Sept. 2, 1947. J. PRESTON 2,426,948

COAXIAL DUAL-UNIT ELECTRODYNAMIC LOUD SPEAKER

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Fig. 2.

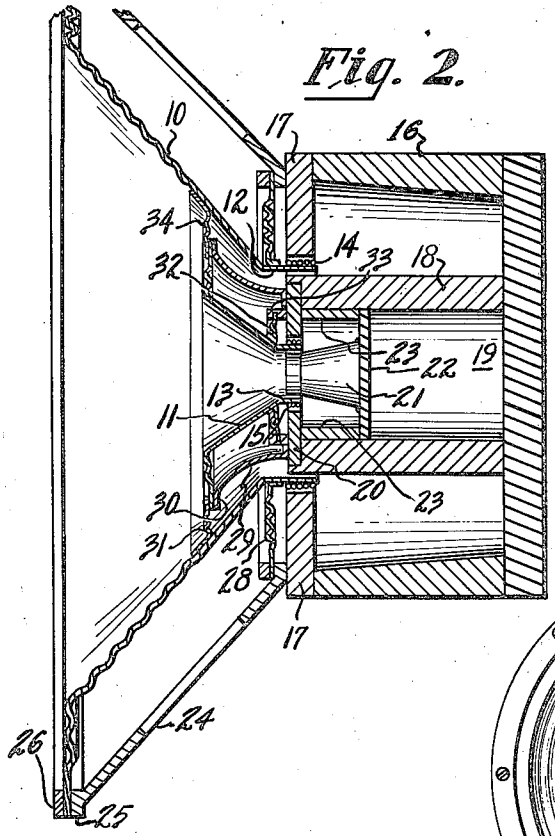


Fig. 5.

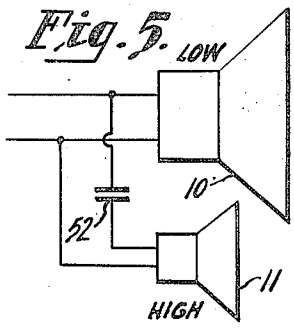


Fig. 1.

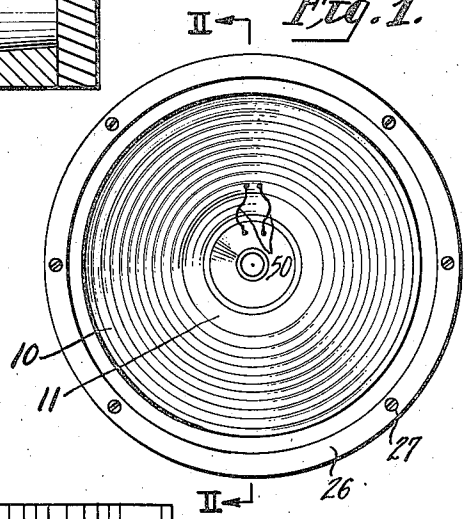
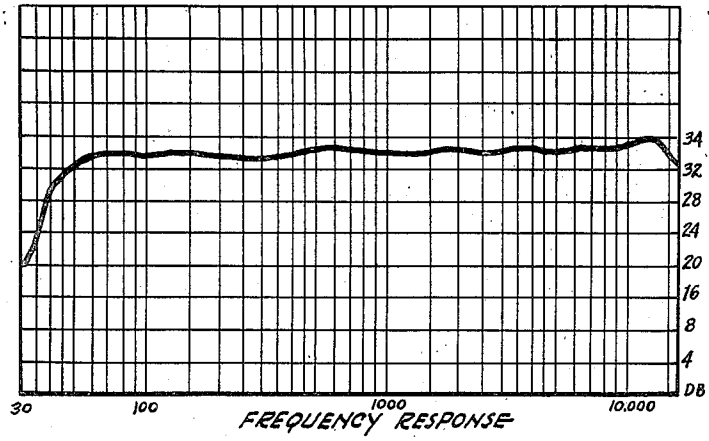


Fig. 6.



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Fig. 3.

