United States Patent

[11] 3,581,015

[72] Inventor **Takeo Masuda**
Tokyo, Japan

[21] Appl. No. **693,436**
[22] Filed **Dec. 26, 1967**
[45] Patented **May 25, 1971**
[73] Assignee **Aiwa Co., Ltd.**
Tokyo, Japan
[32] Priority **Aug. 31, 1967, Aug. 31, 1967, Sept. 6, 1967, Dec. 28, 1966, Dec. 28, 1966**
[33] **Japan**
[31] **42/74645, 42/74646, 42/76302, 42/531 and 42/532**

[54] **DYNAMIC MICROPHONE**
9 Claims, 22 Drawing Figs.

[52] **U.S. Cl.** **179/121,** 179/115.5
[51] **Int. Cl.** **H04r 1/34**
[50] **Field of Search** ..... 335/231, 302; 179/121 DIR, 180; 181/31, 32, 33

[56] **References Cited**

UNITED STATES PATENTS

2,549,963	4/1951	Boer et al.	179/180
3,014,099	12/1961	Fiala	179/115.5
3,407,371	10/1968	Gosma	335/231
3,342,953	9/1967	Pless	179/115.5
2,718,563	9/1955	Nicholides	179/146

FOREIGN PATENTS

235,918	1/1963	Austria	179/180

Primary Examiner—Kathleen Claffy
Assistant Examiner—Thomas L. Kundert
Attorney—Christen and Sabol

ABSTRACT: This specification discloses a novel dynamic microphone using a flat annular magnet formed of an anisotropic barium ferrite as a permanent magnet to establish a magnetic circuit. The present microphone is extremely flat and of an excellent tone quality, and it can be manufactured at low cost. Various modifications to the microphone of this type become easily possible, and therefore a variety of examples with unidirectional characteristics or other characteristics are disclosed in this specification.

