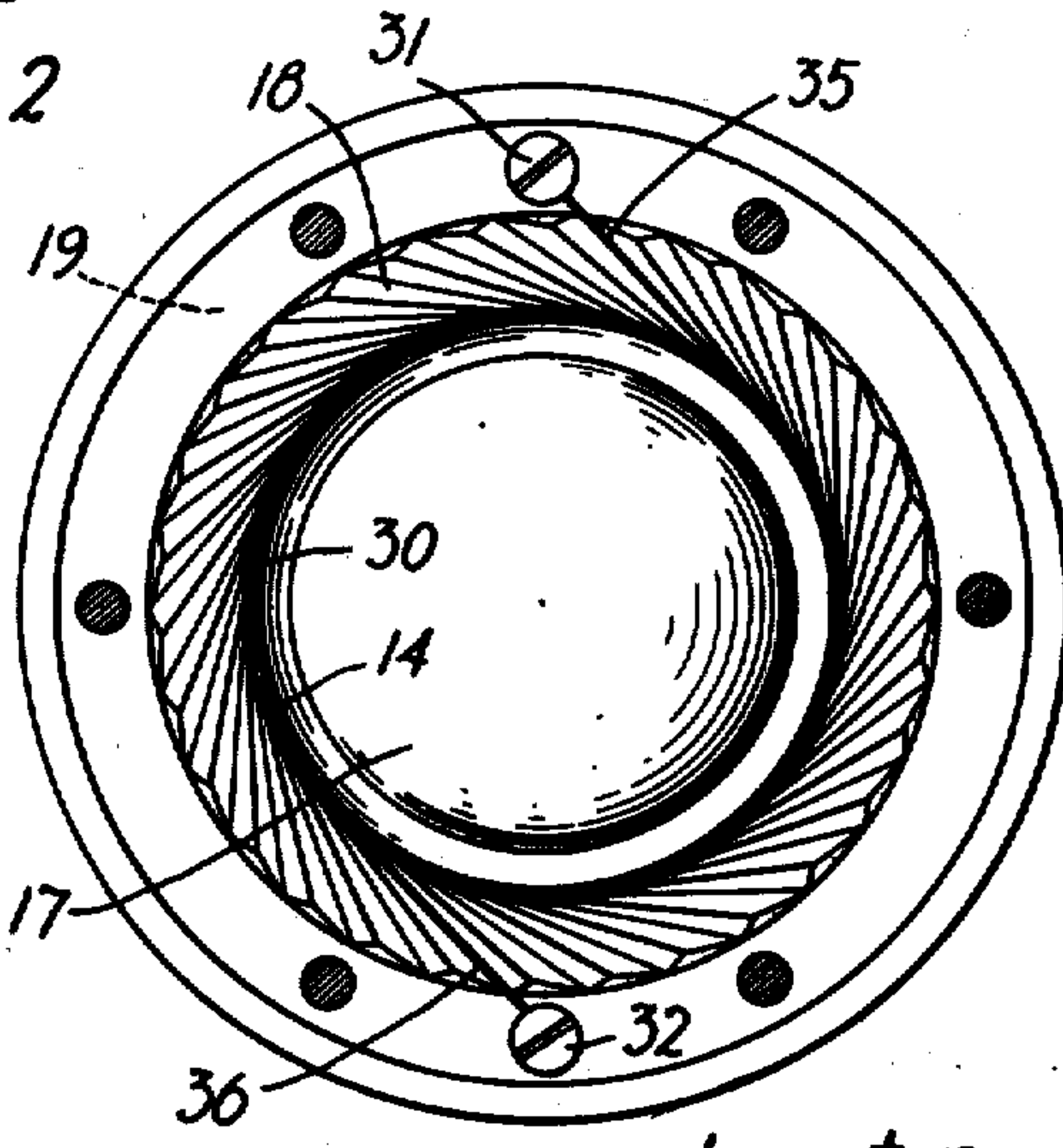
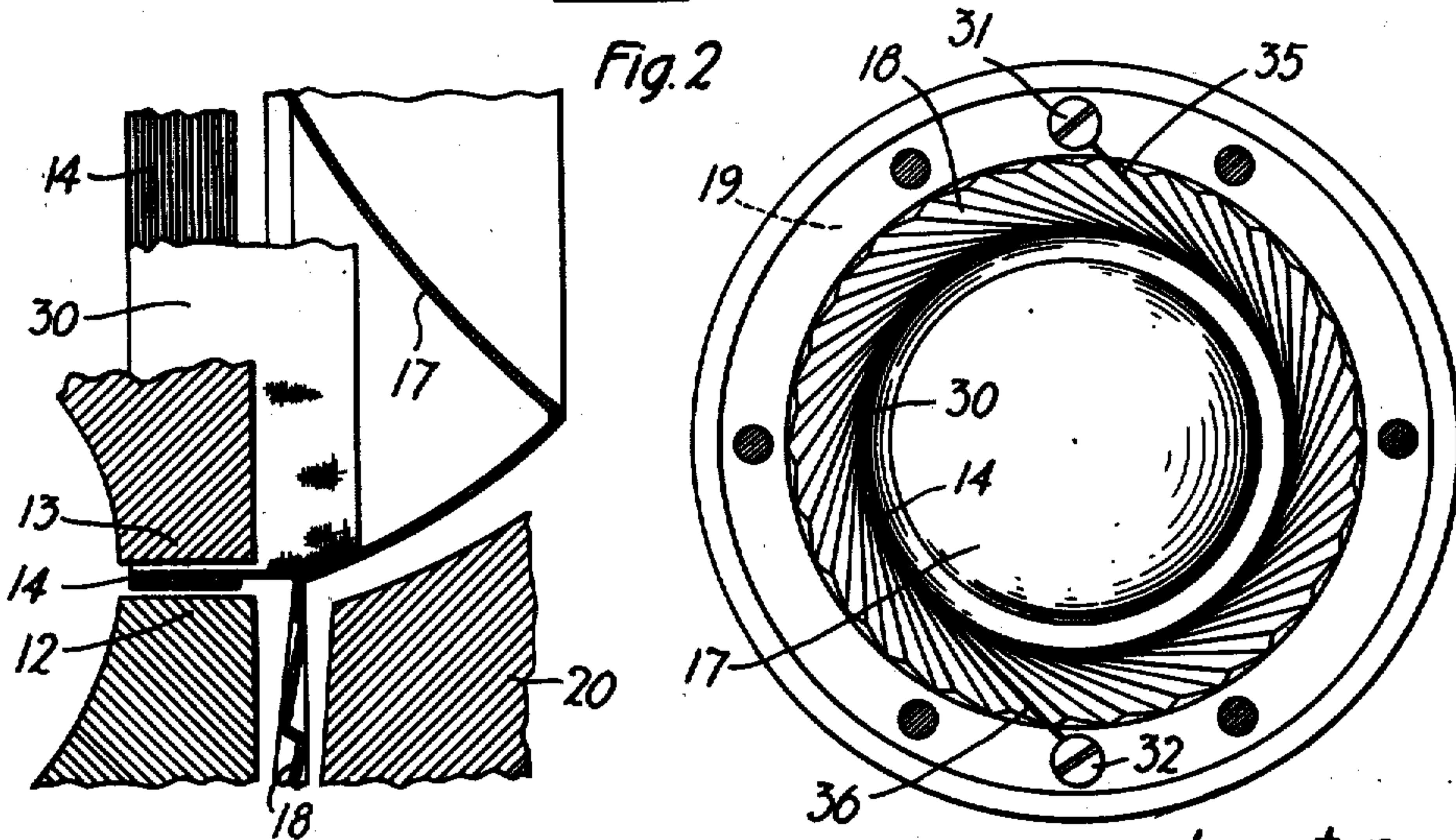
