

May 9, 1933.

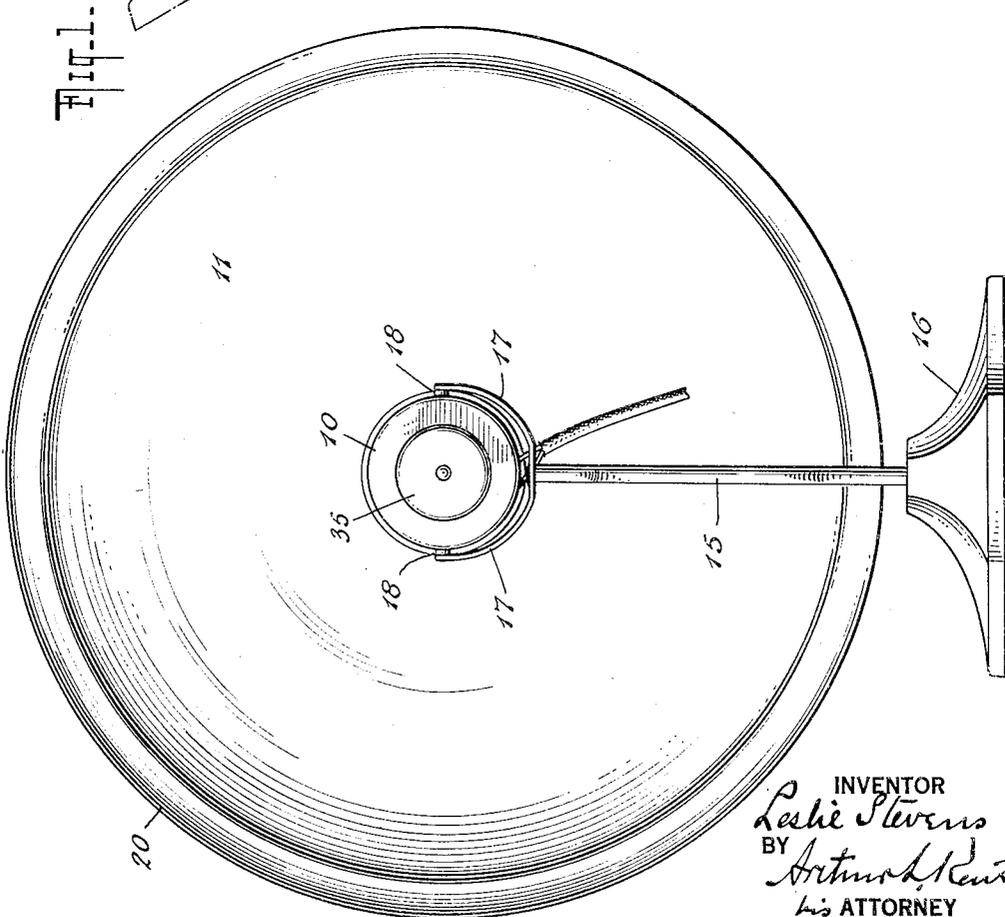
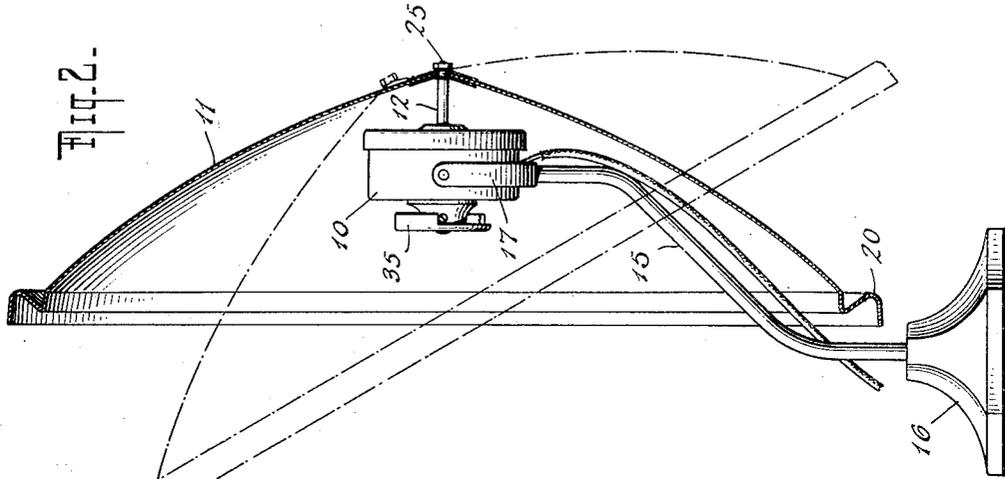
L. STEVENS

