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3,103,987

ACOUSTICAL PANEL CONSTRUCTION

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2 Sheets-Sheet 1

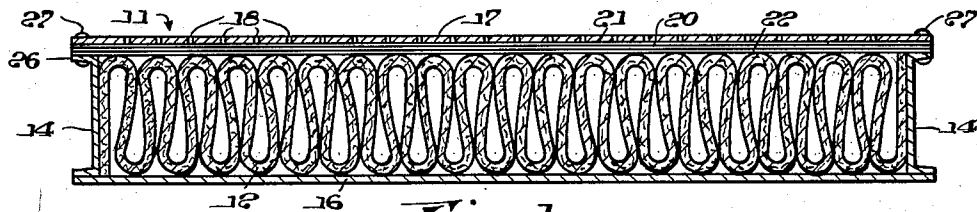


Fig. 1.

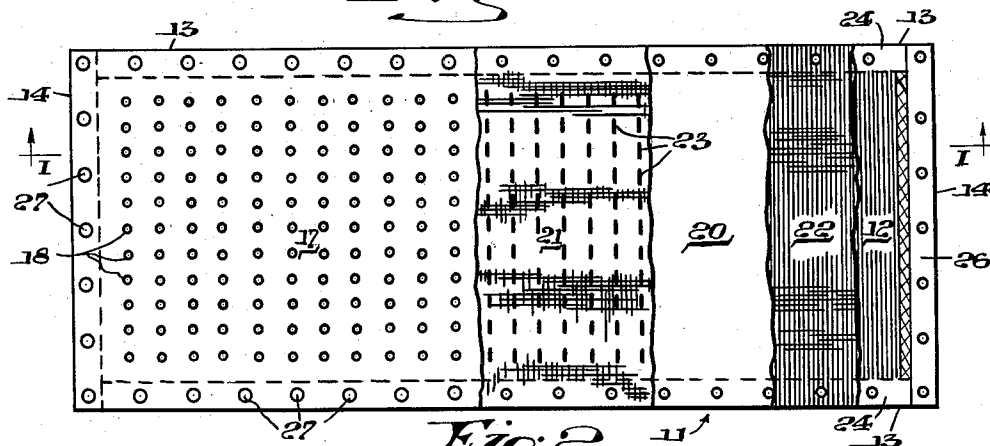


Fig. 2.

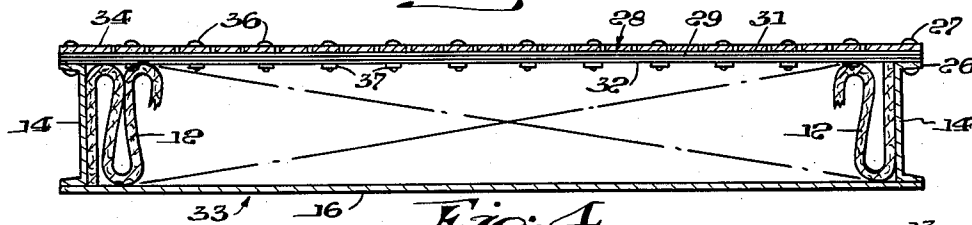


Fig. 4.

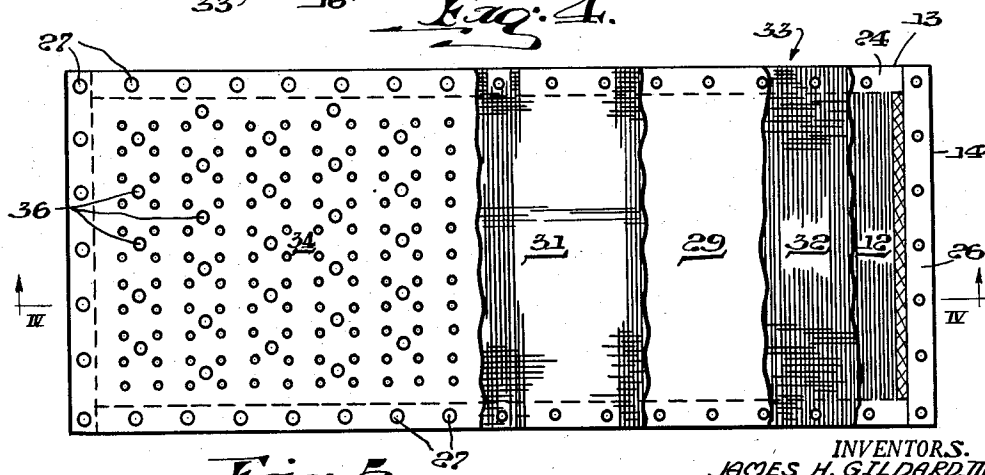


Fig. 5.

