Nov. 27, 1928. 1,693,223

H. I. DANZIGER ET AL

SOUND REPRODUCER

Filed Jan. 4, 1927

Fig. 1.

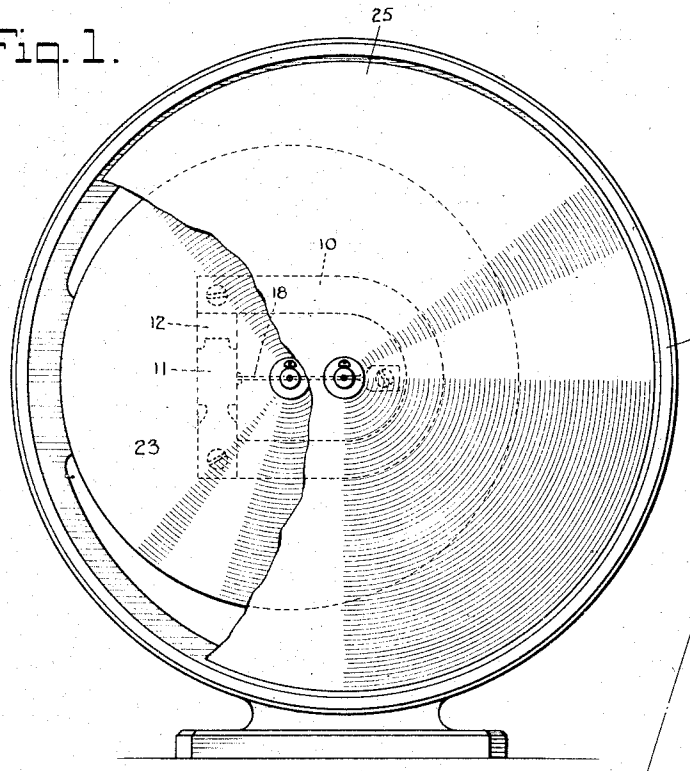


Fig. 3.

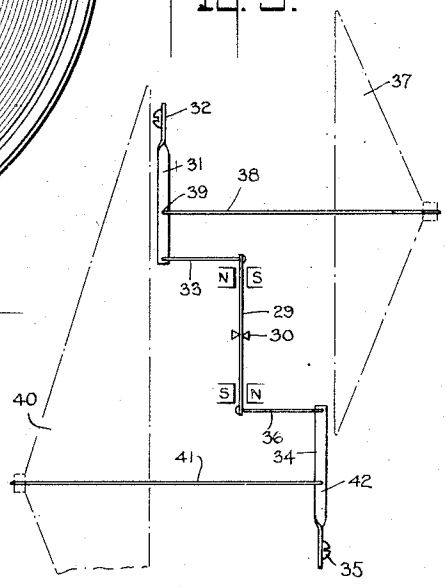
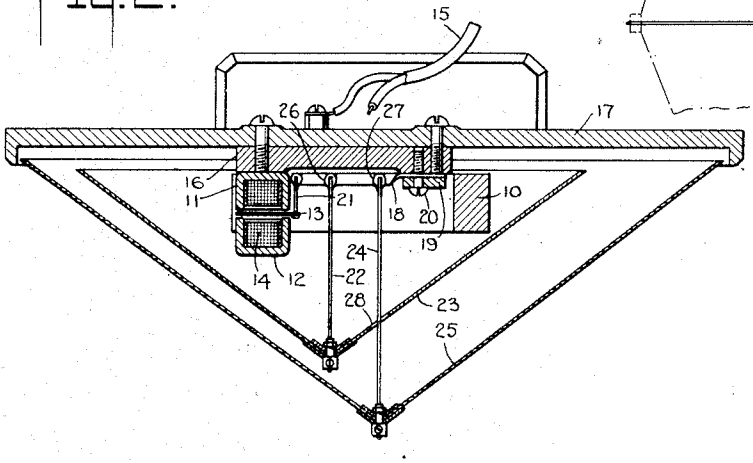


Fig. 2.



