Sept. 6, 1932. C. LAING 1,876,306

DIAPHRAGM FOR SOUND RECORDING AND REPRODUCING DEVICES

Filed May 9, 1928

Fig. 1.

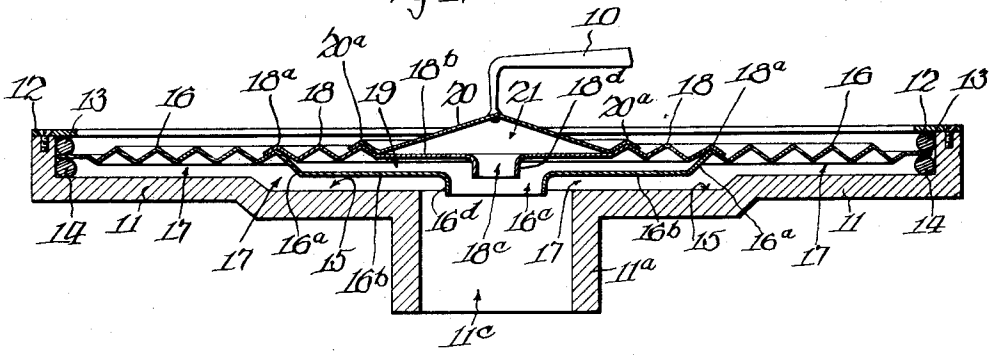

Fig. 2.

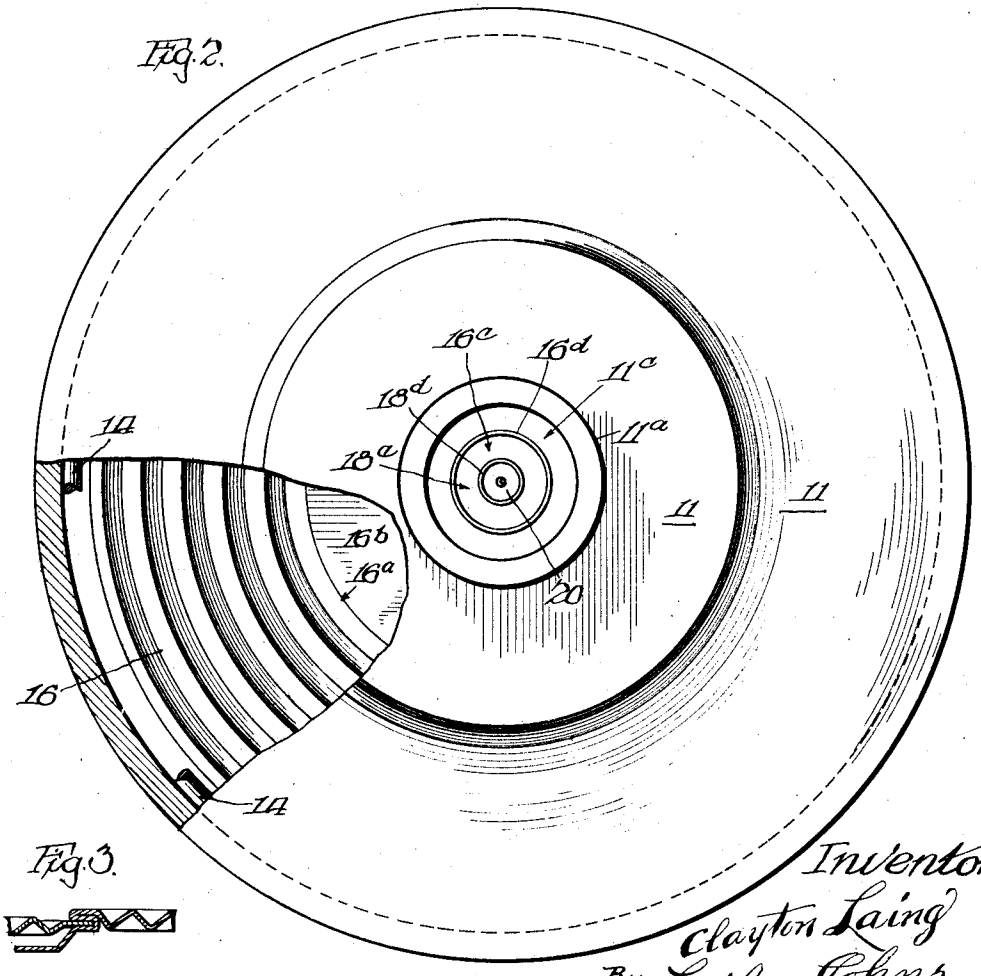

Fig. 3.

