June 9, 1953 S. E. LEVY ET AL 2,641,329

LOUD-SPEAKER DIAPHRAGM WITH TRANSVERSELY ARCHED STIFFENER MEANS

Filed May 29, 1950 3 Sheets-Sheet 1

Fig. 1

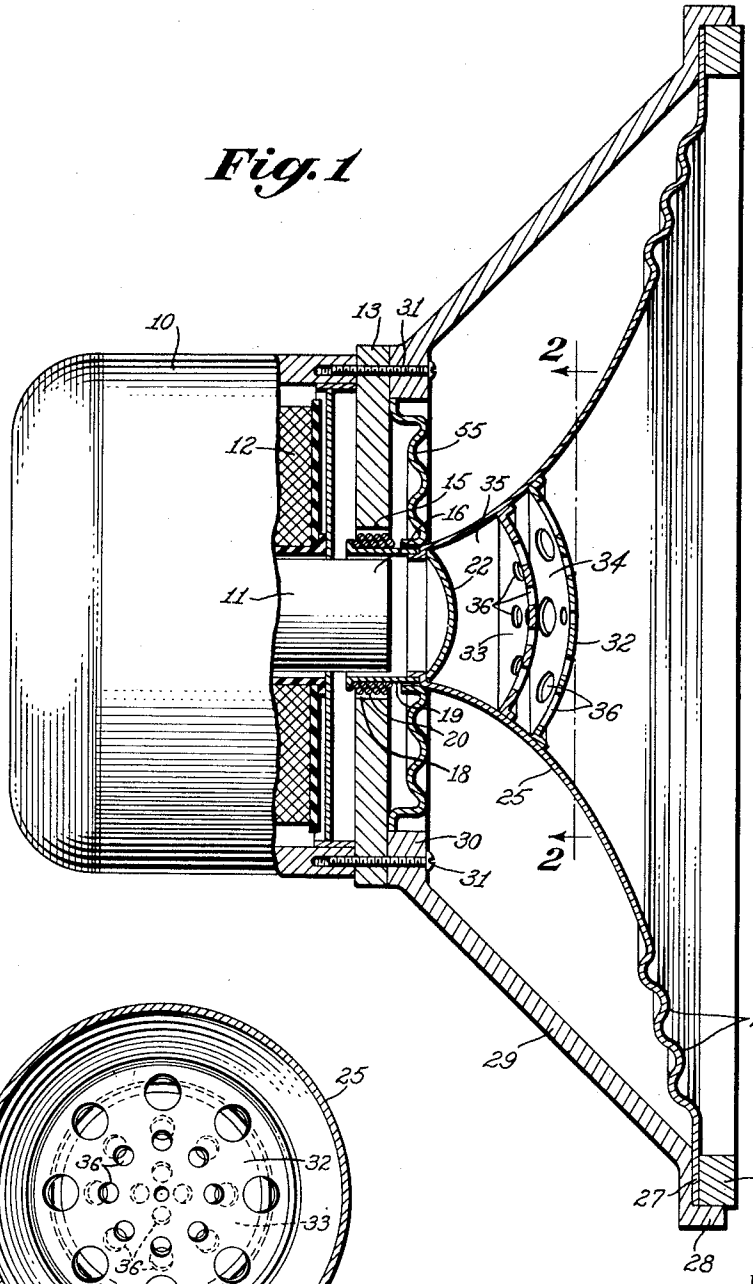

Fig. 2