INVENTORS
HAROLD I. DANZIGER
CHARLES LUCAS WACHTER
BY
Frederick Bretenfeld
their ATTORNEY

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UNITED STATES PATENT OFFICE.

HAROLD I. DANZIGER AND CHARLES LUCAS WACHTER, OF NEW YORK, N. Y.

SOUND REPRODUCER.

Application filed January 4, 1927. Serial No. 158,848.

Our present invention relates to sound reproducers, and has particular reference to so-called "loud speakers" employed in connection with radio receiving sets.

Although we have illustrated, and shall hereinafter describe our invention as applied to such loud speakers, nevertheless it will be obvious hereinafter that as to certain phases of the invention, such an application is not essential.

It is an object of the invention to provide a reproducing device having features which render it peculiarly efficient in reproducing all ranges of sound.

One object of the invention is to achieve this result by the employment of more than one diaphragm, the diaphragms being so arranged and constructed as to have differing natural periods. It is well known that a diaphragm having a low natural period will reproduce sounds of low frequency with greater efficiency than other sounds; and similarly, diaphragms having a high natural period will more efficiently reproduce sounds of high frequency.

Where we have attempted to employ arrangements rendering the proportional vibrations of the diaphragms adjustable or variable, we have found it difficult to obtain uniformly efficient results for the reason that the dividing line between sounds most efficiently reproduced by one or the other of the diaphragms is extremely indefinite. Sounds having frequencies which approach the natural period of one diaphragm will of course be most efficiently reproduced by that diaphragm, but for a given sound frequency, it is almost impossible to determine what proportion of the vibratory energy should be transmitted to one or the other diaphragm. In other words, it is extremely difficult, if not impossible, to determine the varying points of frequency at which certain predetermined proportional reproduction by the diaphragms will produce the most efficient result.

Difference in natural periods is probably most easily provided by difference in size of diaphragm. But whether the differing natural periods are produced by differing sizes or otherwise, the resistance which the differing diaphragms offer to vibration will be different. Accordingly, where we have attempted to vibrate two or more diaphragms, of differing natural periods, by means of a common vibrating member or reed, a certain loss in efficiency has been found to take place since the diaphragms will not impose equal loads upon the reed.

It is an object of the present invention to provide a device of the character referred to, wherein certain features of construction and arrangement assure not only uniformity of reproduction, but also a reproduction which is most efficient from the standpoint of vibratory energy available.

One feature of the invention lies in providing a fixed arrangement wherein the diaphragms are vibrated in certain predetermined proportions throughout the entire range of sound frequencies.

An important feature of our invention lies in an arrangement whereby the oscillating energy is transmitted in such a manner that it will distribute itself equally among the various diaphragms. Thus, where two diaphragms are employed, the arrangement is such that the energy transmitted to one of the diaphragms will be equal to the energy transmitted to the other. Where the diaphragms employed are of differing weights or sizes, this effect is particularly desirable, and is preferably effected by suitably designing the transmitting instrumentalities between the source of energy and the diaphragm.

In a preferred embodiment of the invention, we employ two diaphragms of differing sizes, the diaphragms being of the disc or cone type and being so constructed as to have substantially different natural periods of vibration. A preferred construction associates these diaphragms with an oscillating armature of usual construction by means of lever arrangements properly designed and arranged to equalize the energy employed in causing vibration of each diaphragm. In a preferred form, one lever is provided having a fixed fulcrum, whereby the operating or "force" arm remains fixed; and actuating reeds are associated with the lever in a manner whereby the opposite or "load" arms are of a suitable nature to produce the desired effect.

In another embodiment, we employ a so-called "polarized" armature, wherein a separate lever is provided for each diaphragm, and wherein the two arms of each lever are suitably designed and arranged in accordance with the same general plan.

Another object of the invention is to pro-

vide a device of this character wherein certain features of construction produce a finished article having enhanced attributes of good appearance. One feature lies in providing the diaphragms or cones in nested positions; and in a preferred embodiment, wherein two such cones are employed, they are so arranged that one will lie wholly within the other, thereby permitting the production of a finished article having an appearance substantially identical with that of the usual cone speakers.

