976,230.

H. R. STUART.

TELEPHONE RECEIVER.

APPLICATION FILED JUNE 29, 1909.

Patented Nov. 22, 1910.

2 SHEETS—SHEET 1.

Fig. 3.

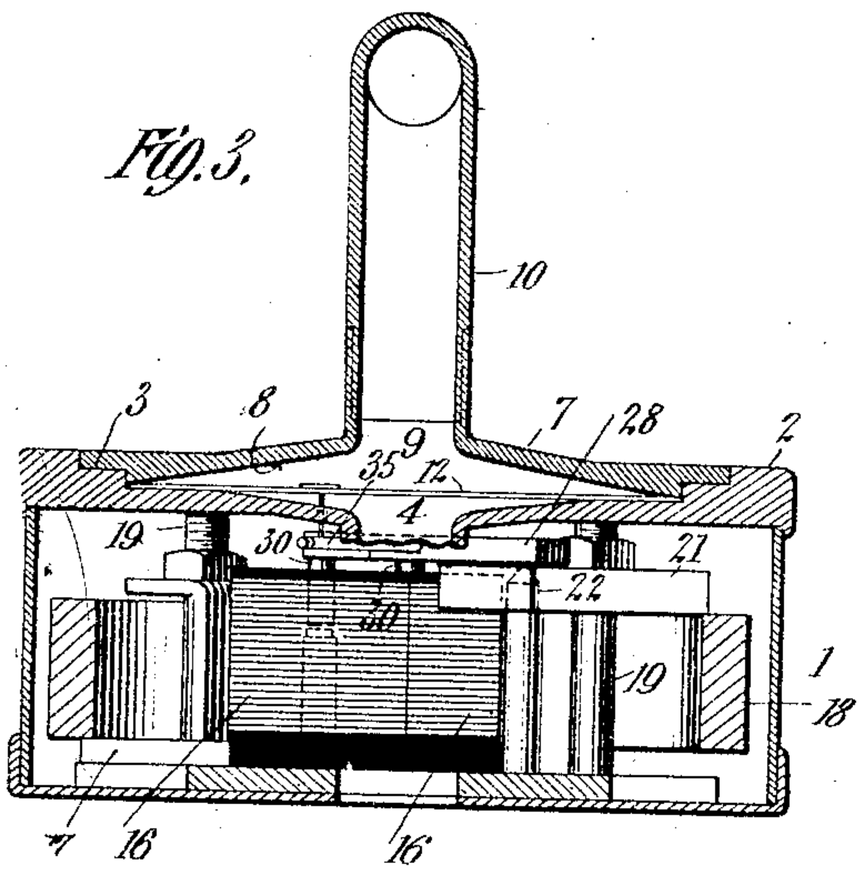


Fig. 1.