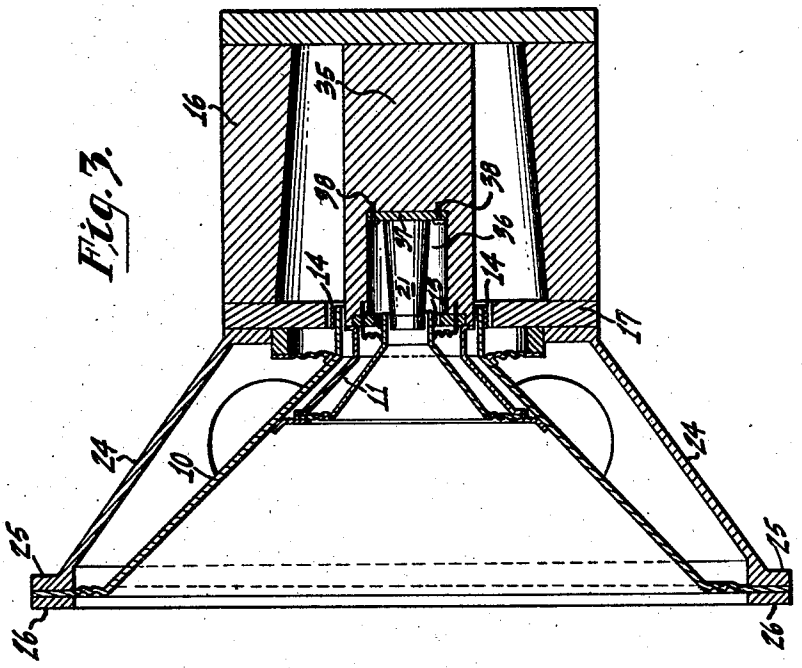
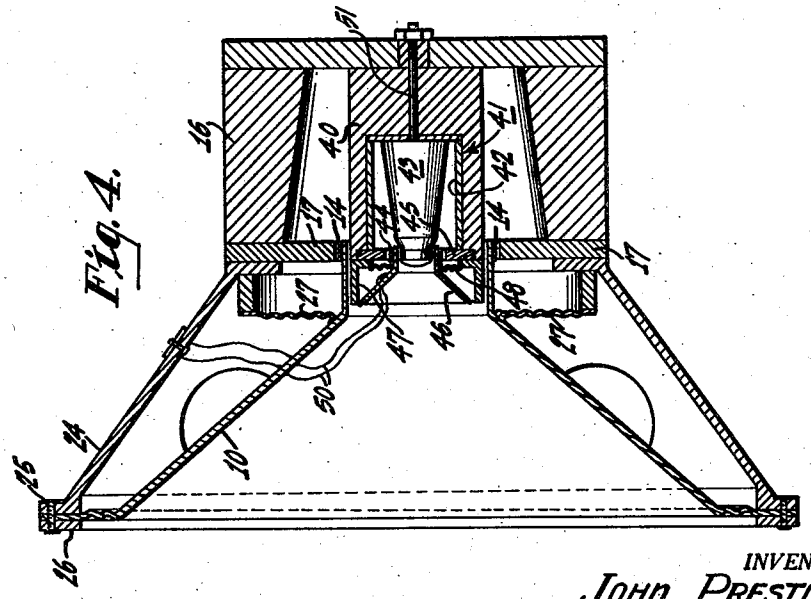


Fig. 4.



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COAXIAL DUAL-UNIT ELECTRODYNAMIC LOUD-SPEAKER

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1 Claim. (Cl. 179—109)

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The present invention relates to sound reproduction and more particularly to an improvement in loud speakers.

Many factors govern the performance of a direct radiator loud speaker. The conditions which are favorable for maximum efficiency at the high frequencies are not the same as those which obtain for maximum at the low frequencies. In order not to overload the system, and the resultant production of harmonics, it is necessary to use a relatively heavy cone at the low frequencies. At low frequencies, the mass reactance of the air load is usually comparable to the mass reactance of a moderately heavy cone, so that the loss in efficiency incurred by the use of a heavy vibrating system is not serious. In the high frequency range the main obstacle to good efficiency is the large mechanical reactance of the vibrating system. A number of two separately driven cone systems have been designed and built from time to time. In one type, a high frequency loud speaker is mounted in the same baffle with the low frequency unit. In another type, the small high frequency loud speaker is mounted in front of the low frequency cone. All existing systems exhibit phase distortion and anomalies in the directional pattern in the cross-over range because the two sounds from the low and high frequency loud speakers do not issue from a common origin.

Some of the objects of the present invention are: to provide a direct radiator loud speaker which eliminates the undesirable features that are present in all two speaker arrangements heretofore in use wherein the high frequency comes from one point and the low frequency from another; to provide a loud speaker characterized by an absence of undersirable wave pattern characteristics; to provide a simple, inexpensive loud speaker capable of covering the entire audible frequency range with the sound coming from one source; to provide a duplex speaker wherein the destructive interference between the high and low frequencies is eliminated; to provide a loud speaker wherein the high frequency range is extended without impairing the power handling capacity; to provide a duplex speaker wherein a large cone is a virtual continuation of a small cone; to provide a loud speaker formed of two cones having essentially the same sound origin; to provide a duplex speaker wherein the high frequency cone is separately mounted with respect to the low frequency cone and comprises an assembly readily removable as a complete

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separate unit; and to provide other improvements as will hereinafter appear.

