June 14, 1932. E. H. SMYTHE 1,863,073

METHOD AND MEANS FOR TENSIONING AND FOR MOUNTING DIAPHRAGMS

Filed April 23, 1930 2 Sheets-Sheet 1

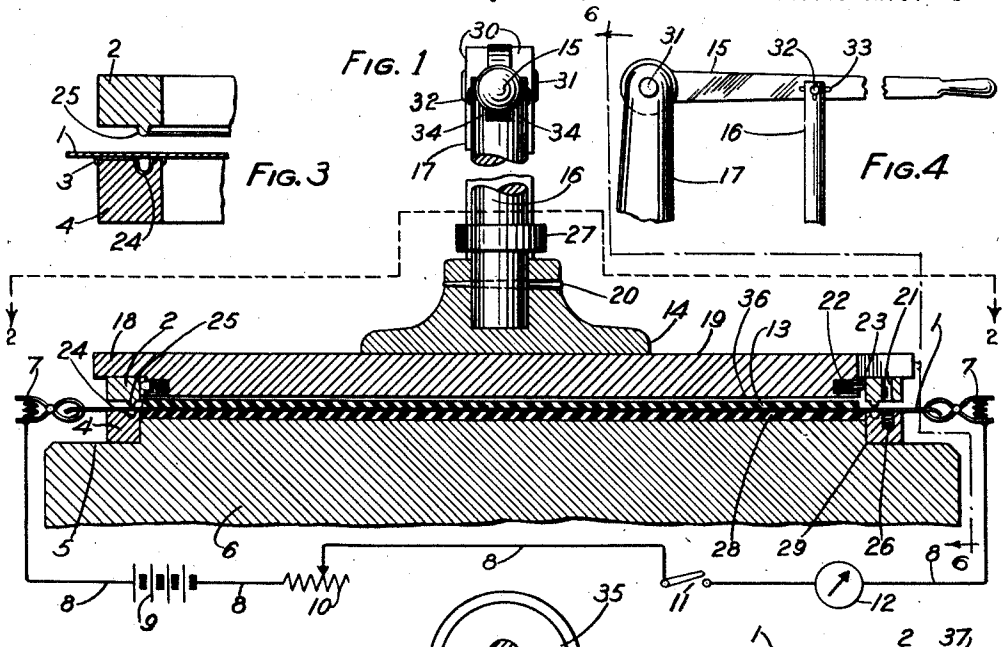


FIG. 1

FIG. 3

FIG. 4

FIG 2

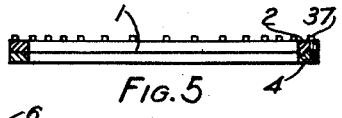
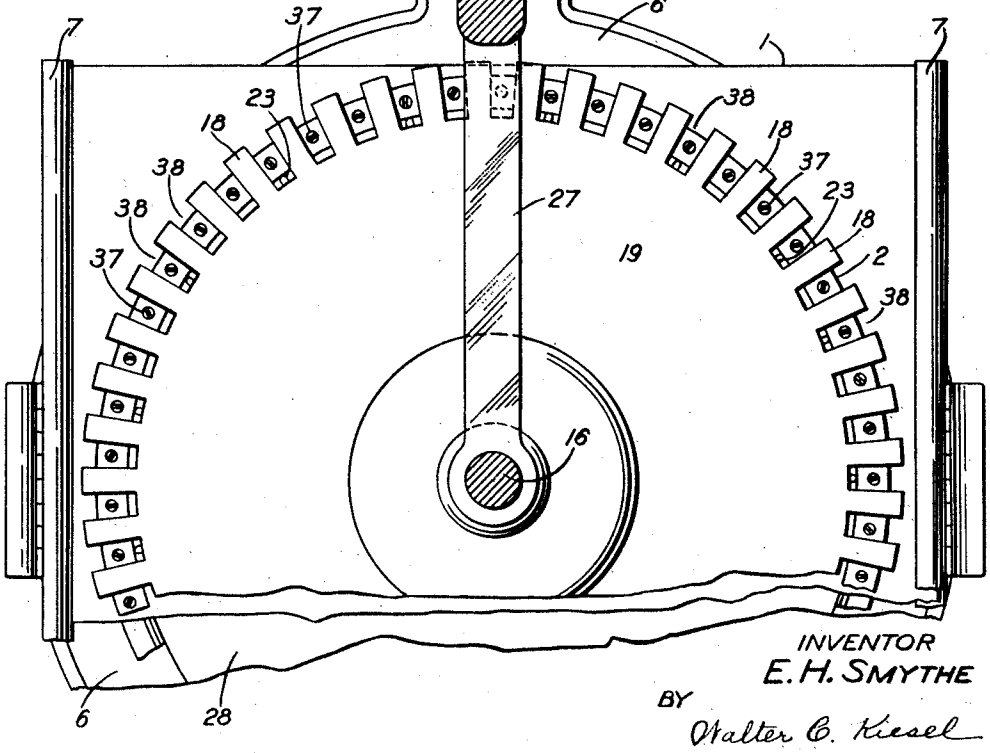


