July 30, 1957 G. WURDEL 2,801,294

ELECTRODYNAMIC RECEIVING APPARATUS

Filed Nov. 13, 1951

FIG. 1

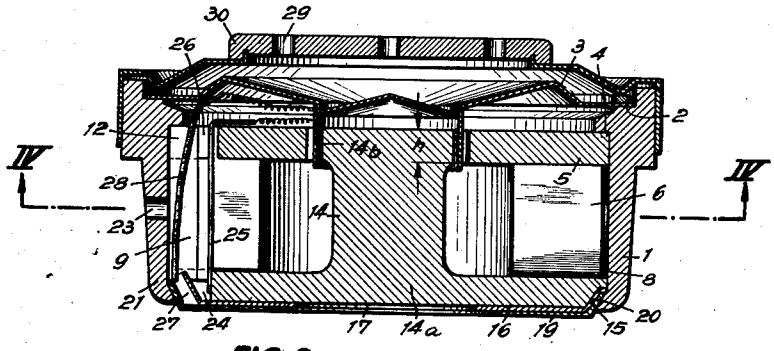


FIG. 2

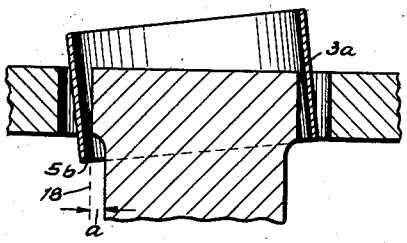


FIG. 3

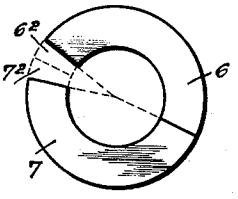


FIG. 4

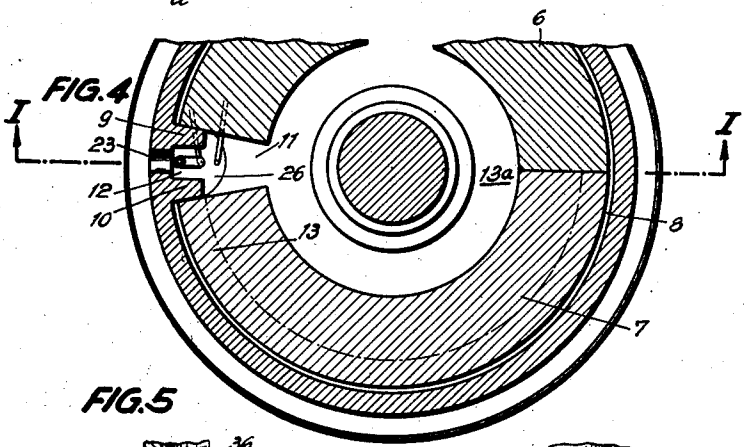
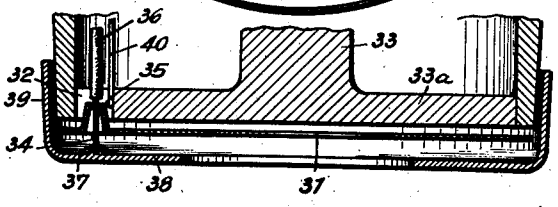


FIG. 5



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ELECTRODYNAMIC RECEIVING APPARATUS

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Claims priority, application Germany November 24, 1950

13 Claims. (Cl. 179—115.5)

This invention relates to high power electrodynamic receiving apparatus, such as telephones, small loud speakers and the like. In such receiving apparatus which are used as telephone and microphone receivers for telephone installations working without batteries over short and medium distances, more particularly on ships and in mines or in very noisy surroundings, special efforts as regards the construction have for a considerable time been directed to keeping the dimensions, more particularly the width and depth of the part to be inserted, and the weight as small as possible and at the same time to increasing the efficiency and obtaining as wide a frequency band as possible.

