May 27, 1958 F. A. MANLEY ET AL 2,836,664

LOUDSPEAKER

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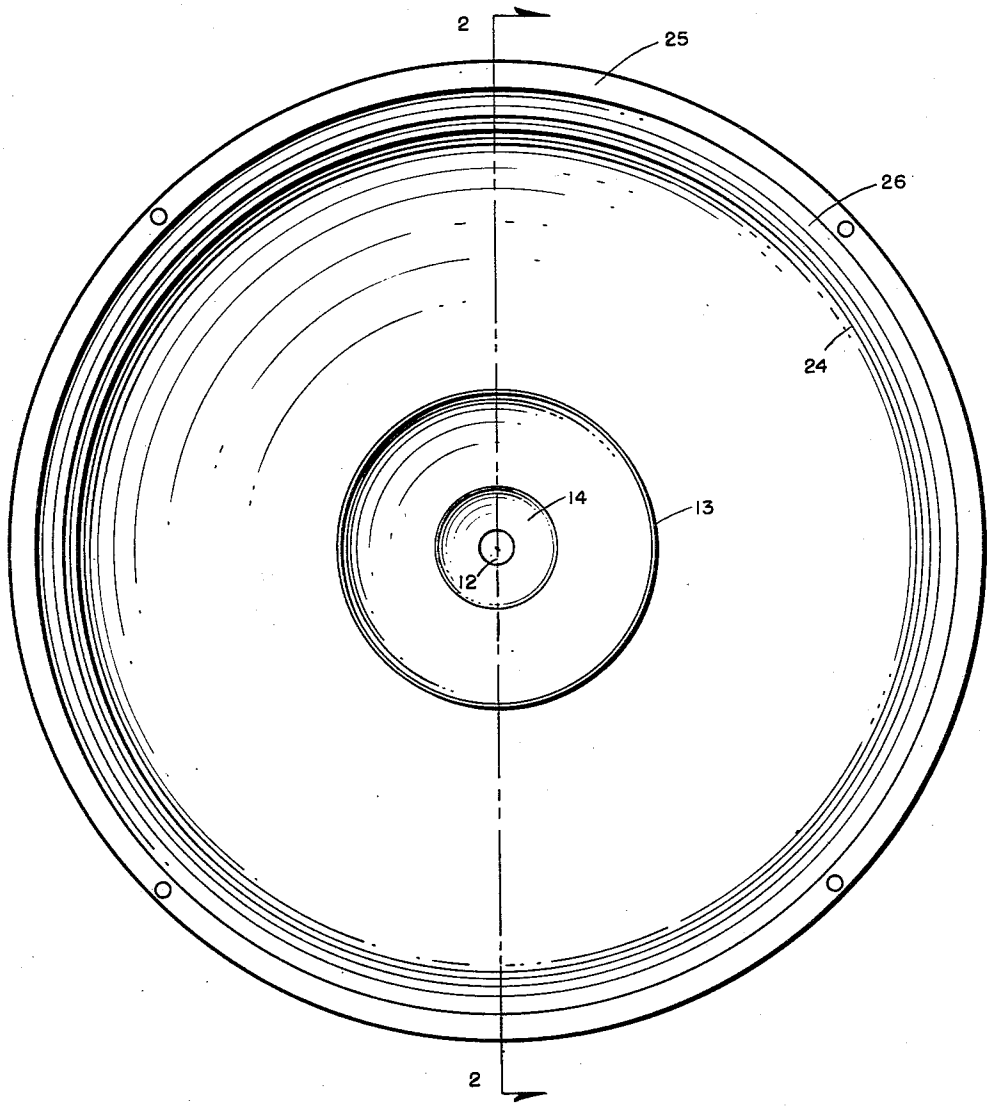


