

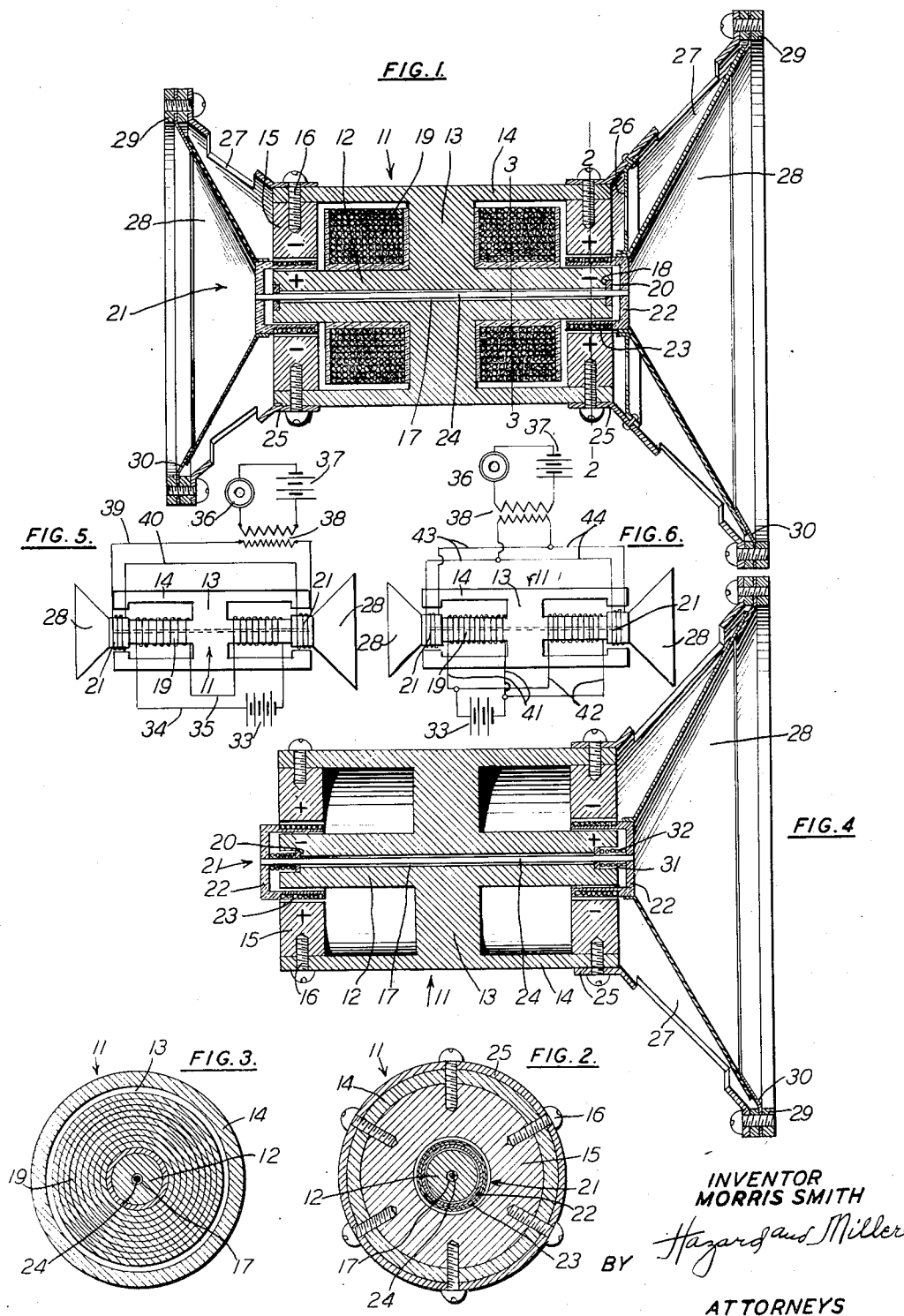
June 2, 1931.

