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MULTIPLE SECTION DIAPHRAGM LOUDSPEAKER

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FIG. 1

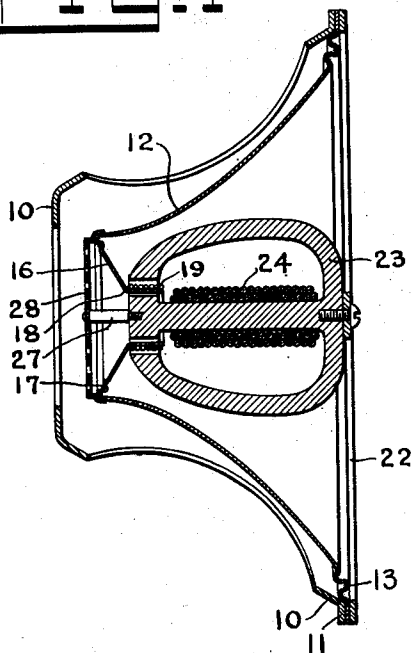


FIG. 2

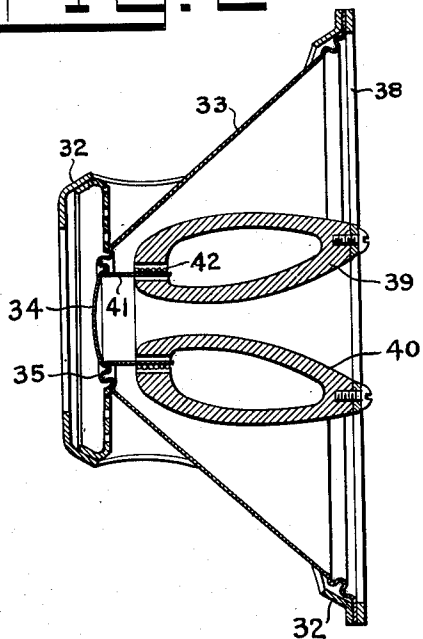
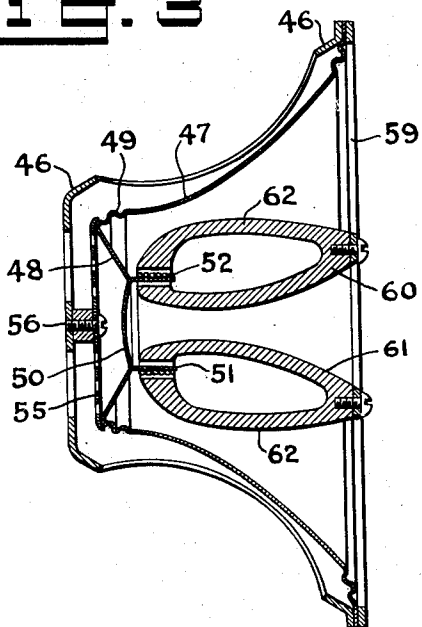


FIG. 3



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MULTIPLE SECTION DIAPHRAGM
LOUD-SPEAKER

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The invention relates to a loud speaker or sound reproducer which transforms electrical oscillations or vibrations into sound vibrations. Particularly it relates to a loud speaker having a double section cone for high and low frequencies and the frame of the motor is shaped with a horn contour for the high frequency section of the cone.

It is an object of the invention to construct a loud speaker having a cone diaphragm or a portion of a diaphragm for low frequencies and a smaller diaphragm or portion for higher frequencies with a driving motor located within the cone of the low frequency portion and the frame of the motor means shaped so that it forms a horn for the high frequency sounds emitted from the smaller diaphragm.

Another object of the invention is to construct a loud speaker having a large conical diaphragm and a smaller diaphragm connected therewith in which the driving motor means is connected with the smaller diaphragm and with the inner surface of the larger conical diaphragm as well as the outer surface of the driving motor means or its magnet being shaped to form a horn or throat construction for high frequencies emitted from the smaller diaphragm.

A still further object is to construct a loud speaker having a large conical diaphragm having a smaller diaphragm connected therewith and with a driving motor means located within the larger conical diaphragm, the driving motor means or its magnet means having a passage through its center shaped to form a horn for the high frequency vibrations emitted from the smaller diaphragm.

Another object of the invention is to construct a loud speaker providing a double horn for the high frequencies.