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SOUND REPRODUCING APPARATUS

Filed July 21, 1926

3 Sheets-Sheet 1



INVENTOR
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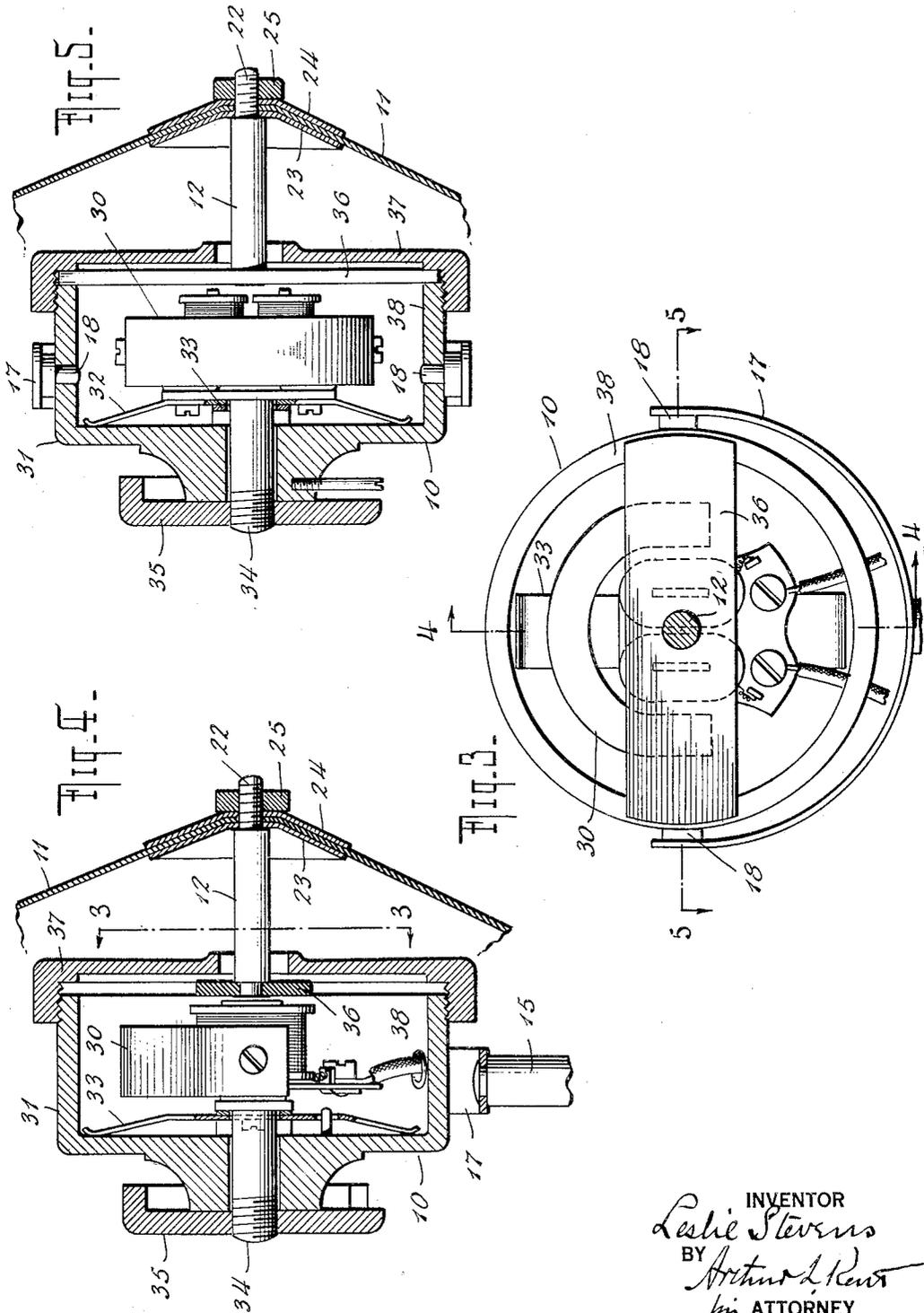
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3 Sheets-Sheet 2