FIG. 1

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FIG. 3

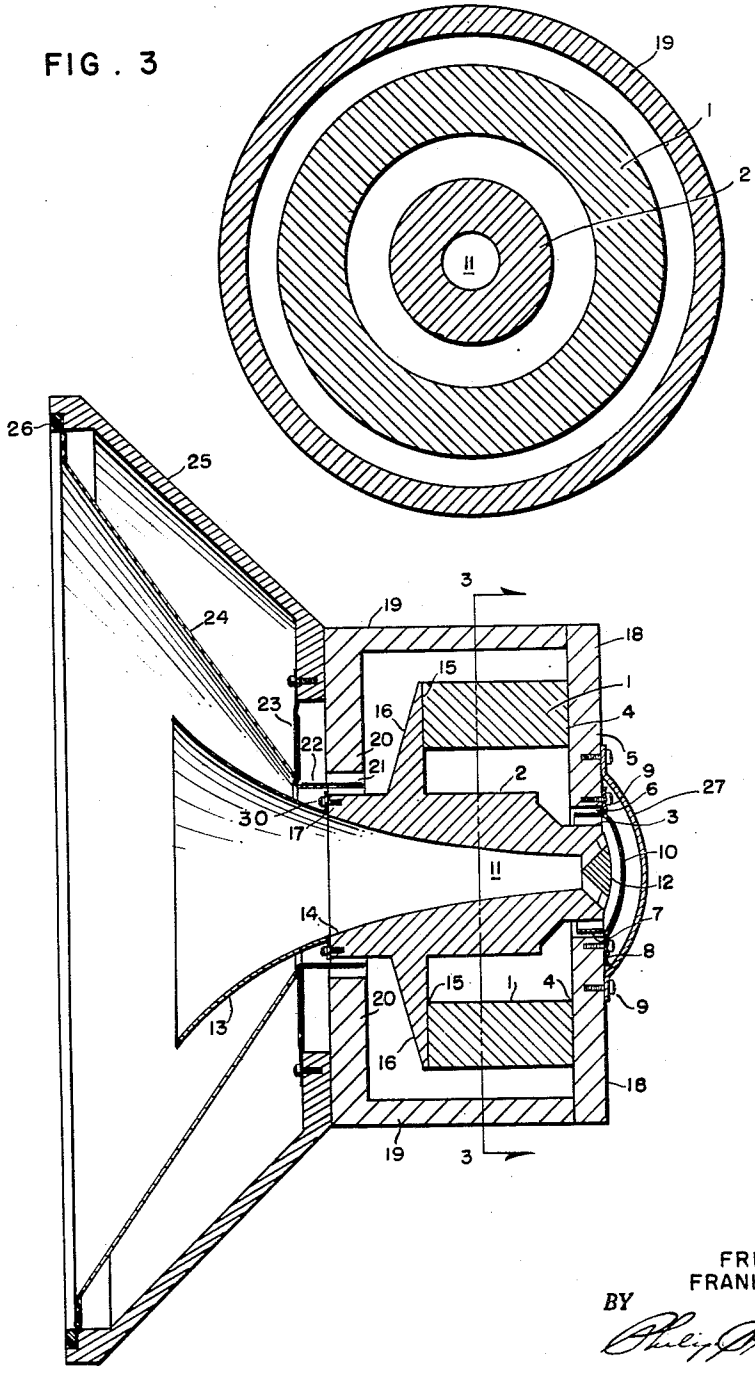


FIG. 2

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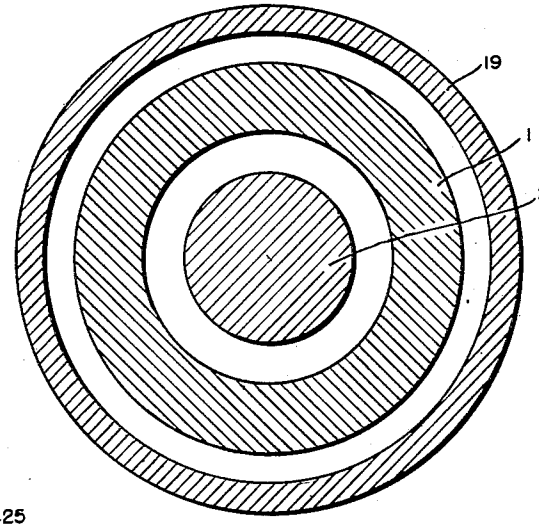
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FIG. 5