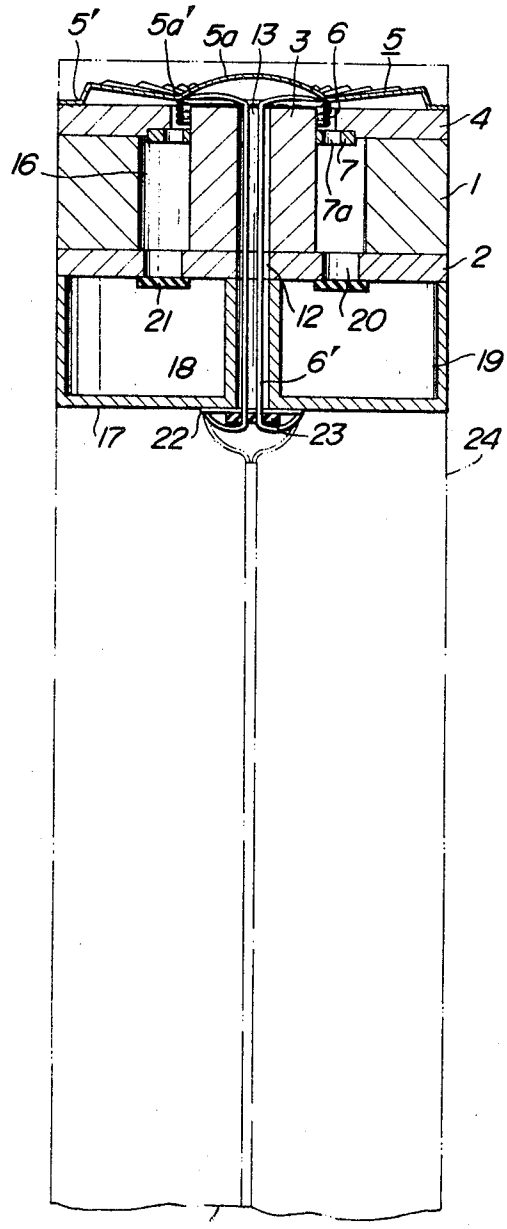


FIG. 1a

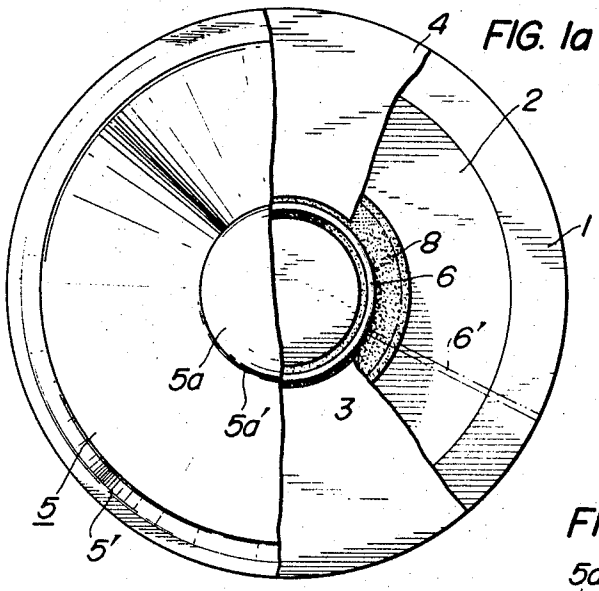


FIG. 1b

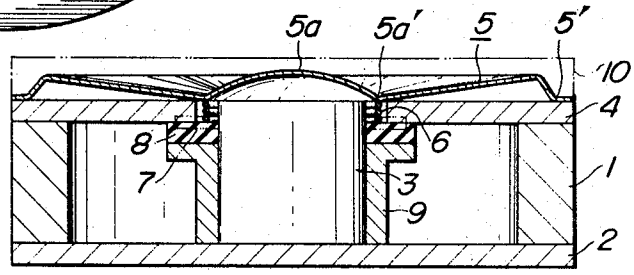


FIG. 2

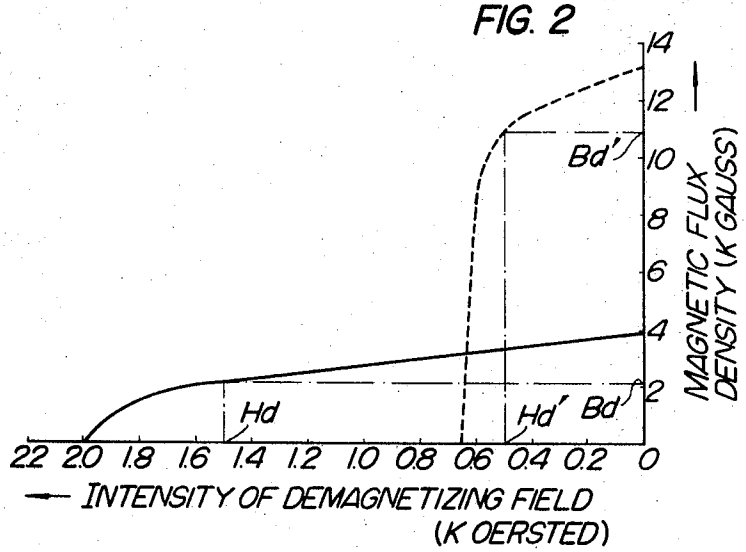


FIG. 3

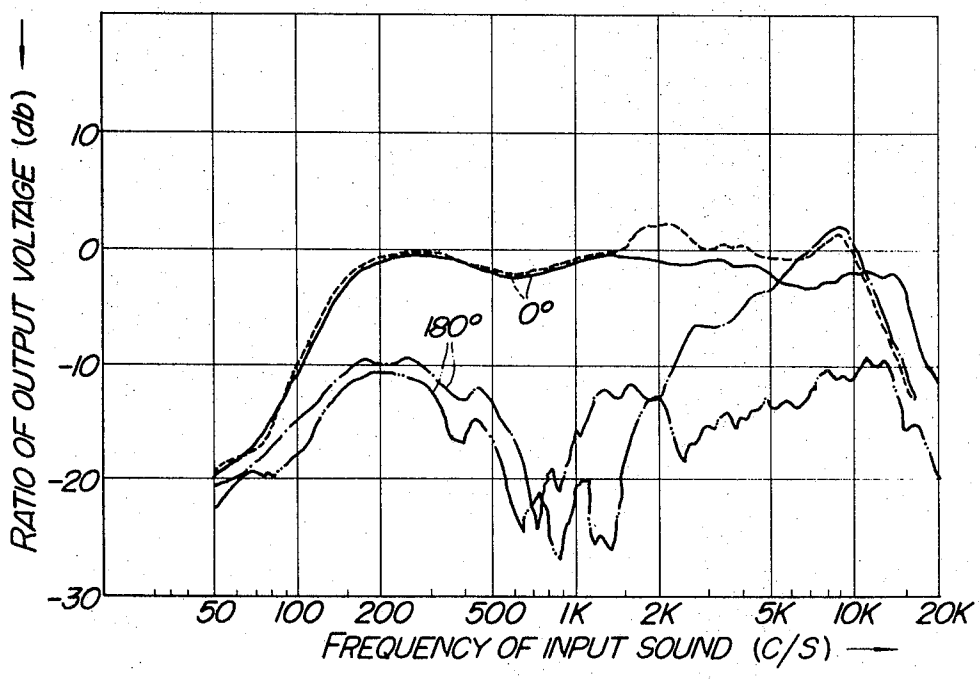

RATIO OF OUTPUT VOLTAGE (db)
10
0
-10
-20
-30
180°
0°
50
100
200
500
1K
2K
5K
10K
20K
FREQUENCY OF INPUT SOUND (C/S)

