

Feb. 6, 1951

J. E. KEDDIE

2,540,450

METHOD OF DIAPHRAGM MANUFACTURE

Filed July 19, 1947

Fig. 1.

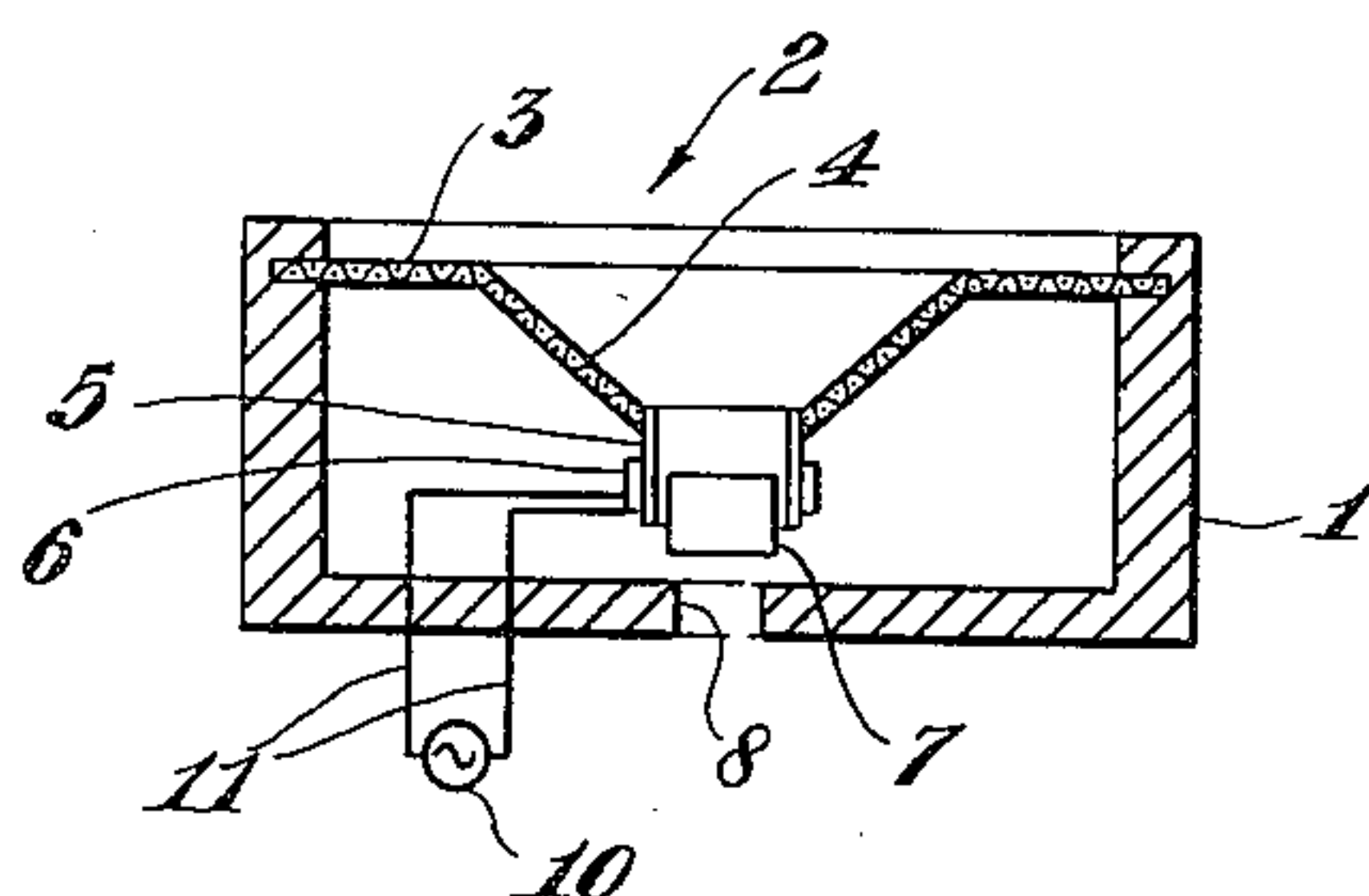


Fig. 2.

- A DIAPHRAGM 2 IS COATED OR IMPREGNATED FOR RIGIDITY WITH A RESIN SOLUBLE IN AN ORGANIC SOLVENT.
- B EITHER CONE 4 OR RING 3 IS EXCLUSIVELY SOAKED WITH ORGANIC SOLVENT TO SOFTEN THE SAME.
- C SPEECH COIL 6 SUPPORTED ON CONE 4 IS CONNECTED TO A SOURCE OF ALTERNATING CURRENT ADAPTED TO PROVIDE THE DESIRED DRIVING FREQUENCY FOR CONE 4 OR RING 3.
- D CONE 4 AND RING 3 ARE CONTINUED TO BE SO DRIVEN UNTIL THE ORGANIC SOLVENT EVAPORATES FROM EITHER CONE 4 OR RING 3 TO WHICH IT WAS ORIGINALLY APPLIED SO THAT THE ORIGINAL RIGID STATE OF A ABOVE IS ASSUMED.