Other objects of the invention will be more apparent from the following description when taken in connection with the accompanying drawings illustrating preferred embodiments of the invention in which:

Figure 1 is a longitudinal section through a loud speaker with a horn throat formed between the motor frame and the larger portion of the cone of the diaphragm.

Figure 2 is a longitudinal section through another form of loud speaker in which the horn throat is through the center of the driving motor frame.

Figure 3 is a section through a third form of loud speaker having a double horn construction comprising that of Figures 1 and 2.

It is known that a horn improves the fidelity,

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particularly of high frequency waves emitted from a vibrating diaphragm. A satisfactory method of obtaining this result with the customary loud speakers has not heretofore been devised and at the same time producing a compact loud speaker as well as a simple method of achieving the above expressed result.

The loud speaker shown in Figure 1 includes an inner frame 10 which may be of spider or open conformation so that the sound vibrations generated by the diaphragm may be projected rearwardly of the cone. The frame 10 carries a rim 11 to which is secured the outer periphery of a conical diaphragm 12. Preferably the diaphragm has a compliance connection 13 between the cone proper and its periphery which is secured to the rim 11. The conical diaphragm is curved convex inwardly, that is, the inner surface is convex in conformation to form the outer wall of a conical horn.

A smaller diaphragm 16 has its outer periphery connected with the inner periphery of the larger portions of the conical diaphragm 12 through a compliance connection 17. The smaller diaphragm may be an inverted cone, that is its conical direction is the reverse of the conical direction of the larger portion of the diaphragm 12. The inner diameter of the smaller portion of the diaphragm carries a tubular extension 18 which carries a voice coil 19.

The frame 10 carries an outer spider or open frame 22 at the front edge thereof to which is secured a driving motor means 23. The magnet frame thereof has its outer surface shaped so as to form with the inner convex surface of the large portion of the conical diaphragm 12, a horn construction with an enlarged inner end between the surface at the smaller portion of the diaphragm then curving together to form a throat and thereafter the surface curve away from each other. The driving motor means may carry the usual magnet coils 24 or it may be a permanent magnet. Any form of driving motor means may be used so long as the shape of the frame is such as to form a horn construction or conformation with the larger portion of the conical diaphragm.

It is important that the voice coils be accurately centered in the gap of the driving motor means. This may be accomplished by providing a pin 27 in the end of the motor means, which pin carries a supporting spring mounting 28 which is relatively rigid radially but easily movable in an axial direction, so that the vibrations of the diaphragm in response to the electrical vibrations in the voice coil are freely transmitted to the

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diaphragm. The supporting spring mounting is secured at its outer periphery either to the outer diameter of the smaller portion of the diaphragm or to the inner diameter of the large portion of the conical diaphragm, although the former point of attachment is preferable since it removes from the support any inaccuracies which may occur in the compliance coupling.

In operation the voice coil vibrates or operates the tubular extension 18 which is secured to or forms a part of a smaller diaphragm and vibrates it. The compliance connection 17 permits the entire diaphragm to vibrate to the lower frequencies, whereas in the main the smaller diaphragm vibrates only to the higher frequencies. The lower frequency vibrations are transmitted directly forwardly or rearwardly from the large conical diaphragm and the high frequency vibrations are compressed in the horn throat formed between the surface of the large conical diaphragm and the outer surface of the driving motor means frame. This improves the fidelity of the high frequency vibrations, giving them a wider distribution angle, and also dampens any spurious vibrations generated in the diaphragm as well as improving the acoustical efficiency. It will be noted therefore that the low frequency vibrations are generated and emitted in the customary manner from the large conical diaphragm whereas the higher frequencies are generated by a small diaphragm within a sound chamber of a horn construction with its resultant greater fidelity. The rear of the loud speaker may be constructed in the usual fashion with infinite baffle or folded horn construction, or other known loud speaker designs.

Figure 2 illustrates another form of the construction in which a center passage through the driving motor or its magnet is shaped to form a horn construction for the high frequencies emitted from the high frequency portion of the diaphragm. In this construction a frame 32 is provided to which a large conical portion 33 of a diaphragm is secured at its outer periphery. The diaphragm has a central portion 34 which is connected to the large conical portion of the diaphragm through a suitable compliance connection 35.

