SOUND-ABSORBING WEDGE

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Filed: Apr. 12, 1974

Appl. No.: 460,387

Related U.S. Application Data

U.S. Cl. 181/33 GD, 181/33 GE, 52/144

Int. Cl. E04g 1/99, G10k 11/04

Field of Search 181/33 G, 33 GE, 33 GD; 52/144-145

References Cited
UNITED STATES PATENTS
2,160,638 5/1939 Bedeil....................... 181/33 GD
2,730,942 1/1956 Peterson.................... 181/33 G
2,753,440 7/1956 Warefield.................. 181/33 GD
2,840,179 6/1958 Junger...................... 181/33 G
2,886,859 5/1959 Siering.................... 181/33 GD
3,321,877 5/1967 Alexieff.................. 181/33 G
3,712,413 1/1973 Eckel..................... 181/33 GE

FOREIGN PATENTS OR APPLICATIONS
1,279,145 0/1961 France..................... 181/33 GD
1,111,836 0/1956 France..................... 181/33 GD
1,111,836 0/1958 France..................... 181/33 GD

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ABSTRACT
A wedge-shaped sound-absorbing structure is positioned and hung similar to a conventional ceiling system. The wedge functions as a sound-absorbing structure to limit noise exposure in industrial areas. The wedge is formed of boards which have a sound-absorbing characteristic.

7 Claims, 4 Drawing Figures
1 SOUND-ABSORBING WEDGE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of applicants’ copending application Ser. No. 302,653, filed Nov. 1, 1972, entitled “Sound-Absorbing Wedge,” now U.S. Pat. No. 3,819,010.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The structure herein is directed to a sound-absorbing apparatus and, more particularly, to a wedge-shaped sound absorber which is suspended from a ceiling.

2. Description of the Prior Art

One of the provisions of the new Occupational Safety and Health Act has established limited noise exposure for industrial employees. The law requires that protective measures be taken so that employees are not exposed to noise levels exceeding the following limits:

<table>
<thead>
<tr>
<th>dBA Level</th>
<th>Maximum Allowable Hours of Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>8.0</td>
</tr>
<tr>
<td>95</td>
<td>4.0</td>
</tr>
<tr>
<td>100</td>
<td>2.0</td>
</tr>
<tr>
<td>105</td>
<td>1.0</td>
</tr>
<tr>
<td>110</td>
<td>0.5</td>
</tr>
</tbody>
</table>

A certain percentage of the workers will still experience work-associated hearing losses at these exposure ranges, but they have been established as a realistic initial goal. It is believed that by 1980, the maximum 8-hour exposure level may be lowered from the present 90 dBA to somewhere between 85 and 88 dBA.

The decibel, when used as a unit of sound measurement, is a logarithmic function of the sound intensity. A reduction of 3 decibels corresponds to a halving of the sound intensity.

The dBA scale of measurement responds to noises much as does the human ear; that is, it emphasizes the importance of the middle frequencies required for good communication and reduces the significance of the lower frequencies. The Occupational Safety and Health Act requires are referenced to the A Scale of measurement. The following are some examples of various common noises:

<table>
<thead>
<tr>
<th>Noise Source</th>
<th>Decibels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jet aircraft at take-off</td>
<td>140-150</td>
</tr>
<tr>
<td>Threshold of pain</td>
<td>140</td>
</tr>
<tr>
<td>Loud power mower</td>
<td>107</td>
</tr>
<tr>
<td>Food blender</td>
<td>90-95</td>
</tr>
<tr>
<td>Stenographic work in a large office</td>
<td>80</td>
</tr>
<tr>
<td>Range of conversation</td>
<td>60-70</td>
</tr>
<tr>
<td>Quiet residence at night</td>
<td>40</td>
</tr>
<tr>
<td>Whistle</td>
<td>20</td>
</tr>
<tr>
<td>Threshold of hearing (youth)</td>
<td>0</td>
</tr>
</tbody>
</table>

There are four main methods of controlling the exposure to noise:

1. Machine modification to quiet the noise source.
2. Barrier installation to block the direct sound path of the noise by the use of enclosures and screens.
3. Acoustical treatment of surfaces to reduce the amount of reflected noise.
4. Operator treatment which involves the use of ear plugs and ear muffs.