Fig. 3.

- A DIAPHRAGM 2 IS COATED OR IMPREGNATED WITH A THERMOPLASTIC COMPOSITION TO IMPART RIGIDITY.
- B EITHER CONE 4 OR RING 3 IS EXCLUSIVELY HEATED FOR OBTAINING A SEMI-PLASTIC STATE.
- C SPEECH COIL 6 SUPPORTED ON CONE 4 IS CONNECTED TO A SOURCE OF ALTERNATING CURRENT ADAPTED TO PROVIDE THE DESIRED DRIVING FREQUENCY FOR CONE 4 OR RING 3.
- D CONE 4 AND RING 3 ARE CONTINUED TO BE SO DRIVEN UNTIL THE THERMOPLASTIC COMPOSITION HEATED ON EITHER CONE 4 OR RING 3 REVERTS TO THE ORIGINAL STATE OF A ABOVE BY COOLING.

Fig. 4.

- A DIAPHRAGM 2 IS COATED OR IMPREGNATED WITH A THERMOSETTING COMPOSITION.
- B SPEECH COIL 6 SUPPORTED ON CONE 4 IS CONNECTED TO A SOURCE OF ALTERNATING CURRENT ADAPTED TO PROVIDE THE DESIRED DRIVING FREQUENCY FOR CONE 4 OR RING 3.
- C EITHER CONE 4 OR RING 3 IS EXCLUSIVELY HEATED FOR CAUSING THE THERMOSETTING COMPOSITION TO BEGIN TO SET.
- D CONE 4 AND RING 3 ARE CONTINUED TO BE DRIVEN UNTIL THE THERMOSETTING COMPOSITION HEATED ON EITHER CONE 4 OR RING 3 BECOMES COMPLETELY SET.

JAMES EDWARD KEDDIE.
INVENTOR.

BY *Fred H. Vogel*

AGENT

UNITED STATES PATENT OFFICE

2,540,450

METHOD OF DIAPHRAGM MANUFACTURE

James Edward Keddie, London, England, assignor
to The Hartford National Bank and Trust Com-
pany, Hartford, Conn., as trustee

Application July 19, 1947, Serial No. 762,214
In Great Britain April 25, 1945

Section 1, Public Law 690, August 8, 1946
Patent expires April 25, 1965

8 Claims. (Cl. 181—32)

1

This invention relates to the manufacture of diaphragms for electro-acoustic apparatus, such for example as the cone of a loud speaker. These diaphragms are frequently made from material of the nature of fabric or paper which is not sufficiently rigid in itself but is impregnated or treated with a binder or stiffening medium.

As is already well known in the art, it is often desirable to arrive at a loud-speaker cone structure and suspension system which will reproduce faithfully by displacement the waveform of the applied electrical power.

In dealing with large amplitudes of displacement, the outside edge of the conventional cone as used in loudspeakers of normal construction is under restraint from the supporting ring. Due to the non-linear nature of the restraining force of the ring, the cone may be forced against an excessive restraint at large amplitudes, and will distort from its given shape. Thereby undesirable harmonics may be generated. Being in effect associated with large displacements, this form of distortion will be serious at the lower frequencies where the amplitudes are naturally large and particularly at the base resonant frequency, where the effective mass of the moving system resonates with the effective stiffness.

The frequency of the base resonance will also be in part dependent on the structure of the cone or its ring.

It is also particularly desirable that the cone should move as a whole at all frequencies unless special means are incorporated to provide a defined "breakup," as is arrived at by the many multi-element proposals. In conventional constructions break-up of the structure of the cone gives rise to various amplitudes over the cone area with corresponding various values of acoustic output, changing with frequency.

The present invention is concerned with cones or other diaphragm of such construction that they can be obtained temporarily in a semi-plastic state, either by being returned from their final rigid form to this semi-plastic state by suitable treatment, or at an intermediate stage in manufacture before reaching the rigid form. In the case of diaphragm of fabric or paper or other fibrous material to which rigidity has been imparted by impregnation or coating the material, this semi-plastic state can be achieved by applying a solvent for the impregnating or coating composition whereby the latter is softened, but reverts to the rigid form when the solvent is evaporated. For a diaphragm constructed from or treated with a thermo-plastic compo-

2

sition, the softening can be achieved by heating, whereas in the case of thermo-setting compositions a plastic state constitutes an intermediate stage in manufacture before the final hardening.