A still further feature of the invention lies in nesting the diaphragms in a manner whereby they are eccentrically disposed with respect to each other, this feature of construction permitting the achievement in a simple manner of the other objects of the invention.

It is an object generally of the invention to provide a reproducing device which is of relatively simple construction, thereby minimizing the cost of manufacture and assembly, which is of extremely attractive appearance, and which is efficient in fulfilling the objects of reproduction hereinbefore referred to.

For the attainment of the foregoing objects and such other objects as may hereinafter appear or be pointed out, we have illustrated two forms of our invention in the accompanying drawings in which—

Fig. 1 is a front elevational view of a device embodying the features of our invention, a portion being broken away to disclose otherwise hidden parts;

Fig. 2 is a cross-sectional plan view taken substantially along a plane passing through the horizontal diameter of the circular disc 25 shown in Fig. 1; and

Fig. 3 is a diagrammatic representation of one possible modification.

Referring now to the drawings, and particularly to Figs. 1 and 2, it will be observed that we have shown a source of oscillating energy in the form of the ordinary or well known permanent magnet and armature arrangement which comprises a U-shaped magnet 10 having pole pieces 11 and 12 between which an armature 13 is arranged for oscillation. More particularly, it will be observed that the pole piece 11 is permanently affixed to one end of the magnet 10, whereas the other pole piece 12 is permanently connected to the opposite end of the magnet 10, these pole pieces being arranged in mutually spaced and superposed positions to permit the armature to be oscillated therebetween. Suitable coils 14 are provided in association with the pole pieces, these coils being in electrical connection through the lead wires 15 with the source of electrical energy initially set up by certain sound vibrations and sounds which are now to be reproduced.

We have shown the magnet 10 mounted upon a supporting plate 16, the latter being in turn supported upon a back plate or panel 17 constituting the rear wall of the reproducing device or loud speaker.

It will be understood that any suitable source of oscillating energy other than one of the type illustrated by the armature 13 may be employed, just so long as the source used is applicable for the present purposes. It will also be obvious that any other suitable type of mounting may be utilized to meet desired requirements.

In Figs. 1 and 2 we have illustrated a preferred form of the invention wherein an operating lever 18 has been provided, this lever being fixedly mounted at one end and having its other end operable by the armature 13. We have illustratively shown one end of the lever 18 mounted upon the supporting plate 16 by a holding plate 19 and a screw 20, and we have shown the opposite end of the lever 18 in operable association with the armature 13 by means of a link 21. The lever is preferably constructed of a resilient strip of metal whose fixed end is disposed at right angles to the balance of the lever, whereby free oscillation of the latter about the fixed end will be most efficiently rendered possible.

In the employment of a lever 18, it will be obvious that the operating or force arm is constituted of the entire length of the lever. The actuating or load arms of the lever will be constituted of predetermined and predesigned lengths thereof from the fixed end to points short of the free end. Thus, we have shown an actuating reed 22 projecting at right angles from the lever and associated at its end with a disc or diaphragm 23; and we have shown a second actuating reed 24 arranged substantially parallel to the reed 22 and having its end associated with a second diaphragm or disc 25. In the embodiment shown, the diaphragms are composed of conical elements whose existence per se is well known in the radio art.

It will be observed that we have shown the diaphragm 23 of relatively smaller construction than the diaphragm 25, the former being designed to have a natural period of vibration which is relatively high, and the latter being designed to have a natural period which is relatively low. This difference in natural periods is effected, in the embodiment shown, by varying the sizes of the diaphragms, but whether the difference in natural periods is effected by differing sizes of diaphragms, or by the employment of differing materials, or otherwise, the diaphragms will in most cases offer different resistances to movement. In a preferred embodiment, the diaphragms are made of the same material, and hence the larger diaphragm 25 will offer greater resistance to movement than will the diaphragm 23. Accordingly the reed 22 is associated with the lever 18 at a point further from the fixed point or fulcrum than the point of associa-

tion of the reed 24. Specifically, we have shown the reed 22 associated with the lever 18 at a point 26, and it will be obvious that the load arm of the lever arrangement for the diaphragm 23 will be constituted of that portion of the lever 18 which lies between its fixed end and the point 26. Similarly, we have shown the reed 24 associated with the lever 18 at a point 27, and the load arm of the lever arrangement for the diaphragm 25 will thus be constituted of that portion of the lever 18 lying between the fixed end thereof and the point 27.