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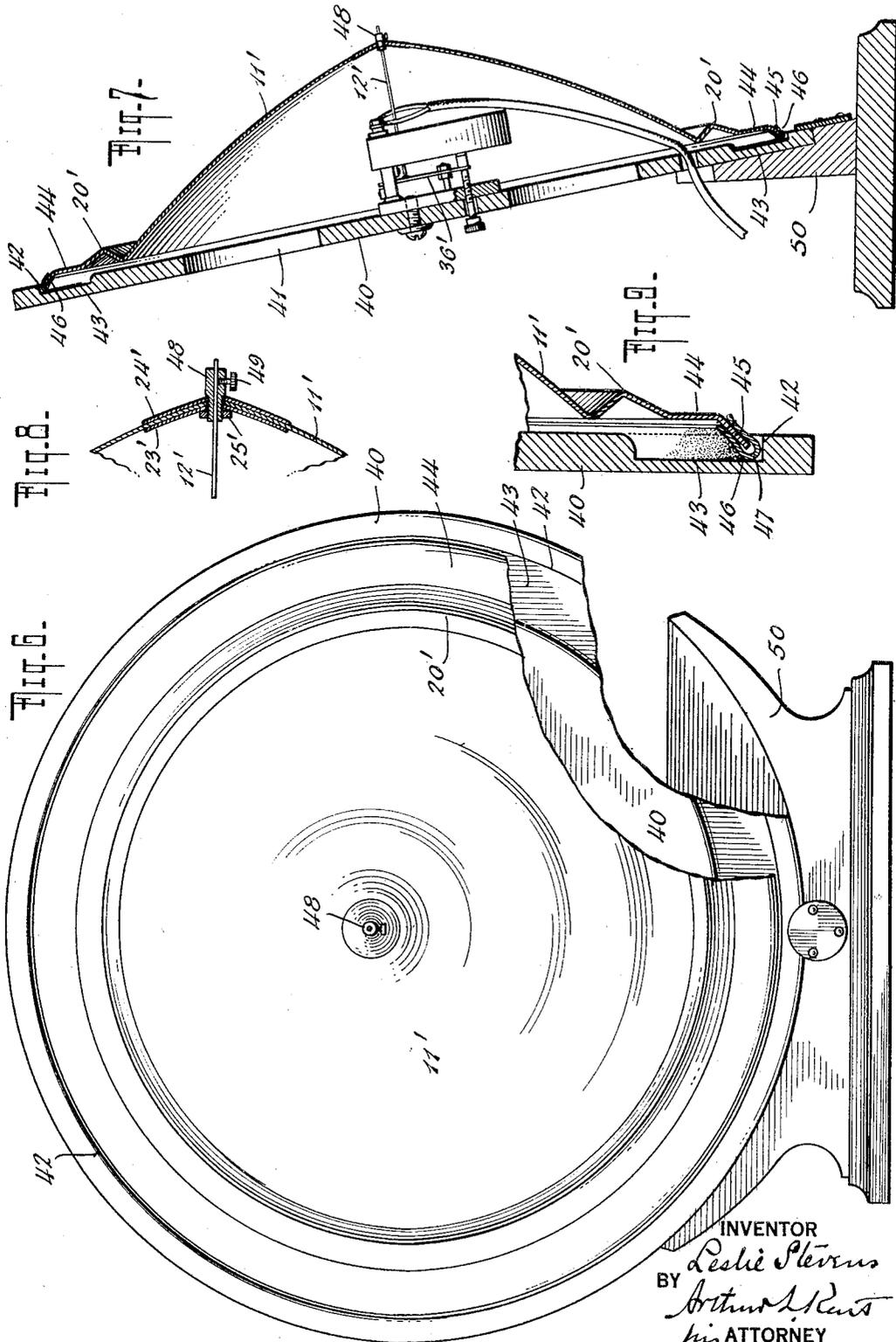
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