An open grill or spider 38 is secured to the frame 32 to which is secured a driving motor means 39 which is largely the magnet structure. The motor means may be a permanent magnet or may carry windings to produce the magnetic flux across the pole gap. A center passage 40 extends through the driving motor means or its magnet and is shaped in the form of a horn with an enlarged chamber at the center or high frequency portion 34 of the diaphragm which narrows to a throat and then enlarges again. The diaphragm carries a tubular extension 41 upon which is wound the voice coil 42 for vibrating the whole diaphragm in accordance with the electrical oscillations carried by the voice coil. The voice coil, as is well known, is provided within the gap of the magnet 39 of the driving motor means.

The high frequency electrical oscillations vibrate the voice coil and the center portion 34 of the diaphragm thereby converting the electrical oscillations into sound vibrations which are emitted therefrom, and pass through the horn formed by the center passage 40 of the driving motor means. Low frequency oscillations of the voice coil are transmitted through the compliance 25 and vibrate the larger conical portion 33 of the

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diaphragm which are projected forwardly or rearwardly in known loud speaker fashion.

Figure 3 illustrates a form of the invention which combines the structures of Figures 1 and 2. In this construction an open frame 45 is provided to which the outer periphery of the larger conical portion 47 of a diaphragm is secured. This larger portion of the diaphragm is shaped convex inwardly similar to the diaphragm 12 of Figure 1 and the curvature corresponds with the curvature of conical horn. The diaphragm has also a smaller center portion 48 which is secured to the large portion 47 through a compliance connection 49. The smaller diaphragm 48 is an inverse cone with respect to the cone 47 and hence is similar to the small diaphragm 16 of Figure 1. In the construction of Figure 3, however, a center portion 50 is also provided. The diaphragm carries a tubular extension 51 which carries the usual voice coil 52.

The outer periphery of the diaphragm portion 48 may be supported by a spring spider 55 which is secured to the frame by a screw 56 in known fashion. This spider gives support in a radial direction yet permits a maximum of freedom in an axial direction so that the tubular extension 51 and the diaphragm may vibrate freely. The main frame 46 has an open frame 59 secured thereto which carries a driving motor means 60, the magnet of which has a center passage 61 shaped to form a horn with a chamber at the diaphragm which narrows to a throat and then increases in diameter. The portion 47 of the diaphragm is convex inwardly and shaped so that it forms the outer wall of a conical horn. The outer surface 62 of the driving motor means is also shaped to form the other or inner wall or surface of a conical horn in cooperation with the inner surface of the diaphragm 47.

High frequency oscillations of the voice coil and the extension 51 will be transmitted to the central portion 50 of the diaphragm and the inverted conical portion 48. These high frequency vibrations will not pass through the compliance 49 to any substantial extent. The sound waves emitted from the diaphragm portion 48 pass through the conical horn formed between the inner convex surface of the diaphragm portion 47 and the outer convex surface 62 of the driving motor means, which together form a conical horn construction. High frequency sounds emitted or generated by the diaphragm portion 50 pass through the horn structure formed by the inner passage 61 of the driving motor means. Low frequency oscillations of the voice coil vibrate the diaphragm portions 48 and 50 which low frequency vibrations are transmitted through the compliance 49 so that the whole diaphragm 47 vibrates at the low frequencies and emits low notes or tones in the usual fashion from the diaphragm.

The loud speakers described may be secured at their outer periphery to the customary housing or box which may be provided with an infinite baffle construction or other known loud speaker acoustical amplifiers. The construction of the loud speaker described not only utilizes the driving motor as a horn construction, but, compactness is also achieved in that the driving motor is within the confines of the diaphragm and does not project rearwardly from the loud speaker as in the customary mounting therefor.

This invention is presented to fill a need for improvements in a loud speaker. It is understood that various modifications in structure, as well

as changes in mode of operation, assembly, and manner of use, may and often do occur to those skilled in the art, especially after benefiting from the teachings of an invention. Hence, it will be understood that this disclosure is illustrative of preferred means of embodying the invention in useful form by explaining the construction, operation and advantages thereof.

What is claimed is:

1. A loud speaker comprising a frame, a large conical diaphragm secured at its outer periphery to the frame, a smaller diaphragm, a compliance coupling connecting the outer circumference of the smaller diaphragm to the inner circumference of the large conical diaphragm, a driving motor means having a voice coil connected with the smaller diaphragm, the driving means being located within the large conical diaphragm, and the driving means having a surface shaped to form at least part of a horn for the high frequency sound waves emitted from the smaller diaphragm with an air chamber in front of the smaller diaphragm merging into a horn throat and thereafter an enlarged diameter.