It will be obvious that the ratio between force and load arms of the lever arrangement for the disc 25 will be greater than the ratio of force and load arms of the other lever arrangement. In this way, the energy actuating the disc 25 (the heavier) will be equalized with respect to the energy actuating the disc 23 (the lighter). The exact location of the points 26 and 27 will have to be determined by computation and experiment, and will depend upon the relative sizes and resistances of the diaphragms.

In the embodiment shown, we have so positioned the diaphragms 23 and 25 that they nest within one another, and to achieve this result we have found it necessary to provide an opening 28 in the diaphragm 23 to permit the passage therethrough of the reed 24. We have found that the provision of such an opening has no more than a negligible effect upon the efficiency of the diaphragm 23.

It will thus be seen that the instrument provided is one which appears from the outside to be of the usual type employing only one cone or diaphragm. It will also be obvious that the diaphragms will at all times divide the oscillating energy equally between them in accordance with predetermined design. While it is true that the lower notes will be most efficiently reproduced by the diaphragm 25 and the higher notes will be most efficiently reproduced by the diaphragm 23, nevertheless the composite result will be one which is extremely efficient and uniform throughout the entire range of audible sounds. Most of the sounds to be reproduced lie within a large area whose reproduction is not clearly most efficiently effected by one or the other diaphragm, and in accordance with our invention, the reproduction is effected by both diaphragms simultaneously, thereby permitting a self-compensation to be effected which produces a uniformly efficient result.

It will also be obvious that more than two diaphragms may, if desired, be provided, the general arrangement of the parts being similar to the arrangement shown, and the effect being substantially the same as that described.

It will also be obvious that as to certain phases of our invention the nesting of the diaphragms may not be essential. For example, in Fig. 3 we have diagrammatically illustrated an arrangement wherein two diaphragms are employed in a manner which produces the same acoustic effect but which entails the provision of a separate lever for each diaphragm and an arrangement thereof other than nesting.

In Fig. 3, we have shown a vibrating armature 29 of the so-called polarized type, wherein the armature oscillates about a center axis 30. We have found that an oscillating source of this type may be advantageously employed in a manner whereby each end of the armature actuates at least one diaphragm. Thus, we have shown a lever 31 having a fixed or fulcrum point 32 and actuated at its opposite end by a connecting link 33 leading from one end of the armature. We have also provided a lever 34 having a fixed or fulcrum point 35, and actuated at its opposite end by a connecting link 36 leading from the opposite end of the armature.

Each of the levers 31 and 34 corresponds to the lever 18 of Fig. 2. Thus, associated with the lever 31 we have shown a disc 37 mounted upon an actuating reed 38 connected with the lever at a point 39. We have also shown a relatively large disc 40 mounted upon an actuating reed 41, the latter being associated with the lever 34 at a point 42. The disc 40 corresponds to the disc 25 of Fig. 2, and the disc 37 corresponds to the disc 23 of Fig. 2. Assuming the levers 31 and 34 to be of equal length, the points 39 and 42 are so arranged that the distance between the point 32 and the point 39 is larger than the distance between the point 35 and the point 42.

The operation of the device illustrated in Fig. 3 will be obvious from the description contained herein with respect to Figs. 1 and 2.

It will thus be seen that we have provided a device which is extremely efficient, yet simple of construction and attractive in appearance; and that our invention takes into account the factor of different resistances of a plurality of diaphragms, compensating for this factor in a manner which produces very desirable and efficient results.

It will be obvious that many changes in the details herein described and illustrated for the purpose of explaining the nature of our invention may be made by those skilled in the art without departing from the spirit and scope of the invention as expressed in the appended claims. It is therefore intended that these details be interpreted as illustrative, and not in a limiting sense.