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2 Sheets-Sheet 2

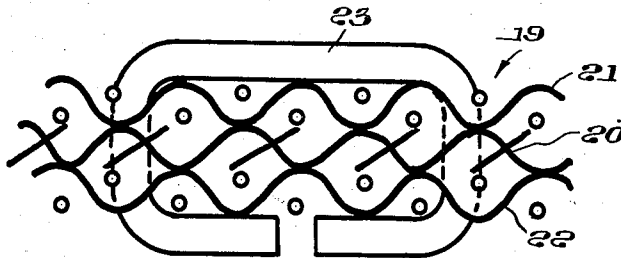


Fig. 3.

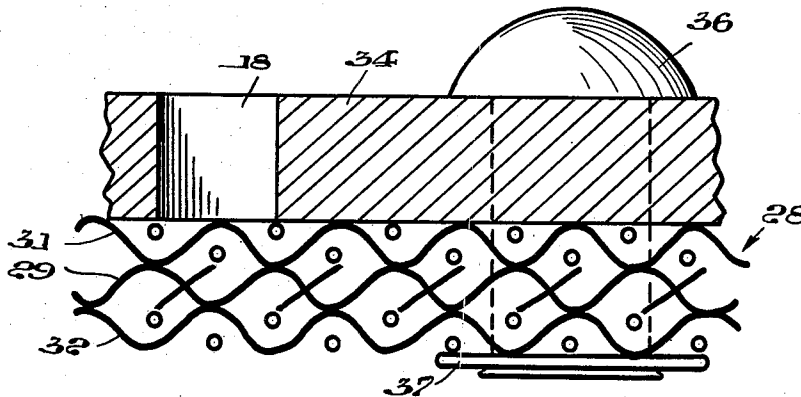


Fig. 6.

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ACOUSTICAL PANEL CONSTRUCTION

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12 Claims. (Cl. 181-33)

This invention relates to acoustical panel construction and, more particularly, to the construction of acoustical panels for use in installations in which such panels are exposed to high velocity gas flow such as in inlet and exhaust ducts for jet engine exhaust facilities.

It is well known in the prior art that materials such as glass fiber, mineral wool and the like provide excellent sound absorbing media. Such material in blanket form is typically packed into enclosures behind perforated face sheets which serve the dual function of providing a durable facing for the blanket while at the same time permitting the entry of sound waves therethrough for absorption by the blanket material. The face sheets for such enclosures or as they are generally termed, panels, are typically constructed of such materials as metal, asbestos-cement board, hardboard or the like.

When the simple construction outlined above is used to absorb sound frequencies in industrial applications, an added problem sometimes even more severe than that of sound absorption often presents itself. Thus, when these acoustical panels are exposed to sustained high velocity gas flow in excess of 200 feet per second whether the gas velocity path be parallel to the panel, perpendicular thereto or at some intermediate angle of incidence, there arises the danger of losing the fibrous blanket material by having it literally blown out of the panel through the perforations in the face sheet.

Accordingly, it is an object of the present invention to provide means within an acoustical panel to protect the sound absorbing material therein from the destructive effects of high velocity gas flow.

Another object of this invention is to provide a protective lamination of dissimilar materials covering the sound dissipating medium in an acoustical panel exposed to high velocity gas flow whereby the effective flow resistance of the lamination serves to deflect the high velocity gases from the sound dissipating medium or, at least, to reduce the velocities of those gases reaching the sound dissipating medium.