2. A loud speaker comprising a frame, a large conical diaphragm secured at its outer periphery to the frame, a smaller diaphragm inverted with respect to the larger diaphragm, a compliance coupling connecting the outer circumference of the smaller diaphragm to the inner circumference of the large conical diaphragm, a driving motor means having a voice coil connected with the smaller diaphragm, the driving motor means being located within the larger conical diaphragm, and the driving motor means having a surface shaped to form at least part of a horn for the high frequency sound waves emitted from the smaller diaphragm with an air chamber in front of the smaller diaphragm merging into a horn throat and thereafter an enlarged diameter.

3. A loud speaker comprising a frame, a large conical diaphragm secured at its outer periphery to the frame, the large conical diaphragm having its inner surface shaped at different angles, a smaller diaphragm, a compliance connecting the outer circumference of the smaller diaphragm to the inner circumference of the larger conical diaphragm, a driving means having a voice coil connected with the inner circumference of the smaller diaphragm, the driving means being located within the large conical diaphragm, the driving means having its outer surface shaped with respect to the large conical diaphragm to form therewith a horn for the higher frequency sound waves emitted from the smaller diaphragm with a chamber at the smaller diameter merging into a horn throat between the larger diaphragm and the outer surface of the driving means.

4. A loud speaker comprising a frame, a large cone secured at its outer periphery to the frame, the large cone having its inner surface shaped so that its angle is less at the smaller diameter than at the larger diameter, a smaller cone inverted with respect to the larger cone, a compliance securing the outer circumference of the smaller cone to the inner circumference of the larger cone, a driving means carried by the frame and connected with the inner circumference of the inverted cone, the driving means being located within the large cone, and the driving means having its outer surface shaped with respect to the large cone to form a horn for the higher frequency sound waves emitted from the inverted cone with a sound chamber in front of the smaller cone merging into a horn throat be-

tween the large cone and the outer surface of the driving motor and thereafter an enlarged diameter.

5. A loud speaker comprising a frame, a large cone secured at its outer periphery to the frame, the large cone having its inner surface curved convex inwardly, a smaller cone inverted with respect to the larger cone, a compliance securing the outer circumference of the smaller cone to the inner circumference of the large cone, a driving motor means connected with the inner circumference of the inverted cone, the driving motor means being located within the large cone, and the driving motor means having its outer surface curved convex outwardly to form a horn for the higher frequency sound waves emitted from the inverted cone with a sound chamber in front of the smaller cone and a horn throat between the large cone and the outer surface of the driving means expanding into a larger diameter.

6. A loud speaker comprising a frame, a large conical diaphragm secured at its outer periphery to the frame, a smaller diaphragm, a compliance coupling connecting the outer circumference of the smaller diaphragm to the inner circumference of the large conical diaphragm, a driving motor means having a voice coil connected with the smaller diaphragm, the driving motor means being located within the larger conical diaphragm, and the driving motor means having a central passage therethrough forming a horn for the high frequency sound waves emitted from the smaller diaphragm with an air chamber in front of the smaller diaphragm merging into a horn throat and thereafter gradually increasing in diameter.

7. A loud speaker comprising a frame, a large conical diaphragm secured at its outer periphery to the frame, the large conical diaphragm having its inner surface curved convex inwardly, a smaller conical diaphragm having a central portion, a compliance coupling connecting the outer circumference of the smaller conical diaphragm to the inner circumference of the large conical diaphragm, a driving motor means having a voice coil connected with the smaller diaphragm, the driving motor means being located within the larger conical diaphragm, and the driving motor means having its outer surface shaped to form a conical horn with the larger diaphragm for the high frequency sound waves emitted from the smaller diaphragm with an air chamber in front of the smaller conical diaphragm merging into a horn throat and thereafter enlarging, and a central passage through the driving motor means shaped to form a horn for the sound waves emitted from the central portion of the smaller diaphragm.

FREDERICK A. LINDLEY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,943,499	Williams	Jan. 16, 1934
2,007,747	Ringel	July 9, 1935
2,058,555	Betts	Oct. 27, 1936
2,077,170	Harrison	Apr. 13, 1937

FOREIGN PATENTS

Number	Country	Date
679,439	Germany	Aug. 5, 1939

Certificate of Correction

Patent No. 2,534,040

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FREDERICK A. LINDLEY

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 1, line 54, for the word "comprising" read *combining*;
and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of February, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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