Feb. 9, 1932. E. H. SMYTHE 1,844,108

METHOD OF MANUFACTURING ACOUSTIC IMPEDANCE ELEMENTS

Filed June 19, 1930 3 Sheets-Sheet 1

FIG. 1

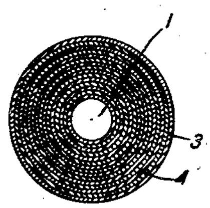


FIG. 1-A

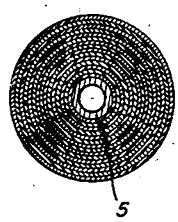


FIG. 2

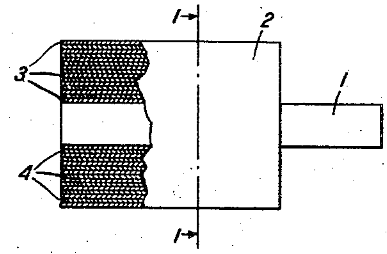


FIG. 3

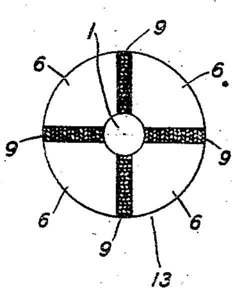


FIG. 3-A

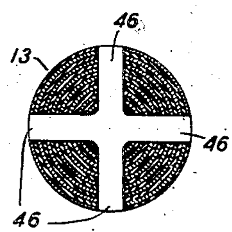


FIG. 4

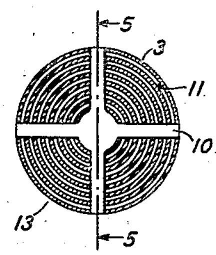


FIG. 5

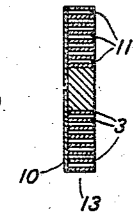
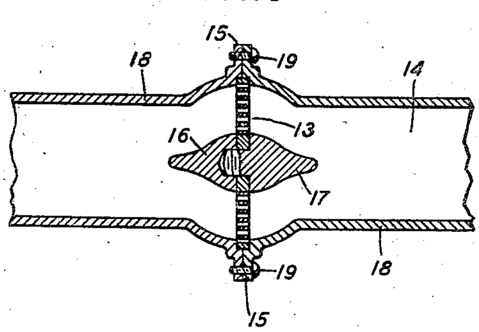