M. SMITH

1,808,149

ELECTRODYNAMIC SPEAKER

Filed April 3, 1929 3 Sheets-Sheet 1



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FIG. 8

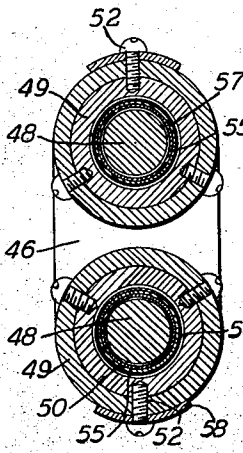


FIG. 9

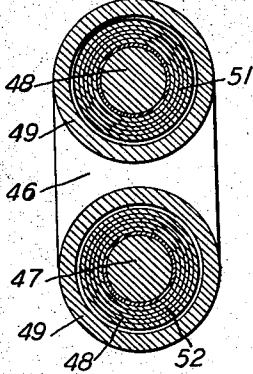


FIG. 7

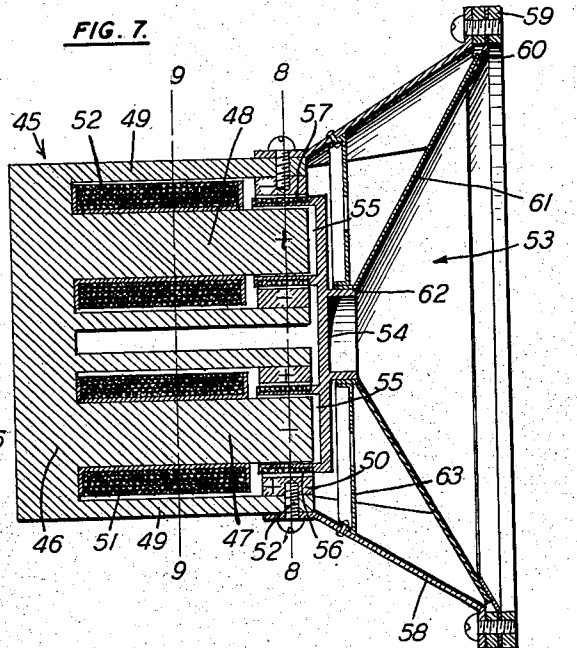


FIG. 10

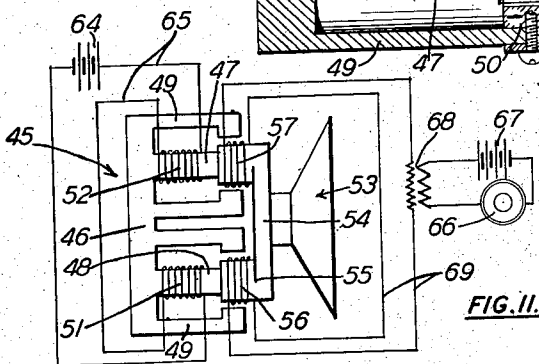
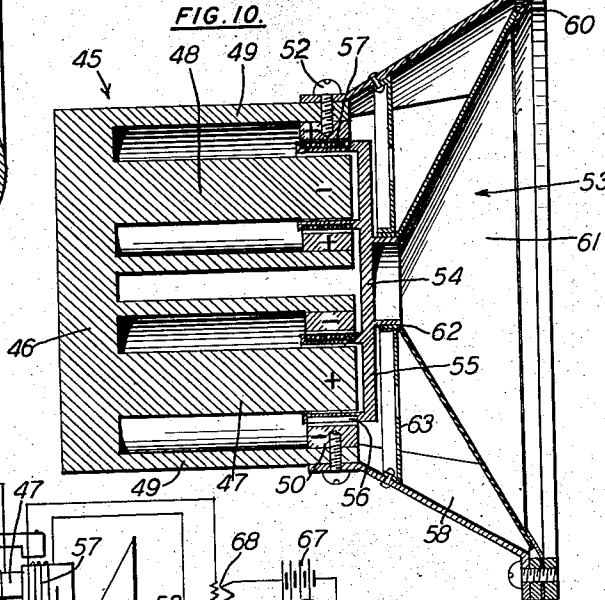