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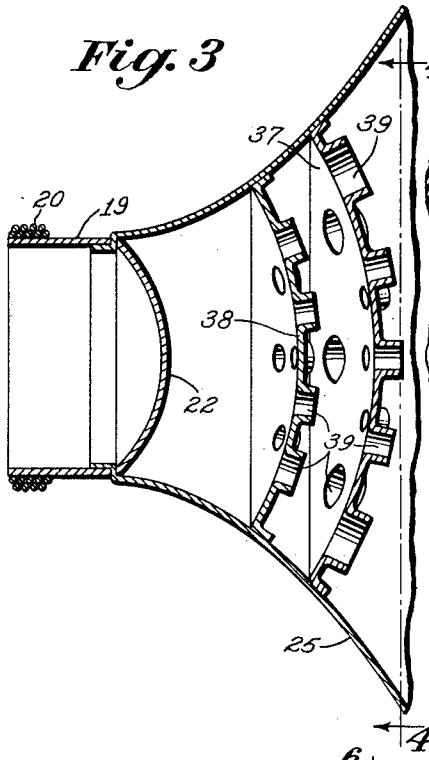
Fig. 3



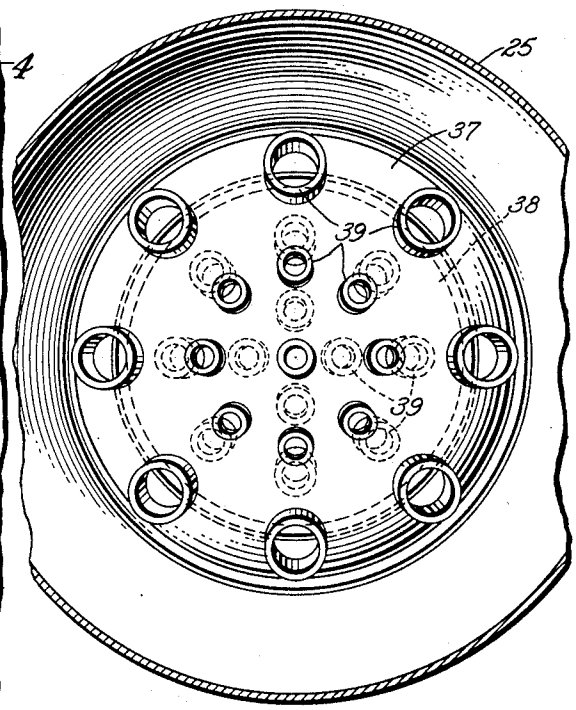


Fig. 4

Fig. 6

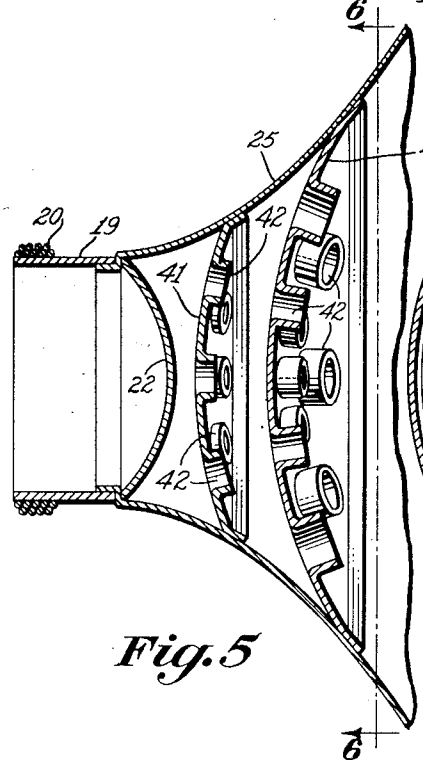
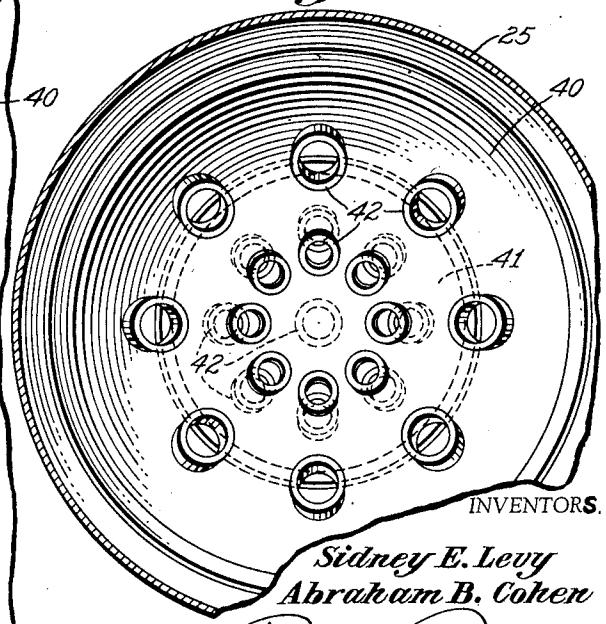