In the first place it is essential, that the dimensions of the usual post office receivers shall not be exceeded. As substantial portions of the small internal space of the receiver have to be occupied by the magnet material, in order to obtain as great a strength of field as possible, difficulties are presented in providing in addition adequate resonance spaces for increasing the efficiency. In order to obtain a certain balance in this respect, the free outer enclosing space between the receiver and the outer casing is also utilised as a further partial resonance space through the provision in the wall of the receiver of an acoustic coupling aperture which connects the outer enclosing space with the internal spaces of the receiver.

It has been found, that through the annular magnets which are used with special advantage with these small magnets it is not only difficult to make sufficient space for the acoustic coupling connections available, but also to provide sufficient room for housing the electric connecting lines from the moving coil to the bottom contacts. In order to avoid these disadvantages, it has hitherto been the practice to provide in the magnet ring a recess which has approximately the dimensions of the acoustic coupling aperture. The provision of this recess entailed the disadvantage of a relatively considerable amount of finishing work.

All these disadvantages are overcome according to the invention, through giving the annular magnet the form of an open ring. The gap in the magnet, thus formed, may be utilised with advantage for the acoustic coupling, through the opening in the ring being brought, when building in the open annular magnet, to the place of the coupling aperture in the receiver casing.

A further appreciable advantage is to be found in the circumstance, that the provided magnet gap can also be utilised for housing the electric connecting lines between the moving coil and the bottom contacts. But even this does not exhaust the purpose of the magnet gap. It can, as shall be hereinafter shown, be used for further purposes, more particularly for the definite positioning of various constructional parts of the receiver, when they are being assembled.

It has in addition been found, that the arrangement according to the invention of a magnet gap is of the greatest importance for technical reason as well, more

particularly when there is used as material for the magnets one of the magnetic special alloys which have been developed in the last few years, such more particularly as the aluminum-nickel-cobalt alloys. These materials are used with preference for small apparatus, for the reason that, with small dimensions, they provide very high magnetic effects.

They present certain manufacturing difficulties, it is true. They have, for instance, to be cast as separate rings, in view of the peculiarity of the material forming the alloy, which is relatively costly. The considerably cheaper method of manufacture by casting in long tubular form and dividing up into separate rings is with this material very difficult for technical reasons. According to the invention, this disadvantage is avoided through forming the open magnet ring in at least two parts. This makes it easily possible to cast sufficiently long bars of part-ring cross-section, to be subsequently divided up into separate part-rings. The part-rings are then put together to form an opening and are fitted in position.

Through the provision of the magnet gap in the ring magnet the volume of the magnets would of itself be diminished. As this is undesirable, however, if the high field strength in the ring gap, which is aimed at, is to be maintained, the volume must again be brought up to the original magnitude, which can only be effected, however, by reducing the internal diameter of the part-ring magnets, if the external dimensions of the magnets are not to be increased. Through the reduction of the internal diameter, however, the distance with respect to the centre pole would be diminished in an undesired manner, so that the dispersion losses occurring at this place would reach excessively high values. In order to keep the distance between the part magnets and the centre pole sufficiently great, the diameter of the centre pole is diminished within the magnetically admissible limits. This would result in the centre pole in the region of the ring gap and consequently the moving coil as well becoming smaller than is desirable, for, as the diameter of the moving coil decreases, the height of the ring gap and consequently the height of the pole disc would have to be made greater, in order to maintain the same volume in the ring gap and consequently the same magnetic effect. This increase in the thickness of the pole disc is, however, undesirable with regard to the overall height, as the post office receiver dimensions could then no longer be adhered to. For these reasons it is proposed according to the invention, to make the diameter of the centre pole greater in the region of the ring gap than in the region of the part-ring magnets. This results in a stepping down of the centre pole in such a manner that in the region of the ring gap it is widened by an annular extension. The height of this annular extension is made equal to or nearly equal the height of the ring gap and consequently to the thickness of the pole disc lying opposite it.