FIG. 6



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METHOD OF MANUFACTURING ACOUSTIC IMPEDANCE ELEMENTS

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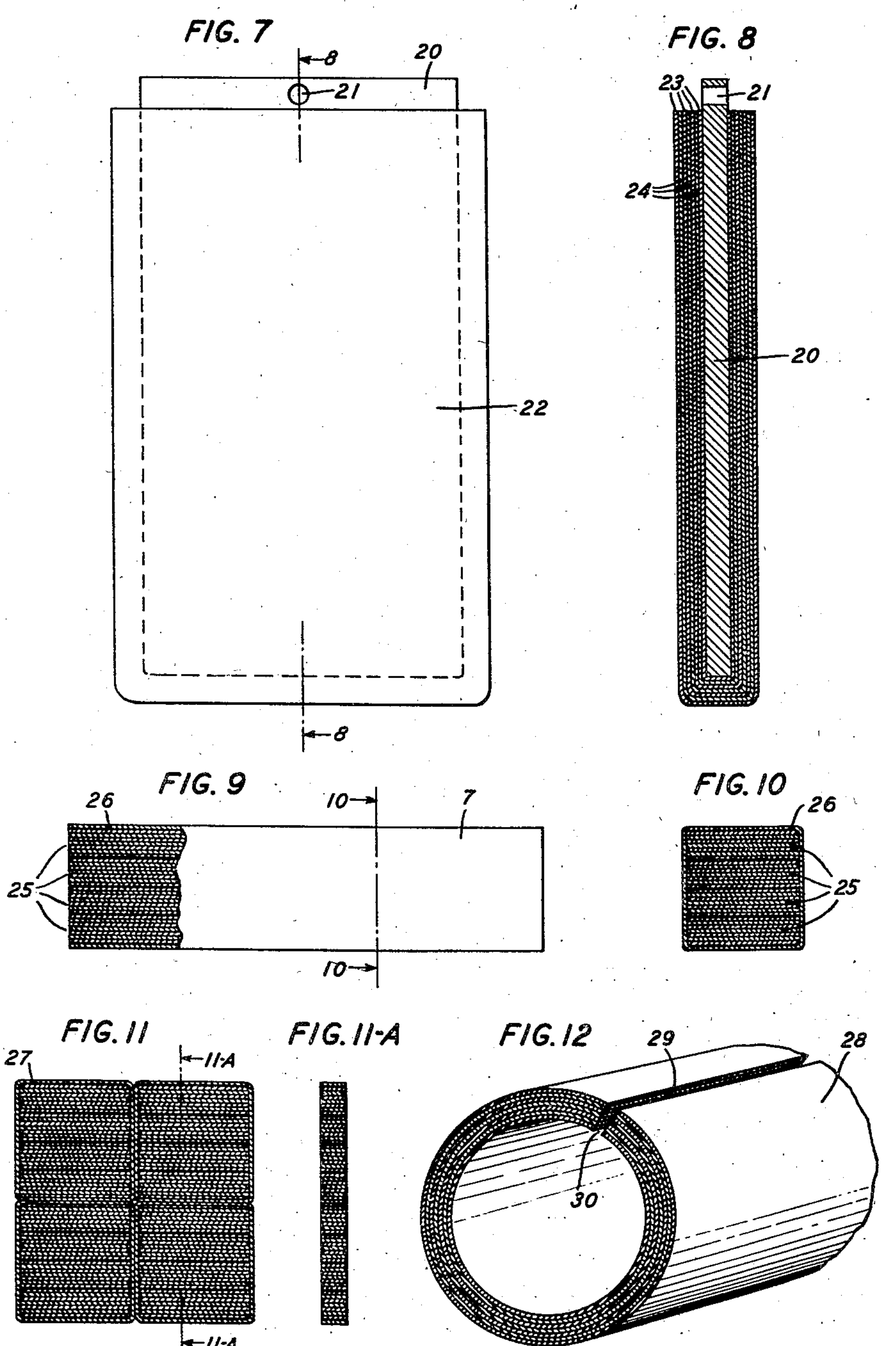

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METHOD OF MANUFACTURING ACOUSTIC IMPEDANCE ELEMENTS

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FIG. 13

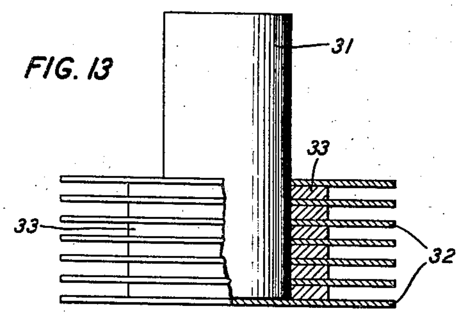


FIG. 14

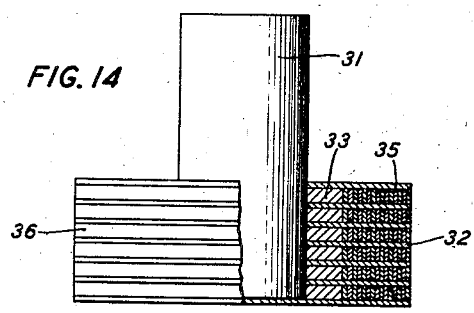
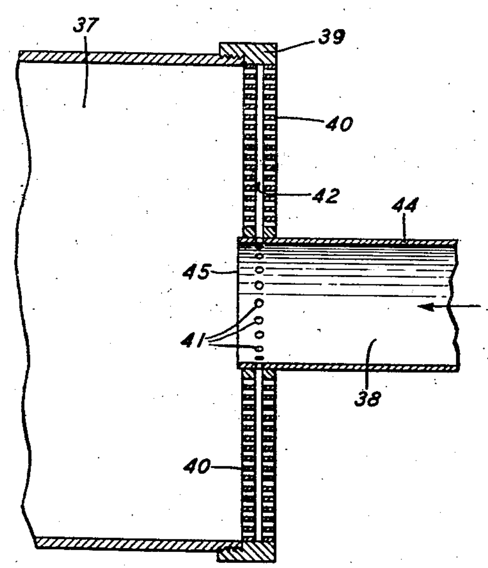


FIG. 15



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UNITED STATES PATENT OFFICE

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METHOD OF MANUFACTURING ACOUSTIC IMPEDANCE ELEMENTS

Application filed June 19, 1930. Serial No. 462,178.