FIG. 4

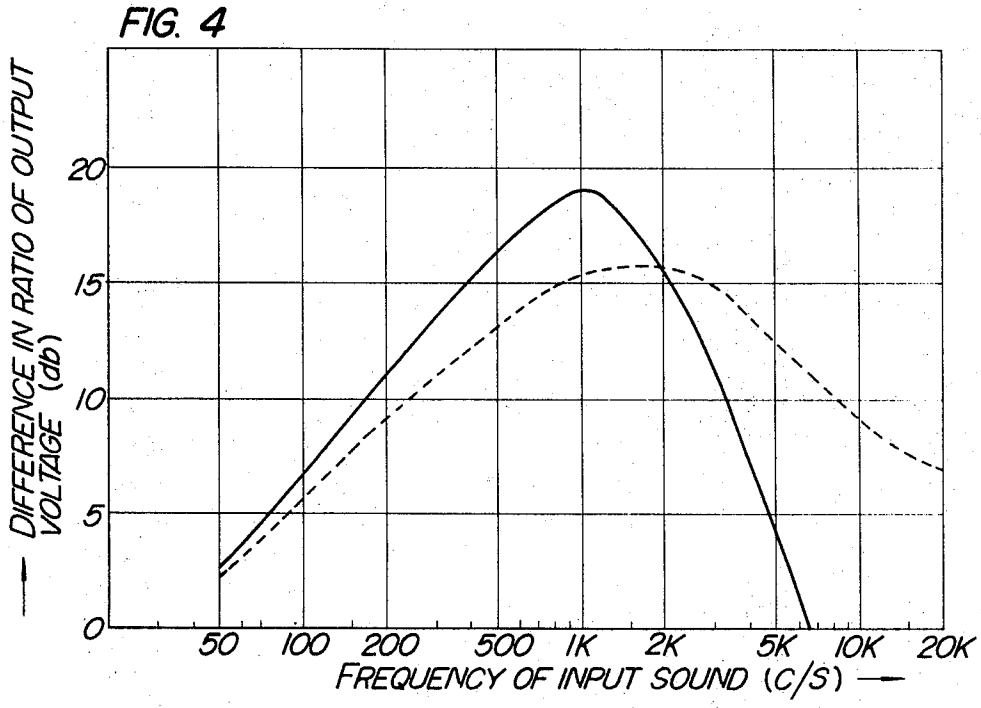

DIFFERENCE IN RATIO OF OUTPUT VOLTAGE (db)
20
15
10
5
0
50
100
200
500
1K
2K
5K
10K
20K
FREQUENCY OF INPUT SOUND (C/S)