The first three above methods are preferred since the wearing of ear plugs could possibly cause operator discomfort and would require enforcement by the employer. The application herein is directed to the third control technique.

Acoustical ceilings are old in the art and the art has also used baffles and screens on ceilings for additional sound-absorbent purposes. U.S. Pat. No. 2,884,512 shows something similar to a wedge structure which is used as part of an overall ceiling system. However, the structure in the above-mentioned patent is built into the overall ceiling system and is tied in with the lighting system and the fire protection system of a room.

Similar types of sound-absorbing baffle structures are shown in U.S. Pat. Nos. 2,753,440, 2,886,859, 2,160,638, 2,730,942 and in French Patents 68,820 and 1,111,836. In each case, these structures appear to be an acoustical material which is surrounded by a metal covering.

French Patent 1,279,145 should also be noted because it discloses a wedge-shaped acoustical structure. Here, metal-covered acoustical material is formed into resonating panels bent at an angle of 60° along their mid-lines. These panels are then assembled together to form an acoustical wedge.

SUMMARY OF THE INVENTION

The invention herein is directed to a wedge-shaped sound absorber made from acoustical panels or boards. A frame structure segment is made to form a triangular wedge-shaped structure. This frame segment provides two triangular cross members and at least one interconnecting member to form a metal frame which is wedge-shaped. Acoustical board side panels are placed in the frame. The sound absorber is designed so that it can be suspended from any existing ceiling and made a continuous structure across a room or spaced 1' or more apart so as to minimize interference with existing sprinkler and lighting installations. The angled shape provides an attractive sound absorber and its irregular shape helps dissipate sounds. Acoustical material may be inserted into the inside of the wedge structure or an acoustical backer panel may be placed across the top of the wedge. When the wedge is provided with a closed back, the inside of the wedge acts as a sound-absorbing chamber. The wedge can be readily installed in position and any number of them can be installed in close proximity to noisy machinery.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. I is a perspective view of one form of the invention herein;
FIG. II is a perspective view of a connecting member of the skeleton frame for the wedge;
FIG. III is a perspective view of one form of cross member for the skeleton frame of the continuous form; and
FIG. IV is an end view of a modified cross member structure for the continuous form invention described herein.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings herein, the sound-absorbing wedge 2 is designed to be mounted below the structural ceiling 4 of any room.
The sound-absorbing wedge 2 is formed from a framework of approximately 1 inch metal corner molding, which is nothing more than thin pieces of metal bent in the middle with a 90° angle between the sides. These pieces of corner molding are notched and folded together to form two triangular members 3. Interconnecting member 7 is used to connect together the lower corner of each of the two triangular end members. The structure is mounted in position with a corner of the end members facing downward. There is thus provided a skeleton metal framework 6 which will serve to hold two acoustical rectangular boards 8 in position. The acoustical boards are conventional perforated surface acoustical boards such as is well-known in the art in most conventional ceiling systems. The boards are simply fiberboard structures which are provided with perforations in the surface thereof to assist the board to act as a sound absorber. The boards are not provided with a metal facing nor are they provided sandwiched between two metal surface structures. The acoustical boards 8 are placed in the framework 6 along the two sides of the skeleton framework. The foremost visible ceiling acoustical board 8, as shown in FIG. 1, is held on two opposite sides by the metal triangular framework 3 and on one other side by the connecting member 7. Triangular acoustical boards 9 are placed in the end of the acoustical wedge within the triangular metal framework 3. This forms a wedge-shaped structure which has the point of the wedge facing downwardly away from the ceiling structure 4. It can thus be seen that the wedge is made from a metal framework which consists of two triangular end members and an interconnecting metal member 7 which forms an open skeleton wedge-shaped frame. Member 10 is a hanger strap shaped like a U, with the width of the U being one-fourth inch less than the length of the width of the wedge and with the legs of the U being 3° or more in length if desired. The legs of the U pass through a slot in the upper flange of the triangular members 3. Into this frame are placed two triangular acoustical boards and two rectangular acoustical boards to form the resulting acoustical sound wedge.