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DIAPHRAGM FOR SOUND RECORDING AND REPRODUCING DEVICES

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These improvements relate to diaphragms such as may be employed in instruments or devices for recording or for reproducing sound, as in the phonograph, the telephone and the radio arts, etc.

The chief object of the invention is to improve the tonal results in such recording or reproducing instruments. It is an object to accomplish this through a simple and cheap form of diaphragm, and one which may be readily applied for use wherever the ordinary simple type of diaphragm has been used. Other objects and advantages will appear hereinafter.

Perhaps the most noteworthy objection to the simple diaphragm almost exclusively being used at the present time, whether made of a single piece of sheet material or of two or more pieces so arranged as to be in effect a single sheet, is that the tones throughout the audible range are not reproduced with equal fidelity.

Each such simple diaphragm has a fundamental rate of vibration. Tones produced by rates of vibration approximating the fundamental rate of the diaphragm are the less free of distortion. A perfect diaphragm would reproduce tones of the high, the intermediate, and the low registers with equal fidelity, and the chief object of the present invention is directed to improvement in that regard.

There are many considerations affecting the reproduction of sound by means of a diaphragm. I have discovered that one of them is the size of the discharge opening through which the sound waves emerge after being created by the diaphragm. Through extensive experimentation I have ascertained that for reproducing the high tones the discharge opening should be very much smaller than it should be for the low tones. It is impossible to accomplish the desired results in this respect with a single discharge opening. One part of the present invention is directed to the discharge of the high, the intermediate, and the low tones through openings respectively appropriate to them.

I may mention also that the diameter of the diaphragm is a factor. It is well known that with diaphragms of a given thickness, one of relatively small diameter will respond to vibrations of a high frequency much better than does one of larger diameter. My present invention takes cognizance of this feature also in the provision of a diaphragm comprising vibratory members which are effectively of different diameters.

I may point out, too, that the character of the metal or other material of which the diaphragm is made has a bearing upon the results. In view of the delicacy of the force used for producing many of the vibrations the diaphragm in most of such devices should be extremely light. Whatever the physical properties and proportions may be for the desired results in the various respects the present invention lends itself to the embodiment of all desirable variations. I have found that aluminum in very thin sheet form is highly suitable for the device herein illustrated, and I may mention that owing to the relative sizes and shapes given to the several parts the diaphragm as a whole may have a total weight considerably less than that of many of the simple diaphragms respectively which are currently being used. In other words, thinner material may be used throughout or for the narrower members; and better tonal results may thus be obtained through the proportioning of the thickness of material, as well as the diameters of the respective members, in accordance with the requirements for tones of high, intermediate and low registers.

In the accompanying drawing Figure 1 is a greatly enlarged medial sectional view of a diaphragm in accordance with these improvements, the same being operatively held by means of conventional form; Fig. 2 is a

broken rear view of the device of Fig. 1; and Fig. 3 is a fragmentary view showing how adjacent ones of the respective diaphragm members may be crimped in tight relation to each other.

The device as a whole is shown for purposes of illustration as what may be considered the sound box or reproducer of a phonograph, and the part 10 may be considered as part of the stylus arm. The means for vibrating the diaphragm in loud speakers and other reproducers may be of the magnetic type or otherwise according to any approved practice. In the telephone, microphone, and kindred adaptations sound waves may stimulate the diaphragm to set up variations in an electric current.

The casing or frame 11 is cup-shaped and circular in outline, and the ring 12 clamps the diaphragm between two rubber rings 13 and 14. The frame 11–12 and the rings 13–14 are old features. The frame has a tubular extention 11*a* which, in a phonograph, would be connected to the hollow tone arm leading to the amplifying horn. The recess 15 in the frame 11 may be a novel feature. It is provided in this connection for the sake of clearance in view of the extension of the diaphragm in that direction.

My improved diaphragm is illustrated as comprising three diaphragm members in superposed relation to each other successively. I may employ two of the members shown or more than three. They constitute a series of diaphragm members.

