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SOUND-ABSORBING COVERING

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Fig. 1

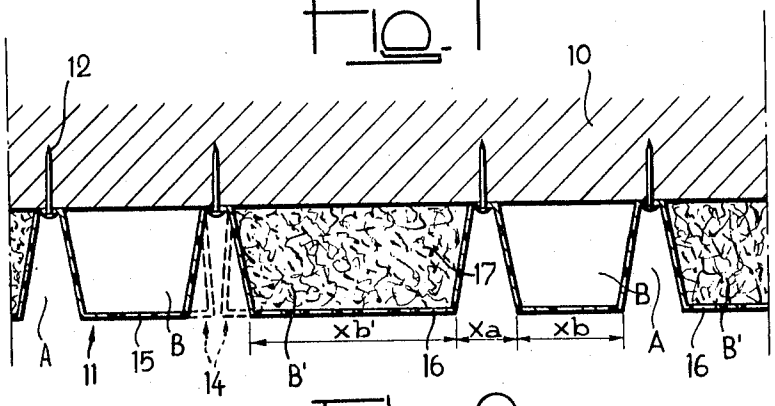
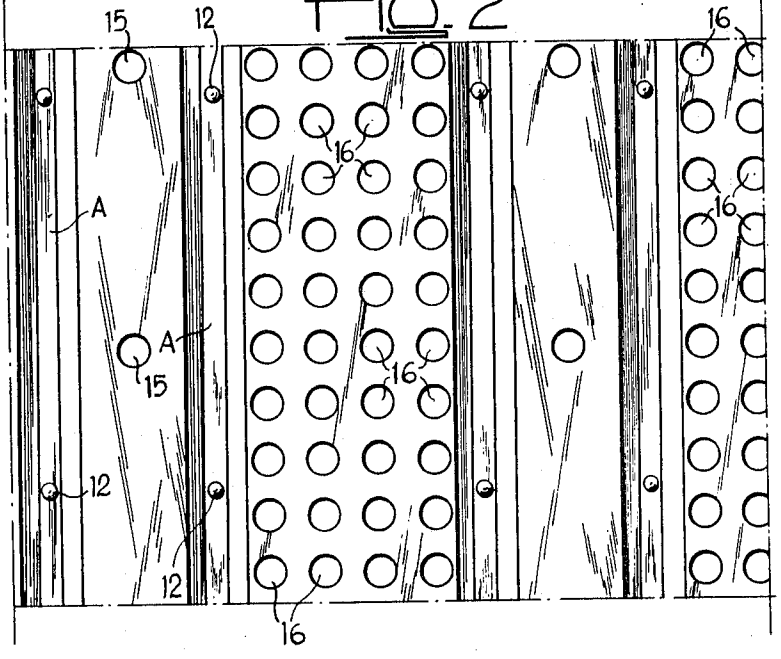


Fig. 2



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SOUND-ABSORBING COVERING

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2 Claims. (Cl. 181—33)

This invention relates to sound-absorbing coverings for noisy rooms and the like, more particularly to sound-deadening of road tunnels and underground railways.

An object of this invention is to provide a sound-absorbing covering which is extremely simple in structure, inexpensive and easily fitted even by non-qualified, workmen without any prejudice to effectiveness of the covering.

A further object of this invention is to provide a sound-absorbing covering which is capable of truly following the curvature of the tunnel vault.

Still a further object of this invention is to provide a sound-absorbing covering which will resist deterioration by motor vehicle exhaust gases and tunnel drain water, will not prevent drainage of such water and is not adversely affected thereby in operation.

Further objects and advantages of this invention will be understood from the appended description.

With the above objects in view the invention provides in combination with a wall confining an enclosure, more particularly a tunnel, a sound-absorbing covering of the type comprising a corrugated foraminated sheet, part of the channels in which may contain a fibrous filling, characterized by the following features: (a) the width of the outer channels, measured at the level of the bottoms of the inner channels, ranges between 0 and a fraction only of the width of the inner channels measured on the same level; (b) the bottom of the inner channels only is foraminated; (c) the bottom of part at least of the outer channels is riveted to said wall.

The adjectives "outer" and "inner" employed herein with reference to given channels formed by the corrugated sheet are intended to convey that, in the covering, said channels open outwardly and inwardly, respectively, of the covering-wall structure; so, the "inner" channels open towards the wall and have their bottom turned towards the enclosure to be sound-deadened.

In view of the above recited objects the improved sheet is preferably made of synthetic resins, such as polyvinyl chloride, although, if desired, proper metallic materials can be employed. The term "corrugated sheet" should be understood in the sense that the channels formed by the sheet are at least substantially parallel with one another, so that the sheet can be rolled upon itself and can therefore easily suit the curavature of a tunnel vault, in an arrangement wherein the channels formed by the sheet extend longitudinally of the tunnel. It will be clear that, by thus curving the sheet, the outer channels, namely, the channels opening towards the tunnel bore, spontaneously close or can be closed, so that their width at the level of the bottoms of the inner channels is totally annulled; in this manner, the foraminated bottoms of the inner channels form a practically uninterrupted foraminated surface behind which the inner channels form a system of acoustic resonators absorbing noise.

According to a further feature of this invention the inner channels comprise relatively wide channels alternating with relatively narrow channels, the closeness of the bottom foramination in the relatively wide channels being greater than in the relatively narrow channels, the fibrous filling being contained in the relatively wide channels only.