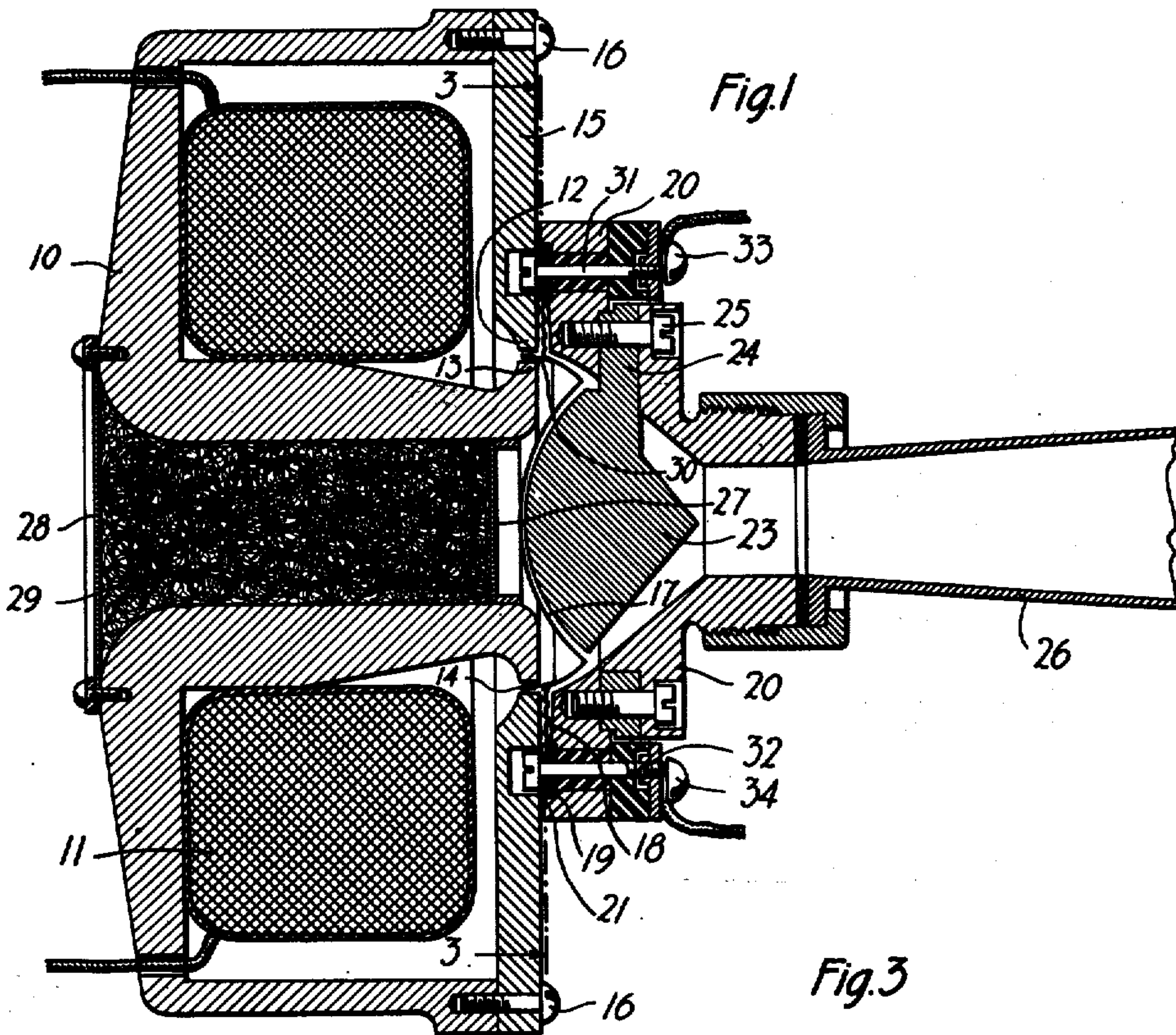