LESLIE STEVENS, OF GLEN RIDGE, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS,
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SOUND REPRODUCING APPARATUS

Application filed July 21, 1926. Serial No. 124,051.

This invention relates to sound reproducing apparatus, and aims to provide a simple and effective loud speaker for radio receivers and other telephonic circuits.

5 The loud speaker according to the invention comprises a telephone unit having a stiff armature member and a large direct-acting diaphragm mounted on the armature member of the unit by a connection which is rigidly
10 secured to both the armature member and the diaphragm and which is sufficiently stiff to serve as the sole support of the diaphragm, the edge of the diaphragm being left free. The device is of simple construction, and
15 with a light, highly resilient diaphragm of proper size and shape and with a properly constructed telephone unit the sound reproduction is exceptionally good both in tone quality and value and in definition. Damp-
20 ing of vibrations in peripheral portions of the diaphragm resulting from clamping or otherwise rigidly supporting the edge of the diaphragm is avoided. Not only is the quality of reproduction improved, but a diaphragm
25 of a given size having its edge free is in power or loudness of sound produced under a given intensity of the vibrations imparted to it equal to a larger diaphragm having its edge rigidly secured.

30 The nature and advantages of the invention may best be understood from a detailed description of loud speakers embodying the invention which are illustrated in the accompanying drawings, in which:—

35 Fig. 1 is a front elevation of one such loud speaker having a conoidal diaphragm looking toward the concave side of the diaphragm;

40 Fig. 2 is a side elevation showing the diaphragm sectioned on its vertical diameter;

45 Fig. 3 is an enlarged elevation of the telephone unit and associated parts looking in the direction opposite from Fig. 1 and showing the connecting rod sectioned on the line 3—3 of Fig. 4;

Fig. 4 is a side elevation of the telephone unit and associated parts sectioned on the line 4—4 of Fig. 3;

50 Fig. 5 is a plan view of the telephone unit

and associated parts sectioned on the line 5—5 of Fig. 3;

Fig. 6 is a front elevation of another loud speaker according to the invention, looking toward the convex side of the diaphragm, and
55 showing parts broken away;

Fig. 7 is a side elevation of the loud speaker shown in Fig. 6 sectioned on the vertical diameter of the diaphragm; and

60 Figs. 8 and 9 are enlarged fragmentary sections taken on the same section line as Fig. 7 and showing respectively the central and edge parts of the diaphragm.

Referring first to Figs. 1 to 5, the loud speaker shown in these figures has a bi-polar
65 telephone unit 10 and a large direct-acting dished diaphragm 11 mounted on the armature of the unit 10 by means of a transmission rod 12 which is rigidly secured at one end to the armature member of the unit and
70 at the other end to the diaphragm at the center thereof. The unit 10 is mounted on a bent standard 15 rising from a base 16 and having at its upper end a U-shaped fork 17 between the ends of which the telephone unit
75 10 is mounted on pins 18 on which the unit is journaled to swing on a horizontal axis. The unit is on the concave side of the diaphragm and the transmission rod 12 is so short that the unit is positioned entirely in-
80 side the diaphragm. The bend of the standard 15 is such as to permit the diaphragm to stand with its periphery in a vertical plane. The axis of the diaphragm is capable of universal adjustment by swinging the telephone
85 unit on the pivots 18 and by turning the base 16 on any supporting surface on which it may be placed. This is of advantage since the dished diaphragm has a markedly directional effect, the maximum intensity of the sound being along the axis of the dia-
90 phragm extending from the concave side thereof. Full advantage is taken of the sound waves of maximum intensity since the concave side of the diaphragm is almost en-
95 tirely unobstructed. Spring pressure of the fork arms 17 may be relied on to hold the unit in any position of adjustment about the axis of the pivot pins.

