April 18, 1933. H. J. ROUND ET AL 1,904,537

LOUD SPEAKER

Filed Nov. 19, 1925

Fig. 1 Fig. 2 Fig. 3

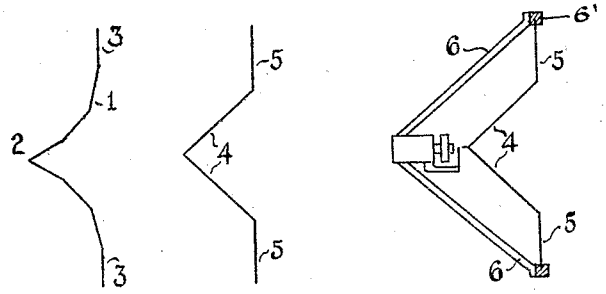
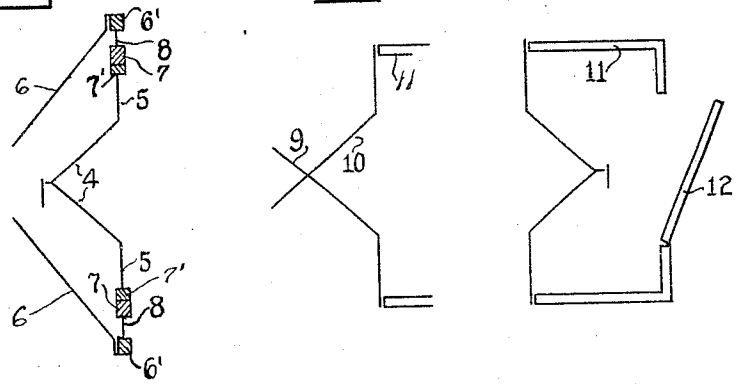


Fig. 4 Fig. 5 Fig. 7



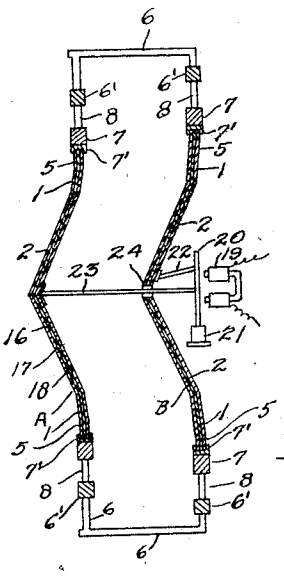


Fig. 6.

INVENTORS
HENRY JOSEPH ROUND
BY JOHN GLOVER ROBB
Ira J. Adams
ATTORNEY

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UNITED STATES PATENT OFFICE

HENRY JOSEPH ROUND, OF MUSWELL HILL, LONDON, AND JOHN GLOVER ROBB, OF HENDON, LONDON, ENGLAND, ASSIGNORS TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE

LOUD SPEAKER

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This invention relates to loud speakers, of the type in which the sound is generated by the movement of a diaphragm of comparatively large area, and in which horns are dispensed with.

Loud speakers without horns are known, in which the rigidity of the diaphragm is greatest at the centre and decreases from the centre to the circumference.

According to this invention the diaphragm of a loud speaker is so constructed that the alteration of the radial rigidity is adjusted to correct for the non-uniform radiation of the various frequencies.

The adjustment for the correction of non-uniform radiation may be obtained in various ways. For example, in the case of a conical diaphragm the cone angle is varied.

The variation of the angle of the cone is governed by the law of the moving electromagnet system, by the size of the diaphragm required, and by the quality of the material used.

The angle of the cone may at the apex be comparatively small, and then gradually enlarged until at the rim of the cone it is 180° or approximately so.

In one suitable construction, a conoidal diaphragm is made in two parts, one part being conical and with a constant cone angle, and the second part being a cone of 180° angle, or, in other words, an annulus.

Any suitably shaped diaphragm may be used, for example, it may be circular or oval, or it may even be a structure where energy is delivered at one edge and travels in a parallel path across the radiator, as for instance, in the shape of a strip possessing a V section, the angle of which increases continuously or in steps, from one end of the strip to the other.

The diaphragms may be made of any stiff material, such as metal or paper, or preferably by joining together layers of material of different quality. In the case of a cone diaphragm, the cone is formed of thin extremely stiff paper which is cemented with photographic mounting tissue to a fine silk or blotting paper, by pressing together the three materials, i. e. hard paper, photographic mounting tissue and silk or blotting paper, together in a hot press. The resulting material is very rigid and light, and has a natural self damping, due to the silk or blotting paper, which tends to prevent local resonance.

The diaphragms may be freely suspended, as by elastic bands, attached at several points, or they may be gripped round the edge and if necessary slightly stretched.

Preferably the diaphragms are suspended by mass action. For example, in the case of a cone diaphragm, there is provided around the periphery of the said diaphragm an annular ring, connected to a relatively heavy fixed ring loosely suspended from a rigid framework. This construction has several advantages, one of them being that additional adjustment of the low tones can be effected during manufacture by adjusting the mass of the heavy ring.