FIG. 5



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METHOD AND MEANS FOR TENSIONING AND FOR MOUNTING DIAPHRAGMS

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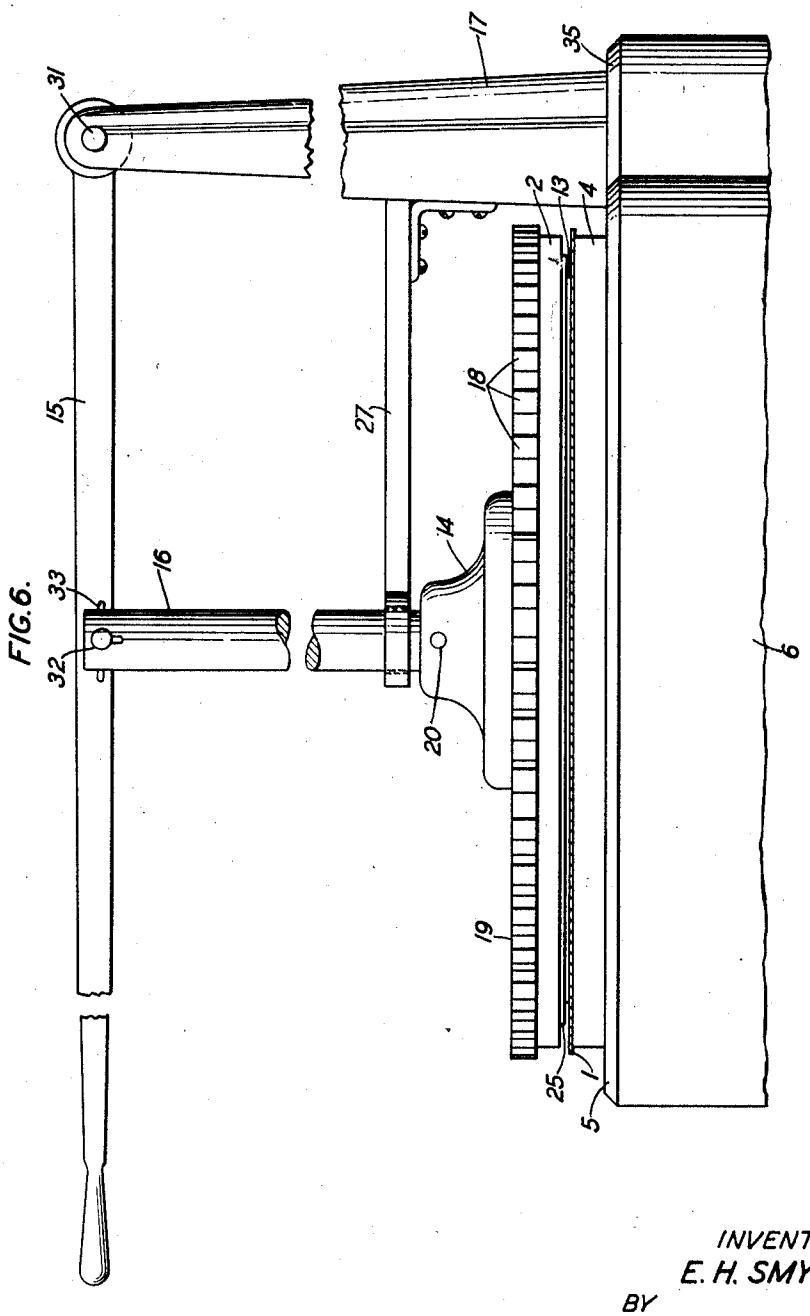