The diaphragm 11 may be made of vari- 100

ous materials, such as cloth treated with suitable stiffening material to give the diaphragm the necessary resiliency, paper or sheet celluloid. The diaphragm should, of course, be light in weight and highly resilient. The diaphragm is supported solely by the transmission rod 12, the edge of the diaphragm being free and unconfined. In order that the peripheral portion of the diaphragm shall maintain its shape, the diaphragm is formed near its peripheral edge with an annular corrugation 20. The slight stiffening of the peripheral portion of the diaphragm by this corrugation serves not only to maintain the shape of the diaphragm but also avoids loss of definition in sound reproduction which results when a diaphragm without such corrugation is mounted with its edge free and unconfined. I have found that a diaphragm of convex conoidal form continuously curved in one direction from its axial center outward in all radial directions as shown gives the best reproduction. The transmission rod 12 is secured to the center, or apex, of the diaphragm by passing a threaded stud 22 of reduced diameter at the outer end of the rod through a hole in the center of the diaphragm and through conical washers 23 and 24 placed one on each side of the diaphragm and clamping the washers against the diaphragm and the inner washer against the shoulder at the base of the stud by means of a nut 25 screwed on to the outer end of the stud.

The telephone unit 10 might be of any suitable type and construction. The unit shown in these figures is a bi-polar unit of special form. It includes a bi-polar electro-magnet 30 adjustably supported in the unit casing 31 by means of crossed springs 32 and 33 bearing against the back wall of the casing and a supporting bolt 34 extending through a hole in the back wall of the casing and having at its outer end an adjusting nut 35 which resists the action of the springs 32 and 33. By turning the nut 35 the position of the magnet may be adjusted with relation to the armature member. The armature member 36 consists of a flat bar the ends of which are rigidly clamped between a peripheral shoulder on the front wall 37 and the side wall 38 of the casing 31. The central part of the armature member opposite the poles of the magnet is made of magnetic metal such as soft iron, and the entire member may conveniently be made of a single piece of such metal as shown. The armature member is of such thickness and stiffness that its natural period of vibration is far above audible frequencies. It may, for example, be a bar of soft iron 3 inches long, $\frac{3}{4}$ inch wide and $\frac{1}{16}$ inch thick. The transmission rod 12 has its inner end rigidly secured at the center of the armature member and projects

outwardly through a central opening in the front wall of the unit casing. The armature member is sufficiently stiff to support the transmission rod and diaphragm mounted thereon without appreciable deflection.

Figs. 6 to 8 show a modified form of loud speaker in which the unit is mounted on a member 40 which extends opposite the concave side of the dished diaphragm 11'. In the device shown, this member 40 forms a back wall of the device and is a flat board of thin wood or other suitable material. Most desirably it has a plurality of openings 41 of any desired size and shape, the device shown having four such openings, of which two are shown in Fig. 7. Whether serving as the back wall or the front wall of the device, and whether flat or otherwise, and whether having openings therein or not, this member or board 40 modifies the sound reproduction, and if it is of suitable thickness and of resonant material such as wood and unless it has openings 41 therein which are too large, it acts also as a resonance board or wall, modifying the character of the sound reproduction, more especially by strengthening the lower reproduced tones. It may have noticeable effect as a resonance board or wall even though the openings 41 take up a relatively greater portion of its area than in the device shown, but by extending the openings so as to leave only a mere skeleton member, as well as by making this member of material entirely nonresonant, such resonance effect would be lost. The member 40 may be circular as shown, its diameter being slightly greater than the diameter of the diaphragm, and it has near its periphery a circular shoulder 42 the diameter of which is just slightly greater than that of the diaphragm so that the edge of the diaphragm may extend inside the shoulder. This shoulder is conveniently formed by the outer side of an annular groove 43 provided in the face of the back board. The diaphragm 11' shown in these figures is similar to the diaphragm shown in Figs. 1 and 2 and is mounted on a transmission rod 12' which extends from the armature 36' of the telephone unit. The diaphragm has an annular corrugation 20' near its peripheral edge, and beyond the corrugation it has a flat portion 44 and a narrow intumed edge flange 45 which is provided with a buffer 46 formed by a binding of soft flexible material such as felt, the edges of which are stitched or otherwise secured to the flange 45 and the fold 47 of which extends slightly beyond the free edge of the flange.