Now, it is found that this annular extension is of advantage in another respect as well, as through it the magnetic flux is given already within the pole shoes the direction, causing it as it flows into the ring gap to flow at all places practically perpendicularly to the cylindrical pole shoe surfaces. The annular extension of the centre pole has the further advantage, that, with the tolerances which are unavoidable in the manufacturing processes with respect to the concentric and coaxial arrangement of the diaphragm and the coaxial arrangement of the coil body, contact with the parts of the centre pole lying outside the pole shoe is far more effectively avoided, than is the case with the usual arrangement, which shall be explained hereinafter in greater detail with reference to the drawing to be described below.

A further advantage of the invention is, that the part-ring magnets can be mounted in the casing with relatively

great clearance and without additional safety means not only with respect to the casing but also with respect to one another. As it is of advantage to secure the part-ring magnets in their relative position, when being mounted in the casing, in such a manner that the space between the end surfaces will lie at the place of the acoustic coupling aperture, the involuntary displacement or turning of the part-ring magnets is prevented by the provision of special holding means. Still, this provides no absolute certainty that the part-ring magnets will retain their correct position and it is therefore to be recommended to provide at the inside wall of the casing at the place of the acoustic coupling aperture a stop member projecting into the interior of the casing. The fixing in position of the part-ring magnets is then carried out in such a manner that the oppositely disposed ends the part-ring magnets will bear both sides against this stop. By this means any undesired shifting of the part-ring magnets is prevented with certainty. The stop must of course not extend so far into the interior of the casing that the magnet gap between the end surfaces of the part-ring magnets will be more or less filled.

In order to keep this connecting space as large as possible, it is preferable to form the stop out of two abutment ribs which lie parallel next to one another, extend in the direction of the generating lines and form between them a free channel. Into this channel open the acoustic coupling aperture. This construction has the further advantage, that in the recess between the two ribs it is possible conveniently and securely to fix by means of an adhesive an acoustically permeable covering against the entry of foreign bodies, more particularly in the form of a gauze fabric.

As the novel receivers are to be used mostly as post office receivers, it is not only of special advantage to be able to adapt them as regards their external dimensions to the post office receivers, but also to be able to construct the contact connections as bottom contacts just as in post office receivers, when not only the channel provided between the abutment ribs but also the magnet gap can be utilised in an advantageous manner for the electrical conductors.

For taking through the conductors there must also be provided a recess in the pole disc. For this purpose the connecting aperture serving the purpose of the pressure equalisation and the acoustic coupling between the diaphragm space and the interior space of the magnet may at the same time be utilised for taking through the conductors, provided that this aperture be made of such a size that besides the conductors sufficient space remains free for the acoustic coupling. It is further of advantage, that this aperture shall be at the place of the magnet gap, that is to say, where there is no magnetic material, so that the magnetic field of force shall not be weakened by this gap in the pole disc.

In order to enable the conductors to be taken to the bottom contacts through as short a distance as possible, the bottom contacts will preferably be constructed as disc contacts. In this arrangement, according to the invention the bottom plate of the centre pole is at the same time utilised as one of the contact discs and provided at the rim with a recess. This recess can be used not only conveniently as the soldering place for one of the connecting conductors, but also for fixing the centre pole and its bottom plate in a definite position, thereby securing it against turning. All that is necessary for this purpose is to extend the abutment ribs far enough for the two sides of the recess to embrace the ribs from the outside, when the parts are being assembled. At the place of this recess the other connecting conductor is also connected to the second bottom contact disc. With this arrangement it is necessary to provide between the bottom contacts and the conductors for a reliable insulation of one from the other. For this purpose, according to the invention there is provided between the outer surface of the bottom plate and the annular contact disc an insulating disc which is also annular.

It is of advantage, to flange over the bottom plate at its outer rim, so as to use it not only as an abutment and centring surface for the correspondingly flanged-over rims both of the insulating disc and of the contact disc, but also as bearing surface for the flanged-over outer rim of the casing. With this arrangement it is preferable to make the rim surfaces conical at the three parts referred to, namely at the bottom plate, at the insulating disc and at the contact disc.