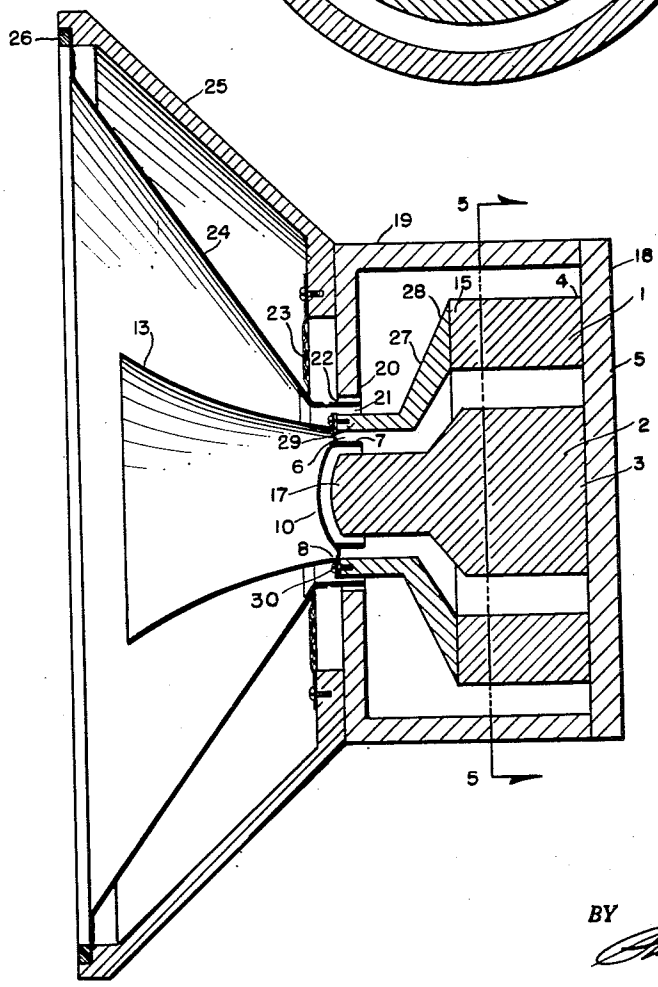


FIG. 4

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2,836,664

LOUDSPEAKER

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Application January 12, 1953, Serial No. 330,692

4 Claims. (Cl. 179—115.5)

Our invention relates to improvements in loudspeakers, and more particularly to loudspeakers of the coaxial type in which a plurality of diaphragms is provided, each diaphragm being adapted to radiate sound over a given range of frequencies.

Coaxial loudspeakers known heretofore have employed either a plurality of flux sources or have employed series airgaps for the voice coils attached to the respective diaphragms. These expedients are expensive because, in the first case, two magnets must be provided, while in the second, a magnet sufficiently strong to overcome the combined magnetic potential drops of the two gaps is required.

It is accordingly an object of our invention to provide a coaxial loudspeaker in which a single flux-source magnetic member, or magnet, feeds a plurality of airgaps in parallel rather than in series.

It is also an object of our invention to provide a coaxial loudspeaker which provides maximum magnet economy.

It is a further object of our invention to provide a loudspeaker in which airgaps are fed in parallel from a single source of magnetic flux; in which one diaphragm is at the opposite end of the magnetic structure from the other; and in which a central magnetic member has a horn-shaped channel formed therein to convey sound from one diaphragm in the direction of the other diaphragm.

It is another object of our invention to provide a loudspeaker in which a plurality of airgaps and their accompanying voice coils are disposed in co-planar fashion.

Further objects and advantages of our invention will become apparent as the following description proceeds and the features of novelty which characterize our invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

We have chosen in the following description to explain our invention as applied to two embodiments thereof. Since these embodiments may have substantially the same frontal appearance, we have therefore shown, in Fig. 1, the frontal appearance of one embodiment only.