In the accompanying drawings, Fig. 1 represents a front elevation of a duplex speaker embodying one form of the present invention; Fig. 2 represents a section on line 2—2 of Fig. 1; Fig. 3 represents a section similar to Fig. 2 but illustrating another form of the invention; Fig. 4 represents a section similar to Fig. 2 but illustrating a preferred form of the invention; Fig. 5 is a wiring diagram of a circuit which may be employed for energizing the two voice coils; and Fig. 6 is a response graph of the speaker of the present invention taken over a frequency range of 30 to 15,000 cycles.

Referring to Fig. 2 of the drawings, one form of the loud speaker system of the present invention comprises two nested overlapping cones 10 and 11 made of vibratile material, such as heavy paper or the like now well known in the part of direct radiator loud speakers. The cone or diaphragm 10 is relatively large for the purpose of reproducing frequencies in the lower audible range of between 40 and 1500 cycles, while the cone or diaphragm 11 is relatively small in order to reproduce frequencies in the higher audible range of between 1500 and 15,000 cycles. Both cones 10 and 11 are of truncate shape to provide in each case an annular base portion 12 and 13, the former being joined to an annular cylindrical voice coil 14 and the latter being joined to an annular cylindrical voice coil 15, the two coils 14 and 15 thereby respectively forming the driving sections for the two cones.

For producing the magnetic field, a suitable magnetic structure is provided comprising, in the present instance, a permanent magnet 16 having an annular pole 17 encircling the voice coil 14, and a center pole 18 coaxial of the two cone base portions and having an end within and encircled by the voice coil 14. This pole 18 is formed with a through bore 19 and has an annular pole piece 20 mounted to encircle the voice coil 15 to thereby serve as the outside magnetic path of the small speaker. Within the bore 19 is a second permanent magnet 21 attached to a base 22, of soft iron fitted transversely within the bore 19 and locating the magnet 21 coaxially with respect to the base of the cone 11. A sleeve 23, also preferably of soft iron, encircles the magnet 21 and abuts the pole 20, thereby forming a complete assembly readily removable from the pole piece 18. The magnet 21 terminates in a cylindrical head, which in assembled condition is located within and encircled by the voice coil

15. Thus, the complete magnet assembly comprises the magnet 16, pole 17, voice coil 14, center pole 18, annular pole 20, voice coil 15, and magnet 21, all of said parts being concentrically arranged in substantially the same transverse plane and coaxial with respect to the cone bases. From this construction it will be seen that the lines of magnetic flux for poles 17 and 18 include voice coil 14, while the lines of magnetic flux for poles 20 and 21 include voice coil 15.

For mounting the cone 10 a spider or annular dishpan structure 24 is attached at its end of smaller diameter to the annular pole piece 17 and terminates at its larger diameter end in a ring 25, to which the outwardly turned flexible margin of the cone 10 is clamped by a ring 26 and screws 27. The marginal edge of the small end of the cone 10 is supported by a flexible member or compliance 28 stretched between the cone end and a part attached to the pole piece 17.

For mounting the cone 11, a spider or outwardly flared annular dishpan structure 29 is attached to the pole 20 and carries a ring 30 to which the outwardly turned flexible margin 31 of the cone 11 is clamped. The marginal edge of the small end of the cone 11 is supported by a flexible member or compliance 32 from a ring 33 anchored to the annular pole piece 20. A compliance 34 may be interposed between the two cones and allows the cone 11 to vibrate independently of the cone 10.

Referring to Fig. 3 of the drawings, a modified form is illustrated wherein those parts which are respectively common to like parts in Fig. 2 are given like reference numerals since the description thereof remains unchanged. In this form the center pole 35, which is common to the magnets 16 and 21, is formed as a solid block supported coaxially of the magnet 16 and having its other end provided with a recess 36 in which the magnet 21 is located. This magnet 21 is attached to a base 37 detachably connected to the bottom of the recess by screws 38 or like removable fastenings. Thus, provision is made for separately detaching and removing the high frequency cone 11 and its associated parts without disturbing the low frequency cone 10.

Referring to the form of the invention shown in Fig. 4, the modification concerns the mounting of the high frequency cone 11, while that of the low frequency cone remains unchanged from the forms of Figs. 2 and 3, and therefore the parts thereof are respectively identified by the same reference numerals. In the form of Fig. 4 the center pole 40 of the magnet system is a solid block, such as soft iron supported coaxially with respect to the cone 10 and having an end recess 41, which receives a cup-shaped member 42, the bottom of which supports a permanent magnet 43 of a length to enter and be encircled by the voice coil 44, which in turn is encircled by the annular pole 45.