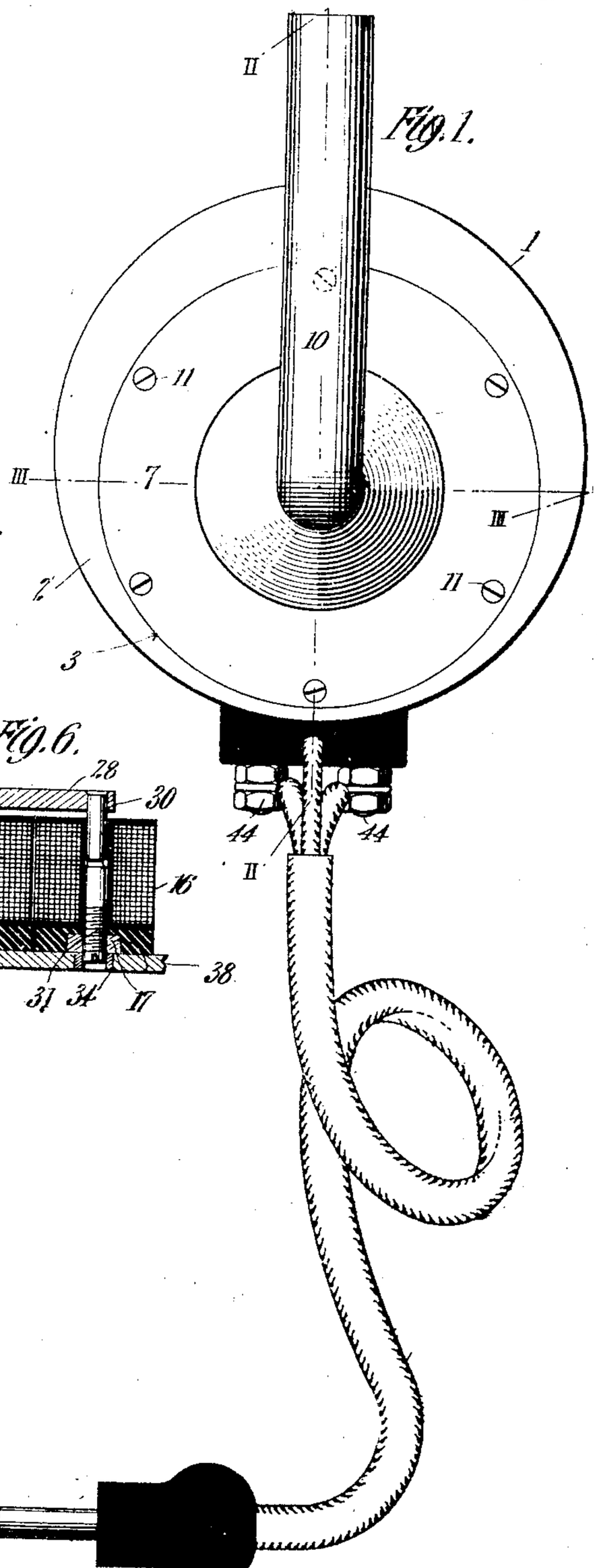
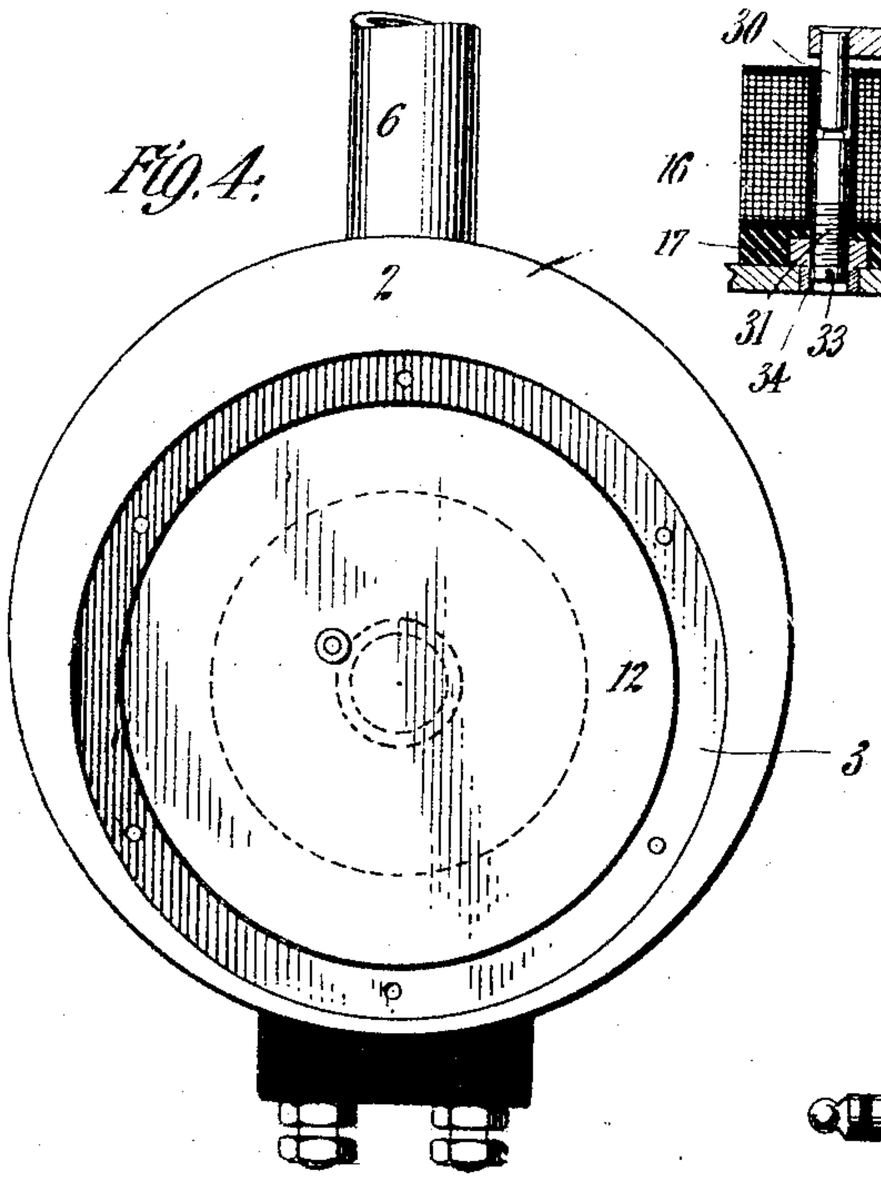