An additional object of the invention is the provision of a unique combination of materials yielding sufficient flow resistance to high velocity gases to prevent fiber blow-out but yet not so great as to prevent the conduction of sound waves therethrough to enable absorption by the blanket.

Still another object of this invention is to provide a velocity resistant lamination for use in an acoustical panel to protect the sound dissipating medium which lamination at one and the same time resists the erosive forces of high velocity gas flow and yet serves to enhance the acoustical qualities of the sound dissipating medium.

The general purposes of this invention as set forth above are attained by providing a device for the attenuation of sound comprising in combination an enclosure having a portion of the surface thereof perforate for the communication of sound pressure waves from the exterior to the interior of this enclosure to reach sound dissipating material disposed therein and means transparent to sound pressure waves held in place between the perforate portion and the sound dissipating material to deflect or at least to reduce the velocity of gas stream flow incident upon the perforate portion and thereby prevent the erosion of the sound dissipating material during sustained exposure to high velocity gas flows.

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Other objects will be in part obvious and in part specifically pointed out in greater detail in the following description wherein:

FIGURE 1 is a transverse sectional view along line I—I through an acoustical panel constructed in accordance with the preferred embodiment of the present invention,

FIGURE 2 shows a plan view of the panel in FIGURE 1 with a portion thereof broken away,

FIGURE 3 is an enlarged view of the manner of unification of the lamination of FIGURE 1,

FIGURE 4 is a transverse sectional view along line IV—IV through an acoustical panel embodying a modification of the present invention,

FIGURE 5 shows a plan view of the panel in FIGURE 4 with a portion thereof broken away, and

FIGURE 6 is an enlarged view showing the manner of unification of the lamination of FIGURE 4.

Referring to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, numeral 11 makes reference in FIGURES 1 and 2 to an acoustical panel into which has been incorporated the novel construction of the present invention.

In typical panel construction, as shown in FIGURES 1 and 2, the sound dissipating medium 12 (illustrated herein as glass fiber in blanket form) is enclosed within a metallic frame structure formed by side members 13 secured, as by welding, to end members 14, and covered on the one side with a non-perforated metallic sheet 16 and on the other side by a face sheet 17 of conventional perforate metallic plate. In general the frame members, side members 13 and end members 14, are formed from channel stock and are assembled with their flanges directed outwardly of panel 11 to facilitate assembly with other panels. In the event that panel 11 is made in a very large size, cross pieces (not shown) are employed to strengthen the panel construction.

Such panels are used to reduce noise particularly in industrial application by lining the walls of ducts, tubes, passageway and rooms in which the sound problem occurs. In other applications, the panels are arranged in spaced parallel relationship dividing such ducts, tubes, or passageways into narrow passages for some distance. In the latter application the panels have perforate plates on both faces of the panel. By using these arrangements, the perforate portion such as face sheet 17 of the panel 11 are exposed to the sound pressure waves which pass through the perforation 18 and dissipate their energies in the glass fiber blanket 12. The degree to which the sound energy is dissipated is dependent, of course, on the frequencies of vibration and the efficiency of the sound dissipating medium at those frequencies.

The construction and operation as described up to this point, is conventional. However, should such construction be employed in the presence of gas stream flow of the magnitude encountered in modern jet engine exhaust facilities (velocities in excess of 200 feet per second), the sound dissipating medium in this case the fibrous material comprising blanket 12 would be quickly eroded being blown out of the panel bit by bit through perforations 18 in face sheet 17.

To prevent this destruction, blanket 12 is protected by laminated construction 19 which is transparent to sound pressure waves and which is mounted between the perforated portion, face sheet 17, and the sound dissipating material, blanket 12. As shown in the drawings, this laminated construction 19, shown in detail in FIGURE 3, consists of glass fiber cloth 20 sandwiched between layers of wire screen 21 and 22. There are, of course, certain limitations to be observed in the selection of these materials. The first limitation is in the