FIG. 11

INVENTOR
MORRIS SMITH

BY *Hazard and Miller*
ATTORNEYS

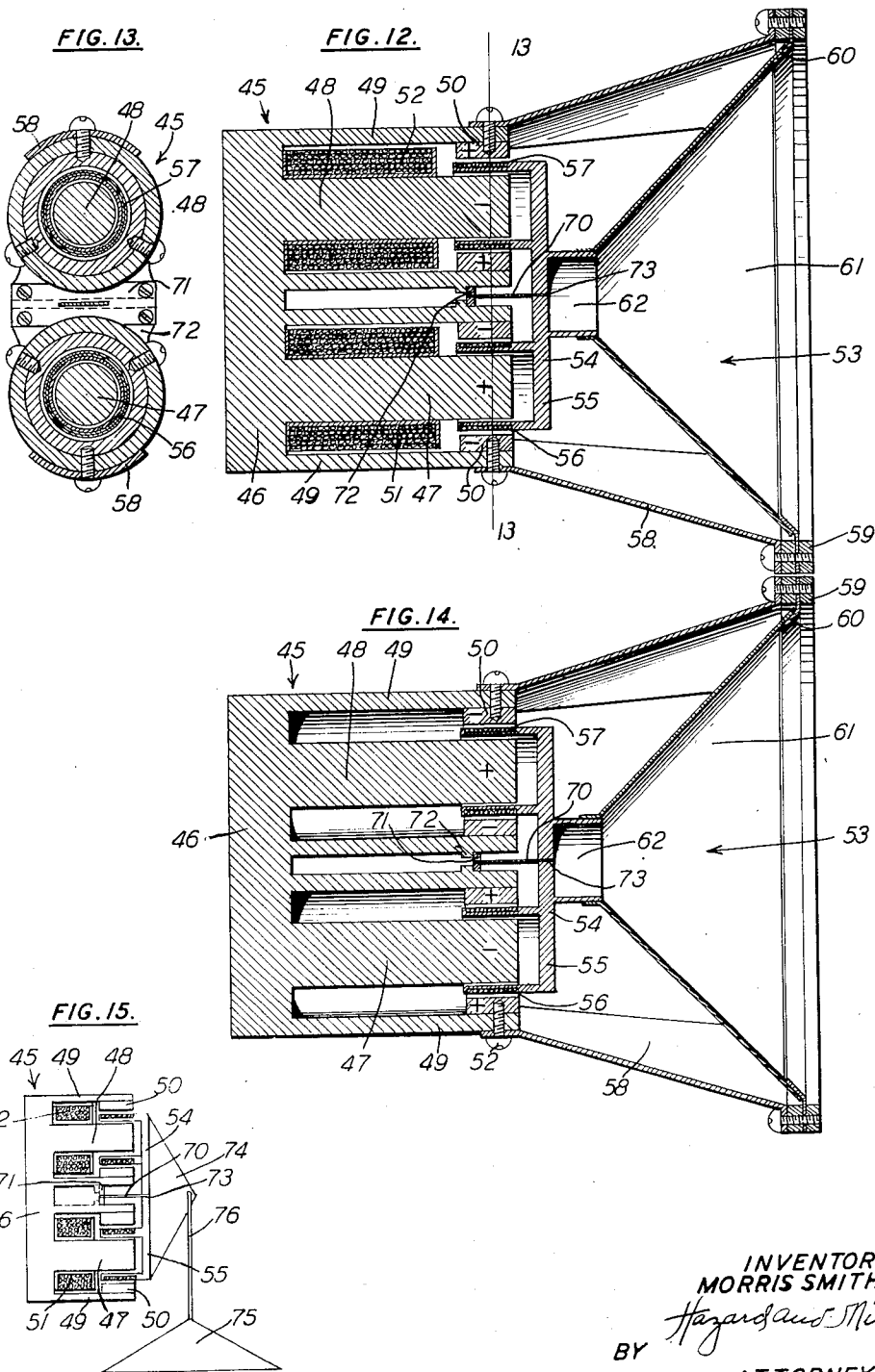
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INVENTOR
MORRIS SMITH
BY *Hazard and Miller*
ATTORNEYS

UNITED STATES PATENT OFFICE

MORRIS SMITH, OF LOS ANGELES, CALIFORNIA

ELECTRODYNAMIC SPEAKER

Application filed April 3, 1929. Serial No. 352,215.

My invention pertains to an electrodynamic speaker suitable for a radio loud speaker or a public address loud speaker or the like.

5 An object of my invention is the construction of a so-called electrodynamic unit which may be adapted for reproducing sounds in which the magnets, either electromagnets or permanent magnets are of such construction
10 that the magnetic field through the vibrating or moving coils is relatively large, whereby the device will respond with considerable amplitude and act to fluctuations in the sound producing current.

15 It is known that the force developed and which may be applied to mechanically produce sounds as by operating a diaphragm, varies directly in accordance with the strength of the magnetic field with the length
20 of the conductor carrying the sound producing current and with the current flowing in such conductor. The magnetic field may be made of considerable strength by utilizing an electro-magnet or magnets energized by
25 a constant current. The length of the conductor on the moving coil is fixed when this is once constructed and the current flow through this coil has comparatively small variations. Therefore I endeavor to secure a
30 magnetic field of considerable strength by the development of several what may be considered independent fields, which co-act or combine together in their action relative to the moving coils.