The last diaphragm member of the series from front to rear is marked 16. That is the largest one in diameter. The corrugations in it are according to common practice. The purpose of such corrugation is merely to strengthen the disc-like piece, for the metal is very thin. This member 16 deflects in a direction which I shall term inwardly at 16*a* and then extends toward the center at the flat portion 16*b*, thus forming a flat-bottom depression in the form illustrated. There is a central opening or passageway 16*c* defined by an outwardly-turned flange-like extension 16*d*. There is an air space 17 between the member 16 and the frame 11.

Only one intermediate diaphragm is shown and is numbered 18. One such intermediate diaphragm will ordinarily be sufficient. A corrugation at 18*a* fits upon the innermost corrugation of the diaphragm 16 as the device is illustrated. The diaphragm 18 is shown as having a flat central portion 18*b* and there is a central opening 18*c* in it defined by an inwardly-turned flange-like extension 18*d*. There is an air space 19 between a portion of the diaphragm member 16 and the diaphragm member 18.

The outer or first member of the series is marked 20. It is shown as conical in shape, a form highly advantageous in view of its relative strength with very thin material. It may have other shapes. It is shown as having an annular corrugation 20*a* which fits upon the innermost annular corrugation of the diaphragm member 18. The member 20 is of lesser diameter than the member 18. A space 21 is provided between members 20 and 18.

These air spaces 21 and 19 are shown as being substantially coextensive with the effective diameters of the members 20 and 18 respectively. The air space 17 is coextensive with the effective diameter of the member 16.

When the construction is as in Fig. 1 the members 20 and 18 and the members 18 and 16 may be held tightly together at 20*a* and 18*a* by means of a cementing agency. I have found that a small amount of the ordinary powdered resin of commerce sprinkled at the overlapping portions of these members and then heated over a flame produces a very strong and tight connection. In Fig. 3 I have shown how such members may be crimped together.

In my practice the material for the several diaphragm members is successively thinner from rear to front, and this is recommended for best results.

When the outer or first diaphragm member 20 is agitated mechanically the physical vibration is communicated first to member 18 and thence to member 16, and thus the diaphragm as a whole is put into vibration. Tones of the higher registers are highly accurately reproduced by the relatively small and highly resonant member 20 and these sound waves issue through the relatively small passageway 18*c*. The intermediate tones are very faithfully reproduced by member 18 of intermediate size and resonancy, and the sound-waves thereof issue through the passageway 16*c* of intermediate size. The lower tones are produced in highly natural effects by the relatively large and more sluggish member 16 and those sound waves issue through the relatively large passageway 11*c* of the housing.

Note that the sound waves coming from each of the air chambers 21, 19 and 17 are given direction toward the final discharge passageway. Note also that the sound waves in spaces 19 and 17 are so deflected that they do not interfere with those issuing from a preceding sound-wave chamber. A simple opening in each of the members would be of advantage, but the deflecting flanges as 18*d* and 16*d* make for very much better results, in that there are first formed several distinct bodies of sound waves and these are then directing in bodily formation to the final outlet and without confusing and commingling the various sound waves within the air chambers of the device.

For the telephone, microphone and the like the diaphragm illustrated would be reversed

whereby the member 20 would become the last of the series. For some such applications the central openings might desirably be enlarged.

I contemplate as being included in these improvements all such changes, variations and departures from what is thus specifically illustrated and described as fall within the scope of the appended claims.

I claim:

1. A diaphragm for sound-wave recording or reproduction comprising a series of thin sheet-material vibratory diaphragm members in superposed relation to each other in a series, each of said members being to a large extent in spaced relation to the adjacent one thereof in the series, each member of the series except the last being connected to the adjacent member of the series, in the order from first to last thereof, within the area of the next adjacent member of the series in the order from first to last whereby each member of the series except the first thereof is dependent upon the next adjacent preceding member of the series for its vibration, each member of the series except the first thereof having an opening forming a passageway for air vibrations, with means for vibrating the first member of the series.

2. The combination of claim 1 hereof in which each successive member of the series from first to last is of increased face area and has a lower fundamental rate of vibration than has the one preceding it.

3. The combination of claim 1 hereof in which said members are of disc-like shape and each thereof is successively larger in diameter in the order from first to last of the series.

4. The combination of claim 1 hereof in which the first member of the series is cup-shaped and the second member of the series has a substantially small sound passageway therein and the peripheral edge portion of the first member of the series is in physical vibration-transmitting association with the second member of the series intermediate said passageway and the peripheral edge of said second member.