Fig. 5



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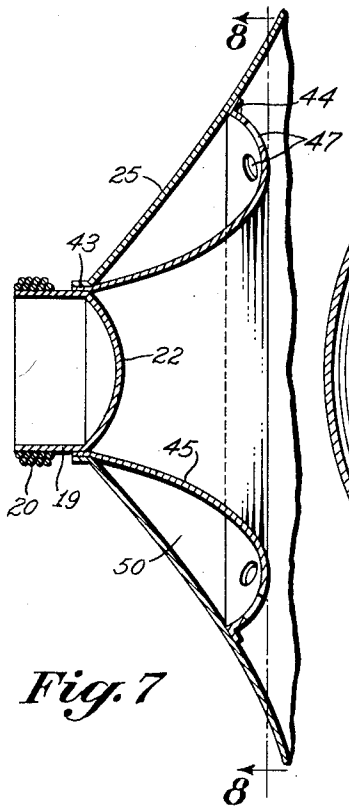

Fig. 7

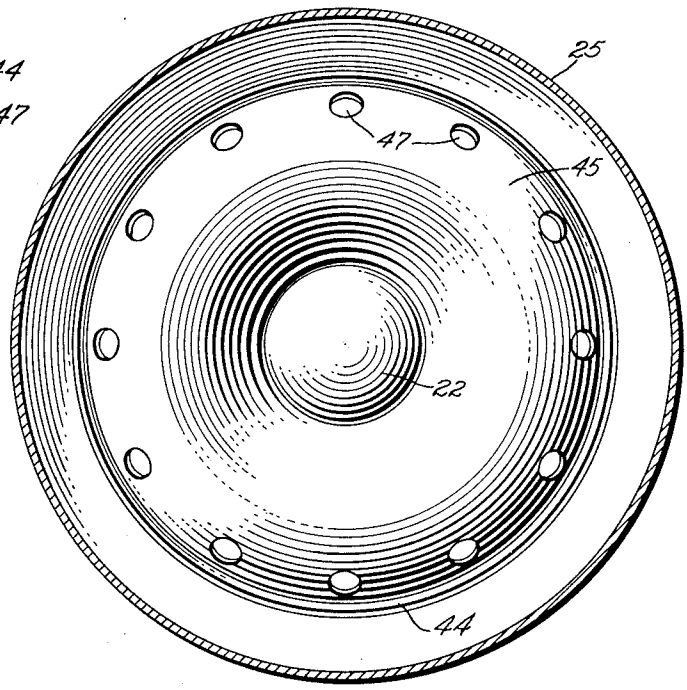

Fig. 8

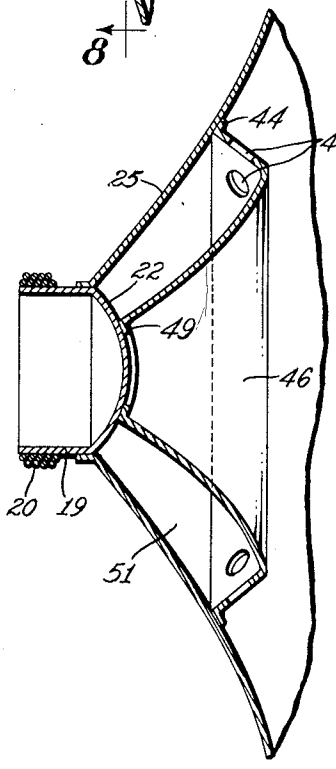

Fig. 9

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2,641,329

LOUD-SPEAKER DIAPHRAGM WITH TRANSVERSELY ARCHED STIFFENER MEANS

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Application May 29, 1950, Serial No. 164,892

5 Claims. (Cl. 181—32)

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The present invention relates to loud speakers, and more particularly, to diaphragms and stiffener means for diaphragms of loud speakers.