FIG. 5a

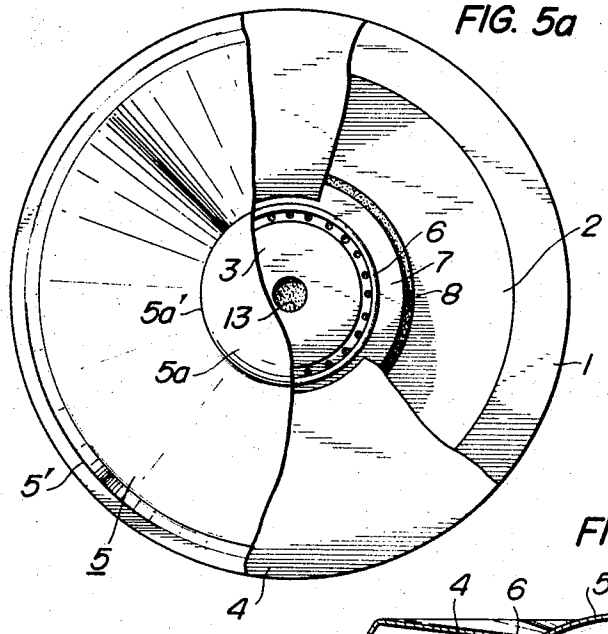


FIG. 5b

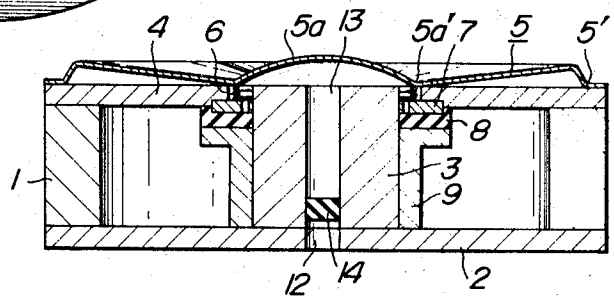


FIG. 6a

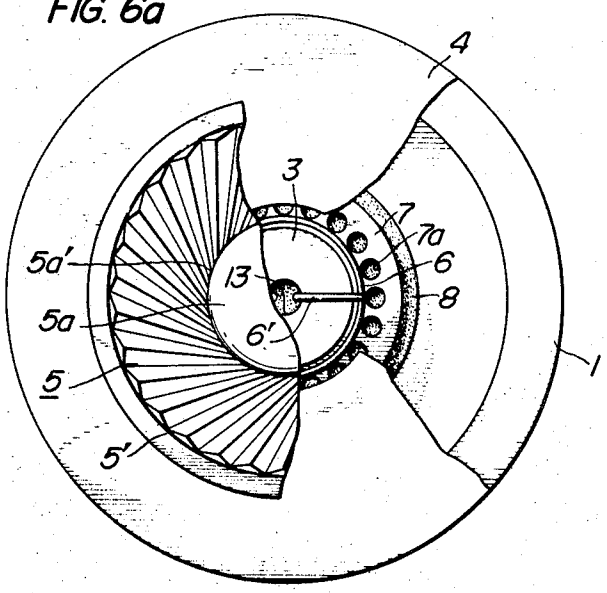


FIG. 6b

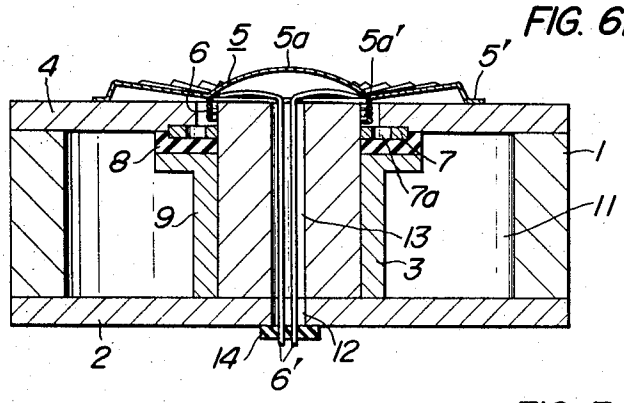


FIG. 7a

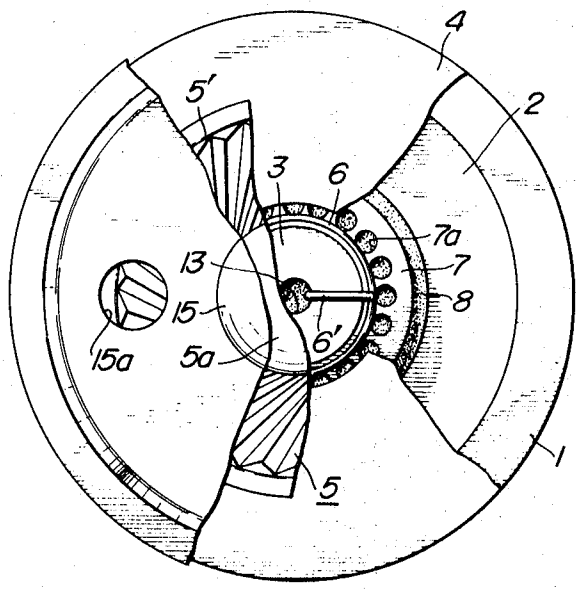


FIG. 7b

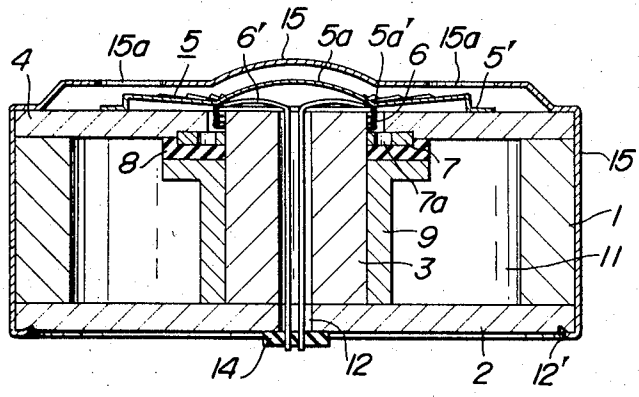


FIG. 8b

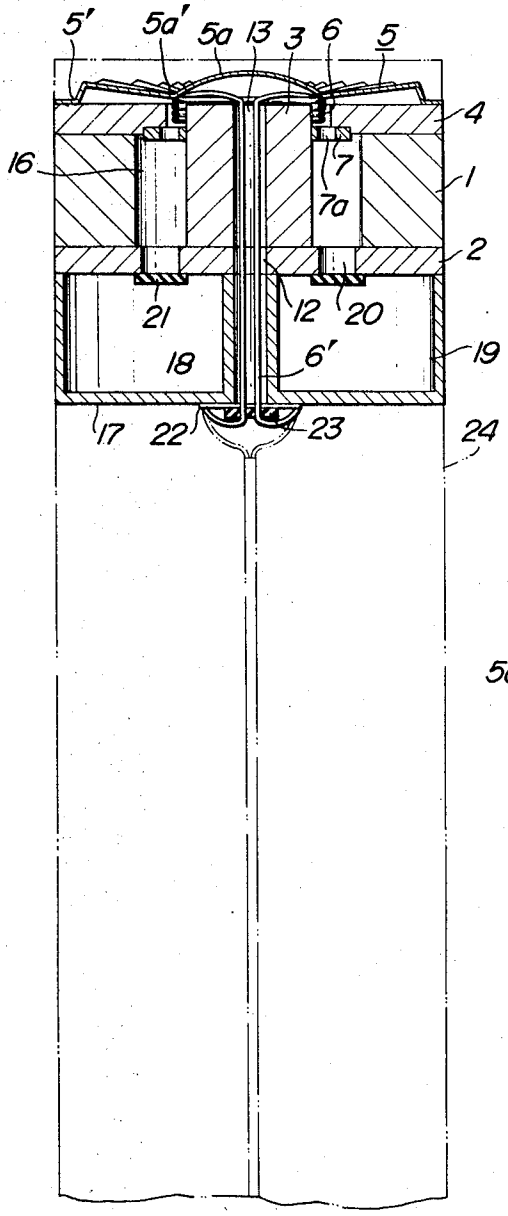

5'
5a'
5a
13
3
6
5
4
16
7
7a
1
2
21
12
20
18
6'
19
17
22
23
24

FIG. 8a

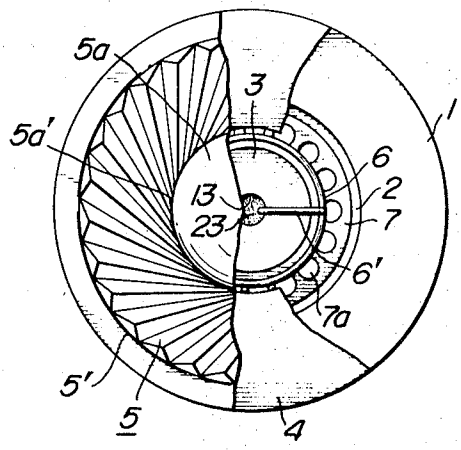

5a
3
1
5a'
6
2
13
7
23
6'
7a
5'
5
4

FIG. 9

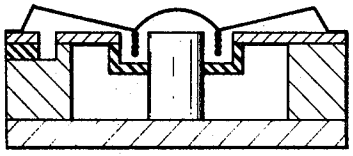


FIG. 10

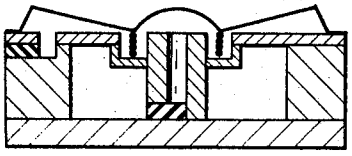


FIG. 11

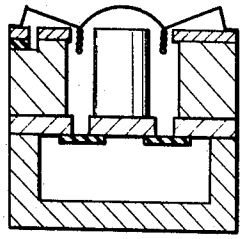


FIG. 12

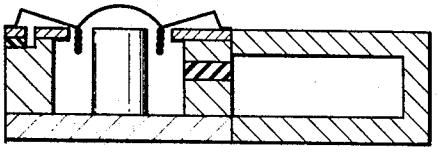


FIG. 13

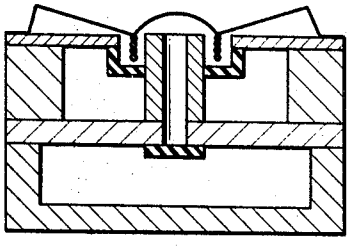


FIG. 14

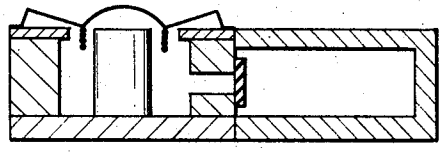


FIG. 15

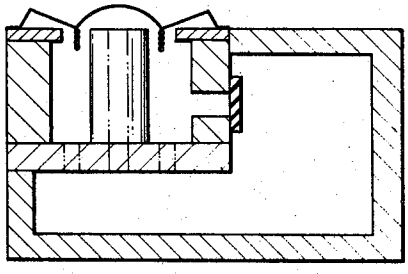


FIG. 16

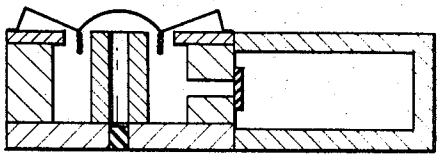
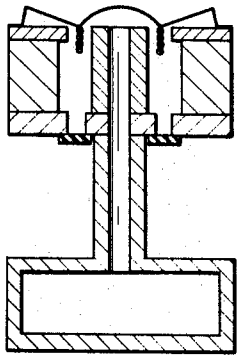


FIG. 17



DYNAMIC MICROPHONE

BACKGROUND OF THE INVENTION

This invention relates to a dynamic microphone, and more particularly it pertains to a dynamic microphone using a magnet formed of an anisotropic barium ferrite to establish a magnetic circuit.

As well known in the art, the magnetic characteristics of the magnetic circuit of a dynamic microphone are determined in accordance with the following equations.

$$f \cdot Bg \cdot Lg = AHd \cdot Lm \quad (1)$$

$$F \cdot Bg \cdot Ag = ABd \cdot Am \quad (2)$$

where f is the magnetoresistance coefficient, Bg is the magnetic flux density (Gauss) in the gap portion in which the voice coil is to be inserted, Lg is the length (cm.) of said gap portion, Hd is the intensity of demagnetization (Oersted), Lm is the effective length (cm.) of the permanent magnet, F is the magnetic leakage coefficient, Ag is the opposed area of said gap portion (the height of the gap portion multiplied by the average circumference), Bd is the magnetic flux density (Gauss) of the magnet, and Am is the sectional area (cm.^{2}) of the magnet.

Conventionally, a magnet called anisotropic alnico V having such a characteristic as shown by the dotted curve in FIG. 2 is often used in a dynamic microphone of this type, and the intensity of the demagnetizing field Hd^1 is about 500 oersted at the optimum operating point. In the case of the anisotropic barium ferrite magnet used in the microphone according to this invention, the intensity