This invention relates to acoustic impedance elements of resistive or energy dissipative character suitable for damping of acoustic vibrations, and more particularly to a method of manufacturing them.

An object of this invention is to manufacture acoustic impedance elements of predetermined characteristics in a variety of configurations and sizes in a simple and accurate way. The results desired to be obtained with an acoustic impedance element being known, the dimensions-breadth, width and length of the acoustic passage-ways therein—may be determined in accordance with the disclosure in the pending application of P. B. Flanders, Serial No. 273,523, filed April 28, 1928.

In accordance with this invention and in its preferable form, layers of two materials, one of which is later to be dissolved out or otherwise removed, are alternately plated upon a conducting core until a composite layer of the desired thickness is obtained, having a desired number of layers of material, each layer of a desired thickness and that of the material to be dissolved out, being such that when removed in a solvent, apertures of predetermined dimension are obtained. When the composite layer is built up to the desired degree, and if the core is rectangular or circular in section, slices of the desired thickness may be cut therefrom, each slice provided with strengthening means upon one or each surface and then dipped in a solvent whereby the soluble material is dissolved out, leaving a grid-work, the apertures in which provide sound passage-ways of predetermined acoustic properties.

In another embodiment of this invention, a composite layer after having been built up on a flat core may be stripped therefrom, cut into strips, piled in stacks of desired dimension and held firmly together by plating a thin layer of material thereabouts, said material not to be attacked by the solvent to be used to remove one of the alternately plated materials, or by sweating the adjacent surfaces of the respective strips together. Slices may then be cut from this bar and subjected to the action of an appropriate solvent to dissolve out one of the materials used in forming the composite layer. When the thin plating is employed to secure the strips into a single bar, no other support is necessary to maintain the non-dissolved material properly spaced. When, however, the strips are sweated together, a supporting frame-work on one or each surface is necessary.

In still another embodiment of this invention, individual acoustic impedance elements may be manufactured by using a core of conductive material and mounting alternately thereon washer-like members of conductive material and of non-conductive material, the latter being, preferably, of larger diameter than the former. The assembly is then immersed alternately in plating baths of chosen materials thereby building up on each individual conductive washer, annuli of the two materials. Upon completion of the plating operations, each unit is removed from the core, provided with a supporting frame-work or the like, and immersed in an appropriate solution whereby one of the plated materials may be dissolved out.

In the embodiments of the invention described hereinbefore, it has been said that when a unit or slice of the desired thickness is obtained it should be provided with strengthening means or a supporting framework before one of the alternately plated materials is dissolved out or otherwise removed. Instead of providing this on the surfaces of said slice or unit, radial bands of insulating material of greater width than the thickness of the slice or unit may be painted thereon. Then, when the slice or unit is subjected to the action of an appropriate solution, the portions protected by the insulating bands will not be as readily attacked as the free portions and a unit having the desired acoustic passageways and integral supporting ribs is obtained.

A more complete understanding of this invention will be had from the description which follows and by reference to the appended drawings wherein:

Fig. 1 is a section along the line 1—1 of Fig. 2 showing how a composite layer of two materials may be built up on a solid core;

Fig. 1—A is a section similar to that of

Fig. 1 except that the composite layer is built up on a tubular member;

Fig. 2 is a partially broken view of a cylindrical composite layer built up in accordance with this invention and from which acoustic impedance elements may be obtained;

Fig. 3 illustrates one step in providing a slice cut from the bar of Fig. 2 with a supporting frame-work;

Fig. 3—A illustrates an alternative method to provide a slice cut from the bar of Fig. 2 with a supporting structure;

Fig. 4 shows the slice of Fig. 3 after being provided with a supporting frame-work and dipped in an appropriate solvent to dissolve out the layers of one material;