35 A particular object of my invention as applied in one form is an electrodynamic unit in which the magnet has poles at opposite ends which may be generated by an electric winding or I may utilize a permanent
40 magnet. The vibrating coils are connected together, there being one at each end of the magnet and these coils therefore operate in unison to transmit the vibrations to the sound producing medium, such as a cone-like diaphragm. In this connection I preferably
45 make the magnet with a core having a central cylindrical portion with a central partition extending outwardly and have a tubular outer section connected to the partition with
50 internal rings at the end. I use two coils

in the electromagnet type, wound on the central portion of the core in the space inside of the rings and between the outer portion and the central portion of the core. The vibrating coils are positioned between the rings and the end of the central portion of the core. In the permanent type of magnet I omit the windings.

Another object of my invention in constructing an electrodynamic unit with the double ended magnet and vibrating coils at each end, is in using a plurality of vibrating diaphragms operated by the vibrating coils, there being one at each end and having different harmonic characteristics to produce to better advantage sounds of low and high frequencies.

Another object of my invention is in forming a core with two parallel pole pieces. These may be energized by an energized coil or may be made in the form of permanent magnets. In this case I utilize preferably two vibrating coils at the open end of the magnet structure, these being connected together and arranged to drive a diaphragm or the like. In this construction I preferably form the magnet with a core having two main cylindrical poles, each having an annular space around it and the electromagnet having a winding in each of these spaces. A cylinder is positioned outside of the space or windings and is connected to a common base to which the cores are also connected. A pair of rings are fitted inside of the open end of each of the cylinders to form a magnetic path for the magnetic flux passing through the movable coils which are positioned between the rings and the poles of the main magnet.

Another object of my invention in a third construction is in utilizing an electromagnet having double poles, both on the same side and utilizing a plurality, preferably two, vibrating coils in connection with the magnet. These coils are connected to a rigid structure which is mounted to have a pivotal movement. This pivotal movement is communicated to the diaphragm and gives the diaphragm both a reciprocating and a lateral vibration.

My invention in its various aspects is illus-

trated in the accompanying drawings, in which;

Figure 1 is a longitudinal section through a loud speaker unit having the poles of the magnet at opposite ends and with the vibrating ends on such magnet;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3;

Fig. 4 is a section similar to Fig. 1, utilizing a permanent magnet;

Fig. 5 is a wiring diagram suitable for the construction of Fig. 1, utilizing a series winding;

Fig. 6 is a diagram similar to Fig. 5, showing a parallel winding;

Fig. 7 is a longitudinal section of a modification having the poles of the magnet at one end and utilizing a plurality of vibrating coils on one side of the device;

Fig. 8 is a section on the line 8—8 of Fig. 7;

Fig. 9 is a section on the line 9—9 of Fig. 7;

Fig. 10 is a section similar to Fig. 7, utilizing a permanent magnet;

Fig. 11 is a wiring diagram suitable for the construction of Fig. 9, showing a series winding;

Fig. 12 is a longitudinal section of a magnet construction similar to Fig. 9 and with the vibrating coils mounted on a pivot;

Fig. 13 is a section on the line 13—13 of Fig. 12;

Fig. 14 is a section similar to Fig. 12, showing a permanent magnet;

Fig. 15 is a diagram similar to Fig. 12, showing different positions of the sound producing diaphragm or cone.

Referring first to the construction of Figs. 1, 2 and 3, the magnet has a core designated generally by the numeral 11, in which there is a central cylindrical core section 12 extending outwardly from the central portion. Midway between each end there is a thick partition 13 and outside of the partition there is a tubular or cylindrical structure 14. These parts 12, 13 and 14 are preferably formed integral and of suitable material for an electromagnet. A ring 15 is secured at each end of the cylinder 14 extending inwardly. These may be secured by bolts 16 or the like. The central portion of the core has a bore 17 extending therethrough from end to end and preferably has a recess 18 at each end. The energizing coils 19, of which there are two, are fitted in the space between the central portion 12 of the core, the cylindrical portion 14, the central partition 13 and the rings 15. Bushings 20 are fitted in the recess 18.