allowable increase in the effective acoustical resistance of the perforations 18 which may be effected by the positioning of laminated construction 19 adjacent perforations 18. If laminated construction 19 contributes too great a flow resistance, the effective acoustical resistance of perforations 18 is increased too much with consequent reduction in the acoustical qualities of panel 11. On the other hand, if laminated construction 19 provides too small a flow resistance there will be insufficient protection against the erosion of blanket 12 by high velocity gas streams. It has been determined that the critical range of permissible acoustical resistance for the glass fiber cloth 20 is from 3-7 rayls (1 rayl is that resistance involved when a pressure of 1 dyne per sq. cm. causes a linear flow of 1 cm. per sec. of standard dry air). Within this range, optimum results are obtained (4 rayls) by the use of glass fiber cloth having a thread diameter of .006" and a weave of 34 threads per inch in one direction and 32 threads per inch in the other. This weave allows good entry of sound waves while being sufficiently tight to prevent the sifting out of small fibers that may become detached from blanket 12. The close mesh wire screens 21 and 22 are usually made of wire having a diameter of .011" and having 18 wires per inch in one direction and 14 wires per inch in the other. This wire diameter is chosen as it is sufficiently large so as not to cut the glass fiber cloth 20, yet not so large as to be overly expensive. So far as the close spacing is concerned, this serves a particular purpose to be elaborated upon below.

In order to prevent the destruction of lamination 19 from flapping and fraying (wind-flap) under the application of the velocity forces of the gas stream, a combination is made of glass fiber cloth 20 interposed between the wire screens 21 and 22 by fastening them together in quilt fashion by the application of conventional staples 23 as shown approximately every four inches in both directions. This unification by means of staples 23 enables lamination 19 to withstand the self-destructive whipping action (known in the art as "wind flap") to which it is subjected in use, an action similar to that commonly experienced by flags on display in high winds.

In the embodiment shown in FIGURES 1, 2, and 3, the lamination 19 is assembled in panel 11 by interposing it as a quilted unit between face sheet 17 and upper flanges 24, 26 of members 13 and 14 respectively at the edges of face sheet 17 and clamping lamination 19 in place by means of assembly rivets or bolts 27. In this manner, lamination 19 is restrained only along the edges of panel 11.

While it would seem possible to select a given weave and weight of glass fiber cloth 20 which by itself would provide the correct flow resistance and also perhaps provide the necessary protection against fiber blow out, it has been found in actual practice that screens 21 and 22 are required to perform the very necessary task of preventing glass fiber cloth 20 from being punched through as a result of being pounded against perforations 18 in face sheet 17 by the action of the gas flow. Therefore, it has been found that by unifying these materials as described above into quilted lamination 19, a protective agent is produced which, on the one hand, protects sound blanket 12 from being destroyed by the erosive force of high velocity gas streams and yet, on the other hand, is sufficiently transparent to the passage of sound pressure waves to enable their entry to and dissipation in blanket 12.

A modification of the preferred embodiment is shown in FIGURES 4, 5, and 6 wherein the panel construction shown is identical with that in FIGURES 1, 2, and 3 with the exception that lamination 28 though still composed of glass fiber cloth 29 interposed between close mesh wire screens 31 and 32 is integrated into panel 33 in a different manner. Instead of being stapled together in quilt-fashion, glass fiber cloth 29 and screens

31 and 32 are joined together and to the face sheet 34 by means of rivets 36 passing through all layers of the lamination 28 and also through the face sheet 34. In a typical application of this modified form of the invention, rivets 36 and the accompanying washers 37 are placed on approximately six inch centers in both directions.

Whether the velocity protective lamination be of quilted construction and supported only along its edges or whether it be fastened by means of riveting as in FIGURES 4, 5, and 6 the same function is performed thereby. Thus, as the gas stream strikes the face of the acoustical panel the effective flow resistance of the lamination serves either to deflect the high velocity gases or at least to reduce their velocity. Since the prime function of an acoustical panel is to absorb sound, however, any construction which would hinder the performance of this function would involve an objectionable compromise.

Fortunately, the present arrangement enables the choice of a design flow resistance not only giving the necessary protection under sustained exposure to gas flow velocities in excess of 300 f.p.s., but also enabling the entry of sound energy for its dissipation by blanket 12. Also, due to the particular selection of materials employed in this lamination, it has been found that the acoustical qualities of sound blanket 12 are actually improved by combination with the acoustical resistance of the lamination with the net result that a more effective acoustical panel is produced thereby.