As a further feature of the idea underlying the invention the flange at the rim of the bottom plate and the rim of the insulating disc are stepped in such a manner and the rim of the contact disc is bent over simply (not stepped) in such a manner that, after the parts have been assembled, a broken, but not stepped contour surface results at the flanged-over place. This construction of the lower and outer bottom plate rim with the insulating disc and the contact disc provides a simple possibility of using the outer casing rim by flanging it over as secure fixing means for the said three parts. Through the inclined flanging sharp edges at the flanging over place are avoided. Moreover the material need not be deformed to such an extent, as would be the case, if a right angled flanging over had to be effected.

According to the invention there is provided at the rim of the insulating disc an indentation, in which, when the parts are being assembled, in which one of the connecting conductors connected with the contact disc together with the thickening which is unavoidably formed during soldering engages. Owing to the indentation there is also formed, when viewed from above, a recess, through which the connecting conductor to the moving coil winding is taken.

The receivers according to the invention are provided first and foremost for obtaining a specially high efficiency with the best possible magnetic volume obtainable, while adhering to the post office receiver dimensions, so that the receivers in their preferred use in telephone installations without batteries or also as small loud speakers will have as good an acoustic performance as possible. On the other hand, there is a number of possible applications, in which such higher performaces are not required. This is, for instance the case with battery-fed telephone installations, where above all a high acoustic transmission quality is required and where an extremely great strength of sound is not of such great importance. In such a case the division of the magnet into two parts provides a considerable advantage, owing to the circumstance that through a quite slight change, while for the rest the dimensions remain exactly the same, apparatus of different magnetic performance can be put together. For this purpose only a single part-ring magnet need be used. For securing it in the desired position, in place of the other part-ring magnet a substitute arcuate piece of the same or similar shape and made of non-magnetic material, more particularly of synthetic can be mounted in the casing. Although through this arrangement an unbalanced magnetic filed is produced in the annular gap, practical experience has shown, that no appreciable disadvantages in the acoustic respect are caused thereby. The same sound quality is obtained, irrespective of whether the magnetic field is homogeneous, as with the closed annular magnet, or unhomogeneous. It has unexpectedly been found, that by this means the buzzing factor remains within neglible limits.

The invention is illustrated by two constructional examples in the accompanying drawing, in which:

Fig. 1 shows an axial section through a receiver,

Fig. 2 a partial axial section through the receiver at the place of the annular gap with a coil body shown in an exaggeratedly inclined position, so as to show the danger of contact clearly,

Fig. 3 shows the annular sectors to be separated from the part-rings,

Fig. 4 a cross-section through the same receiver on line 4—4 of Fig. 1 and

Fig. 5 a partial axial section through a receiver similar to that of Fig. 1, but with a different formation of the bottom, insulating and contact plate.

According to the constructional form of Figs. 1 to 4 the receiver consists of a casing **1**, preferably of thermoplastic material. On an upper annular offset **2** the diaphragm **3** is supported without clearnace. Below the diaphragm there is supported on a further offset **4** the pole disc **5** without clearance centrally, unless it has already been centrally enclosed in the mass of synthetic material during the manufacture of the casing by the spraying method. Thereupon, the two part ring magnets **6, 7** are placed in the casing with only slight clearance **8** in such a manner that they will bear against the outer surfaces of the two ribs **9, 10** and thus leave a gap **11** free between them. The gap is made in the order of magnitude of 16°, so as to have sufficient space for the coupling aperture and the conductors. The ribs **9, 10** are arranged parallel to the generating lines at the inner circles of the casing in such a manner that they form between them a longitudinal groove **12.** It is apparent that with this construction, gap **11** serves to communicate the acoustic coupling aperture **23** with the acoustic chamber **13***a* formed between the center core **14** and the open rings **6** and **7.**