Hd of the demagnetizing field at the optimum operating point is about three times as high as the Hd^1 of said alnico magnet or about 1500 oersted. As will be seen from Equation (1), the intensity Hd of the demagnetizing field is reversely proportional to the length Lm of the magnet or the height of the annular magnet. Thus, by using an anisotropic barium ferrite magnet as the annular magnet in accordance with this invention, it is possible to keep the product of the magnetic flux density Bg in the gap portion and the length Lg of the gap portion, that is, the electroacoustic conversion efficiency unchanged even if the height of the annular magnet is reduced to about one-third. Consequently, in accordance with this invention, an extremely flat dynamic microphone can be constructed. As shown by the solid line in FIG. 3, the rate of change in the magnetic flux density Bd with respect to the intensity Hd of the demagnetizing field at a desired operating point of an anisotropic barium ferrite magnet is much lower than that of a widely used magnet called anisotropic alnico V as shown by the dotted line in FIG. 3. As will be appreciated from Equation (2) and (1), the magnetic flux density Bg across the voice coil in the gap has little effect on the change in the length Lg of the gap, and therefore it is possible to manufacture microphones with uniform efficiency on a mass-production basis, even through the length Lg of the gap is subjected to some dispersion due to mass-production. Furthermore, by making the height Lm of the annular magnet equal to that of the conventional one or by making the sectional area Am of the annular magnet large as is the case with an external magnet type microphone, the decrease in efficiency can be minimized even if the length Lg of the gap is selected considerably large, as will be apparent from Equations (1) and (2). Thus, it is possible to effectively prevent such trouble as a so-called "ripping" tone or the like, so that the yield on the mass-production basis can be increased. In this way, the manufacturing cost can be greatly reduced to industrial advantage.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an extremely flat dynamic microphone with an excellent tone quality adapted for mass-production and capable of being manufactured at low cost, using a flat and annular anisotropic barium ferrite magnet or equivalent magnet as a permanent magnet to provide the magnetic field.