The vibrating coil structures designated generally by the numeral 21 comprises a cup-shaped support 22 having the windings 23 thereon through which the variable sound produced current is transmitted. The cup-shaped structures are connected by a rigid bar 24 which extends through the bore 17

and may be guided lightly by the bushings 20. It will be noted by this construction that the coils 23 and the electrical portion of the cup fit between the inside openings of the rings 15 and the cylindrical end of the central core section 12.

I may center and support the vibrating coils by utilizing a ring-like supporting base 25 secured to the end of the magnet and having a flexible web-like spring 26 connecting between this base and the cup structure 22. In the illustration I show a diaphragm supporting frame 27 extending outwardly from the base 25, one end having a cone-shaped diaphragm 28 secured between rings 29, there being a flexible member 30 such as chamois secured to the outer edge of the cone and clamped between the rings 29. The central portion of the spring 26 is secured outside of the apex structure of the cone which apex is attached to the cup 22.

The construction shown in Fig. 4 is substantially the same as that of Figs. 1 and 2, except that the energizing coils for the magnet are omitted. In this case the magnet may be permanently charged by inserting coils similar to the coils 19 and energizing these coils for a sufficient length of time and removing the rings 15 to take out the coils and then replacing such rings. In this construction however, I only show a vibrating diaphragm or cone at one end of the structure.

In the construction of Fig. 4 I have a recess 31 in the opposite ends of the central part of the core in which there is fitted coil springs 32 which bear on the cup-shaped supports 22, thus maintaining a balance between both vibrating ends of the device and in effect holding the vibrating coils centered. The centering is also aided by the cone construction.

In Fig. 5 I show a wiring diagram in which the coils 19 are energized from a source of power 33 by a series circuit as indicated by the leads 34 and 35. The energizing of the vibrating coils is indicated by the microphone or other sound pickup 36 having a source of power 37, a transformer 38 and series leads 39 and 40 to the windings 21. In Fig. 6 I show a construction in which the magnet energizing coils 19 are energized by a source of power 33 and have circuits in parallel 41 and 42. Also in this case the vibrating coils 21 are energized from the transformer by parallel circuits 43 and 44.

The action of the device of Figs. 1 through 6 is substantially as follows: Presuming that the electro or permanent magnet is energized so that the central part of the core is negative at one end and positive at the other as indicated, then the rings 15 are respectively positive and negative at the opposite ends, that is in opposite polarity to the adjacent central part of the core. Magnetic circuits

are thus established, circling through the center part 12 of the core, the partition portion 13, the cylindrical outside section 14 and the rings 15. The vibrating coils are so wound that when due to the current through these coils, at any one instant such coils are urged in the same direction. Thus the total force acting on the vibrating diaphragm or core is the summation of the forces acting in the same direction on the vibrating coils which coils float freely in the magnetic field between the central part of the core and the rings 15. The bushings 20 give but little resistance to the vibrational sliding of the central bar 24.

In Figs. 7 through 11 I show a magnet construction having a core designated generally by the numeral 45. This has a base 46 and two what may be termed central sections 47 and 48 each of which is surrounded by a cylindrical core section 49 and at the open ends there are rings 50 secured to the cylindrical sections. There are two energizing windings 51 and 52 wound in the space between the two central core sections 47 and 48 and the cylindrical sections 49. The rings are illustrated as being held in place by screws 52.

The vibrating coil structure designated generally by the numeral 53 has a bridging structure 54 with a pair of cup-like winding holders 55 at its opposite ends, these having the vibrating windings 56 and 57 mounted thereon. Such windings and their support are in the space between the ends of the central core sections 47 and 48 and the rings 50 attached to the cylindrical sections 49.

In this construction I illustrate a sound reproducer having a suitable spider-like frame 58 secured to the magnetic core and this device has clamping rings 59 which engage the outer edge of a flexible ring 60, such as chamois, this latter being attached to the outer periphery of the cone 61. The inner part of the cone is illustrated as attached to a cylindrical portion 62 of the bridging holder 54. A spring 63 formed of sheet material, with perforations, is secured between the frame 58 and the central portion of the bridging structure 54.

The construction of Fig. 10 using the permanent magnets is substantially the same as that of Fig. 7 and is energized by using coils positioned similar to the coils 51 and 52, then removing the rings and the coils and replacing the rings. Fig. 11 shows the wiring diagram in which the coils 51 and 52 are energized by a source of power 64 having a series connection 65. The vibrating windings 56 and 57 are illustrated as being energized through a sound pickup such as a microphone 66 having a source of power 67, there being a transformer 68 with series leads 69 in the transformer to the coils.