The telephone unit shown in these figures is one of the balanced armature type. Any suitable unit might be used. The transmission rod 12' is longer and thinner than the transmission rod 12 of the construction first described, but it is sufficiently stiff to serve

as the sole support of the diaphragm. As stated above, the diaphragm is of light weight. The diaphragm is secured to the transmission rod by means permitting it to be adjusted toward or away from the member 40, that is, longitudinally of the rod. For this purpose the diaphragm is rigidly secured to a small fitting or sleeve 48 having a longitudinal bore to fit on the rod and being externally shouldered and having its reduced end portion threaded to receive a clamping nut 25' by which conical washers 23' and 24' are clamped against the central portion of the diaphragm and against the shoulder of the fitting. The sleeve 48 is adjustably secured on the connecting rod by means of a set screw 49. The member 40 may be mounted on a base 50 or otherwise supported. The back board 40 is most desirably inclined somewhat backwardly from the vertical, as shown. This not only improves the appearance of the loud speaker, but, the transmission rod being correspondingly inclined from the horizontal, the tendency of the weight of the diaphragm to bend the rod is reduced, thus permitting the use of a lighter rod.

When properly adjusted for use of the speaker, the sleeve 48 is positioned on the rod 12' so that the edge of the flange 45 of the diaphragm does not bear against the member 40 at any point, the diaphragm being supported solely by the transmission rod and the edge of the diaphragm being free. It is immaterial whether the fold of the buffer 46 extending beyond the free edge of the diaphragm makes light contact with the member 40 or not. It is desirable, however, that the edge of the diaphragm shall extend slightly within the recess in the member 40 so that in the event of the device being strongly jarred the adjacent portions of the member 40 may serve as supporting means for the edge of the diaphragm to prevent excessive displacement of the diaphragm by reason of such jarring. The buffer 46 serves to prevent rattling which might result from accidental contact of the edge of the vibrating diaphragm with the member 40, and also aids in preventing possible vibration dampening contact of the edge of the diaphragm with the member 40. For greater safety in transportation, the sleeve may be adjusted on the transmission rod so as to cause the edge of the diaphragm to be seated in the annular recess of the member 40.

What is claimed is:

1. A sound reproducing device, comprising a telephone unit having an armature member, a transmission rod rigidly secured to the armature member and extending substantially horizontally therefrom, and a large direct-acting dished vibratory diaphragm mounted on and supported by the transmission rod with its concave side to-

ward the telephone unit, the edge of the diaphragm being free and the transmission rod being sufficiently stiff to serve normally as the sole support of the diaphragm.

2. A sound reproducing device, comprising a telephone unit having an armature member, a large direct-acting dished vibratory diaphragm, and a connecting member by which the diaphragm is supported with its edge in an approximately vertical plane, the edge of the diaphragm being free, and said connecting member being rigidly secured to both the armature member and the diaphragm and being sufficiently stiff to serve normally as the sole support of the diaphragm.

3. A sound reproducing device, comprising a telephone unit having an armature member, and a large direct-acting vibratory diaphragm connected to and supported by the armature member.

4. A sound reproducing device, comprising a telephone unit having an armature member, a transmission member rigidly secured to the armature member, and a large direct-acting dished vibratory diaphragm rigidly connected at its center to the transmission member and supported thereby, the edge of the diaphragm being free and the diaphragm having an annular corrugation adjacent its periphery.

5. A sound reproducing device, comprising a telephone unit having an armature member, a support on which the unit is mounted, and a large direct-acting dished vibratory diaphragm connected to and supported by the armature member, the telephone unit being located wholly within the concavity of the diaphragm.