There is a cavity within the wedge. As is shown in the exposed portion of FIG. 1, within this cavity, there are placed bags 31 of sound-absorbing material. The bags of sound-absorbing material would be thin 1-mil thick plastic bags which are filled with a mineral wool, fiberglass or inorganic aggregate. In particular, the bags have been prepared from 1-mil polyethylene plastic material and have been filled with 500 grams of mineral wool each. A number of these bags could then be placed in the open cavity in the backside of the sound-absorbing wedge 2. These bags greatly increase the sound-absorbing ability of the sound-absorbing wedge 2. It is obvious that hanger batts, boards or other means may be used in lieu of bags to provide additional acoustical material.

It is also true that an acoustical board could be placed on top of the wedge to close in the third side of the wedge and form a sound-absorbing chamber totally enclosed within the wedge structure.

The invention shown in FIG. 1 has been used specifically in a printing press room. In an area of 1,250 square feet of ceiling surface over the press structures, there were placed a total of 174 wedge-shaped sound absorbers which constitute about 1,000 square feet of acoustical board. These were suspended three inches from a conventional acoustical board ceiling system and were spaced apart about one foot. As shown in FIG. 1, any conventional hanging structure or the previously described U-shaped hanger strap 10 could be used to hold the wedge 2 in place relative to ceiling. Through the use of the above wedges on the ceiling, it was possible to secure a reduction of three dBA in the sound level of the room. This was sufficient in all areas of the press room to meet the requirements of the Occupational Safety and Health Act as proposed for 1980. While the number of decibels may appear to be a small change, it must be remembered that three decibels correspond to a halving of the sound intensity. Higher reductions (5–7 dBA) are experienced when acoustical absorbers are added to a live room (one having had no previous acoustical treatment as is usually the case). Relieving of the sound intensity secured a very favorable reaction from the workers involved with the presses.

Referring now to FIG. II, there is shown a perspective end view of the connecting member 7 which connects the two opposite corners of the triangular end members 3. The included angle between the surfaces 11 and 12 of the connecting member is approximately 60°. It can be readily seen that one of the rectangular acoustical boards 8 will rest on surface 11 while the opposite surface 12 will have the second rectangular acoustical board resting thereon.

As shown in FIG. I, the triangular end member is formed from a right angle corner molding which is nothing more than a thin piece of metal bent in the middle with a 90° angle between the sides. One of these angle moldings is notched at two points and bent together to form an equilateral triangle.

In many installations, large relatively open spaces must be treated and labor costs for inserting small, individual wedges are high. Therefore, there was developed the concept of continuous wedges running the full span of the room. The advantage of this continuous system is the use of basic acoustical ceiling suspension systems to form continuous wedges spaced at some distance apart. This allows the contractor to install a large amount of absorbent material without incurring problems associated with the addition of a continuous acoustical ceiling to an existing space. Other advantages are:

1. Easy access for maintenance of piping, etc. above the units.
2. Elimination or minimization of the need to relocate existing light fixtures.
3. Eliminate the problems of relocating an existing sprinkler system.

FIGS. III and IV show another embodiment with the modification of the structure of the triangular end member 3 of FIG. I for use in the continuous wedge described hereafter. Here a conventional inverted T runner is used instead of a right angle corner molding. This then provides a triangular end member with a web 13 that will have flanges 14 and 15 on opposite sides thereof. If such a structure were used in the embodiment of FIG. I, the shown acoustical ceiling boards 8 would rest upon flange 15. Flange 14 would be exposed if it were the end of a continuous wedge or else it would function as the triangular cross member for an adjacent wedge. In effect, the structure of the FIG. III embodiment provides for the mounting of two wedges in an abutting end-to-end relationship. Such a structure would be composed of a number of triangular cross or
end members. These cross members are supported from acoustical ceiling type main runners 16 and 17 at the two 45° angles of the cross member (see FIG. IV). The cross members are inter-connected with another at the lower or 90° angle by a member such as illustrated in FIG. II. This structure is then capable of supporting acoustical boards in a side-by-side relationship, and the structure of FIG. III would actually support the ends of four boards. The two boards forming the right-hand wedge would rest upon the flanges 14 while the two boards forming the left-hand acoustical wedge would rest upon the flanges 15. Naturally, there would be used only a triangular acoustical board at the two ends of the combined two or more adjacent sound wedges and no triangular acoustical board would be used with the intermediate cross members.