For a better understanding of our invention, reference may be had to the accompanying drawing in which, in addition to Fig. 1 explained above,

Fig. 2 is a sectional view of one embodiment of our invention taken along line A—A in Fig. 1;

Fig. 3 is a sectional view taken along line 3—3 in Fig. 2;

Fig. 4 is a sectional view of another embodiment of our invention, but taken along a line similar to A—A in Fig. 1; and

Fig. 5 is a section taken along line 5—5 of Fig. 4.

Referring now to Fig. 2, there is provided a flux-source magnetic member, or magnet, 1 which is preferably of generally tubular configuration. In accordance with our invention, we provide dual magnetic circuits fed in parallel from flux source member 1, these circuits being respectively completed by passing inside and looping outside of tubular member 1. Thus we may provide, in addition to magnetic member 1, a central magnetic member 2 which extends substantially coaxially through the tubular magnetic member. A first end 3 of member 2 extends beyond end 4 of member 1. We also provide means 5 magnetically coupled, as by direct contact, to end 4 of member 1. Means 5 magnetically extends radially inward toward end 3 of member 2 but is spaced therefrom to define a first airgap 6. We prefer that magnetic means 5 be a substantially plane plate made of low magnetic reluctance material.

A voice coil 7 is supported in airgap 6 by a compliance 8, which is in turn secured to plate 5 by means of screws 9 or other suitable means. Those skilled in the art can appreciate that voice coil 7 and compliance 8 are preferably circular, as is common in the loudspeaker art. It can likewise be appreciated that connecting terminals may be provided in suitable location for the leads from voice coil 7. Terminals have not been shown in the drawing because they are well known in the art and in any event are not essential to an understanding of our invention.

Also attached to voice coil 7 and compliance 8 is a high frequency diaphragm 10 which is adapted to radiate sound over a relatively high range of frequencies. Compliance 8 supports diaphragm 10 for vibratile motion, relative to the magnetic structure, in accordance with the electrical currents fed to voice coil 7 by reaction with the magnetic flux in gap 6.

To increase efficiency, we prefer to provide a horn shaped channel 11 extending substantially coaxially forward through member 2, with its smaller end adjacent diaphragm 10. We may also provide a plug 12 in the throat of horn 11 suitably to control the pressure distribution and phase of the sound fed into channel 11. In addition to channel 11, we may provide a horn extension section 13 attached by any suitable means, such as screws 30, to end 17 of member 2. We may further prefer that horn channel 11 and horn extension section 13 have a continuous exponential shape, although those skilled in the art are aware that other contours may be employed.

The foregoing exposition has explained one loudspeaker of the coaxial loudspeaker combination. For the other loudspeaker of the coaxial assembly under discussion, we provide means magnetically connecting end 15 of flux-source magnetic member 1 to central magnetic member 2. We may prefer that this magnetic connecting means be a flanged portion 16 formed integrally with central magnetic member 2, although again, those skilled in the art are cognizant that other arrangements would be equally suitable. The main consideration is that the flux density in portion 16 be as nearly uniform as possible.

The opposite end of the magnetic circuit under consideration is completed outside flux source member 1 by means extending magnetically outward from end 4 of member 1, around the outside of member 1 and inwardly toward end 17 of member 2. These sections of the path may be formed by an outwardly extending portion 18 of plate 5 and a yoke 19 of low-reluctance magnetic material, the inwardly extending portion 20 of yoke 19 being spaced from end 17 of member 2 to define a second airgap 21 therebetween. The second airgap has suspended therein a second voice coil 22 which is in turn suspended for vibratile motion relative to the magnetic structure by a suitable compliance 23. A second diaphragm 24 adapted to radiate sound over a relatively low range of frequencies is supported at its outer circumference by a basket 25 which is secured by any convenient means, such as welding, to yoke 19. Voice coil 22 is drivingly

attached to diaphragm 24. Ring 26 may be provided against the outer circumference of diaphragm 24 to assist in retaining the latter in place. A cover 27 may be placed over diaphragm 10 for protection and to provide acoustical stiffness.