Fig. 5 is a section of Fig. 4 along the line 5—5;

Fig. 6 illustrates the application of an acoustic impedance element in an acoustic channel;

Fig. 7 illustrates a modification of the method comprising this invention;

Fig. 8 is a section of the showing in Fig. 7 along the line 8—8;

Figs. 9, 10 and 11 and 11—A illustrate stages in carrying out another application of this invention employing the composite layer shown in Figs. 7 and 8;

Fig. 12 shows another embodiment of the composite layer of Figs. 7 and 8 from which acoustic impedance elements may be formed;

Figs. 13 and 14 illustrate the application of this invention to the formation of individual acoustic impedance elements;

Fig. 15 illustrates a use in an acoustic channel of acoustic impedances manufactured in accordance with this invention.

There is shown in Figs. 1 and 2 a cylindrical core member 1 of electrically conductive material, not soluble in the solutions in which it is immersed, upon which has been built up a composite layer 2 comprising alternate layers of materials 3 and 4 which have been plated thereon and upon one another by immersing the conductive core as an electrode first in a plating bath of one material and then into that of the other. Before alternate immersions the last layer of plating material is rinsed in an appropriate solution and may if desired be polished or buffed to smooth out irregularities on its surface and to provide a good plating surface for the succeeding layer of material. As shown in Fig. 1—A, a tubular core member 5 may be employed in preference to the solid core 1.

From the composite bar shown in Fig. 2, a slice 13 of the desired thickness may be cut and on one or each surface coated, as in Fig. 3, with an insulating paint 6 except on those portions 9 whereon it is desired to plate a supporting and insoluble framework whereby alternate annuli of the slice may be held in spaced relation after the insulating coating has been washed off and the slice 13 immersed in an appropriate solution whereby the alternate layers of the material 4 are dissolved out, leaving the structure shown in Figs. 4 and 5: an acoustic impedance element provided with a supporting rib structure 10, and concentric annuli 3 in spaced relation and defining a plurality of concentric acoustic channels 11.

Fig. 3—A shows another method of providing the acoustic device with a supporting structure for its unit or slice. Each surface, preferably, of the slice 13 is coated with radial bands 46 of an insulating material, said bands being greater width than the thickness of the slice and not being subject to the action of the solvent or other means used to remove one of the materials from the slice. When the unit is immersed in an appropriate solution, the desired passageways will be formed by the removal of the soluble material in the free areas but a portion only will be removed from under the insulating bands. Hence, radial integral ribs are obtained obviating the need of a supporting frame-work on one or each surface of the unit.

The use of the acoustic unit so fabricated in a sound channel whose cross sectional area is desired to be kept constant is illustrated in Figure 6 wherein the core portion of the unit 13 has been reamed and tapped whereby molded portions 16 and 17 may be mounted on opposite surfaces thereof. The unit 13 may be secured by bolts 19 between the flanges 15 of the acoustic channel defining members 18.

It will be understood that instead of using a cylindrical core and thus forming cylindrical acoustic members, a core of any desired geometrical configuration may be employed dependent, of course, upon the use to which the unit obtained therefrom is to be put and the characteristic desired. Furthermore, after the slices of desired thickness are cut from the bar, a supporting frame-work need not necessarily be plated thereon but a previously formed skeleton may be attached thereto, for instance: by soldering, sweating or the like.

In carrying out this invention, the material to be dissolved is plated to a thickness determined by the characteristics desired in the acoustic impedance units. This thickness is between one mil and five mils, although it may be less or greater as desired. Usually, however, a thickness of one mil is employed whereby, if the transverse breadth and the length of the acoustic channels are of appropriate dimensions, an impedance unit having a substantially resistive characteristic, only, may be obtained. It is to be understood, however, that this invention is in no way restricted to the manufacture of acoustic units of that characteristic only.