FIG. 6.

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METHOD AND MEANS FOR TENSIONING AND FOR MOUNTING DIAPHRAGMS

Application filed April 23, 1930. Serial No. 446,691.

This invention relates to a method of and means for uniformly stretching metal diaphragms or membranes to be used in acoustic devices in general and more particularly in phonographs, transmitters, receivers, loud speakers and the like.

The object of this invention is to uniformly tension metallic diaphragms to any desired degree in a simple, cheap, accurate and time saving way which requires a minimum of skill or knowledge on the part of the operator.

The feature of this invention consists in heating the diaphragm by passing an electric current therethrough, thereby causing it to expand, the amount of expansion thereof depending upon the temperature to which the diaphragm material is heated. When it has reached a predetermined temperature, cold mounting members are clamped upon and secured to it.

Another feature of this invention consists in the provision of means in the electric circuit of which the diaphragm material is a part to indicate to the operator that it has been heated to the predetermined temperature. The operator then clamps the mounting members to the diaphragm and the electric circuit is simultaneously broken whereby the diaphragm may cool and be tensioned inasmuch as it is constrained by the mounting members from returning to its original condition.

Still another feature of this invention resides in the means employed in carrying out the method forming a feature of this invention.

In accordance with this invention, a strip of diaphragm material is inserted in an electric circuit which includes a source of current, a circuit resistance varying means, a switch and a current indicating means. The diaphragm material is then placed between the fixed and movable elements of a clamping device in which the mounting members to which the diaphragm is to be secured have already been positioned one on the movable element and one on the fixed element. An electric current is then permitted to flow through the diaphragm material heating it and causing it to expand. When heated to a predetermined temperature, the current flow is interrupted and simultaneously the movable element of the clamping device is brought down against the fixed element positioning the mounting members on opposite surfaces of the diaphragm material to hold them together and to prevent the contraction of the diaphragm material to its original condition, while the mounting members are being rigidly secured together. The means for connecting the diaphragm material in the electric circuit are removed, the diaphragm unit is removed from the clamping device, the portion outside the mounting members trimmed off; and the diaphragm unit is ready for use.

A more complete understanding of this invention will be obtained by reference to the appended drawings wherein:

Fig. 1 is an elevational view, partly in section, of means for effectuating the method comprising a feature of this invention;

Fig. 2 is a view of Fig. 1 along the lines 2—2 and shows more in detail the nature of the movable element of the clamping device by means of which the expanded diaphragm material is secured by the mounting members;

Fig. 3 is an enlarged section of a portion of the mounting members shown in Fig. 1 and illustrates how the lower mounting ring may be electrically insulated from the diaphragm material;

Fig. 4 illustrates a force producing arrangement which may be employed with the movable element of the clamping device of Fig. 1;

Fig. 5 is a section to a reduced scale of a diaphragm unit, the diaphragm unit of which has been tensioned in accordance with the method forming one feature of this invention and assembled in the means forming another feature of this invention and

Figure 6 is an elevational view of Fig. 1 along the line 6—6.