It has been found from experience with most loud speakers that the diaphragms thereof are susceptible to deflection or mechanical distortion when the supporting housing, basket or chassis is placed under stress, as when mounted on an irregular surface or baffle. This results in undue displacement of the position of the voice coil in the usual air gap, causing rubbing of the voice coil against the pole pieces or other adjacent parts of the speaker, with consequent distortion of the sounds or acoustical response produced by the diaphragm.

In acoustics, a small opening in a baffle which is inserted in a sound field acts itself as a point source of sound. This is generally known as the "Huygens" principle, wherein a pin-point perforation in a barrier which is placed in the path of a plane wave becomes a separate radiator by itself. Then as a separate radiator, it radiates a spherical wave. Therefore, a plane front wave hitting a barrier in which there are small apertures, becomes transformed into many pinpoint spherical wave fronts. These will combine into a single spherical wave front provided that the perforated plate is curved. That is, when these perforations are placed on a spherical surface, a curved wave is emanated which conforms to the envelope of the wavelets conforming to the pinpoint sources. As is well known in the art, a curved wave front is a wave which radiates over a wide angle and is therefore considerably diffused. If a second perforated plate is disposed in front of the first with the holes offset, this primary curved wave will be doubly curved by hitting another set of perforations, the effect being compounded and a more extremely diffused radiation results. Likewise, by perforating a member which has a concave shape, a concentration or focusing effect will result.

Accordingly, it is the primary purpose of the present invention to provide means for improving the rigidity of diaphragms of the paper or other type, as used in conventional loud speakers, by the provision of one or more stiffening elements, which elements serve at the same time as a form of zone plate or acoustic duct to create dispersion or concentration, as desired, of the high frequency energy generated by the center areas of the diaphragm and by those areas of the diaphragm behind the stiffener.

We have found that when the surface of a

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cone speaker diaphragm is reinforced or stiffened in the area adjacent to its apex, according to one form of the present invention, the voice coil no longer is subject to misalignment or displacement with respect to the air gap by reason of stress or distortions in the loud speaker chassis.

A further object of the invention is to increase the rigidity of the speaker diaphragm near its apex in order to prevent undue mechanical displacement or misalignment of the voice coil, while at the same time aiding or improving the acoustical response of the diaphragm.

Another object of the invention is to provide means for directing certain portions of the acoustic spectrum such as the higher frequencies generated by the loud speaker, to areas where they will be rendered most desirable and subject to higher fidelity.

Other and further objects and advantages of the invention will be hereinafter described, and the novel features thereof defined in the appended claims.

In the drawings—

Figure 1 is a view partly in section and partly in elevation, of a loud speaker unit of the electro-dynamic type, said loud speaker unit being provided with an improved diaphragm constructed in accordance with one embodiment of the present invention:

Figure 2 is a sectional view through the diaphragm of Figure 1, as taken on the line 2—2 of Figure 1, looking in the direction of the arrows;

Figure 3 is a fragmentary sectional view showing a modified form of the loud speaker diaphragm according to another embodiment of the invention;

Figure 4 is a sectional view taken on the line 4—4 of Figure 3, looking in the direction of the arrows;

Figure 5 is a fragmentary sectional view generally similar to Figure 3, but showing still another modified form of speaker diaphragm, according to another embodiment of the invention;

Figure 6 is a sectional view taken on the line 6—6 of Figure 5, looking in the direction of the arrows;

Figure 7 is a fragmentary sectional view of still another modified form of diaphragm according to another embodiment of the invention;

Figure 8 is a sectional view taken on the line 8—8 of Figure 7, looking in the direction of the arrows; and

Figure 9 is a fragmentary sectional view generally similar to Figure 7, showing still another modified form of diaphragm according to a further embodiment of the invention.

