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LAMINATED ACOUSTIC PANEL WITH SOUND ABSORBING CAVITIES

Filed Jan. 2, 1962

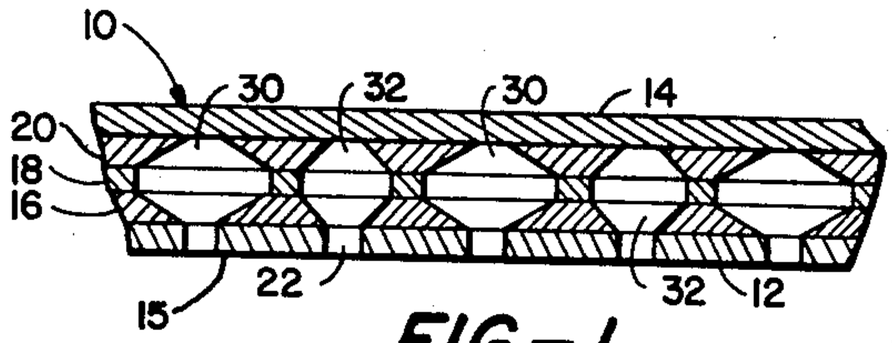

FIG.-1

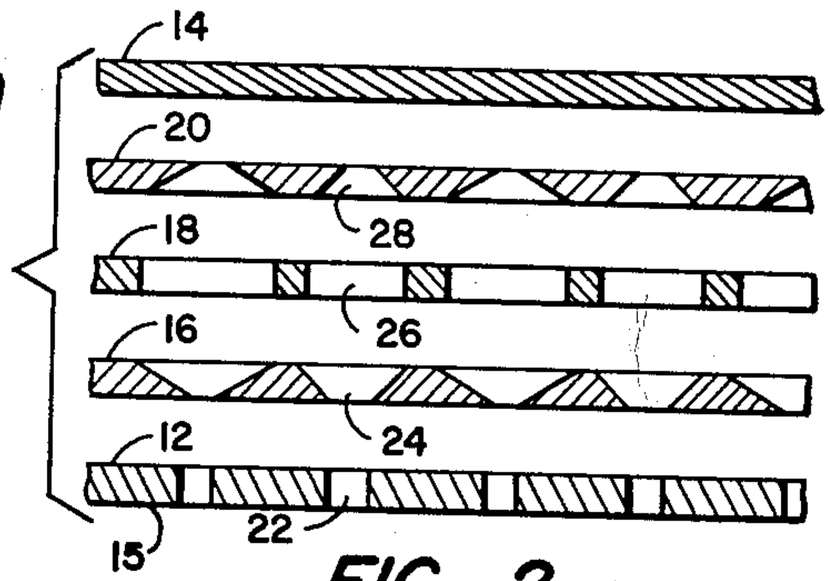

FIG.-2

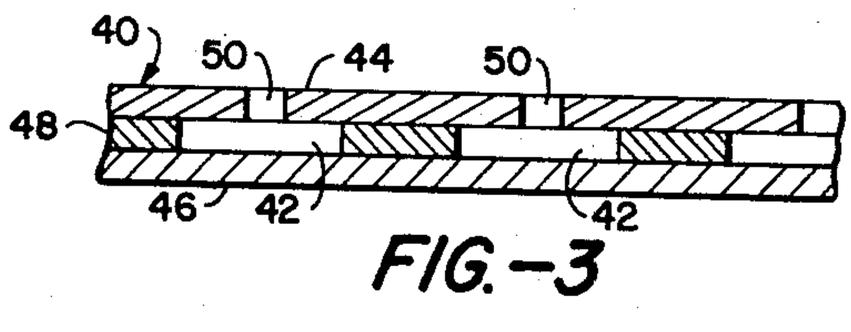

FIG.-3

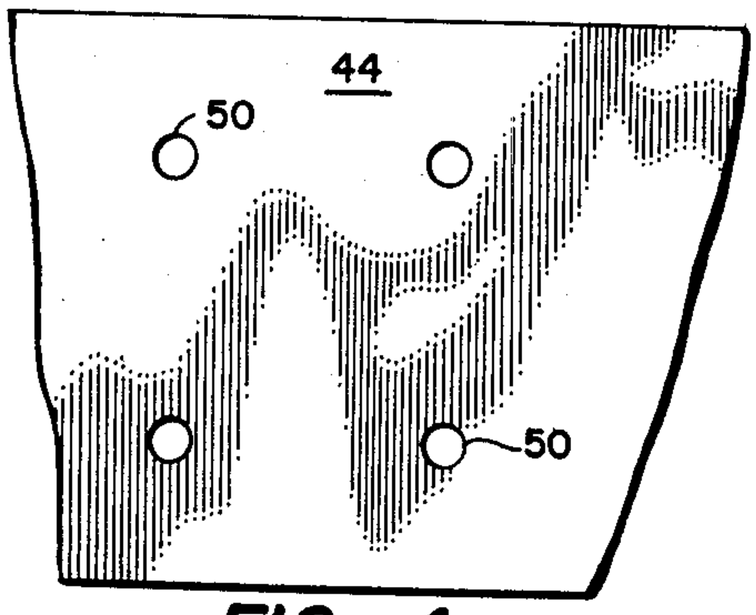

FIG.-4

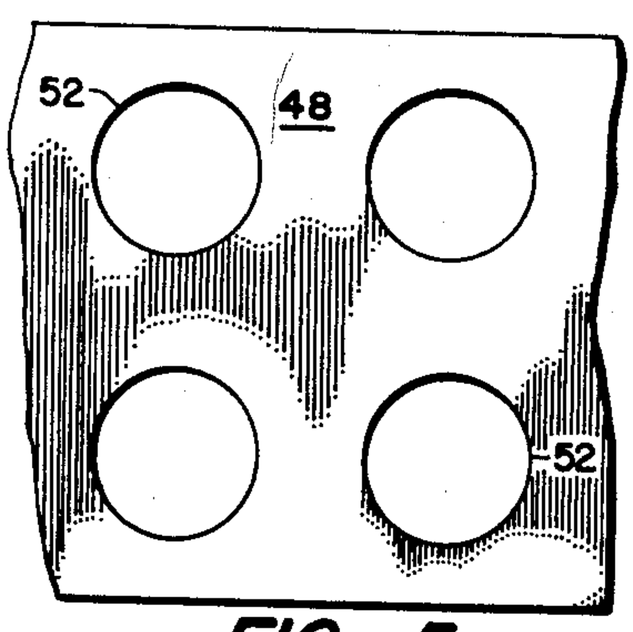

FIG.-5

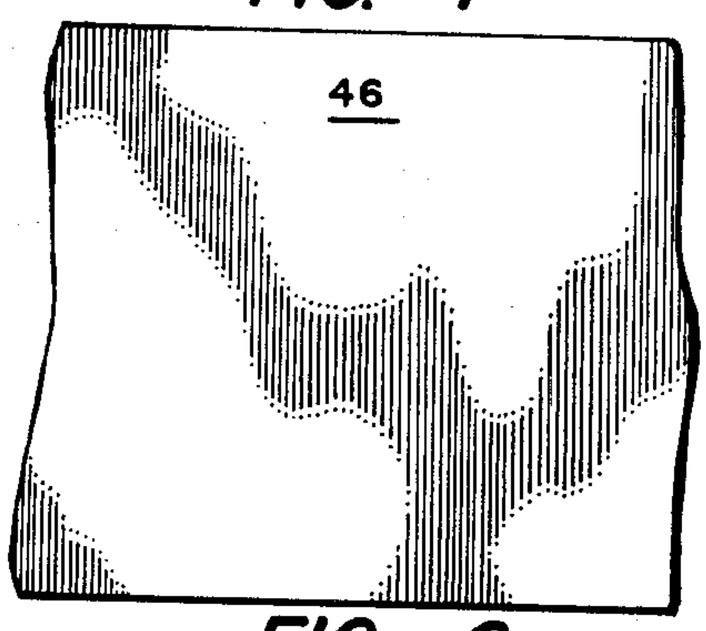

FIG.-6

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LAMINATED ACOUSTIC PANEL WITH SOUND ABSORBING CAVITIES

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This invention relates to sound proofing and more particularly to an acoustic damping panel.

Heretofore, acoustic damping panels were formed from porous materials or from panels into which a large number of holes were drilled. The sound absorbing characteristics of a panel formed from porous material are not completely satisfactory because the panel is a less efficient sound absorber at higher frequencies where noise is most objectionable. Other sound absorbing panels have small holes drilled therein and these holes help the panel to more efficiently absorb certain frequencies which depend on the dimensions of the holes. These holes may cause the panels to act as a reflector rather than a sound absorber for other frequencies.

Many of these difficulties could be avoided if a conventional acoustic panel could be made larger in order to provide a greater sound absorbing area. However, space limitations often make this impossible.