Referring now to the drawings, there is shown a rigid block 6 having an annular shoulder portion 5. A mounting member 4 in the form of a ring of a light weight, high strength material, such as aluminium, rests

thereon, there being a slight clearance only between its inner surface and the annular surface 29 of the block 6. The ring 4 is provided with an annular groove 24 and with tapped drillings 26 at spaced intervals about its periphery. The surface of the member 4 is given a thin coating 3 of an electrically insulating substance, for instance, shellac, to insure that surface against short circuit of electric currents. The block 6 is provided with a layer of heat insulating material 28 such as asbestos, the upper surface of said layer being preferably in the plane of the upper surface of the mounting member 4.

Extending vertically from the rearwardly projecting portion 35 of the block 6 is a standard 17 having bifurcations 30 between which a lever arm 15 is rotatably supported on the pin 31. Another lever 16 is attached at one end to arm 15 by means of a pin 32, joining its bifurcated portions 34 and passing through and slidably movable in the slot 33 of arm 15. At its lower extremity, lever 16 passes through the centering arm 27, which projects horizontally outward from the standard 17, and fits into a cylindrical depression in member 14. It is secured therein by a pin 20 passing through it and said member.

The member 14 includes a flat plate portion 19 having a multiplicity of spaced projecting portions 18, said portions defining recesses 38 which provide passageways for easy access to the mounting member 2 for the insertion of fastening bolts. The portions 18, also, distribute the force exerted on the member 14 to the mounting member 2. Supported on the underside of these fingers is a mounting member 2 which may be of the same material as member 4 and likewise ring shaped. It is provided with an annular ridge 25 which is adapted to fit into the groove 24 in the member 4. In alignment with the tapped drillings 26 in member 4 are drillings 21. The member 2 is held in place on the movable element of the clamping device by a plurality of spaced depressible buttons 23 acted upon at their bases by springs 22 and mounted in said member 19.

A strip of metallic diaphragm material is shown between the elements of the clamping device and rests upon the flat surface formed by the ring 4 and the heat insulating or thermally non-conductive material 28. On the upper surface of the diaphragm material rests a flat plate 13 of heat insulating material, for instance, of asbestos, which acts not only to prevent heat loss when the diaphragm material is being raised to its predetermined temperature but also to prevent heat loss after the closed electrical circuit has been opened. This plate acts, also, to maintain the diaphragm material in the same plane when current is passing through it and when it is expanding. There should be sufficient clearance between the upper surface of this plate 13 and the under surface 36 of portion 19 of member 14 to permit the mounting members to be brought together without the plate exerting any pressure on the diaphragm material within the mounting members other than that due to its own weight. The diaphragm material 1 is shown connected to an electric circuit, to form an element thereof, by means of elongated clips 7 clasping the opposite edges of the diaphragm material between their jaws. The remaining portion of the circuit comprises a source 9 of electric current, a variable resistance element 10, a switch 11 (shown in its open position) and a current indicating means 12. These elements are connected to one another and to the clips 7 by the wires 8.

The diaphragm material is to form an element in an electric current carrying circuit and by the passage of current therethrough will be heated to a desired degree to cause it to expand. The coefficient of expansion of the material being known, the temperature to which the diaphragm material must be raised to obtain the desired expansion may be easily calculated. The expansion of the diaphragm material will be a measure of its contraction upon cooling and if it is to be constrained against such contraction a measure of the tension which will be induced in the diaphragm material by its inability to return to its original condition. Hence, to obtain a desired degree of uniform tension in the diaphragm, the extent to which it is to be expanded and the temperature to which it must be raised must be predetermined. Furthermore, the specific resistance of the diaphragm material being known, or easily determinable, its resistance at the "hot" temperature of the diaphragm material is mathematically ascertainable and for a given impressed voltage the current flowing through said diaphragm material at that temperature may be determined. When a closed electric circuit exists, an indicating instrument therein will reveal the variation in current with the increase in temperature and when the current reading indicates that the diaphragm has reached the desired temperature, the current through the diaphragm material may be interrupted and the diaphragm material immediately secured in its expanded state against peripheral contraction on cooling to cause the desired uniform tensioning to be produced in the diaphragm material.