The operation of the device of Figs. 7

through 11 is substantially as follows: Presuming that the windings 51 and 52 or the permanent magnet have the cores so energized that the outer end of one of the central core sections is negative and the section 48 is positive, then the ring 50 surrounding the core section 47 is positive and the ring surrounding the core section 48 is negative. The vibrating coils are so wound that both are energized to move in the same direction, thus giving a linear vibrating movement to the vibrating diaphragm or cone. In this case the vibrating coils substantially float in the magnetic field between the central portions of the core 47 and 48 and the rings 50.

There are apparently several magnetic circuits set up, that is the circuits including each of the central core sections 47 and 48, the cylindrical sections 49 immediately adjacent thereto and the rings 50 attached to these sections 49. These circuits are through the base 46. There is also apparently a circuit through the base 46 and the two core sections 47 and 48 to the opposite poles at the end of said sections.

In the construction of Figs. 12, 13 and 14, the electro-magnet and the permanent magnet are the same as illustrated in connection with Figs. 7 and 10 and the vibrating coils are mounted in a similar manner, except that a flexible sheet material spring 70 is mounted in a base 71 which latter is attached to ribs 72 in the adjacent surfaces of the cylindrical portion 49 of the cores. The outer end of this spring is secured to the central portion 73 of the bridge 54. In this construction the moving coils are so energized in reference to the electro-magnet or the permanent magnet, that they tend to rock or have opposite directions of movement under way instantaneous energizing. Therefore this rocking gives a pivotal movement substantially on the support of the spring 70 on its base. Such rocking action sets up to a certain extent the combination of a lateral and a reciprocating movement to the vibrating diaphragm or cone.

With this type of device the spring 70 and the cone structure substantially hold the vibrating coils in a floating relation to the central core sections and the rings thereabouts. In the construction of Figs. 15 I utilize a magnet and vibrating coils similar to the construction of Figs. 12 and 14 and have a triangular base 74 mounted on the bridging piece 54 and by this structure I may operate a cone 75 through the medium of the link 76. By this construction the main body of the cone may be placed at right angles to the axis of the magnets and by changing the size of the triangular base 74 different amplitudes of vibration may be given.

In order to have the sound producing units located at opposite ends emphasizing the magnet produce sounds of low and high harmonics, I make these preferably of different

characteristics. For instance, the large cone may be made of heavy material and of considerably greater diameter than the small cone. The small cone therefore produces
 5 more readily tones of high pitch or high frequency and the large cone sounds of low frequency that is of a low pitch.

With my construction it is possible to use two cones either of different sizes or having
 10 different characteristics so that although both cones vibrate at the same frequency due to the same electrical reactions, one will emphasize the lower and the other the upper harmonics of the fundamental note. Therefore, a pleasing
 15 combination is obtained in that the low and the high harmonics are not damped out by the conical sound reproducer but the mechanical construction may faithfully, within certain limits, respond to the electrical vibrations.
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Various changes may be made in the principles of my invention without departing from the spirit thereof as set forth in the description, drawings and claims.

25 I claim:

1. A device as described comprising in combination a magnet having a core with a plurality of poles, a vibrating coil mounted adjacent each pole of the core, the said core
 30 being constructed to have a plurality of magnetic circuits intersecting the coils, a rigid structure connecting the various coils, whereby on energizing of the said coils a vibration of the coils and the said rigid structure is effected.
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2. A device as described comprising in combination a magnet having a core with a plurality of poles, a vibrating coil mounted adjacent each of the poles, said magnet forming
 40 a plurality of magnetic circuits through each of the poles intersecting the said coils, rigid means connecting the coils and a sound reproducing device connected to said rigid means.

3. A device as described comprising in combination a magnet having a core with a plurality of poles energized by said magnet, a vibrating coil mounted adjacent each of the
 45 poles, the said magnet forming a plurality of magnetic circuits intersecting the said coils, a rigid means connecting the coils, whereby on energizing of the coils a vibration is effected of the coils and the connecting structure.
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4. A device as described comprising in combination a magnet having a core formed with a central portion having ends of opposite polarities and having a cylindrical portion concentric therewith, with a central partition portion connecting the central and the
 55 cylindrical portion, and a ring at each end of the central portion connected to the cylindrical portion, an energizing coil mounted adjacent each end of the central portion, a vibrating coil mounted to vibrate adjacent each of
 60 the poles of the central portion, the central

portion, the concentric portion, the central partition portion, and the rings forming a plurality of magnetic circuits through the core and the ring structures, a rigid connection between the coils, the energizing of the
 70 coils causing a vibration thereof and of the said connecting structure.