What is needed, therefore, and comprises an important object of this invention is to provide an acoustic damping panel which has a substantially greater sound absorbing surface area than the external dimensions of the panel and which is designed so it can efficiently absorb sound frequencies above any predetermined frequency so that the objectionable higher noise frequencies can be absorbed or attenuated.

The invention, in its broadest aspect, comprises forming an acoustic panel from a plurality of strips of sound absorbing material secured together. Certain of these strips are formed with holes or openings extending therethrough. These holes are shaped so that when the strips are secured together to form the laminated panel, the holes which are in alignment with each other cooperate to form enlarged cavities in the panel. If these cavities are Helmholtz cavities, they effectively absorb or attenuate sound at frequencies above the resonating frequency of the cavity as determined by the dimensions of the cavity. With this arrangement, sound will be more efficiently attenuated and absorbed both by the greater surface area of the panel provided by the inner walls of the cavities and by the absorption or attenuation of sound at frequencies above the resonant frequency of the cavity.

This and other objects of this invention will become more apparent when read in the light of the accompanying drawings and specification wherein:

FIG. 1 is a side sectional view of the new and improved acoustic panel constructed according to the principles of this invention;

FIG. 2 is an exploded side sectional view of the acoustic panel shown in FIGURE 1 showing how the panel is assembled;

FIG. 3 is a side sectional view showing a modified acoustic panel which embodies some of the principles of this invention;

FIG. 4 is a plan view of a portion of the inner strip forming the modified panel;

FIG. 5 is a plan view of a portion of the intermediate strip forming the modified panel; and

FIG. 6 is a plan view of a portion the outer strip forming the modified panel.

Referring now to FIGURE 1 of the drawings, an

acoustic panel indicated generally by the reference numeral **10** is composed of a plurality of strips laminated together by any suitable means. These strips include an inner perforate strip **12**, an outer imperforate or base strip **14** and a series of intermediate strips **16**, **18**, and **20** which both connect the inner and outer strips together, and, as described below, serve to absorb and attenuate sound frequencies above any predetermined frequency. As will become apparent below, the number of intermediate srtips can be varied as desired.

As best seen in FIGURE 2, the inner perforate strip **12** and the series of intermediate strips **16**, **18**, and **20**, are all provided with openings **22**, **24**, **26**, and **28** extending therethrough. These openings have varying sizes and shapes and in the particular embodiment shown, the openings in each strip are shaped so they are generally similar to a particular segment or section of a Helmholtz resonating cavity.