6. A sound reproducing device, comprising a bi-polar telephone unit having an armature member formed by a flat bar rigidly supported, a transmission rod having one end rigidly secured to the center of said bar and extending at right angles to the bar, and a large direct-acting vibratory diaphragm mounted on the other end of said rod, said bar being of such thickness as to form a substantially rigid support for the transmission rod and to have a natural period of vibration far above audible frequencies.

7. A sound reproducing device, comprising a telephone unit having an armature member, a transmission rod rigidly secured to the armature member, a large direct-acting dished vibratory diaphragm rigidly connected at its center to the transmission rod, the transmission rod being sufficiently stiff to serve normally as the sole support for the diaphragm and the edge of the diaphragm being free and the diaphragm having an annular corrugation adjacent its periphery, and means adjacent the edge of the diaphragm adapted to support the edge of the

diaphragm if the device is strongly jarred.

8. A sound reproducing device, comprising a telephone unit having an armature member, a transmission rod rigidly secured to the armature member, a large direct-acting dished vibratory diaphragm rigidly connected at its center to the transmission rod, the transmission rod being sufficiently stiff to serve normally as the sole support for the diaphragm and the edge of the diaphragm being free and the diaphragm having an annular corrugation adjacent its periphery, edge supporting means adjacent the edge of the diaphragm, and a buffer of non-vibration-transmitting material between the edge of the diaphragm and the edge supporting means.

9. A sound reproducing device, comprising a telephone unit having an armature member, a board on which the telephone unit is mounted, a transmission member rigidly secured to the armature member, and a large direct-acting dished vibratory diaphragm rigidly connected at its center to the transmission member and supported thereby, the concave side of the diaphragm facing said board and the edge of the diaphragm being free, said board having a circular shoulder past which the free edge of the diaphragm extends, and a buffer of soft material between the edge of the diaphragm and said board and shoulder.

10. A sound reproducing device, comprising a telephone unit having an armature member, a transmission member rigidly secured to the armature member, a large direct-acting dished vibratory diaphragm rigidly connected at its center to the transmission member, and a flat resonance board extending opposite the concave side of the diaphragm and on which the telephone unit is mounted.

11. A sound reproducing device, comprising a telephone unit having an armature member, a large direct-acting vibratory diaphragm connected to and supported by the armature member, and a resonance board extending opposite one side of the diaphragm and on which the telephone unit is mounted.

12. A loud speaker, comprising a wooden sound-board, a conical diaphragm mounted on said sound-board, and actuating means connected to the diaphragm.

13. A loud speaker, comprising a wooden sound-board, and a conical diaphragm mounted on said board, said sound-board being arranged substantially in the plane of the base of the conical diaphragm.

14. A loud speaker, comprising a flat sound-board, a conical diaphragm located on one face of the sound-board, and actuating means connected to said diaphragm.

15. A sound reproducing device, comprising a telephone unit having an armature member, a transmission rod rigidly secured

to the armature member, a large direct-acting dished vibratory diaphragm rigidly connected to the transmission rod, the diaphragm being stiffened adjacent its periphery and the edge of the diaphragm being free and provided with a binding of soft material, and edge supporting means adjacent the edge of the diaphragm.

16. A sound reproducing device, comprising a telephone unit having an armature member, a large direct-acting dished vibratory diaphragm, a diaphragm supporting and vibration transmitting connection between the center of the diaphragm and the armature member, the edge of the diaphragm being free and provided with a binding of soft material to serve as a buffer, and edge supporting means adjacent the edge of the diaphragm.

17. A sound reproducing device, comprising a telephone unit having an armature member, a large direct-acting dished vibratory diaphragm, a diaphragm supporting and vibration transmitting connection between the center of the diaphragm and the armature member, the edge of the diaphragm being free, edge supporting means adjacent the edge of the diaphragm, and means providing a buffer of soft material between the edge of the diaphragm and said supporting means.