April 2, 1929.

A. L. THURAS
ELECTRODYNAMIC DEVICE

1,707,544

Filed Aug. 4, 1926



Inventor:
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1,707,544

UNITED STATES PATENT OFFICE.

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ELECTRODYNAMIC DEVICE.

Application filed August 4, 1926. Serial No. 127,152.

This invention relates to electrodynamic devices and particularly to an acoustic device employing an electrodynamically actuated vibrating element.

5 An object of the invention is to increase the operating efficiency of electrodynamic devices.

10 A more specific object is to convert electrical energy into acoustic energy with high and substantially uniform efficiency over a wide frequency range.

15 In carrying out the invention there is preferably provided a light piston type diaphragm which is driven by a light rigid coil secured to the diaphragm near the periphery of its piston portion. The mass of the coil is made approximately equal to the effective mass of the diaphragm in order to obtain a maximum operating efficiency in the vibrating structure. The effective mass of a diaphragm of the piston type is approximately equal to the mass of its vibrating portion.

25 In its preferred form, the present invention employs a diaphragm and a sound chamber in accordance with the structure disclosed and claimed in a copending application of E. C. Wentz, Serial No. 127,023, filed Aug. 4, 1926, whereby the cutoff point of the sound passage takes place at a frequency above the essential range employed in speech and music. The low frequency cut-off point of a loud speaking system employing the vibrating structure of the present invention is largely determined by the length and mouth opening of the horn through which the sound is transmitted. It is preferable to employ an exponentially tapered horn having a sound passage approximately 11' in length in order to uniformly transmit frequencies down to 80 cycles. By increasing the length of the horn this cut-off frequency may be lowered to any desired frequency.

45 The invention may be readily understood by referring to the accompanying drawing in conjunction with the following detailed description.

50 In the drawing, Fig. 1 is a sectional view of a loud speaker employing the present invention;

Fig. 2 is an enlarged view of a portion of the diaphragm and the coil attached thereto;

Fig. 3 is a view taken along the line 3—3 of Fig. 1.