This enhancement of the acoustical properties of blanket 12 by the use of the present velocity protective lamination is an interesting phenomenon in that the laminated construction either 19 or 28 actually "de-tunes" the panel to receiving lower frequency vibrations. This "de-tuning" by the laminated construction actually shifts the entire sound absorptive effect of the panel as an entity by $\frac{1}{2}$ to 1 full octave into the lower frequencies of vibration in which range blanket 12 possesses greater ability to absorb or dissipate sound. Thus, by employing this unique construction having an acoustical resistance of 3-7 rayls located immediately under perforations 18 serving to increase the effective acoustical resistance of perforations 18 by a critically small amount the inventors have produced an acoustical panel with enhanced acoustical performance in low frequency sound reduction and, at the same time, an efficient protective measure against the erosion of its sound-dissipating medium.

Since the panel construction illustrated has only one perforated face sheet per panel, only one protective lamination is required. In cases in which such panels are constructed with perforated faces on each side thereof two protective laminations would be used per panel, one under each face sheet. Panels of such dual-faced construction, as stated below, are used for installations in which the panels are arranged in spaced parallel relationship to permit gas flow therebetween.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed:

1. A device for the attenuation of sound energy in high velocity gas flow comprising in combination an enclosure, sound dissipating material disposed within said enclosure, a portion of the outer surface of said enclosure being perforate, at least three layers of a plurality of dissimilar flexible meshed fabrics transparent to sound pressure waves mounted between said perforate portion and said sound dissipating material and means for joining said laminates in a plurality of positions spaced over the surface thereof to form a unitary lamination.

2. A device for the attenuation of sound energy in gas flows with velocities in excess of 200 f.p.s. comprising in

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combination an enclosure, sound dissipating material disposed within said enclosure, a portion of the outer surface of said enclosure being perforate for the communication of sound energy from the exterior to the interior of said enclosure, at least three layers of a plurality of dissimilar flexible meshed fabrics transparent to sound pressure waves located between said perforate portion and said sound dissipating material and means for fastening said laminates together over the surface thereof in a plurality of spaced positions to form a unitary lamination.

3. A device for the attenuation of sound energy substantially as described in claim 1 wherein the unitary lamination is composed of a laminate of glass fiber cloth interposed between two laminates of close mesh wire screen.

4. A device for the attenuation of sound energy substantially as described in claim 3 wherein the unitary lamination has an acoustical resistance in the range from 3 to 7 rayls.

5. A device for the attenuation of sound energy substantially as described in claim 3 wherein the laminates are assembled into a quilted unitary lamination by multiple joining means placed in spaced relationship.

6. A device for the attenuation of sound energy substantially as described in claim 2 wherein the unitary lamination is composed of a laminate of glass fiber cloth interposed between two laminates of close mesh wire screen.

7. A device for the attenuation of sound energy substantially as described in claim 6 wherein the unitary lamination has an acoustical resistance in the range from 3 to 7 rayls.

8. A device for the attenuation of sound energy substantially as described in claim 6 wherein the laminates are assembled into a quilted unitary lamination by multiple joining means placed in spaced relationship.

9. A device for the attenuation of sound energy substantially as described in claim 2 wherein the plurality of laminates are attached to the perforate portion by multiple joining means arranged in spaced relationship.

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10. In a device for the attenuation of sound energy in high velocity gas flow wherein a portion of the outer surface of the enclosure of the device is perforate for the communication of sound energy to sound dissipating material disposed within the enclosure so as to absorb the sound energy, the improvement comprising means disposed between said perforate portion and said sound dissipating material for reducing the velocity of gases reaching said sound dissipating material whereby said sound dissipating material is protected from erosion, said means comprising a layer of glass fiber cloth interposed between two layers of close mesh wire screen, said layers being joined over a surface thereof in a plurality of spaced positions.

11. A unified lamination substantially as described in claim 10 wherein the layers are joined by multiple fastenings arranged in a quilted arrangement.

12. A unified lamination substantially as described in claim 10 having an acoustical resistance in the range from 3 to 7 rayls.

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