The simplified flat construction according to this invention can be variously modified as described hereinafter, so that there can be produced dynamic microphones with improved low frequency characteristics, unidirectional characteristics and a variety of configurational features. BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1*a* is a plan view, taken partly in section, showing the dynamic microphone according to a typical embodiment of the present invention;

FIG. 1*b* is a vertical sectional view thereof;

FIG. 2 is a view showing the magnetization characteristic of a permanent magnet;

FIG. 3 is a view showing the frequency characteristic of one embodiment of this invention, in comparison with those of the conventional microphones;

FIG. 4 is a view showing the unidirectional characteristic of one embodiment of this invention, in comparison with those of the conventional microphones;

FIGS. 5*a* and 5*b*, 6*a* and 6*b*, 7*a* and 7*b*, and 8*a* and 8*b* are plan views, taken partly in section, and vertical sectional views showing other embodiments of this invention; and

FIGS. 9, 10, 11, 12, 13, 14, 15, 16 and 17 are simplified schematic views showing various embodiments of this invention. DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1*a* and 1*b*, a flat annular magnet 1 is provided which is formed of an anisotropic barium ferrite. To the bottom surface of the annular magnet 1 is affixed a yoke 2 configured in a disclike shape or the like. A center pole 3 formed of soft iron or the like is provided at the center of the upper surface of the yoke 2 coaxially with respect to the annular magnet 1, and a magnetic coupling ring 4 formed of soft iron or the like is affixed to the top surface of the annular magnet 1. A diaphragm 5 has its outer peripheral portion 5′ fixed to the top surface of the magnetic coupling ring 4 with adhesives or the like. A voice coil 6 is secured to that inner surface portion of the diaphragm 5 which is immediately below the periphery 5*a*′ *of a domelike portion 5a* of the diaphragm 5 in such a manner as to depend therefrom so as to be positioned within a gap defined by the magnetic coupling ring 4 and the center pole 3. An acoustic resistance ring 8 such as felt is attached to that lower surface portion of the magnetic coupling ring 4 which is immediately below the voice coil. The bottom surface of the acoustic resistance ring 8 is engaged by a cylindrical member formed of a nonmagnetic material such as brass which is configured in a π-shaped cross section so that it may be fitted on the center pole 3. The reference numeral 7 represents a sound permeating center ring made of a nonmagnetic material such as brass or the like and having a number of perforations formed therethrough. The center ring 7 is adapted for centering the center pole 3. The line 10 shows the inside surface of a sound-permeating plate which also serves as a protector for the front face of the diaphragm 5.

With the flat-type dynamic microphone having the above structure according to this invention, if the diaphragm 5 is vibrated by acoustic energy such as a voice or the like, the voice coil 6 depending therefrom is integrally vibrated so that a voice current is caused to flow through the coil so as to be taken out through leads 6′.

As described above, in accordance with this invention, there is obtained a flat dynamic microphone. By utilizing the advantageous features obtained in accordance with this invention and variously modifying the foregoing typical embodiment of this invention, it is possible to produce a variety of dynamic microphones having the desired features.

Referring now to FIGS. 5*a* and 5*b*, and 6*a* and 6*b*, the center pole 3 and yoke 2 are formed with holes 13 and 12, respectively. In FIG 5*b*, an acoustic resistor 14 such as felt, cloth or the like is provided in the hole 13 of the center pole 3, while in FIG. 6 *b*, such acoustic resistor is provided outside of the hole 12 of the yoke 2. A back sound wave is applied to the back face of the diaphragm 5 through the resistor 14. Thus, the microphone will have unidirectional characteristics. In the

case of FIG. 6*b*, an acoustic housing 11 is defined in the space surrounded by the annular magnet 1, yoke 2 and magnetic coupling ring 4. In accordance with these embodiments of this invention, the above space can be utilized as the acoustic housing 11 as it is, and therefore it is possible to easily produce a microphone with improved unidirectional and low frequency characteristics without forming a separate acoustic housing in the microphone casing.