The operation of the device and apparatus above described will now be recited tc point our more clearly their functions in effectuating the method of uniformly stretching metallic diaphragms or membranes which comprises one feature of this invention.

The diaphragm material is inserted between the fixed and movable elements of the clamping device so as to rest upon the coplanar surfaces of the block 6 and the mount-

ing member 4 between the upper and lower surfaces of the heat insulating materials 28 and 13, respectively. As pointed out above, the surface of the mounting member 4 adjacent the diaphragm material is insulated therefrom to avoid the possibility of a short circuit occurring when current is flowing through said material. The extremities of the diaphragm material are clamped within the jaws of the elongated clips 7. The operator then closes the switch 11, thereby causing current to flow through the closed circuit heating the diaphragm and causing it to expand equally in all directions in a horizontal plane. When the instrument 12 indicates to the operator that the diaphragm has reached its desired temperature—and it will do so very quickly—he opens the switch 11 and simultaneously pulls down the handle 15 to bring the mounting rings together so that the diaphragm material is held therebetween in its expanded condition. It will be understood that the means for operating the movable element of the clamping device is illustrative and that it would be possible to have it operated upon by a hydraulic or pneumatic ram to ensure greater force to bring the mounting rings together. The ring 25 forces the diaphragm material into the groove 24 forming therein a peripheral corrugation which aids in maintaining the material against peripheral contraction while the fastening bolts 37 are being thrust through the drillings 21 of mounting member 2, through the diaphragm material 1, and secured into the aligned tapped drillings 26 of the mounting member 4. It will be appreciated that although the diaphragm material obstructs the ready passage of the bolts 37, the diaphragm material is held in expanded condition between the ridged and grooved rings and, consequently, the bolts may be forced through the diaphragm material to engage with the drillings 26. The heat insulating plates 13 and 28 act also to retard the loss of heat from the diaphragm material while it is being rigidly clamped between the mounting members. After the mounting members have been secured together the clips 7 are removed, the lever 15 pushed upwardly to lift the member 14 from the assembly and the latter is removed so that the diaphragm material external the mounting may be trimmed off. The diaphragm unit, as shown in Fig. 5 to a reduced scale, is now ready for use.

It will be apparent that this method and means of uniformly tensioning metallic diaphragms may be used in the production of diaphragms of any size and are conducive to maximum production and to uniformity of product. The method is simple, rapid, accurate and requires a minimum of skill only on the part of the operator.

What is claimed is:

1. The method of uniformly tensioning a metallic diaphragm which comprises passing an electric current therethrough to cause it to increase in temperature and to expand, and constraining said diaphragm against contraction upon the cessation of said current flow and the consequent cooling of the diaphragm.

2. The method of uniformly tensioning a metallic diaphragm which comprises heating the diaphragm material to a predetermined degree by passing electric current therethrough whereby the peripheral dimension thereof increases, and constraining said diaphragm in its expanded state against peripheral contraction upon cooling.

3. A method of tensioning a metallic diaphragm which comprises passing a heating current through the diaphragm material to cause it to expand, securing said diaphragm in its expanded condition to a mounting, and permitting said diaphragm material to cool, while so constraining it against contraction, such constraint inducing the desired tension in the diaphragm.

4. The method of tensioning a metallic diaphragm which comprises passing a heating current through the diaphragm material to cause it to expand, securing said diaphragm material so expanded to relatively cold mounting members, and allowing said diaphragm material to cool to its original temperature, whereby the constraint exerted by the mounting members prevents contraction of said diaphragm material, and causes tension to be induced therein.