According to the present invention, the diaphragm mounted on its suspension is driven while in the semi-plastic state by the application of the driving effort to an appropriate point and the drive is maintained while the diaphragm is allowed or caused to pass from the semi-plastic state into the final rigid state. In the case of a cone, the driving effort may be applied at or near the apex by passing a suitable current through the coil carried by the diaphragm.

By appropriate control of the drive during the change from the semi-plastic to the rigid form, it has been found that the natural resonances of the diaphragm can be altered.

In the same way it has been found possible to modify the response curve at other frequencies so as to correct excessive or insufficient acoustic output at these frequencies.

The invention will be more fully explained by reference to the several examples of actual working embodiments thereof contained hereinafter and to the accompanying drawings in which:

Figure 1 is a schematic cross-sectional view of a conventional loudspeaker to which the methods of the present invention may be applied;

Figure 2 is a flow-sheet representation of one such method according to one embodiment of the invention;

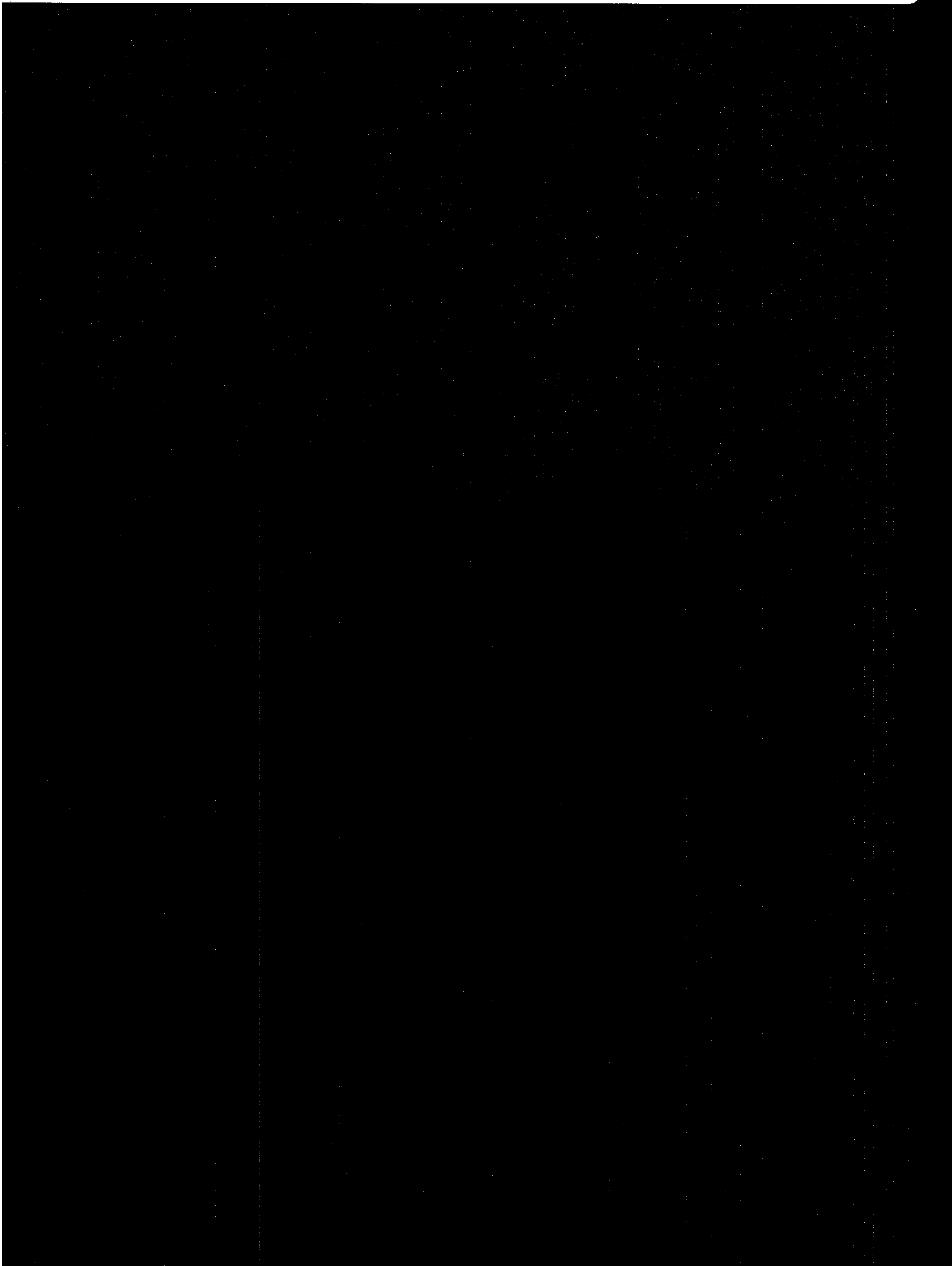
Figure 3 is a flow-sheet representation of another method according to a variant of the invention; and

Figure 4 is a flow-sheet representation of still another method according to a different embodiment of the invention.