The frequency vs. output voltage ratio characteristics for a front sound wave and a back sound wave of the conventional unidirectional microphone using a magnet called anisotropic alnico V (where the effective distance between the front and back acoustic terminals is 20 mm.) are shown by the dotted line and two-dot chain line in FIG. 3, respectively, and such frequency vs. output voltage ratio characteristics of the microphone according to this invention using an anisotropic barium ferrite magnet as the annular magnet 1 wherein the effective distance between said acoustic terminals is half that of the above conventional microphone or 10 mm. are represented by the solid line and one-dot chain line in FIG. 3, respectively. Comparison of the frequency characteristic of the unidirectional characteristic (difference between the output voltage for a front wave and that for a back wave) of the microphone according to this invention with that of the conventional microphone shows that for a low frequency sound wave having a frequency lower than 2000 c./s., the unidirectional characteristics of the two microphones are substantially identical to each other as shown in FIG. 4, while for a high frequency sound wave having a frequency higher than 3000 c./s., the characteristic of the microphone according to this invention is improved by 8 to 20 db. over that of the conventional one as shown by the dotted curve in FIG. 4. Thus, the microphone according to this invention is very convenient and advantageous in that when it is used at a theater stage or the like, it detects the voice of a singer or a master of ceremonies standing in front of the microphone as an output signal outstanding by about 8 to 12 db. over noise waves containing relatively high frequency components, for example, higher than 10 KC. Obviously, in the case of the embodiment as shown in FIG. 1, too, the low frequency characteristic thereof can be improved by permitting the space surrounded by the annular magnet 1, yoke 2 and magnetic coupling ring 4 to serve as acoustic housing.

The dynamic microphone as shown in FIGS. 7*a* and 7*b* corresponds to the case where the dynamic microphone as shown in FIGS. 6*a* and 6*b* is covered with a cover 15 having the lower periphery affixed to the bottom surface of the yoke 2 by such means as rolling or the like. In the top surface of the cover 15 are formed sound apertures 15*a*. The cover 15 serves to improve the air-tightness of the acoustic housing 11, thereby completely preventing variations or deterioration in the directional characteristics due to poor air-tightness which can often be observed in dynamic microphones of this type.

Needless to say, such cover can also be applied to the dynamic microphones as shown in FIGS. 1*a* and 1*b*, and 5*a* and 5*b*.

FIGS. 8*a* and 8*b* show a microphone with a reduced outer diameter, wherein the space surrounded by the annular magnet 1, yoke 2 and magnetic coupling ring 4 is adapted to serve as an acoustic duct 16, a single-ended, double-walled cylindrical body 17 is coaxially affixed to the lower surface of the yoke 2, the space surrounded by the cylindrical body 17 and yoke 2 is adapted to serve as acoustic housing 19, the acoustic duct 16 and acoustic housing 19 are acoustically communicated with each other through apertures 20 formed in the yoke 2 and an acoustic resistor 21 such as felt or the like; and the leads 6' of the aforementioned voice coil 6 are taken out through the bore 13 of the center pole 3, the aperture 12 of the yoke 2 and the center bore 18 of the double-walled cylindrical body 17 so as to be fixed to an insulator plate 22 provided on the lower surface of the cylindrical body 17. An acoustic resistor 23 such as felt or the like is either inserted in the bore 13, 12 and 18 or adhered to the center of the lower surface of the double-walled cylindrical body 17. A back sound wave is applied to the back surface of the diaphragm 5 through said bore 13, 12 and 18. In use, a hollow, sound-passing grip member 24 may be attached to the microphone, as indicated by the chain line in FIG. 8*b*.

FIGS. 9 to 17 show other possible embodiments of this invention, and these FIGURES are simplified only for the purpose of illustrating the features of such various microphones.

FIG. 9 shows an arrangement wherein a recess is formed in the outer top portion of the magnetic cylinder and a hole is formed in the coupling ring in alignment with the recess so that a sound-passing hole may be easily defined, thereby improving the directional characteristics.

FIG. 10 shows a modification to the arrangement as shown in FIG. 9, wherein a hole is formed in the magnetic cylinder in such a manner as to extend along the center axis thereof and communicate with the acoustic housing at the lower end thereof. With such arrangement, a damper (a kind of acoustical resistance) can easily be mounted in the hole, as compared with the arrangements of FIGS. 5 and 6.

FIG. 11 shows another modification to the arrangement of FIG. 9, wherein the space surrounded by the annular magnet, yoke and magnetic coupling ring is adapted to serve as acoustic duct, an acoustic housing is formed below the yoke, a plurality of holes are formed in the yoke; and the acoustic duct and the acoustic housing are communicated with each other through an acoustic resistor. With such arrangement, the directional characteristics in the low frequency range can be improved, and the outer diameter of the microphone can be reduced. Furthermore, the microphone having the arrangement as shown in FIG. 11 can be easily manufactured, as compared with that according to the embodiment shown in FIG. 8.

FIG. 12 shows a modification to the arrangement of FIG. 11, wherein the acoustic housing formed below the yoke in the case of FIG. 11 is provided in one side surface. With such arrangement, substantially the same effects as those of the arrangement shown in FIG. 11 can be produced, and the contour is different from that of the microphone as shown in FIG. 11.

FIG. 13 is a modification to the arrangement of FIG. 5, wherein an acoustic housing is provided in the lower portion. With this arrangement, the acoustic characteristics can be improved by mere addition of a relatively small housing thereto. This example and the following two examples are non-directional microphones.

FIG. 14 is a modification to the arrangement of FIG. 13, wherein the housing provided in the lower portion in the case of FIG. 13 is provided on one side surface. This arrangement can produce substantially the same effects as produced by the arrangement of FIG. 13, and it meets the demands for flat microphones.