Fig. 6.

Fig. 4.



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2 SHEETS—SHEET 2.

Fig. 5.

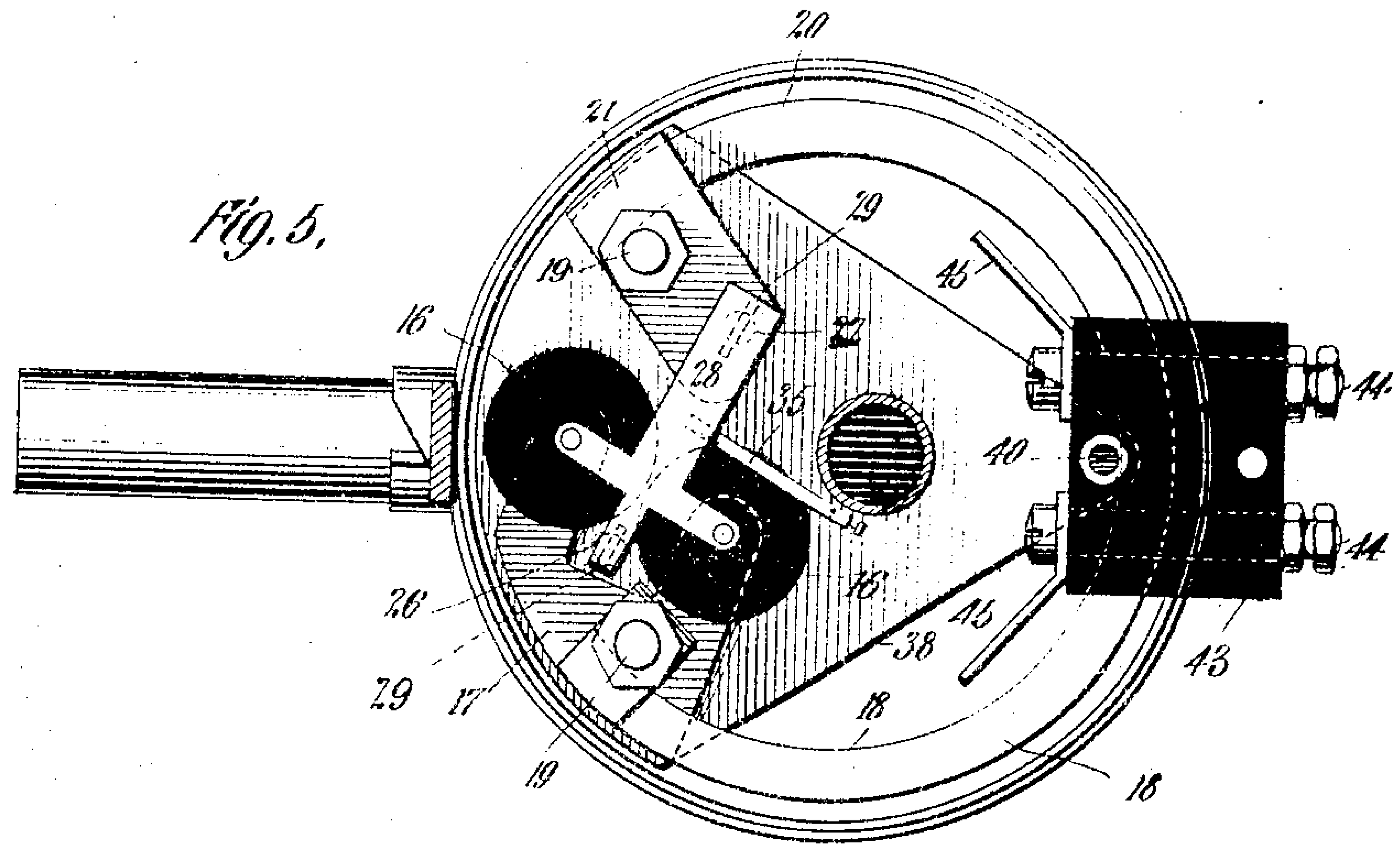
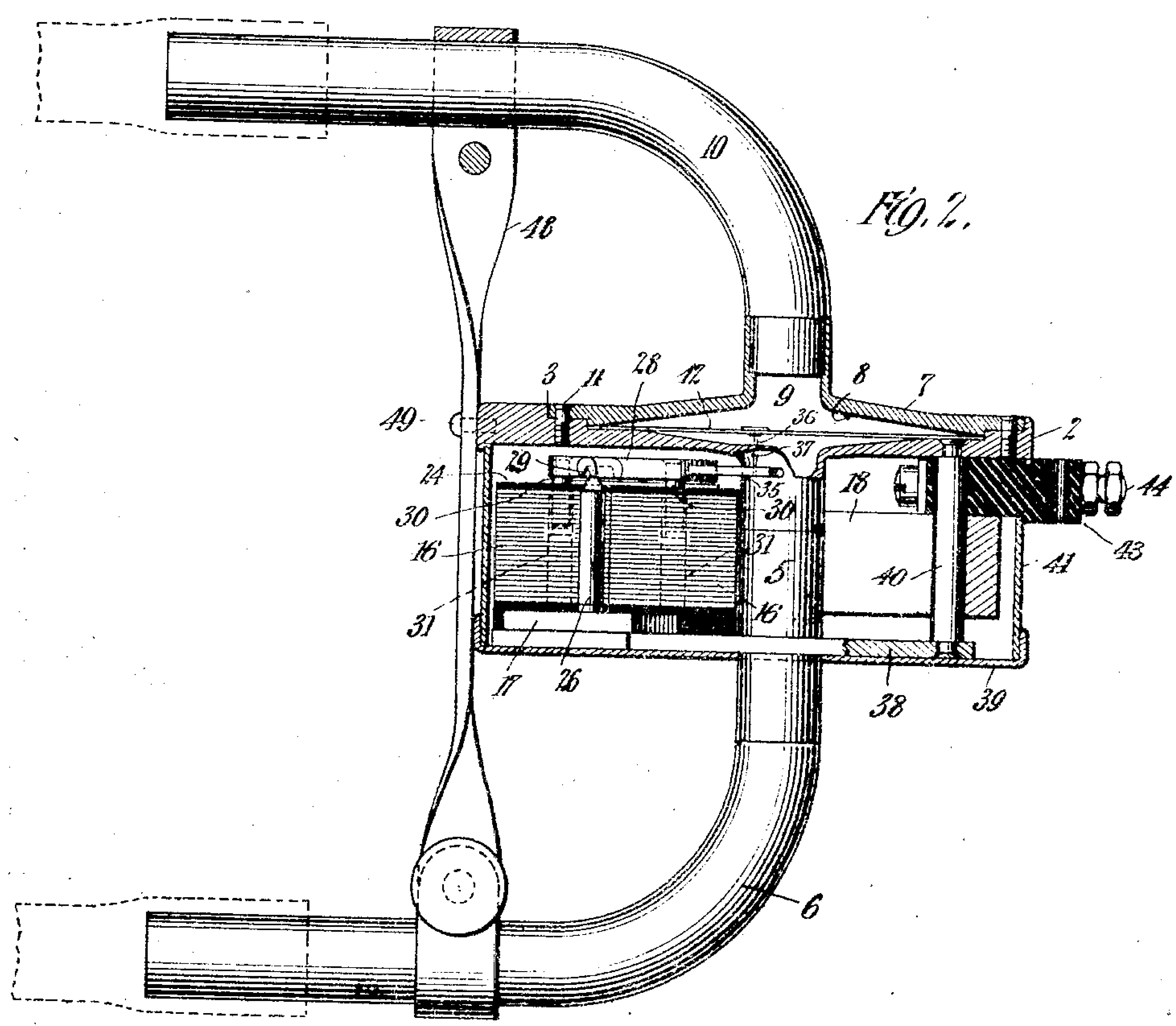


Fig. 2.