55 In the drawing, an electromagnet having the hollow annular core 10, the winding 11 and the annular pole pieces 12 and 13, provides a magnetic field in which the coil 14 is positioned. The top portion 15 of the magnetic core 10 is detachable to permit the assembling of the winding 11 on the core structure, and is secured to the lower portion of the core by the screws 16. The diaphragm to which the coil 14 is attached comprises a stiff dish-shaped portion 17, a flexible corrugated portion 18, and a flat portion 19 which is clamped between the housing structure 20 and the upper portion 15 of the core structure. The diaphragm is separated from the portion 15 of the magnetic structure and the housing 20 by the clamping rings 21, and is held in a clamped position by screws which pass through the flanged portion of the housing 20, washers 21 and the flat portion 19 of the diaphragm and are threaded into the upper portion 15 of the magnetic structure.

80 The metallic plug 23 in the form of a spherical sector is secured to the housing 20 by the projecting lugs 24 and the screws 25. The radius of the plug 23 is slightly smaller than that of the adjacent surface of the stiff dish-shaped portion 17 of the diaphragm so that the area of the sound passage formed between these surfaces progressively increases from the center of the diaphragm and from its peripheral portion toward the sound passage formed by the housing 20 and the plug 23. The rate of increase is such as to maintain a constant velocity in the air chambers. The remainder of the sound passage is also preferably designed to progressively increase in area from the diaphragm to the mouth of the horn 26.

95 The space at the mid-portion of the core 10 is closed at each end by a material having a series acoustic resistance such as the fine mesh wire gauze members 27 and 28 and a sound absorbing material 29, such as wool is employed to fill the space between these gauze members. Such an arrangement substantially eliminates acoustic resonance at this portion of the structure.

100 Since the large gain in the operating efficiency of a receiver constructed in accord-

ance with this invention is due to the specific embodiment of the coil and the diaphragm described herein, the method of constructing the coil and the method of attaching the coil to the diaphragm is of considerable importance. While the relative magnitudes of the various factors entering into the construction of the vibrating element of the receiver are often of more importance than the specific values of individual magnitudes, yet it seems desirable, for the sake of clearness, to point out the specific magnitudes by the use of which desired results have been obtained.

The process of making the coil 14 consists in coating a clean aluminum ribbon, having a thickness of about .002" and a width of about .014", with a thin solution of a phenolic condensation product dissolved in acetone. The coated ribbon is then subjected to a temperature of about 350° C. for a short period in order to thoroughly harden the coating. The coated conductor is then passed through a second solution of a phenolic condensation product, preferably slightly more viscous than the previous coating solution, after which it is subjected to a temperature of about 250° C. in order to cause the evaporation of some of the solvent. This leaves the coating in a relatively dry but unhardened condition. The coated ribbon is then wound edgewise on a collapsible mandrel to form a coil about 2" in diameter which is baked at a temperature of about 250° C and gradually cooled to room temperature. The coil, now rigid and substantially free from internal strains, is removed from the mandrel and trimmed down to about 50 turns which gives the coil a height of about .105". The inner surface of the coil is coated with a cementing material for example, a phenolic condensation product, or shellac and one edge of a strip 30 of fabric material, such as oiled silk, is secured thereto by means of the cement. The coil is again placed on a mandrel, the diameter of which is less than that of the mandrel previously used by an amount equal to the thickness of the silk, and is heated to about 150° C. in order to thoroughly dry the cement after which the opposite edge of the strip of oiled silk is secured to the diaphragm near the periphery of the stiffened portion 17 and the end portions 35 and 36 of the ribbon conductor are insulated and secured along the troughs of the corrugations of the flexible portion 18 of the diaphragm by means of a coating of shellac. The assembled structure is again heated to a temperature of approximately 150° C. after which it is ready to be mounted in the receiver.

The coil is positioned midway between the annular pole pieces 12 and 13 which are separated by about .035" and the ends of the ribbon conductor are secured to the screws 31 and 32 which are electrically connected to the

terminals 33 and 34, respectively. Since the width of the coil and fabric is about .017" there remains a clearance of only about .009" between either pole piece and the coil. By employing the flat conductor and the very thin layers of insulating and stiffening material, a compact, rigid coil having the desired number of turns is produced.