This results in two sets of acoustically differentiated channels, namely, relatively wide narrowly foraminated, fiber-filled channels acting as absorbers for relatively high frequencies, and narrow rarely foraminated channels deprived of a fibrous filling, acting as low frequency resonators.

Since the inner channels opening towards the tunnel wall or vault all have a foraminated bottom, drain waters easily drain from said channels through the foraminations and cannot therefore adversely affect operation of the resonators. As far as the fibrous filling is concerned, fibers of water repellent materials or fibers made water repellent shall be suitably employed; a large number of synthetic fibers are water repellent by virtue of their chemical composition, and a large number of products are known which confer water repellency to synthetic, mineral and vegetable fibers, though the latter are undesirable as they are combustible and subject to deterioration.

An embodiment of the covering according to this invention is shown on the accompanying drawings, wherein:

FIGURE 1 is a part cross sectional view of a tunnel on a plane perpendicular both to the tunnel axis and the longitudinal direction of the channels, and

FIGURE 2 is a part view from below of FIGURE 1.

A solid tunnel wall **10** has riveted thereto by means of rivets **12** a corrugated sheet **11**. The sheet **11** is of plastics, such as polyvinyl chloride, generally ranging in thickness between 0.5 and 1.5 mm., which has been hot corrugated (in a pastic state), so that its corrugations are of a permanent though elastically deformable nature. The corrugations extend parallel with the longitudinal tunnel axis.

The wave shape in the corrugations is trapezoidal, but this is not essential, as a rectangular wave can be employed too; similarly, the edges of the corrugations can be sharp edges (as shown) or rounded. The sheet **11** thus forms outer channels denoted by A and inner channels denoted by B and B′. The latter are mutually insulated by the walls of channels A and comprise relatively narrow channels B alternating with relative wide channels B′. The width Xb' of the channels B′ advantageously range between twice and three times the width Xb of the channels B. The width Xa of the outer channels A, measured at the level of the bottoms of the inner channels B, B′ amounts to a fraction only of the width Xb of the channels B and can be reduced to zero, as diagrammatically indicated by dash lines **14** in FIGURE 1. In this manner, the flanks and bottom of each outer channel A actually form a narrow separating rib only between the two inner channels B, B′ adjacent the channel A, the bottom of the latter being riveted to the wall **10** in order to position the sheet **11**. All the channels are of the same depth.

The bottom of each of the relatively narrow inner channels B is formed with a single row of apertures **15** which are rather widely spaced, whereas the bottom of each of the relatively wide inner channels B′ is formed with four rows of apertures **16** which are relatively narrowly spaced. Considering the volume of each inner channel, each hole **16** in the channels B′ has associated therewith at the back a volume which amounts to a fraction only of the volume associated with each of the holes **15** in channels B. Each aperture **16** thus acts as a mouth of a high frequency resonator, whereas each aperture **15** acts as a mouth of a low frequency resonator.

The apertures **15, 16** provide the only access to the inner channels B, B′ through the sheet **11**.

In order to expand the absorption band for high frequencies a fibrous filling **17** can be arranged in each of the channels B′.

Although road tunnels and underground tunnels are not similar in noise acoustic spectra, nevertheless it has been found that an excellent sound-deadening extent can be obtained in both said tunnel types by adopting the following numerical values:

Channel depth	cm.	2–3
Width Xa, max.	cm.	1
Width Xb	cm.	1–2
Width Xb'	cm.	3,5–4,5
Diameter of apertures **15**	mm.	5,5–6,5
Diameter of apertures **16**	mm.	3,5–4,5
Volume of channel B per each aperture **15**	$cm.^3$	16–24
Volume of channel B' per each aperture **16**	$cm.^3$	2–3

It should be noted that in the above described case the width Xa which represents a dead zone ranges between 22% and 15% of the sum of the effective widths Xb and Xb' and by further reducing said dead zone, the percentage of the effective absorption area can be increased practically to 100% (Xa=zero); this depends chiefly on the method of riveting the sheet **11** to the wall **10**.

What I claim is:

1. In combination with a tunnel wall, a sound-absorbing covering consisting of a corrugated sheet material forming relatively wide and relatively narrow inner channels alternating with outer channels extending lengthwise of the tunnel and wherein: the bottoms of the outer channels are fitted to said wall thereby to mutually insulate the inner channels; the width of the outer channels measured at the level of the bottoms of the inner channels amounts to a fraction only of the width of both the relatively wide and relatively narrow inner channels measured on the same level; a relatively dense plurality of apertures is formed in the bottom of each of the relatively wide channels and a relatively rare plurality of apertures is formed in the bottom of each of the relatively narrow channels; and a fibrous filling in each of the relatively wide inner channels only.

2. In combination with a tunnel wall, a sound-absorbing covering consisting of a corrugated sheet material forming relatively wide and relatively narrow inner channels alternating with outer channels extending lengthwise of the tunnel and wherein: the bottoms of the outer channels are fitted to said wall thereby to mutually insulate the inner channels; the width of the outer channels measured at the level of the bottoms of the inner channels amounts to a fraction only of the width of both the relatively wide and relatively narrow inner channels measured on the same level; a relatively dense plurality of apertures is formed in the bottom of each of the relatively wide channels and a relatively rare plurality of apertures is formed in the bottom of each of the relatively narrow channels; said apertures providing the only access to the inner channels through said sheet; and a fibrous filling in each of the relatively wide inner channels only.

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