The materials which may be alternately

plated on a core in carrying out this invention may be of copper and zinc, zinc being the material to be later dissolved in say a solution of hydrochloric acid; nickel and zinc, zinc being the material dissolved out in a solution of hydrochloric acid; cadmium and copper, nickel or cobalt, and cadmium being the material to be dissolved out later in, say, a solution of hydrochloric acid; cadmium or zinc and chromium, zinc or cadmium being later dissolved out in, for instance, a solution of nitric acid; copper or nickel and chromium, the copper or nickel to be preferably the material to be later dissolved out in a solution of nitric acid. Chromium, however, could be dissolved out in hydrochloric acid but the latter process would not be as expeditious as the former. Zinc, chromium or cadmium and silver may be employed, the zinc, chromium or cadmium being the material later dissolved out say in a solution of hydrochloric acid.

From the foregoing illustrative combinations, it will be apparent that the practice of this invention is not limited as to the materials which may be employed. It will be noted that in all combinations recited in the preceding paragraph, the element which is later to be dissolved out of the composite unit is higher in the electromotive series than the other element with the exception of the copper or nickel and chromium combination. Chromium, however, will not displace either the copper or the nickel when either of the latter is being dissolved out.

Acoustic impedance elements may be manufactured in accordance with this invention also in the following manner:

A flat core member 20 of conductive material (see Figs. 7 and 8) is immersed alternately in plating baths of two different materials, one of which is later to be dissolved out, whereby a composite layer 22 of alternate layers of the materials 23 and 24 is formed thereon, the innermost and outermost layers being of the material which is not to be dissolved out. After a composite layer of the desired thickness and number of alternate layers is obtained, it is stripped from the core member 20 and cut into strips of desired width and a desired number of such strips 25 are stacked, one upon another, as shown in Fig. 9, to form a bar 7 which has been provided thereabouts with a thin plating 26 of, for instance, the same material as that not to be dissolved out to hold the strips together. From this bar may be cut slices of a section shown in Fig. 10 which may then be dipped into an appropriate solvent to cause alternate layers of one material to be dissolved out leaving a plurality of apertures providing acoustic channels of an acoustic impedance of a predetermined characteristic. A number of such slices may be united in a larger unit, for instance, as shown in Figs. 11 and 11—A, by stacking them alongside of one another and holding the assembly together with a thin layer of material 27 plated on the external surfaces of the units. The acoustic passageways are not shown in these figures.

It will be apparent that impedance elements of any desired configuration may be formed from the composite layer 22 stripped from the flat core 20. As an example, instead of cutting the layer 22 into strips, as described in the preceding paragraph, it could be formed into a broken annulus 28 to whose spaced surfaces 29, which form a rectangular opening 30, a supporting member (not shown) may be secured. Slices of a desired thickness may be cut from the annulus 28, dipped into an appropriate solvent to dissolve out one material and an annular acoustic impedance element is obtained which comprises broken spaced annuli supported at their broken portions. A supporting structure to maintain said annuli in spaced relation may be employed in the manner described above. An alternate method would be to form an unbroken annulus by soldering or cementing the surfaces 29 together with a material which will not be readily attacked by the solvent used to remove the one material from the slices later cut from the annulus.

If slices of the desired thickness cannot be cut from the composite layers described above units of greater thickness may be cut therefrom and then ground down to the desired thickness.

Figs. 13 and 14 illustrate the application of this invention to the manufacture of individual acoustic impedance elements. A conductive core 31 has mounted thereon a plurality of thin flat washer-like members 32 and 33 of alternately non-conductive and conductive material respectively, the latter being preferably of smaller dimension than the former. The lowermost non-conductive member 32 is secured to the core 31 in an appropriate manner, the remaining members 32 acting as spacers between the conductive washer-like members 33.

Fig. 13 is illustrative of the assembly before plating operations are begun and which is immersed as an electrode alternately in the plating bath of first one material and then of another whereby a plurality of alternate layers 35 of these materials are caused to be formed on the members 33 to produce the composite members 36. Each individual unit may then be removed and treated as explained with reference to Figs. 1 to 5. It will be understood, of course, that the members 33 may be of either of the materials employed in building up the composite layer or of some other material. Assuming that they were of the same material as that of the layers later to be dissolved out they would go into solution when the unit was dipped into the appropriate solvent after being provided with a supporting member.