With this arrangement, when the strips are secured together, openings **22**, **24**, **26**, and **28** in each strip cooperate with each other to form typical Helmholtz cavities in the panel. The imperforate or base strip **14** closes off one end of the cavity and the perforations **22** in the inner strip **12** serve as mouths for the cavities. The mouths **22** extend inward from surface **15** of strip **12** and are small in comparison to the width of the cavities. In the embodiment shown, there are two different sized openings in each strip. Consequently, when the strips are assembled together, the acoustic panel in this particular embodiment will have two differently shaped Helmholtz cavities **30** and **32** formed therein for reasons to become apparent below. It is apparent that this method of forming the acoustic panel permits any number of differently shaped cavities to be formed in an acoustic panel, using simple, inexpensive, and conventional tools.

The strips are all made of sound absorbing material such as a cellulose board. Consequently, the inner surfaces of cavities **30** and **32** serve to absorb and attenuate sound. As a result, the total sound absorbing surface of the panel **10** is substantially greater than the external dimensions of the panel.

In addition, the Helmholtz cavities resonate and consequently absorb sound frequencies at the fundamental frequency of the cavity, which is primarily determined by the volume of the cavity and the size of the mouth **22**. Helmholtz cavities also have additional resonant or sound absorbing frequencies which are higher than the fundamental resonant frequency and are not harmonically related to the fundamental resonant frequency. These higher or additional resonant frequencies are determined by the shape of the cavity rather than the volume. Consequently, by a judicious selection of the shapes of the holes in the various strips, the panel can be provided with differently shaped Helmholtz resonating cavities. With this arrangement, and acoustical panel can be designed to absorb sound in two ways. First, the sound may be absorbed by the impact of the sound waves on the sound absorbing material of the panel, and second, the sound may be absorbed at the varying fundamental resonant frequencies of the differently shaped Helmholtz cavities in the panel and at their more numerous additional resonant frequencies. In addition, by forming the acoustic panel this way, its inner surface **15** will be smooth and generally planar. Consequently, from the point of view of appearance, the acoustic panel will be just as satisfactory as prior perforate panels.

The modified acoustic panel, indicated generally by the reference numeral **40** in FIGURE 3, shows how acoustic panels having internal cavities with other shapes can be easily fabricated. In this modification, the emphasis is on presenting a sound absorbing surface to the incident sound

which is substantially greater than the external dimensions of the panel. As shown in FIGURE 3, acoustic panel 40 is composed of an inner perforate strip 44, an outer imperforate strip 46, and a single intermediate strip 48. As seen in FIGURES 3 and 4, the inner strip 44 is provided with perforations 50 extending therethrough, the intermediate strip 48 is provided with enlarged circular openings 52 extending therethrough, as shown in FIG. 5, and the outer or base strip 46 is imperforate, as shown in FIG. 6.

With this arrangement, when the strips are laminated together and openings 50 and 52 are arranged so that they are concentric with each other, the combination of these strips forms an acoustic panel with a plurality of enlarged internal cavities 42 therein. It is apparent from inspection of FIG. 3 that the inner surface areas of the cavities 42 provide the panel with a sound absorbing area which is substantially greater than the area defined by the external dimensions of the panel. In addition, it is apparent that the openings 50 and 52 can be easily drilled in strips 44 and 48. Consequently, the fabrication of this new and more efficient acoustical panel 40 is simple and economical.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred examples of the same, and that various changes in the shape, size, and arrangement of the parts may be resorted to without departing from the spirit of this invention or the scope of the claim.

We claim:

An acoustic panel formed from a laminate provided with a plurality of sound absorbing cavities, said laminate

comprising an imperforate strip, a second strip having truncated frusto-conical holes therethrough provided with small openings closed off by said imperforate strip and with large openings, a third strip having large cylindrical holes therethrough communicating with the large openings, a fourth strip having truncated frusto-conical holes therethrough provided with large openings communicating with the cylindrical holes and with small openings, and a fifth strip having small cylindrical holes communicating with the fourth strip small openings, the holes being aligned to form the cavities.

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