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UNITED STATES PATENT OFFICE.

HARVE R. STUART, OF NEWARK, NEW JERSEY.

TELEPHONE-RECEIVER.

976,230. Specification of Letters Patent. Patented Nov. 22, 1910.

Application filed June 29, 1909. Serial No. 505,013.

To all whom it may concern:

Be it known that I, HARVE R. STUART, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Telephone-Receivers, of which the following is a full, clear, and exact description.

This invention relates to telephone receivers, particularly for use in telegraphones where only feeble operating currents are available, and where clear sound reproduction is important.

A type of receiver has hitherto been proposed making use of a solenoid coil in place of a magnet bobbin, the solenoid coil acting to vary the intensity of attraction between a pair of juxtaposed magnetic poles, which are caused to be produced within the interior of the solenoid.

The present invention relates to this general type of apparatus and includes a variety of features by which a more simple and efficient construction is provided, and in which all of the parts are very strongly arranged and organized together in a light compact receiver having two sound delivery tubes or passages. I make use of a diaphragm with centrally located sound passages extending from both sides of the diaphragm, the diaphragm with its sound passages being eccentric within the circular casing of the device, and eccentrically connected to the operating magnet or magnets, the latter being contained within the casing on the more spacious side thereof with respect to the eccentric sound passage. I further make use of two operating magnets of the solenoid type, and provide fixed and movable polar extensions which project into the interiors of the respective solenoids. The respective movable polar extensions within the solenoids, are rigidly connected together in my preferred construction and rock in such a manner that one is entering its solenoid while the other is receding therefrom. This rocking member or armature has an arm from which a wire or connection extends to the diaphragm so as to constitute a multiplying lever. The sound passages being in central alinement with the diaphragm are of course free and undisturbed by the above mentioned wire or connection which is eccentric to the diaphragm and to the sound passages. I also provide a particularly advantageous form of sound chamber acting in conjunction with the sound delivery tubes. With these various and other objects in view, my invention consists in the features of construction and combination as hereinafter set forth and claimed.

In the drawings: Figure 1 is a side or end view of a telephone receiver embodying the principles of my invention. Fig. 2 is a sectional view on the line II—II of Fig. 1, the electrical connections being omitted. Fig. 3 is a section on the line III—III of Fig. 1. Fig. 4 is a view similar to Fig. 1 with part of the casing removed. Fig. 5 is a similar view showing the diaphragm and additional parts of the casing removed. Fig. 6 is a sectional view through the operating magnets or solenoids.

Referring to the drawings, 1 designates a casing, which I construct with one comparatively heavy side or plate 2 constituting a base for the support of the diaphragm and all the operating parts. The outer face of the plate 2 is chambered with a generally flat circular depression or cavity 3 which is eccentric to the outline of the plate 2 as clearly shown in Fig. 4. The central portion of the cavity 3 is coned inward to an increased depth merging at the center into an orifice 4 which is continued through a passage 5 into a curved pipe 6.

7 denotes a disk also having an inwardly coned face 8 which merges at the center into a passage 9 communicating with the curved pipe 10. The disk 7 is designed to fit within the cavity 3 where it is secured by screws or similar fastening devices 11.

12 denotes a diaphragm clamped beneath the disk 7 so as to vibrate in the chamber formed between the base 2 and the disk 7. In this relation the diaphragm sets up air vibrations which travel out through the respective tubes or passages 6 and 10. The location of the diaphragm 12 and its coaxial sound passages eccentric in the casing 1 provides a more or less spacious cavity on one side of the diaphragm axis and in this cavity I locate the operating solenoid magnets 16. Two of these are provided with their axes in a plane more or less distant from the axis of the diaphragm. The solenoids are fixed and supported in this relation by the pole piece 17 of a permanent magnet 18 secured to the base 1 by the bolts 19. The pole piece 17 is preferably forked or furcated so as to evenly distribute the magnetism of this pole of the magnet 18 into the respective solenoids;

such pole piece being bifurcated in the particular embodiment of my invention herein shown. The other pole 20 of the magnet also has a pole piece denoted 21 and which supports a rigid soft iron stud or post 22. The upper extremity 24 of this stud is pointed or otherwise formed to constitute the equivalent of a knife-edge or pivot.