The diaphragms may be partially enclosed at the rear, means being preferably provided for varying the area of the opening.

In a modified construction, there is attached to the apex of the first cone a second cone which latter may be free or gripped at its edge, the object of this second cone being to add efficiency to the production of higher tones and lower the response to low tones in the ratio required.

In a further modification, the second cone may be attached to the same means which effect the vibration of the first cone, the point of attachment to the said means being, if desired, such that different amplitudes of motion are imparted to the two cones. (See Fig. 6.)

The invention is shown diagrammatically in the accompanying drawing in which,

Fig. 1 shows a diaphragm composed of a plurality of conical sections.

Fig. 2 shows a diaphragm made of two sections.

Fig. 3 shows a means for mounting the diaphragm.

Fig. 4 shows a modified form of means for mounting the diaphragm.

Fig. 5 shows a diaphragm composed of two cones.

Fig. 6 shows another form of diaphragm composed of two cones.

Fig. 7 shows a diaphragm and a box partly enclosing one face thereof.

Referring to Figure 1, 1 is a conical diaphragm whose cone angle is varied in steps from the apex 2 to the periphery 3. By "cone angle" is meant the angle formed at the apex of a cone by two oppositely disposed lateral elements, or in the case of a frustum of a cone by extending two opposite lateral elements until they meet. The diaphragm is actuated by any known movement, such as a reed telephone (not shown), attached to the apex 2.

In the modification shown in Figure 2, the variation of the cone angle is effected in a single step, to a flat edge so that in effect the diaphragm comprises a constant angle cone 4, attached at its periphery to the inner circumference of an annulus 5. This diaphragm can be made in two parts, one the conical portion and the other the annulus. The outer edge of the annulus may be gripped by a fixed ring 6′, attached to or forming part of a frame 6, as shown in Figure 3, or it may be lightly suspended by means of strings or the like.

Figure 4 shows a diaphragm of the type shown in Figures 2 and 3, suspended by mass action. 7 is a relatively massive ring, to which the outer edge of the diaphragm or a light ring 7′ attached thereto is fixed. The ring 7 is lightly supported as by suspension strings 8 to the ring 6′ of a frame 6.

Figure 5 shows a further modification, in which the diaphragm is formed of two cones 9, 10, both actuated by the same movement not shown, and with their apices attached to one another.

Figure 6 shows two diaphragms A and B mounted to vibrate independently and to be operated by the same means. Each diaphragm is of the type shown in Fig. 1 and is composed of a layer of hard paper 18 and an outer layer of fine silk 16 these being held together by a binder 17 of photographic mounting tissue. The diaphragms are mounted in the manner shown in Fig. 4, each being attached at the periphery to a light ring 7′ secured in any suitable manner to a heavy or massive ring 7. Ring 7 is flexibly supported from the stationary frame 6 by means of elastic suspension strings 8. Diaphragm A is actuated by a rod 23 connected thereto near its apex, said rod being connected at its other end to a reed diaphragm 20 suitably mounted for vibration in a holding means 21. A hole 24 of suitable size is provided in cone B through which rod 23 passes. Cone or diaphragm B is vibrated by a rod 22 connected thereto in any suitable manner, preferably near its apex, the other end of rod 22 being attached to reed 20 at a more remote point from block 21 than the point to which rod 23 is attached. It will be obvious from this construction that the vibration of reed 20 will cause cone A to vibrate a smaller amount than cone B. Reed 20 may be vibrated by any desired means, that shown being a common type of electro-magnet 19. While we have shown a specific connection between the two cones and the reed, we do not limit ourselves to the particular connection shown, other equivalent connections could be easily substituted instead by one skilled in the art.

Again, as shown in Fig. 7, all the above described diaphragms may be enclosed at the rear by a box 11 which preferably is provided with an adjustable door 12 pivotally mounted at its lower end whereby the opening between the box and door may be varied to control the volume of sound coming from the box.

Having described our invention what we claim is:—

1. A diaphragm adapted to vibrate composed of an outer coating of paper, an outer coating of silk and an intermediate portion of adhesive material adapted to bind the silk and paper together as a unit.

2. An acoustic device comprising a diaphragm, a mass supporting said diaphragm near its periphery and means yieldingly supporting said mass, said means being connected to said mass only.

3. An acoustic device comprising a diaphragm, a frame engaging the periphery thereof and a mass ring carrying said frame, said mass ring being mounted for free vibration.

4. Acoustic apparatus comprising a large vibratile diaphragm of the direct acting type, means for vibrating the diaphragm, structure enclosing the rear of said diaphragm and the diaphragm vibrating means, said structure being provided with an opening, and means for adjusting the size of said opening.

HENRY JOSEPH ROUND.
JOHN GLOVER ROBB.