18. A sound reproducing device, comprising a large direct-acting vibratory dished diaphragm, a back board having a groove in the front face thereof shaped to receive the edge of the diaphragm, and a telephone unit mounted on the front face of said board having an armature member, the diaphragm being operatively connected to said armature member with its concave side toward the board and its edge extending into said groove but held out of contact with the board by a buffer of soft material.

19. A sound reproducing device, comprising a large direct-acting vibratory dished diaphragm, a back board having a groove in the front face thereof shaped to receive the edge of the diaphragm, and a telephone unit mounted on the front face of said board having an armature member, the diaphragm being operatively connected to said armature member with its concave side toward the board and its edge extending into said groove but held out of contact with the board by a buffer of soft material, said board having openings therein within the periphery of the diaphragm.

20. A sound reproducing device, comprising a large direct-acting dished vibratory diaphragm, a back board, a base by which the back board is supported in an upright slightly backwardly inclined position, a telephone unit mounted on said board, and a vibration transmitting connection between the telephone unit and the diaphragm, the con-

cave side of the diaphragm facing the back board.

21. A sound reproducing device, comprising a large direct-acting dished vibratory diaphragm, a back board supported in an upright slightly backwardly inclined position, a telephone unit mounted on said board having an armature member, a transmission rod rigidly secured to the armature member, the diaphragm being rigidly connected to said transmission rod and supported thereby, the concave side of the diaphragm facing said board and the edge of the diaphragm being free, and a buffer of soft material between the edge of the diaphragm and said board.

22. A loud speaking diaphragm of light resilient material having its edge provided with a buffer formed by a binding of soft material.

23. A loud speaking diaphragm of light resilient material and of conoidal form and having its edge provided with a buffer formed by a binding of soft material.

24. A sound reproducing device, comprising a large direct acting, dished vibratory diaphragm, an actuating unit connected to said diaphragm, said actuating unit being located wholly within the concavity of the diaphragm, and a sounding board operatively associated with said diaphragm.

25. A sound-reproducing diaphragm of the free edge type having attached thereto at its periphery a protecting element.

26. A conical diaphragm of large diameter having a freely vibrating periphery and a protecting element of fibrous material attached to said periphery.

27. A conical diaphragm of large diameter having a freely vibrating periphery, and a protecting element of fabric attached to said periphery.

28. A sound-reproducing diaphragm of the free edge type having attached thereto at its periphery a protecting element extending circumferentially of said periphery.

29. A sound-reproducing diaphragm of the free edge type having attached thereto at its periphery a protecting element on each side thereof.

30. A conical diaphragm of large diameter having a freely vibrating periphery, and a protecting element attached to said periphery on each side thereof and continuous across the edge thereof.

31. A conical paper diaphragm of large diameter having a freely vibrating periphery, and a protecting element of cloth stitched thereto and embracing the edge thereof.

32. In combination, a semi-flexible conical diaphragm of large diameter having a free, vibratable periphery, a protecting element attached to said periphery, and a guard member surrounding the periphery of the

diaphragm and substantially spaced from said protecting element.

33. In combination, a semi-flexible conical diaphragm of large diameter having a free, vibratable periphery, a protecting element attached to said periphery, and a guard member embracing the periphery of the diaphragm and said protecting element and substantially spaced therefrom.

34. A sound-reproducing diaphragm of the free edge type, and a circumferential element attached thereto at the periphery of said diaphragm having a width small as compared to the distance to the center of the diaphragm.

35. A conical diaphragm of the free edge type, and an element attached thereto at the periphery of said diaphragm having a width small as compared to the distance to the vertex of the cone.

36. In combination, a sound-reproducing diaphragm of the free edge type, a protecting element attached to the periphery of said diaphragm, and a guard element surrounding said periphery and substantially spaced from said protecting element.

37. In combination, a sound-reproducing diaphragm of the free edge type, a protecting element attached to the periphery of said diaphragm and a guard member embracing said periphery and said protecting element and substantially spaced therefrom.

In testimony whereof I have hereunto set my hand.

LESLIE STEVENS. 100

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