Thus, by means of the process of the present invention it is possible to achieve inter alia the following results:

1. One possible result is the adjustment of the resonant frequency of a movement, or of a complete speaker to any desired frequency, either above or below the original resonant frequency, within the limits set by the electrical and mechanical construction.

For this purpose, the diaphragm 2, mounted on a support 1 of a conventional loudspeaker shown in Figure 1, is driven at a frequency about 5 c./s. below the desired frequency while the ring 3, by which the usual cone 4 is supported, starts in a semi-plastic state and passes into the rigid state. The figure of 5 c./s. applies for



the diaphragm is obtained by heating, the diaphragm is driven as before, and the reversion to the rigid state during such driving is permitted by cooling. Further, instead of the thermo-plastic substance noted above, a thermo-setting composition such as phenol formaldehyde may be substituted for impregnating the diaphragm. Herein, of course, the driving operation of the diaphragm is begun before the thermo-setting composition has been caused to set, and the operation is continued while heat is applied to the diaphragm to then cause thermo-setting.

From the point of view of manufacturing technique, a suitable general factory treatment would be first to establish the desired lowest natural frequency as set out above in section 1 and thereafter, with the cone sprayed to apply the whole frequency range which it is desired to cover up and down the scale until the cone is dry. In this way, a standard lowest natural frequency and reasonably standard response throughout the whole frequency range can be ensured in a series of loud-speakers without the necessity for working to close mechanical limits in the manufacture of the loud-speakers.

What is claimed is:

1. A process for modifying the characteristics of electro-acoustic apparatus such as a loud-speaker, comprising the step of driving the diaphragm while the latter is at least in part in a semi-plastic state and continuing to drive the diaphragm while the part in the semi-plastic state is assuming the rigid state.

2. A process as claimed in claim 1 for modifying the characteristics of a moving-coil loud-speaker or microphone, wherein the driving force is produced by passing a current through the coil carried by the speaker diaphragm.

3. A process as claimed in claim 1 for modifying the characteristics of a loud-speaker or microphone having a diaphragm made of fibrous material impregnated or coated with a soluble composition to impart rigidity, wherein the semi-plastic state is obtained by applying a solvent for the impregnating or coating composition and thereafter the reversion to the rigid state is obtained by causing or allowing the solvent to evaporate.

4. A process as claimed in claim 1 for modifying the characteristics of a loud-speaker or microphone having a diaphragm made of fibrous material impregnated or coated with a thermo-plastic composition to impart rigidity, wherein

the semi-plastic state is obtained by heating and thereafter the reversion to the rigid state is obtained by cooling.

5. A process as claimed in claim 1 for modifying the characteristics of a loud-speaker or microphone having a diaphragm made of fibrous material impregnated or coated with a thermo-setting composition to impart rigidity, wherein the driving operation is commenced before the thermo-setting composition has been caused to set and is continued whilst heating to produce thermo-setting.

6. A process for modifying the characteristics of a loudspeaker having a diaphragm comprising a cone and a supporting ring therefor comprising the step of driving the cone and ring while the cone is in a semi-plastic state and the supporting ring is in a rigid state and continuing to drive the cone and ring while the cone is assuming the rigid state.

7. A process for modifying the characteristics of a loud-speaker having a diaphragm comprising a cone and a supporting ring therefor comprising the step of driving the cone and ring while the cone is in a rigid state and the supporting ring is in a semi-plastic state and continuing to drive the cone and ring while the ring is assuming the rigid state.

8. A process for modifying the characteristics of a loud-speaker having a diaphragm comprising a cone and a supporting ring therefor comprising the steps of driving the cone and ring while the cone is in a semi-plastic state and the supporting ring is in a rigid state, continuing to drive the cone and ring while the cone remains in the rigid state and the ring is assuming the rigid state and until such rigid state for the cone is assumed, rendering the ring semi-plastic, and then driving the cone and ring while the cone remains in the rigid state and the ring is again assuming the rigid state.

JAMES EDWARD KEDDIE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,275,468	Pruessman	Aug. 13, 1918
1,904,417	Crystler	Apr. 18, 1933
2,288,832	Pare	July 7, 1942
2,294,479	Peter	Sept. 1, 1942