5. A device as described comprising a magnet having a core formed with a central core portion having ends of opposite polarities, a
 75 vibrating coil mounted adjacent each of the said ends, a cylindrical core structure connected to the central portion of the core, core rings positioned between the cylindrical portion and the ends of the center portion,
 80 spaced from said vibrating coils, a rigid connection between the vibrating coils and a sound reproducing device connected to the rigid structure.

6. A device as described comprising in
 85 combination a magnet having a core with a central portion having ends of opposite polarity, a cylindrical section connected to the central portion by a rigid core structure extending radially outwardly from the central
 90 portion, a ring positioned between the cylindrical portions and the ends of the central portion of the core and spaced from the central portion, a vibrating coil positioned between each pole of the central portion and
 95 the adjacent ring, a rigid connection between the vibrating coils and a sound reproducing device attached to said rigid connection.

7. A device as described comprising in combination a magnet having a core with an
 100 elongated central portion, a central partition structure and an encircling core structure, a vibrating coil mounted at each end of the central portion and a rigid connection between said coils, whereby the said vibrating coils
 105 on energization with the fluctuating current vibrate relative to the said magnet.

8. A device as described comprising in combination a magnet having a central elongated core, a partition structure and an encircling
 110 portion, a vibrating coil mounted at each end of the central portion, there being a bore through the central portion with a connecting means for the said coils, whereby on energizing of the coils by fluctuating current
 115 the coils and the said structure have a vibration relative to the said core.

9. A device as described comprising in combination a magnet having a core with a central
 120 portion having poles of opposite polarity at opposite ends, a central partition and an encircling portion, a ring connected to the encircling portion at each end, a vibrating coil mounted on the ends of the central portion
 125 between same and the ring adjacent thereto, the central portion having a central bore, a rigid connection through the bore to the said coils, whereby on energizing the said coils with fluctuating current, a vibra-
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tion is caused between the coils and their connection relative to the core.

10. A device as described comprising in combination a magnet having a core with a
5 central elongated portion having poles of opposite polarity at its opposite ends, a partition and an encircling portion, rings secured to each end of the encircling portion, a vibrating coil mounted on a supporting structure at
10 each end of the central portion of the core and between such portion and the adjacent ring, the said central portion having a bore therethrough with a connecting rod, whereby
15 on energizing of the coils a vibration of the supports the coils and the rod is effected relative to the core.

11. A device as described comprising in combination a magnet having a core formed with a central elongated portion having poles
20 of opposite polarity at each end with a central partition, an encircling portion connected to the partition and a ring secured to each end of the encircling portion, a winding on the central portion at each side of
25 the partition, a vibrating coil mounted on a cup-like support at each end of the central portion, the coil fitting between the end of the central portion and the adjacent ring, there being a central bore through the central
30 portion and a rod connecting the cup-like support and a sound producing device connected to at least one of cup-like supports.

12. A device as claimed in claim 11, there being a sound producing device connected to
35 each of the said cup-like supports, each being of different size and adapted to generate with sounds with different harmonics.

13. A device as described comprising in combination a magnet having a core with a
40 base and a pair of central core sections extending outwardly from the base in the same direction and having their outer ends forming poles of different polarities, a vibrating coil mounted adjacent each of the poles and
45 a rigid connection between said coils.

14. A device as described comprising in combination a magnet having a base with
50 two central core sections extending therefrom in the same direction, an encircling core structure surrounding each central section, a coil surrounding each of the core sections at the end and fitted inside of the adjacent encircling core section, and a rigid connection between each of the coils.

15. A device as described comprising in combination a magnet having a core with a
55 base and a pair of central core sections extending outwardly therefrom in the same direction, an encircling core section around
60 each of the central sections, a vibrating coil mounted at the end of each of the said central sections between same and the end of the adjacent encircling section, a rigid connection between the coils, a pivotal mounting
65 for said rigid connection, said coils being

energized to operate in opposite directions and cause a pivoting vibration of the said connecting structure.

In testimony whereof I have signed my name to this specification.

MORRIS SMITH.

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