This embodiment of our invention is particularly advantageous in that a horn of adequate length may be provided for high frequency diaphragm 10 without any protrusion from the front of the loudspeaker.

Examination of Fig. 4 reveals that the embodiment of our invention shown therein comprises many parts having similarity to those shown in Fig. 2. There is provided a flux-source magnetic member 1 and a central magnetic member 2 extending substantially coaxially through member 1. A plate 5 connects a first end 4 of member 1 with a corresponding first end 3 of member 2. There is also included a magnetic linking means extending outwardly from end 4 of member 1, which may comprise an outward extension 18 of plate 5, and a yoke 19 extending around the outside of the flux source member 1 and inwardly toward end 17 of member 2. The inwardly extending portion 20 of yoke 19 is spaced from end 17 of member 2.

Further in accordance with this embodiment of our invention, we provide a magnetic coupling member 27 having ends 28 and 29. End 28 is magnetically coupled, as by direct contact, to end 15 of flux source member 1. End 29 of member 27 is disposed between ends 17 and 20 of central member 2 and yoke 17, respectively. We prefer that end 29 of member 27 have a substantially cylindrical shape, whereby a first airgap 6 is defined between ends 17 and 29 of members 2 and 27, respectively, and a second airgap 21 is defined between ends 20 and 29 of yoke 19 and member 27, respectively.

Voice coils 7 and 22 are respectively suspended within airgaps 6 and 21, as by means of compliances 8 and 23. These voice coils are drivingly attached to diaphragms 10 and 24, respectively, for radiation over first and second ranges of frequencies, respectively. Basket 25 supports diaphragm 24 for vibratile motion relative to the magnetic structure, while end 29 supports compliance 8 and thus diaphragm 10.

We may prefer to provide a horn member 13 of substantially exponential contour with its smaller end adjacent to, and acoustically coupled with, diaphragm 10. Horn member 13 may be secured in place by screws 30 or other convenient fastening means.

Figs. 3 and 5 are included in this explanation to indicate the preferred cylindrical character of central magnetic member 2, flux-source magnetic member 1, and yoke 17 in the embodiment shown in Figs. 2 and 4, respectively.

While we have shown and described our invention as applied to a specific embodiment thereof, other modifications will readily occur to those skilled in the art.

We do not, therefore desire our invention to be limited to the specific arrangement shown and described, and we intend in the appended claims to cover all modifications within the spirit and scope of our invention.

What is claimed is:

1. In a loudspeaker, the combination of a flux source magnetic member of generally tubular configuration having first and second ends; a central magnetic member extending substantially coaxially through said magnetic member and having first and second ends extending beyond said first and second ends, respectively, of said flux source member; a flange of magnetic material surrounding said central magnetic member and extending radially outward for magnetically connecting said first end of said flux source member to said central magnetic member; said flange being intermediate said first and second ends of said central magnetic member; means magnetically extending radially inward from said second end of said flux source member toward said second end of said second magnetic member but spaced therefrom to define a first airgap therebetween; means extending magnetically outward from said second end of said flux source member, around the outside of said flux source member, and inwardly toward said first end of said central magnetic member, said last-named means having its inwardly extending portion spaced from said first end of said central magnetic member to define a second airgap therebetween; first and second voice coils, respectively, disposed within said first and second airgaps; first and second diaphragms respectively arranged to radiate sound over first and second ranges of frequency and respectively coupled to said first and second voice coils; means for supporting said first and second diaphragms for vibratile motion relative to said flux source member.

2. The combination of claim 1 in which a horn-shaped channel extends substantially coaxially through said central magnetic member and is coupled for sound radiation to said first diaphragm.

3. The combination of claim 1 in which a channel extends substantially coaxially through said central magnetic member, said channel having an exponential shape with the small end thereof coupled for sound radiation to said first diaphragm.

4. The combination of claim 1 in which a channel extends substantially coaxially through said central magnetic member, said channel having an exponential shape with the small end thereof coupled for sound radiation to said first diaphragm, and a horn extension section is coupled for sound radiation to the large end of said channel.

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