In order to enable the apparatus to be operated as a receiver with half the magnetic power, one part-ring magnet, for instance the magnet **7,** is replaced by a substitute arcuate piece **13** which, while being of the same height, may have a smaller wall thickness, as it only serves the purpose of holding the part-ring magnet **6** in its position and of ensuring the requisite distance. The inner bounding surface of this substitute arcuate piece is indicated in Fig. 4 by a dot and dash line. The two part-ring magnets or the one part-ring magnet and the substitute arcuate piece are held in the axial direction by the bottom plate **14***a* of the center pole **14.** The other rim of the bottom plate **14***a* is bevelled off in an offset manner. In this bevel engages a correspondingly bevelled and stepped rim **15** of an insulating disc **16** which has a circular aperture **17** in the centre. Over this insulating disc is placed an annular contact disc **19** which with a simple conical rim **20** engages in the step of the insulating disc in such a manner that the outer contour line shows no offset, but only a broken surface. This formation has the advantage, that the rim **21** of the casing **1,** which is flanged-over in the thermoplastic process, can be made without any sharp bend with only a slight bevel and acts both as the lower closure of the casing and also for fixing all three parts, namely the bottom plate, the insulating disc and the contact disc. For the rest the flange **21** is not required to act as the sole means of securing the magnet and the centre pole in their positions, as both are already held very firmly together by the strong magnetic field.

The annular extension **14***b* of the centre pole is of greater diameter than the middle part of the centre pole **14.** From the inclined representation of the coil body **3***a* in Fig. 2, which is exaggerated for the sake of clearness, it will be seen that, in the case of a centre pole which is of the same diameter throughout the whole length of the shaft (shown in the figure by dotted line **18**), the lower edge **5***b* of the coil body approaches far closer to the centre pole, than is the case of a centre pole provided with an annular extension (cf. distance *a*), so that the centre pole would be made contact with in the case of movements of the coil body. Between the two ribs **9** and **10** opens the acoustic coupling aperture **23** which is closed at the inside with gauze (not shown in the drawing) which can be easily fixed by an adhesive in the bottom of the groove **12.** At the place, where in the casing are the two ribs **9, 10** there is provided in the bottom plate **14***a* a recess **24,** the sides of which engage round the two ribs, so that the bottom plate will occupy a quite definite position in the casing and be secured against turning. At the bottom of this recess **24** is fixed by soldering one conductor **25** for connecting the bottom plate which also acts as bottom contact. The other end of this conductor is taken through a corresponding recess **26** provided in the pole plate. This end is connected by soldering with one end of the moving coil winding. In the insulating disc **16** there is provided at the place of the recess **24** an indentation **27** which leaves sufficient space free for one connecting end of a second conductor **28** provided with an insulating covering. This conductor is taken through the longitudinal groove **12** and through the recess **26** of the pole disc and terminates in the space between the diaphragm and the pole disc, where it is soldered to the other end of the moving coil. The casing is closed at the top by a protective cap **30** provided with sound openings **29.**

According to the constructional form of Fig. 5, which may suitably be made use of, when the receiver casing consists of a material which cannot be deformed thermoplastically, the bottom plate **33***a* of the centre pole **33** is not flanged at the rim. Correspondingly, the insulating plate **31** is also flat throughout, that is formed without a flanged rim. At the place of the recess **32** of the bottom plate it has an indentation **34** which projects into the interior of the recess **32,** when the parts are assembled. Through a hole **35** in the bottom of the indentation the connecting conductor **36** which is surrounded by an insulating covering is taken and is connected by soldering with the bottom cap **38.** The cap **38** which also acts as contact disc is provided at the edge with a deeply flanged-over rim **39** which is slightly conical to such an extent that, after the parts have been assembled, a firm frictional connection with the outer correspondingly slightly conical casing wall will be ensured.

The indentation **34** is preferably made so deep that, after the parts have been assembled, there will be a safe insulation between the connecting conductor **39** and bottom plate **33***a* and the second connecting conductor **40.**

The constructional form according to Fig. 5 is specially suitable for use in cases, where particularly rough working conditions prevail, as a considerable increase of the mechanical strength will result through the use of the cap, which with the associated part of the casing forms a protective enclosure against excessive mechanical stresses. Where the receivers are to be used for small loud speakers, the bottom contacts may be dispensed with. In such cases they will be replaced by contact making means, such as terminals, in the usual way.