FIG. 15 shows a combination of the arrangements shown in FIGS. 13 and 14, wherein the low frequency characteristics can be further improved by means of a large housing.

FIG. 16 shows a directional microphone wherein a sound-passing hole is formed in the center portion of the center pole as in FIG. 5, in place of the sound-passing hole formed in the upper side surface as in FIG. 12.

FIG. 17 shows a directional microphone wherein an acoustic housing is provided separately from the microphone body and the acoustic housing is connected with the microphone body through an acoustic pipe. With such arrangement it is possible to construct a microphone of a configuration convenient for a certain specific purpose.

As will be appreciated from the foregoing, the microphone using a permanent magnet formed of an anisotropic barium ferrite to establish a magnetic circuit in accordance with this invention can be made flat, so that it can be easily configured in any suitable shape depending upon various objects. Furthermore, in accordance with this invention, various desirable characteristics can be easily secured. Finally, the microphone of this invention can easily be manufactured since a hole or recess can easily be formed in the magnet by the use of simple molds.

I claim:

1. A dynamic microphone, comprising an annular magnet formed of an anisotropic barium ferrite, a yoke affixed to the lower surface of said annular magnet, a magnet coupling ring secured to the upper surface of said annular magnet, a center pole provided on the yoke coaxially with respect to said annular magnet, a diaphragm secured to said magnetic coupling ring, and a voice coil attached to said diaphragm in such a manner as to depend therefrom so as to be positioned in a gap defined by said magnetic coupling ring and said center pole; at lease one hole being formed in said center pole and said yoke extending therethrough; the space surrounded by said annular magnet, said yoke and said magnetic coupling ring being adapted to serve as an acoustic duct, a double-walled cylindrical body being affixed to the bottom surface of said yoke so as to form an acoustic housing, said acoustic housing and said acoustic duct being acoustically communicated with each other through at least one hole having an acoustic resistor piece inserted therein, and a second acoustic resistor piece being provided in the hole extending through said center pole, the center portion of said yoke and the center portion of said double-walled cylindrical body.

2. A dynamic microphone, comprising an annular magnet formed of an anisotropic barium ferrite, a yoke affixed to the lower surface of said annular magnet, a magnetic coupling ring secured to the upper surface of said annular magnet, a center pole provided on the yoke coaxially with respect to said annular magnet, a diaphragm secured to said magnetic coupling ring, and a voice coil attached to said diaphragm in such a manner as to depend therefrom so as to be positioned in a gap defined by said magnetic coupling ring and said center pole; said annular magnet, said yoke and said magnetic coupling ring defining an acoustic housing; at least one recessed portion being formed in the upper side surface of said annular magnet and a hole being formed in said magnetic coupling ring in register with said recessed portion, thereby producing unidirectional characteristics.

3. A dynamic microphone as set forth in claim 2, wherein a hole is formed in the center portion of said center pole extending therethrough and communicating with said acoustic housing at the lower end thereof, an acoustic resistor being provided in said hole.

4. A dynamic microphone, comprising an annular magnet formed of an anisotropic barium ferrite, a yoke affixed to the lower surface of said annular magnet, a magnetic coupling ring secured to the upper surface of said annular magnet, a center pole provided on the yoke coaxially with respect to said annular magnet, a diaphragm secured to said magnetic coupling ring, and a voice coil attached to said diaphragm in such a manner as to depend therefrom so as to be positioned in a gap defined by said magnetic coupling ring and said center pole; the space surrounded by said annular ring, said yoke and said magnetic coupling ring being adapted to serve as an acoustic duct, an acoustic housing being provided to cover at least a part of the side surface of said annular magnet, and said acoustic duct and housing being communicated with each other through at least one hole having an acoustic resistor.

5. A dynamic microphone, comprising an annular magnet formed of an anisotropic barium ferrite, a yoke affixed to the lower surface of said annular magnet, a magnetic coupling secured to the upper surface of said annular magnet, a center pole provided on the yoke coaxially with respect to said annular magnet, a diaphragm secured to said magnetic coupling ring, and a voice coil attached to said diaphragm in such a manner as to be positioned in a gap defined by said magnetic ring and sad center pole; the space surrounded by said annular magnet, said yoke and said magnetic coupling ring being adapted to serve as an acoustic duct, an acoustic housing being provided to cover at least a part of the side surface of said annular magnet and the bottom surface of said yoke, and said acoustic duct and housing being acoustically communicated with each other through at least one hole having an acoustic resistor inserted therein.

6. A dynamic microphone as set forth in claim 4, wherein at least one hole having an acoustic resistor therein is formed in said center pole and said yoke extending therethrough.

7. A dynamic microphone as set forth in claim 4, wherein at least one recessed portion is formed in the upper side surface of said annular magnet, and a hole is formed in said magnetic coupling ring in register with said recessed portion, thereby producing unidirectional characteristics.

8. A dynamic microphone as set forth in claim 5, wherein at least one hole having an acoustic resistor therein is formed in said center pole and said yoke extending therethrough.

9. A dynamic microphone as set forth in claim 5, wherein at least one recessed portion if formed in the upper side surface of said annular magnet, and a hole is formed in said magnetic coupling ring in register with said recessed portion thereby producing unidirectional characteristics.