Like reference characters designate corresponding parts in the several figures of the drawings, wherein Figure 1 illustrates a typical loud speaker of the moving coil type and to which the diaphragm of the present invention is applicable. It is to be understood, however, that the details of the speaker assembly are not material to the present invention, and are to be considered merely as one illustrative arrangement without limitation of the invention to this specific assembly.

According to the construction in Figure 1, the speaker assembly includes a pot **10** provided at its center with a core **11**, both of magnetizable material such as soft iron or steel. Surrounding core **11** and disposed inside the pot **10** is a magnetizing coil **12**. Pot **10** is adapted to be closed by a cover plate **13** whose inner edge portion **15** cooperates with a portion **16** of the core to form pole-pieces between which is defined an annular air gap **18**. Cover plate **13** and pot **10** are of magnetizable material such as soft iron or steel so that upon energization of magnetizing coil **12**, an intense magnetic field will be created within the air gap **18**.

Disposed within the air gap **18** is a bobbin **19** of any suitable material, such as fiber, upon which is disposed a voice coil **20** having suitable leads (not shown) for connection to a source of voice currents. The free end of the bobbin **19** is preferably closed by a generally conical or dome-shaped cap **22** which may be formed of light, thin metal such as aluminum or copper, or it may be formed of thin fiber. The voice coil and bobbin are so proportioned as to move together axially within the air gap **18** in the manner customary with such types of loud speakers.

Attached to the bobbin **19** at the forward end thereof is a generally conical diaphragm **25** of any suitable material, such as stiff paper, metal, phenolic impregnated cloth or any other material. This diaphragm may have the outer edge or end thereof provided with flexing corrugations **26**, if desired. A spider or suspension member **55** is mounted between the bobbin **19** and the cover plate **13**. The extreme outer end or rim **27** of the diaphragm **25** is rigidly secured to the annular flanged mounting portion **28** of a diaphragm supporting housing, basket or chassis **29**, as by a suitable ring **29a**. Housing **29** is provided at its inner end with a mounting flange **30** suitably apertured to accommodate bolts or screws **31** to maintain pot **10**, front plate **13** and housing **29** rigidly assembled in predetermined position. The entire speaker may be mounted by bolting annular flanged portion **28** to any suitable baffle (not shown) in a manner well known in the art.

Mounted near the apex of diaphragm **25** are stiffening members **32** and **33**. The stiffening members are so spaced as to provide chambers **34** and **35**. Staggered perforations **36** are provided in the stiffening members **32** and **33** so as to bend and direct the frequencies generated in the chambers **34** and **35**, as well as those frequencies emanating from the dome cap **22**, thereby affording directional control of the acoustical frequencies.

In Figure 3, the construction of the stiffening members **37** and **38** is similar to that of Figure 1, except that the perforations are provided with tube-like extensions **39** projecting outwardly of

the diaphragm **26** to direct the high frequency sound waves over a given area in a diverging manner.

Another modification is illustrated in Figure 5, wherein the extensions **42** on the stiffening members **40** and **41** are so inclined as to direct the sound waves in a converging manner, the focal point depending upon the radius of members **40** and **41**.

One or more of the stiffening members shown in Figures 1, 3 and 5 may be used, depending on the size and flexibility of the diaphragm **25**. Generally, the smaller diaphragms require but one stiffening member, while the larger diaphragms require two or more of the stiffening members to prevent undue displacement of the voice coil bobbin, and the voice coil carried thereby.

In Figure 7, another modification is illustrated, wherein the stiffening member **45** is horn-like in form and is attached to the apex of the diaphragm **25** between the dome cap **22** and the marginal edge of the diaphragm which surrounds the same. This region is indicated by the reference character **43**. The opposite end of the horn-like member **45** is secured to the side of the diaphragm **25** at **44**, and located a predetermined distance from the apex to provide sufficient rigidity for the diaphragm according to the type and size used. Sound waves generated in chamber **50** are directed outwardly through passages **47**.