I claim:

1. An electrodynamic device of the character described comprising, in combination, a housing provided with an opening therein; a diaphragm covering said opening and secured to said housing; an annular pole disc arranged within said housing adjacent to said diaphragm and having an inner edge face forming a central aperture; a center core having at one end an annular end portion with a diameter slightly smaller than the diameter of said aperture in said annular pole disc and having at its other end an annular disc-shaped projection, said center core being arranged in said housing with said annular end portion thereof located in said aperture of said pole disc so as to form between said annular end portion and said inner edge face of said annular pole disc an annular slot, and to form also between said annular pole disc and said annular disc-shaped projection on said center core an annular space; a voice coil arranged within said annular slot spaced both from said annular end portion of said center core and the inner edge face of said annular pole disc and secured to said diaphragm so as to be held by the same oscillatably in axial direction of said center core; and a ring magnet formed with a radial slot therethrough along its entire axial extent, said ring magnet being arranged within said annular space between said annular pole disc

and said annular disc-shaped projection on said center core.

2. An electrodynamic device of the character described comprising, in combination, a housing provided with an opening therein; a diaphragm covering said opening and secured to said housing; an annular pole disc arranged within said housing adjacent to said diaphragm and having an inner edge face forming a central aperture; a center core having at one end an annular end portion with a diameter slightly smaller than the diameter of said aperture in said annular pole disc and having at its other end an annular disc-shaped projection, said center core being arranged in said housing with said annular end portion thereof located in said aperture of said pole disc so as to form between said annular end portion and said inner edge face of said annular pole disc an annular slot, and to form also between said annular pole disc and said annular disc-shaped projection on said center core an annular space; a voice coil arranged within said annular slot spaced both from said annular end portion of said center core and the inner edge face of said annular pole disc and secured to said diaphragm so as to be held by the same oscillatably in axial direction of said center core; and a ring magnet formed with a radial slot therethrough along its entire axial extent, said ring magnet being arranged within said annular space between said annular pole disc and said annular disc-shaped projection on said center core, said open ring magnet having an inner diameter substantially larger than the outer diameter of said center core so as to form between itself and said center core an acoustic chamber.

3. An electrodynamic device of the character described, comprising, in combination, a housing provided with an opening therein; a diaphragm covering said opening and secured to said housing; an annular pole disc arranged within said housing adjacent to said diaphragm and having an inner edge face forming a central aperture; a center core having at one end an annular end portion with a diameter slightly smaller than the diameter of said aperture in said annular pole disc and having at its other end an annular disc-shaped projection, said center core being arranged in said housing with said annular end portion thereof located in said aperture of said pole disc so as to form between said annular end portion and said inner edge face of said annular pole disc an annular slot, and to form also between said annular pole disc and said annular disc-shaped projection on said center core an annular space; a voice coil arranged within said annular slot spaced both from said annular end portion of said center core and the inner edge face of said annular pole disc and secured to said diaphragm so as to be held by the same oscillatably in axial direction of said center core; a ring magnet formed with a narrow slot therein along its entire extent arranged parallel to the axis thereof, said ring magnet arranged within said annular space between said annular pole disc and said annular disc-shaped projection on said center core, said open ring magnet having an inner diameter being substantially larger than the outer diameter of said center core so as to form between itself and said center core an acoustic chamber; and aperture means in said housing located in the region of said slot in said ring magnet and communicating through said slot in said ring magnet with said acoustic chamber between said ring magnet and said center core.

4. An electrodynamic device of the character described, comprising, in combination, a housing provided with an opening therein; a diaphragm covering said opening and secured to said housing; an annular pole disc arranged within said housing adjacent to said diaphragm and having an inner edge face forming a central aperture; a center core having a diameter smaller than the diameter of said central aperture in said annular pole disc and having at one end an annular end portion with a diameter slightly larger than the diameter of said center core and slightly smaller than the diameter of said aperture in said annular pole disc and having at its other end an annular disc-shaped projection, said center core being arranged in said housing with said annular end portion thereof located in said aperture of said pole disc so as to form between said annular end portion and said inner edge face of said annular pole disc an annular slot, and to form also between said annular pole disc and said annular disc-shaped projection on said center core an annular space; a voice coil arranged within said annular end portion of said center core and the inner edge face of said annular pole disc and secured to said diaphragm so as to be held by the same oscillatably in axial direction of said center core; a ring magnet formed with a radial slot therethrough along the entire axial extent thereof, said ring magnet being arranged within said annular space between said annular pole disc and said annular disc-shaped projection on said center core, said ring magnet having an inner diameter substantially larger than the outer diameter of said center core so as to form between itself and said center core an acoustic chamber said housing being formed with an aperture therethrough in the region of said slot of a smaller diameter than the width of said slot and communicating through said slot with said acoustic chamber between said magnet and said center core.