Fig. 15 is illustrative of an application of acoustic impedance elements formed in the ways previously outlined. Elements 40 are positioned in an acoustic channel 37 and are supported at their peripheries by a ring member 39 in spaced relation to define an annular volume 42 and a member 44, defining an acoustic channel 38, which extends through the central portions of said acoustic elements and is provided with a plurality of vents 41 leading into the annular volume 42. It will be apparent that the structure shown is capable of a variety of uses, for instance, providing a leakage path or a combined series and leakage path for the acoustic disturbances, flowing in the direction of the arrow. In the latter case, the extremity 45 of the acoustic channel member 44 would be walled up.

It will be understood that although the detailed description above proposes that in each embodiment of the invention the acoustic unit be formed from a slice or unit by dissolving out one of two materials forming a composite layer, said one layer may be removed by a deplating operation, if desired, rather than by having it removed in an appropriate solution.

It is to be understood that the above description relates to what are believed to be preferred methods only of carrying out this invention and that the latter's scope is not to be limited other than by the appended claims.

What is claimed is:

1. The method of manufacturing an apertured structure which comprises forming a composite body of alternate layers of different materials, securing said layers to means for holding them in spaced relation, and afterwards removing one of said materials.

2. The method of manufacturing an apertured structure which comprises forming a composite body of alternate layers of different materials, forming on one or both surfaces a frame-work integral therewith, and afterwards removing one of said materials.

3. The method of manufacturing an apertured structure which comprises forming a composite body of alternate layers of different materials by alternate electrodepositions of said materials, securing said layers to a common support, and afterwards removing one of said materials.

4. The method of manufacturing an apertured structure which comprises immersing a member as an electrode alternately in plating baths of different materials, thereby forming a composite layer thereon, providing a supporting frame-work for said layer, and afterwards removing one of said materials to form a structure having a plurality of passageways.

5. The method of manufacturing an apertured structure which comprises forming a composite body of alternate adherent layers of different materials, securing said layers to means for holding them in spaced relation, and afterwards removing one of said materials.

6. The method of manufacture which comprises forming a finely laminated bi-metallic plate having the laminations parallel to the surface of the plate by alternate electrodepositions of said metals on a central portion of said plate, securing alternate laminations, at least, to a common support, and afterwards removing one of the materials to form a finely slotted structure.

7. The method of manufacturing an acoustic impedance element which comprises immersing a conductive member alternately in plating baths of different materials, whereby a composite layer of alternate layers thereof is formed thereon, providing a supporting structure for said layer, and afterwards removing one of said materials to form a slotted structure providing a plurality of acoustic channels.

8. The method of manufacturing an acoustic impedance element which comprises building up a composite layer of a plurality of alternate layers of different materials, cutting slices from said layer transverse to the planes of said alternate layers, securing said layers to means for holding them in spaced relation, and afterwards removing one of said materials to form a slotted structure.

9. The method of manufacturing an acoustic impedance element which comprises immersing a member as an electrode alternately in plating baths of different materials, whereby a composite layer is formed thereon consisting of alternate layers of said materials, cutting said composite layer transverse to the planes of its alternate layers, whereby a slice of a desired thickness is obtained, securing said layers to a common support, and afterwards removing one of said materials to form a slotted structure.

10. The method of manufacturing an acoustic impedance element which comprises forming a finely laminated bi-metallic coating on a core member, thereafter slicing therefrom a unit of desired thickness, associating supporting means for the laminations into said unit, and removing one of the metals to form a finely slotted structure.

11. The method of manufacturing an acoustic impedance element which comprises electrodepositing upon a conductive core thin alternate layers of a plurality of materials to form a composite layer, cutting therefrom a slice of desired thickness, attaching a supporting frame-work on one or both of its surfaces, and thereafter removing one of the materials to leave a slotted structure.

12. The method of manufacturing an

acoustic impedance element which comprises immersing an electrode member alternately in plating baths of different materials, thereby forming a composite layer thereon, removing said composite layer from said electrode, cutting said layer into strips, piling the said strips in stacks, securing them together, cutting said stacks into slices and dipping said slices into an appropriate solution whereby one of said plated materials is dissolved out leaving a structure with a plurality of apertures therein.

In witness whereof, I hereunto subscribe my name this 14th day of June, 1930.

EDWIN H. SMYTHE.