5. The combination of claim 1 hereof in which the passageway openings in said members have successively greater capacity beginning with the second member of the series and including the last member of the series, the first member of the series being free of a sound-wave opening, and in which the diameter of said members increases successively from the first to the last member of the series.

6. The combination of claim 1 hereof in which each of said members but the first one of the series has a sound-wave passageway defined by inwardly-turned flange-like extensions of said members respectively, said openings being substantially in alignment, the first member of the series covering the passageway in the second member of the series.

7. The combination of claim 1 hereof in which said members are successively of larger diameter from the first to and including the last of the series and each of them but the first has a substantially central opening and the peripheral edge of each but the last of the series is in direct contact relation to the following adjacent member.

8. A diaphragm for sound-wave recording or reproduction comprising a series of members of successively increasing diameter from front to rear, each thereof being of thin and vibratory sheet material, the periphery of each of said members but the last thereof being in direct contact relation to the next adjacent one of the series, each of said members but the first thereof having a substantially central sound-wave opening defined by inwardly-directed sound-wave deflecting portions of the members respectively, and each of said members but the last being spaced from the next adjacent one thereof in the direction from front to rear.

9. The combination of means for holding a diaphragm, said means having a sound-discharge opening, and a diaphragm held by said means to provide a space between it and said discharge opening, said diaphragm comprising a plurality of diaphragm members each of which is of thin and vibratory sheet material, each of said members but the outermost one having a sound-wave passageway in communication with said discharge opening, said members being severally attached to the next adjacent one thereof within the marginal limits of such next thereof, and the outermost one of said members overlying the sound-wave passageway in the next adjacent member, said members being spaced apart to provide an air space between portions of the adjacent ones respectively, said air spaces being in communication through said passageway openings.

10. The combination of claim 9 hereof in which each of said sound-wave-emitting openings is defined by sound-wave directing means.

11. A diaphragm comprising a plurality of disc-like diaphragm members of thin and vibratory material arranged face to face in substantially parallel planes and spaced apart throughout most of their extents respectively where facing each other, one of said members being of relatively large diameter, and being adapted to be held at its marginal edge portions, and at least one of said members having its peripheral edge portion tightly attached to said relatively large member within the periphery of the relatively large member.

12. The combination of claim 13 hereof in which the formation of at least one of said

members includes substantially concentric corrugations.

13. The combination of claim 13 hereof in which at least one of said members is perforated to put spaces on opposite sides thereof in communication with each other.

14. A diaphragm comprising two members of thin and vibratory material, each thereof having a circumferential corrugated area, one of said members being smaller in diameter than the other thereof and being attached to the larger one of said members at the marginal edge of the smaller member and substantially coaxially within the area of the larger member, each of said members having a substantially central opening therethrough for sound waves, said members being spaced apart about their central areas respectively, and a relatively small cup-shaped member of thin and vibratory material attached at its marginal edge portion to one of said other members and overlying the same in substantially coaxial relation thereto.

15. A plate-like diaphragm comprising a diaphragm member adapted to be held about the peripheral edge thereof, and another plate-like diaphragm member carried by said first-mentioned member, being in face to face relation and being firmly secured to the first-mentioned member within the area of the first-mentioned member and continuously at the peripheral edge portion of said other member, said members being spaced apart throughout the general areas thereof facing each other, the first-mentioned one of said members being apertured for sound waves within the area thereof facing said other member.

16. A diaphragm comprising at least three diaphragm members each of thin and vibratory sheet material, one of said members being of relatively large area and being adapted to be held about its marginal edge portion, the other diaphragm members being carried by said relatively large member, all of said members forming a series with the adjacent ones thereof in face to face relation and being spaced apart throughout at least most of their respective extents where facing each other, each of said other diaphragm members being of smaller area than said one of relatively large area and each thereof being secured at its marginal edge to next adjacent member of the series, some of said members having sound wave openings therethrough, the arrangement providing that vibrations communicated to one end member of the series are transmitted positively to the next in series and by such next to the one following it in the series.

17. The combination of claim 18 hereof in which at least two of said members are substantially flat throughout most of their extents respectively and all thereof except the one of relatively large area are in substantially tight relation at their marginal edges respectively to the adjacent member of the series.

18. The combination of claim 1 hereof in which each of said members is in substantially tight relation to the adjacent one of the series where the members are connected to each other.

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