26 denotes a non-magnetic standard similar to the iron post 22 but located on the other side of the solenoids 16.

28 denotes an armature having notches or recesses 29 on the undersides of its ends, into which the upper extremities of posts 22 and 26 enter. In this way the armature 28 is delicately pivoted to rock or oscillate in the plane of the axes of the solenoids 16. The armature 28 has polar extensions 30 which project into the hollow interiors of the solenoids.

31 denotes corresponding polar extensions of the pole piece 17, and which project into close proximity to the extensions 30. The latter extensions 31 are made threaded in their engagement with the prongs of the pole piece 17, so as to be adjustable by a screwdriver received in their notched exposed ends 33 in an obvious manner.

34 denotes lock nuts on the threaded ends of the polar extremities 31 to secure them in their adjusted relation.

At a convenient point of the armature 28 I provide a light rigid arm 35 projecting into close proximity to the wall of the sound passage 5. At this point the arm has a wire connection 36 with the diaphragm 12, this wire passing through a minute perforation 37 at the base of the sound passage 5. This perforation is so small as to have no substantial effect from an acoustic standpoint, the sound chamber acting in substantially the same way on this side of the diaphragm as on the other, where of course there is no corresponding perforation or connection whatever; the wire 36 in fact substantially filling the aperture or perforation.

The casing 1 is supported in place, and the magnet 18 with its associated parts is given additional support, by a supplemental base or plate 38 which is fixed to the base 2 by the bolts 19, and an additional post or strut 40.

39 denotes a sheet metal shell secured to the plate 38 and having a flanged edge embracing a cylindrical shell 41 which covers the interior parts.

43 denotes a block projecting through the wall 41 and having terminal screws 44 for the electrical connections.

45 denotes clips within the casing and joined to the terminals 44, and from which the connections may be made to the solenoids 16, which are connected in series or multiple circuit in an ordinary manner, the windings however being in opposite directions.

The sound tubes 6 and 10 are conveniently fixed in position by a strap 48 connecting the respective tubes and secured to the base 1 by screws 49. The usual rubber tubes are connected to the tubes 6 and 10 and lead to ordinary ear pieces which it is not necessary to show.

The use and operation is as follows: Assuming that the terminals 44 are connected in the circuit of a telegraphone or receive voice currents from any other source, it is evident that pulsations will be produced in their magnetizing force. A magnetic field or flux traverses the interiors of both solenoids in the same direction on account of the respective polar extensions 30 and 31 from the two poles of the permanent magnet 18. Inasmuch as the solenoids are wound in opposite directions, this field through one is assisted while the field through the other is opposed, and vice versa, by any change of current whatever in the operating circuit. The resultant changes in the field or flux of the solenoids produce corresponding variations in the attraction between the polar extensions 30, 31 of the respective solenoids, so that the armature 28 rocks on its pivots continuously under the changing forces. This movement is directly communicated through the arm 35 to the diaphragm 12 so that the diaphragm vibrates in its sound chamber. The diaphragm may be made of light and flexible material, and the magnetic system may be made fairly heavy suitable to its magnetic requirements. The result is that substantially all the energy of the current fluctuations is utilized in setting up air vibrations. It will be particularly observed that the movement of the diaphragm produces identical results in two separate sound chambers at each side thereof which are substantially similar in capacity and form, and are suited to the best and most efficient propagation of the sound into the sound tubes. I regard this as distinctive over prior constructions in which attempts have been made to utilize both sides of the same vibrating diaphragm, but in which the chamber at one side was greatly different in form and capacity from that of the other side.