For mounting the high frequency cone 46, a flanged ring 47 is attached to the end of the center pole 40 and secures the marginal edge of the large diameter end of the cone. The marginal edge of the small diameter end or base of the cone 46 is supported by a suitable compliance 48 from the pole 45, in which position it is arranged to be actuated by the voice coil 44. It should be noted that the length of the ring 47 (axially considered) is such that the slope of cone 46 is substantially the same as that of the cone 10, and the mounting is so positioned relative to the mounting of the cone 10 that the surface of the cone 46 is substantially a continuation of the surface of the cone 10, and interrupted only to properly locate the voice coil 14. The leads 50 to the voice coils are brought into operative connection in any convenient way and terminate exterior of the speaker for cable attachment as will be understood.

In order that the high frequency speaker can be readily removed as a unit for repair or replacement, an elongated screw 51 passes axially through the pole 40 to thread into the base of the member 42 and thus retain the magnet 43 and the associated parts in place. When it is desired to remove the high frequency speaker, the voice coil leads 50 are disconnected from the exterior connections and the screw 51 removed so that the member 42 is free to be pushed out of the recess 41 by any suitable push rod entering the pole 40 through the hole vacated by the screw 51, and of a length to shift the speaker unit outwardly to a position where it can be grasped and removed.

The pairs of voice coils used in conjunction with the respective forms of the invention may be connected as shown in Fig. 5 with a capacitance 52 of suitable value connected in series with the high frequency voice coil.

From the foregoing it will be seen that by locating the high frequency cone well back within the low frequency cone, it is possible to use the center pole 17 of the larger cone as the outside magnetic path of the smaller cone. Thus, the large cone is a virtual continuation of the small cone because the cone angles are substantially the same and the high frequency cone lies sufficiently within the cone 10 to bring the two cone faces into substantial alinement. This alinement is brought about by so positioning the cone 11 within the cone 10 as to locate the large marginal edge of the cone 11 substantially in the plane of the marginal edge of the small end of the cone 10. Since the smaller cone 11 has its own center pole in the magnet 22 it will be apparent that each cone is independently energized. By using two cones with essentially the same origin it is possible to use a simple overlap network, such as shown in Fig. 5 without encountering a ragged response in the overlap region. By reference to the frequency graph of Fig. 6, it will be seen, due to novel combination of a separately driven small speaker built into the center pole of the large speaker, that a smooth response ±2 db. from 40 to 15,000 cycles is obtained. One of the outstanding features of the speaker of the present invention is the uniform response and smooth direction pattern in the overlap frequency range.

While the magnet illustrative of the preferred form of the invention is of permanent magnet construction, it could be energized electro-magnetically, as will be understood. The high frequency response could be further extended by a variation in the construction of the high frequency cone. The model described above has a flat frequency response, ±2 db. from 40 to 12,000 cycles. The high frequency efficiency of a direct radiator loud speaker is limited by the mass of the vibrating system. The high frequency response may be increased by the inclusion of a separately driven small speaker, built into the center pole of the large speaker which results in a smooth response, ±2 db. from 40 to 12,000 cycles. One of the outstanding features of this loud speaker is the uniform response and smooth directional pattern in the overlap frequency range.

Furthermore, it should be particularly noted that the high frequency cone or diaphragm assembly is entirely independent of the low frequency cone or diaphragm assembly and hence the vibrations of neither cone can be transmitted to the other to produce the heretofore objectionable interference and distortion of the combined vibrations.

It is to be understood that in the foregoing description the term "cone" is used in a broad sense and as used in the specification and claim contemplates any form of vibratile diaphragm as an equivalent structure and within the scope of the invention.

I claim as my invention:

A loud speaker comprising a magnet forming an annular pole piece and a center pole piece of opposite polarity having an end bore, said pieces being spaced to form an annular air gap, a voice coil in said air gap, a second magnet of opposite polarity from said center pole piece in said bore, means accessible from the exterior

of said first magnet for mounting said second magnet in said bore in spaced relation to said center pole piece to form an air gap, a voice coil in said last mentioned air gap, a vibratile low frequency cone arranged to be actuated by one voice coil, a vibratile high frequency cone arranged to be actuated by the other voice coil, and means interconnecting said high frequency cone, voice coil and second magnet as a complete operable unit removable from said low frequency cone.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,907,723	Bostwick	May 9, 1933
1,908,957	Parry	Nov. 3, 1934
2,122,587	Ringel	July 5, 1938