Having thus described our invention and illustrated its use, what we claim as new and desire to secure by Letters Patent is—

1. A sound reproducer comprising a plurality of vibratable discs, said discs being constructed to have differing normal periods of

vibration, a source of vibratory energy, and means for transmitting said energy in equal proportions to said discs.

2. A sound reproducer comprising a plurality of vibratable discs, said discs being constructed to have differing normal periods of vibration, and said discs therefore offering different resistances to vibration, a source of vibratory energy, and means for transmitting said energy in equal proportions to said discs, said means comprising an arrangement of transmitting levers between the energy source and the discs, said levers having their force and load arms so proportioned that the energy required to vibrate respective discs is equal.

3. A sound reproducer comprising a plurality of vibratable discs, said discs being constructed to have differing normal periods of vibration, a source of vibratory energy, and means for transmitting said energy in equal proportions to said discs, said means comprising a vibratable lever having one end operatively associated with the energy source for actuation thereby and having the other end relatively fixed, and actuating reeds extending from said lever to said discs and variably spaced from the fixed end thereof.

4. A sound reproducer comprising a plurality of vibratable discs, said discs being constructed to have differing normal periods of vibration, and said discs therefore offering different resistances to vibration, a source of vibratory energy, and means for transmitting said energy in equal proportions to said discs, said means comprising a vibratable lever having one end operatively associated with the energy source for actuation thereby and having the other end relatively fixed, and actuating reeds operatively associated with the lever at points spaced from the fixed end by distances inversely proportional to the resistances of the respective discs actuated.

5. In a sound reproducer of the character described, a source of vibratory energy including a vibrating member, a conical diaphragm of the relatively large type adapted to vibrate in free air, said diaphragm enclosing said vibrating member, a larger diaphragm of the same type enclosing the first diaphragm, and a pair of reeds operatively interposed between the vibrating member and said diaphragms respectively.

6. In a sound reproducer of the character described, a source of vibratory energy including a vibrating member, a conical diaphragm of the relatively large type adapted to vibrate in free air, said diaphragm enclosing said vibrating member, a larger conical diaphragm of the same type arranged in nested position over the first-named diaphragm and eccentric with respect thereto, and a pair of actuating reeds operatively interposed between the vibrating member and said diaphragms respectively, the reed associated with the larger diaphragm passing through the smaller diaphragm.

7. In a sound reproducer of the character described, a vibrating member, a vibratable lever actuated thereby at one end of the lever, the other end of the lever being fixed against vibration, a pair of nested conical diaphragms of the relatively large type adapted to vibrate in free air, said diaphragms enclosing the vibrating member and lever, and a pair of actuating reeds extending from spaced points on the lever to the diaphragms respectively.

8. In a sound reproducer of the character described, a vibrating member, a vibratable lever actuated thereby at one end of the lever, the other end of the lever being fixed against vibration, a pair of nested conical diaphragms of the relatively large type adapted to vibrate in free air, said diaphragms enclosing the vibrating member and lever, and a pair of actuating reeds extending from the diaphragms respectively to points on the lever variably spaced from the fixed end thereof, the reed associated with the outer diaphragm being nearer to said fixed end.

9. In a sound reproducer of the character described, a pair of conical diaphragms of the relatively large type adapted to vibrate in free air, said diaphragms being made of substantially the same material and being of different sizes so that their natural periods are different, a source of vibratory energy, a lever having a fixed fulcrum and actuated by said source, and a pair of actuating reeds extending from spaced points on the lever to respective diaphragms.

10. In a sound reproducer of the character described, a pair of conical diaphragms of the relatively large type adapted to vibrate in free air, said diaphragms being made of substantially the same material and being of different sizes so that their natural periods are different, a source of vibratory energy, a lever having a fixed fulcrum and actuated by said source, and a pair of actuating reeds extending from spaced points on the lever to respective diaphragms; said diaphragms being arranged in eccentric nested positions whereby the larger encloses the smaller and the smaller encloses said lever.

In witness whereof, I have signed this specification this 22d day of December, 1926.

CHAS. L. WACHTER.

In witness whereof, I have signed this specification this 22d day of December, 1926.

HAROLD I. DANZIGER.