span the space between adjacent strips and having means insertable between the legs thereof into engagement with the ledges of one leg of each of two adjacent strips, the other legs of said strips being adapted to support additional tiles in cooperation with a leg of the next adjacent strip, said tiles being slidable longitudinally of said strips whereby the tiles can be removed without mutilation of more than one or two individual tiles of each row or tier of the same.

In testimony whereof, I have subscribed my name.

RALPH FORBUSH NORRIS.