5. An electrodynamic device of the character described, comprising, in combination, a housing open on opposite sides thereof; a diaphragm covering one of said open sides and secured to said housing; an annular pole disc arranged within said housing adjacent to said diaphragm and having an inner edge face forming a central aperture; a center core having at one end an annular end portion with a diameter slightly smaller than the diameter of said aperture in said annular pole disc and having at its other end an annular disc-shaped projection, said center core being arranged in said housing with said annular end portion thereof located in said aperture of said pole disc so as to form between said annular end portion and said inner edge face of said annular pole disc an annular slot, and to form also between said annular pole disc and said annular disc-shaped projection on said center an annular space; a voice coil arranged within said annular slot spaced both from said annular end portion of said center core and the inner edge face of said annular pole disc and secured to said diaphragm so as to be held by the same oscillatably in axial direction of said center core; a ring magnet formed with a narrow radial slot therethrough along its entire axial extent, said ring magnet being arranged within said annular space between said annular pole disc and said annular disc-shaped projection on said center core; an annular contact disc covering the other open side of said housing and being secured thereto spaced from said center core and said annular disc-shaped projection thereof; and two electrical conductors, one connecting one end of said voice coil with said annular contact disc and the other connecting the other end of said voice coil with said annular disc-shaped projection on said center core so that said annular contact disc and said annular disc-shaped projection serve as terminals of said electromagnetic device.

6. An electrodynamic device of the character described, comprising, in combination, a housing provided with an opening therein; a diaphragm covering said opening and secured to said housing; an annular pole disc arranged within said housing adjacent to said diaphragm and having an inner edge face forming a central aperture; a center core having at one end an annular end portion with a diameter slightly smaller than the diameter of said aperture in said annular pole disc and having at its other end an annular disc-shaped projection, said center core being arranged in said housing with said annular end portion thereof located in said aperture of said pole disc so as to form between said annular end portion and said inner edge face of said annular pole disc an annular slot, and to form also between said annular pole disc and said annular disc-shaped projection on said center core an

annular space; a voice coil arranged within said annular slot spaced both from said annular end portion of said center core and the inner edge face of said annular pole disc and secured to said diaphragm so as to be held by the same oscillatably in axial direction of said center core; a ring magnet formed with a narrow radial gap therethrough along the entire axial extent thereof, said ring magnet being located in said annular space between said annular pole disc and said annular disc-shaped projection on said center core; an electrical terminal member secured to said housing; an insulating member; and two conductors, one connecting one end of said voice coil to said electrical terminal member and the other connecting the other end of said voice coil to said center core, said two conductors being isolated by said insulating member disposed between said electrical terminal member and said disc-shaped projection of said center core.

7. An audio transducer comprising, in combination, a tubular housing; a diaphragm secured in said housing at one end thereof; a center pole located in said housing and formed with a flange-shaped end portion of greater cross-sectional configuration than the remainder of said pole located adjacent said diaphragm; a tubular magnet member formed with a slot therethrough along its entire axial extent, said tubular magnet member being located in said housing and surrounding said remainder of said center pole and defining therewith a peripheral space; a magnetic pole shoe surrounding said end portion of said center pole and defining therewith a peripheral gap, said pole shoe resting on an end of said tubular magnet member; and a voice coil secured to said diaphragm and located in said peripheral gap, said voice coil extending beyond said peripheral gap and surrounding a portion of the remainder of said center pole, whereby a relatively large amount of angular movement of said voice coil relative to the axis of said center pole is possible without danger of said voice coil striking the remainder of said center pole.