The combined mechanical and electrical losses of the coil are reduced to a minimum by employing a material which has a low value for the product of its resistivity by its mass. Good results have been obtained by employing aluminum for which the product of resistivity in microhms per cubic centimeter by mass in grams is approximately equal to 8.0. Due to the presence of impurities, this value may be slightly increased, but should in no case be above 90. For high efficiency, moreover, it is necessary to employ a diaphragm the vibrating portion of which is sufficiently large to cause a large volume displacement when vibrating and in order to obtain a diaphragm having a stiffened portion of sufficient rigidity it is necessary to employ material of a certain minimum thickness. Good results have been obtained by employing an aluminum diaphragm about .002" thick and having a stiff piston portion about 2.0" in diameter. The small and substantially equal masses of the coil and the diaphragm bring about a maximum mechanical efficiency while the small air gap between the pole pieces of the magnet and the compact coil filling the total available space therebetween results in a maximum electrical efficiency. It is also important to note that the centers of gravity of the coil and the diaphragm are close together which practically eliminates the tendency for the coil to vibrate independently of the diaphragm.

The flexible portion 18 of the diaphragm preferably consists of substantially straight corrugations extending perpendicular to radii drawn to the inner ends of the corrugations as described in a copending application of H. C. Harrison, Serial No. 102,454, filed April 16, 1926. The reactance due to the compliance of this portion of the diaphragm is preferably made about equal in magnitude to the mass reactance of the air which the diaphragm sets into vibration.

When a horn having no inherent losses is employed in conjunction with the receiver constructed in accordance with this invention, an efficiency of about 30% has been obtained, measured from the electrical power input to the acoustic power output, this being a substantial gain over other receivers. When employing a horn having a sufficiently large mouth opening and a sufficient length, the efficiency of the device is substantially uniform over a frequency range from about 80 cycles to above 5000 cycles. While the invention is of special value in conjunction with

an acoustic device as described, a driven means other than a diaphragm may be employed and this feature is to be included within the scope of the present invention.

5 What is claimed is:

1. In combination, a diaphragm of light material and a light stiff cylindrical coil consisting of a flat insulated conductor wound edgewise and connected to said diaphragm
10 for driving it.

2. In combination, a diaphragm having a stiffened central portion and a flexible portion surrounding said central portion, a magnet, a coil of a thin rectangular shaped insulated conductor in operative alignment with said magnet and connected to said diaphragm at the edge of its stiffened portion, the product of the resistivity in microhms per cubic centimeter of the conducting material of said coil by the mass of said material in grams per cubic centimeter being less than
20 9.0.

3. An electrodynamic receiver comprising a diaphragm, a casing therefor, a magnet, and a coil consisting of a single helix of a flat insulated conductor wound edgewise and secured to said diaphragm for driving it, said coil being of such dimensions that it substantially fills the available space between the pole
25 pieces of said magnet.

4. The process of making a vibrational element for an electrodynamic receiver comprising a diaphragm and a coil, which consists in coating a flat conductor with a thin
35 layer of insulating material, baking said insulated conductor, coating said conductor with a second thin layer of insulating material, drying the second layer of insulating material, winding said insulated conductor edgewise on a collapsible mandrel to form said coil,
40 baking said coil, removing said mandrel, ce-

menting one edge of a fabric to said coil, and cementing another edge of said fabric to said diaphragm.

5. An electrodynamic acoustic device comprising a diaphragm having a stiffened central portion and a flexible peripheral portion, and a coil attached to the outer edge of the central portion consisting of an edgewise-wound rectangular shaped conductor whose
45 convolutions are insulated from each other and held together by an insulating cement.

6. A vibrational element comprising driven means, a tubular coil consisting of an aluminum ribbon conductor wound edgewise, and
55 means for securing said coil to said driven means comprising impregnated fabric of tubular shape.

7. An electrodynamic device comprising a pair of circular shaped poles spaced apart to form a magnetic air gap, a piston type diaphragm, a coil comprising a rectangular shaped conductor, an insulating cement for securing the convolutions of said coil together, and means for securing said coil to said
60 diaphragm between its center and rim, said coil being positioned in said air gap, the clearance between said coil and the pole pieces being not greater than .009".

8. An electrodynamic device comprising a
70 diaphragm composed mainly of aluminum comprising a flexible portion and a plurality of curved surfaces joined together to form a stiff portion and a coil secured to the stiff portion of said diaphragm for driving it,
75 comprising a ribbon-like conductor mainly of aluminum wound on and cemented to a piece of fabric.

In witness whereof, I hereunto subscribe my name this 4 day of August, A. D. 1926.

ALBERT L. THURAS.

CERTIFICATE OF CORRECTION.

Patent No. 1,707,544.

Granted April 2, 1929, to

ALBERT L. THURAS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 84, for the number "90" read "9.0"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of April, A. D. 1929.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.

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