Still another modified arrangement is illustrated in Figure 9, wherein the horn-like member **46** is similar to that of Figure 7 except that the smaller end of the horn is secured to the face of the dome cap **22** at the point **49** which is relatively nearer to the central axis of the dome cap. The sound waves generated in chamber **51** are directed outwardly through passages **48**.

From the foregoing description, it will be apparent to those skilled in the art that we have provided a novel arrangement and construction of loud speaker diaphragms for preventing undue displacement of the voice coil, and eliminating much of the sound distortion which otherwise would be created under certain conditions. By employing diaphragms constructed in accordance with the present invention, a much wider distribution and higher fidelity is attained in the higher frequencies that normally travel in a more-or-less straight line, and which, in many instances, cannot be detected in zones spaced from the center of the speaker.

While the specific details have been herein shown and described, the invention is not confined thereto as changes and alterations may be made without departing from the spirit thereof as defined by the appended claims.

We claim:

1. An acoustic diaphragm for loud speakers, comprising an acoustical energy-responsive diaphragm member of substantially conical form having a relatively rigid transversely arched stiffener member secured at its outer marginal edge to an intermediate portion of the diaphragm member and extending across the latter, said stiffener member having a plurality of relatively small sound-radiating perforations therethrough, the perforations of said stiffener member being spaced from each other and each perforation having its axis inclined at an angle to the central axis of the diaphragm member,. and the perforated stiffener member having the property of directional control of high frequency propaga-

tion generated from the center of the diaphragm member.

2. An acoustic diaphragm as defined in claim 1, wherein the stiffener member has the form of a transversely arched perforated plate bridging the central area of the diaphragm member.

3. An acoustic diaphragm as defined in claim 1, wherein the stiffener member has the form of a horn-shaped member secured at its smaller end to said diaphragm and secured at its larger end to said diaphragm at a substantial distance from the smaller end foresaid.

4. An acoustic diaphragm for loud speakers, comprising an acoustical energy-responsive cone member having a relatively rigid transversely arched horn-shaped stiffener member disposed within the same and secured at its outer marginal edge thereto within the region adjacent to the apex thereof and extending across said cone member, said stiffener member having a plurality of relatively small sound-radiating perforations therethrough, each having its axis inclined at an angle to the central axis of said cone member, the apex of said cone member having an imperforate closure member mounted thereon and extended transversely thereacross, said perforated stiffener member having its inner margin secured to said closure member, and said perforated stiffener member having the property of directional control of high frequency propagation generated from the center of said cone member.

5. An acoustic diaphragm for loud speakers, comprising an acoustical energy-responsive cone member, a plurality of axially spaced relatively rigid barriers disposed in the path of the sound wave front generated by said cone member, each

of said barriers having a plurality of relatively small sound-radiating perforations therethrough, the perforations of the respective barriers each having its axis inclined at an angle to the central axis of said cone member and being laterally offset relative to each other, and each of said barriers being supported solely by said cone member on at least one annular contacting surface in the zone of the apex of said cone member and vibratable therewith, while having the property of directional control of high frequency propagation generated from the center of the cone member.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,673,939	Farrand	June 19, 1928
1,757,719	Kent	May 6, 1930
1,846,937	Bedford	Feb. 23, 1932
1,876,306	Laing	Sept. 6, 1932
2,007,747	Ringel	July 9, 1935
2,070,977	Quinnell	Feb. 16, 1937
2,124,834	Stenger	July 26, 1938
2,141,423	Tolerton	Dec. 27, 1938
2,193,399	Fisher	Mar. 12, 1940
2,231,479	Perry	Feb. 11, 1941
2,269,284	Olson	Jan. 6, 1942
2,580,439	Kock	Jan. 1, 1952

FOREIGN PATENTS

Number	Country	Date
368,344	Great Britain	Mar. 4, 1932
611,056	Great Britain	Oct. 25, 1948