8. An audio transducer as set forth in claim 7 wherein said tubular magnet member is formed of a plurality of separate parts, each of said parts extending along the entire length of said tubular member and along a portion of the periphery of said tubular member.

9. An audio transducer as set forth in claim 7 wherein said slot in said tubular magnet member encompasses an angle of not greater than 16° with respect to the axis of said tubular magnet member.

10. An audio transducer, comprising, in combination, a tubular housing; a diaphragm mounted in said housing at one end of said housing; a center pole located in said housing and arranged with one end thereof adjacent said diaphragm; a tubular magnet member formed with a narrow gap therethrough along its entire axial extent, said magnet member being located in said housing and surrounding the major portion of said center pole, defining therewith a peripheral acoustic space; a magnetic pole shoe formed with a cut-out outer edge portion and surrounding said one end of said center pole defining therewith a peripheral gap, said pole shoe resting on an end of said tubular magnet member with said cut-out portion aligned with said narrow gap; and a voice coil having leads, said voice coil being secured to said diaphragm and located in said peripheral gap, said cut-out portion of said pole piece and said axial gap through said tubular magnet member forming a conduit for said leads.

11. An audio transducer comprising, in combination, a cylindrical housing; a diaphragm mounted in said housing at one end of said housing; a cylindrical center pole symmetrically located in said housing and arranged with one end thereof adjacent said diaphragm; an annular magnet member formed with a narrow radial gap therethrough along its entire axial extent and located in said housing coaxially with the major portion of said center pole, the inner wall of said housing being formed with a pair of parallel ridges parallel to the axis of said housing which engage the edges defining said axial gap of said tubular magnet member, whereby said tubular magnet member is held securely in place; an annular magnetic pole shoe formed with a cut-out outer edge portion adapted to engage said ridges, said pole shoe surrounding said one end of said center pole defining therewith a peripheral gap, said pole shoe resting on an end of said cylindrical magnet member with said cut-out portion thereof aligned with said radial gap; and a voice coil having a pair of leads, said voice coil being secured to said diaphragm and located in said peripheral gap, said cut-out portion of said pole piece and said axial gap through said tubular magnet member forming a conduit for said leads.

12. In an audio transducer having a voice coil, in combination, a hollow cylindrical housing open at opposite ends thereof; an outer annular conductive disc having a central aperture therein and secured along the outer edge portions theerof to one end of said housing; an annular insulator disc formed with a central aperture therein and resting on the inner face of said conductive disc; a cylindrical center pole formed with an expanded base portion at one end thereof, said center pole being symmetrically located in said housing with said base portion resting on said insulator disc; an annular magnet member formed with a radial gap therethrough along its entire axial extent arranged in said housing coaxially with said center pole and resting on said base portion, said base portion being formed with a cut-out portion aligned with said gap in said annular magnet member, whereby a pair of leads from a voice coil of said transducer may be led through said radial gap and one of said leads secured to said conductive annular member and the other of said leads secured to said base portion of said center pole, said base portion of said center pole and said annular member forming the terminals for the voice coil.

13. In an audio transducer as claimed in claim 12, said hollow cylindrical housing being slightly tapered at the other end thereof, and said conductive disc being formed with a conical edge portion adapted to form with said tapered portion of said housing a tight friction fit when said conductive disc is in position over said end of said housing.

References Cited in the file of this patent

UNITED STATES PATENTS

1,915,358	Giles	June 27, 1933
2,083,537	Abrahams	June 15, 1937
2,144,184	Hale et al.	Jan. 17, 1939
2,162,270	Mott	June 13, 1939
2,201,059	Stephan	May 14, 1940
2,217,177	Massa	Oct. 8, 1940
2,275,880	Arey	Mar. 10, 1942
2,400,662	Roberton et al.	May 21, 1946
2,537,253	Andersen	Jan. 9, 1951
2,638,510	Brami	May 12, 1953

FOREIGN PATENTS

491,263	Great Britain	Aug. 30, 1938