In another embodiment shown in FIG. IV, an alternative technique is shown for mounting the support framework in position within a conventional ceiling system. A conventional ceiling system is provided with two adjacent inverted T-shaped main runner structures 16 and 17. Normally, a flat ceiling board would be placed between these two main runner structures and would rest upon the flanges of the main runner structures. In lieu of this board structure, a sound-absorbing wedge is placed therein. Triangular end cross-members would be utilized, except the third side of the triangular end members would be removed and only a V-shaped end member would be utilized, and it would have the same cross section structure as the end members of FIG. I. That is, normally the triangular end members would be made from right angle metal. However, they could possibly be made from the structure of FIG. III. For the sake of simplicity, a structure similar to that of FIG. III is shown wherein two inverted T-shaped runner members are formed into a V. The runner members 18 and 19 have flanges 20 and 21 on which the ceiling boards may rest. They also have vertical ribs 22 and 23 which are connected by rivets or other means to a flat metal structure 24 which is the hypotenuse of the triangular end member and this also serves as the crossbar between said parallel runners 16 and 17. The flat metal structure 24 has tabs 25 and 26 which extend through the vertical ribs 27 and 28 of the main runners 16 and 17. The tabs may be left extended or preferably they are bent over, and this helps to lock the flat metal piece 24 in position to the two adjacent main runner structures 16 and 17. The V-shaped structure is therefore supported by the flat metal structure 24 from the main runners 16 and 17. Ceiling boards may then be placed upon the flanges 20 and 21 to form a wedge-shaped acoustical structure. Appropriate triangular end panels may be placed within the triangular end member structure at each end of the module. Acoustical filler or more preferably, a 2' x 4' lay-in backer panel is inserted in the top of each modular segment of the continuous wedge.

What is claimed is:
1. In a room which is subjected to a high decibel noise level and where there is a closed room structure with a ceiling therein, the improvement comprising the placing of sound-absorbing wedges suspended from the ceiling, said sound-absorbing wedges constituting a support means into which is placed a plurality of sound-absorbing boards to form a wedge-shaped structure which is triangular in cross section, said support means being composed of triangular-shaped end members and an interconnecting member connecting together one corner of each of the triangular end members, said corners of the triangular end members which are connected together by the interconnecting member being positioned facing downwardly toward the area below the ceiling, said sound-absorbing boards being triangular boards which fit within the triangular end members to form the ends of the wedge structure and rectangular sound-absorbing board structures which fit within the support means resting upon the interconnecting member and the sides of the end members, said support means and boards forming a wedge-shaped sound-absorbing structure which increases the sound-absorbing ability of the overlying ceiling system and a plurality of wedge structures are placed in an abutting relationship to form a continuous wedge structure which may extend from one side to an opposite side of the room.
2. The sound-absorbing wedge of claim 1 wherein the backside of the wedge adjacent to the ceiling is open and into which is placed a sound-absorbing material.
3. The sound-absorbing wedge of claim 2 wherein said sound-absorbing material is in bags formed of 1-mil plastic material and containing very loose low-density material, preferably of an inorganic nature.
4. The sound wedge of claim 1 wherein the open backside of the wedge is covered over by a third rectangular sound-absorbing board to convert the interior of the wedge into a sound chamber.
5. The sound wedge of claim 1 wherein the continuous wedge structure is composed of two triangular end members and at least one intermediate triangular member interposed between said two triangular end members.
6. The sound wedge of claim 5 wherein the intermediate triangular cross member is formed with sides that have a cross-section which is in the shape of an inverted T so that there is a web structure and flanges on either side of said web structure whereby the flanges on one side of the web structure support the rectangular sound-absorbing boards of one wedge structure and the flanges on the other side of the web structure support the sound-absorbing boards of an adjacent abutting wedge structure.
7. The sound wedge of claim 1 wherein the triangular end member is composed of two sides which support the two rectangular sound-absorbing boards and a third side which is connected directly to the inverted T-shaped runner members of a typical ceiling suspension system to fasten the sound-absorbing wedge structure to an existing suspended ceiling system and to place it as an integral part of an existing ceiling system since the sound-absorbing wedge is being used as a replacement for a ceiling board which would normally be positioned between the two adjacent inverted T-shaped runner members of the existing ceiling system.

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