5. The method of uniformly tensioning a metallic diaphragm which comprises passing a heating current through the diaphragm material to heat it and to cause it to expand, and clamping said diaphragm material on a peripheral portion to relatively cold mounting members and simultaneously interrupting the flow of the heating current, whereby the diaphragm material is prevented by said members from assuming its original condition on cooling.

6. The method of uniformly tensioning a metallic diaphragm which comprises passing a heating current through the diaphragm material to heat it and to cause it to expand to a predetermined degree, and clamping said diaphragm material on a peripheral portion to relatively cold mounting members and simultaneously interrupting the flow of the heating current, whereby the diaphragm material is prevented by said members from assuming its original condition on cooling.

7. The method of tensioning a metallic diaphragm which comprises inserting the diaphragm material in an electrical circuit containing a source of electric current, closing said circuit to produce a current flow therein, whereby said diaphragm is heated to a desired degree and caused to expand, securing

a portion of said diaphragm material to mounting means to constrain it against contraction on cooling, while simultaneously opening the electrical circuit to cause a cessation in current flow therein and permitting said diaphragm to cool and to have the desired tension induced therein.

8. A device for tensioning a metallic diaphragm which comprises relatively movable members, each of which supports a diaphragm mounting member, one of said relatively movable members having a surface of thermally nonconductive material, means for connecting said diaphragm material in circuit with a source of electric current, a member of thermally non-conductive material to be placed upon a portion of said diaphragm and of sufficient mass to maintain said diaphragm material in a flat plane, means to control the electrical circuit of which the diaphragm is a part to cause a heating current to pass through said diaphragm material to heat it and to cause it to expand to a predetermined degree, and means for clamping said relatively movable members together to secure the diaphragm material to its mounting, while in an expanded condition, whereby on cooling it is constrained against contraction and is thereby subjected to tension.

9. In a device for tensioning a metallic diaphragm the combination, comprising a pair of members, one being stationary and the other movable relative thereto and each providing a support for a diaphragm mounting member, said stationary member also providing a support for the diaphragm material, an electric circuit including a source of current, means for connecting the diaphragm material to be tensioned in said circuit, means for opening and closing the circuit through said diaphragm material, and means for bringing said stationary and movable members together.

10. Means for securing a diaphragm to a mounting, which consists of a stationary and a movable member, said stationary member providing a support for a diaphragm mounting member and a diaphragm and said movable member being provided with a plurality of spaced projecting portions and with means for supporting a diaphragm mounting member in alignment with that supported by the stationary member.

11. Means for securing a diaphragm to a mounting, which comprises a stationary and a movable member, each capable of supporting a mounting member, said movable member in its inoperative position being spaced from said stationary member and having a plurality of spaced projecting portions at its periphery, the spaces defined thereby providing passage-ways for the insertion of fastening means in said mounting members.

12. A device for securing a diaphragm to a mounting member which comprises a stationary member and a movable member, means to exert a force on said movable member, said movable member having a plurality of spaced projecting portions under which a mounting member may be supported, said spaced projecting portions acting to distribute the force impressed on said movable member to said mounting when the stationary and movable members are in operative relation.

13. Means for securing a metallic diaphragm in an expanded condition to a mounting, said means comprising a stationary and a movable member, said stationary member being provided with a heat insulating surface and a depressed portion in which a diaphragm mounting member may be placed and said movable member being provided with a plurality of spaced projecting portions and with means for supporting a diaphragm mounting member in alignment with and in spaced relation to that supported by the stationary member.

14. In a device for securing a diaphragm to a mounting, a stationary member providing a support for a diaphragm mounting member, a movable member in spaced relation to said stationary member and likewise providing a support for a diaphragm mounting member, and means for exerting a force on said movable member to bring said mounting members together so as to secure a diaphragm therebetween, said movable member having recess defining portions, the recesses providing passageways for the insertion of fastening means in said mounting members.

In witness whereof, I hereunto subscribe my name this 22nd day of April, 1930.

EDWIN H. SMYTHE.