By my invention not only are the chambers of both sides identical, but each may be made as small in capacity as desired, and of exactly the best theoretical form for sound reproduction. I have chosen the flaring outline shown which gives the best practical results. The essential feature of the formation lies in the fact that the flaring cone of the sound chamber presents a very acute outline with the plane of the diaphragm at all points or elements, rounding into the sound tube at the middle and merging into the plane of the diaphragm at the circumference.

I make the angle of the flaring cone of

the sound chambers of such an inclination that the height thereof at the middle, or in other words the separation of the edge or entrance of the passage 5 from the diaphragm, is one-fourth the diameter of the sound passage 5. This value is derived from the principle that the sound chambers should have as small capacity as possible, but the capacity should not be small enough to restrict the sound passage at any point to a less area than the area of the tube 5. Substantially all the sound passing from the circumference or body of the diaphragm toward the center has to traverse an annular space at the entrance to the sound passage 5 which is in the form of a small cylinder having the area πDH; πD being the circumference and H the height of the small cylinder mentioned. The area of the sound passage 5 is, of course, $\frac{\pi D^2}{4}$, and equating the two areas gives the result $H=\frac{D}{4}$ which is the result above mentioned.

What I claim, is:—

1. A telephone receiver comprising a generally cylindrical casing having an eccentric diaphragm, a pair of solenoids within said casing, an armature having a grooved portion and having polar extensions projecting into said solenoids, an iron post received in the grooved portion of said armature, a permanent magnet joined to said post and having polar extensions also projecting into said solenoids, and a connection from said armature to said diaphragm.

2. A telephone receiver comprising a generally cylindrical casing having an eccentric diaphragm, a pair of solenoids within said casing, an armature having a grooved portion and having polar extensions projecting into said solenoids, an iron post received in the grooved portion of said armature, a permanent magnet joined to said post and having polar extensions also projecting into said solenoids, and a connection from said armature to said diaphragm, said connection extending in a direction along its path of movement when the armature vibrates.

3. A telephone receiver comprising a pair of solenoids, an armature having polar extensions projecting into said solenoids and pivoted to tilt on an axis therebetween, a diaphragm, similarly shaped sound chambers on either side of said diaphragm, and a wire extending from said armature to said diaphragm through a hole in one of said chambers and in a direction along its path of movement when the armature vibrates.

4. In a telephone receiver, a substantially circular magnet having one bifurcated pole piece, polar extensions thereon, solenoids into which said extensions project, a movable armature also having polar extensions projecting into the solenoid, and a diaphragm connected to said armature.

5. In a telephone receiver, a substantially circular magnet having one bifurcated pole piece, polar extensions thereon, solenoids into which said extensions project, an armature also having polar extensions projecting into the solenoid, a diaphragm connected to said armature, and means for adjusting the polar extensions of said magnet in said solenoids.

6. In a telephone receiver, a sound chamber of shallow conical outline terminating in a cylindrical sound passage at its central portion, said conical outline having a height at its middle portion equal to one-quarter the diameter of said sound passage.

7. A telephone receiver comprising a pair of solenoids, an armature pivoted to tilt on an axis therebetween, a diaphragm, a sound chamber on one side of said diaphragm, and a member extending from said diaphragm through a hole in the side of said chamber, substantially in a direction along its path of movement when the armature vibrates.

8. A telephone receiver comprising a casing having a diaphragm, a pair of solenoids within said casing, an armature having a grooved portion and having polar extensions projecting into said solenoids, an iron post received in said grooved portion of the armature, a magnet joined to said post and a connection from said armature to said diaphragm.

9. A telephone receiver comprising a casing having a diaphragm, a pair of solenoids within said casing, an armature having a grooved portion and having polar extensions projecting into said solenoids, an iron post received in said grooved portion of the armature, a magnet joined to said post, a connection from said armature to said diaphragm, said connection extending in a direction along its path of movement when the armature vibrates.

10. In telephone receivers, a pair of solenoids arranged side by side in parallelism, an armature therefor, means for mounting said armature at right angles to the axes of said solenoids, said armature being oscillatable about the major axis thereof, said axis being substantially perpendicular to a line through the respective ends of said solenoids, a diaphragm, and a connection therefrom to said armature.

11. In a telephone receiver, a sound chamber of shallow conical outline terminating in a cylindrical sound-receiving passage at its central portion, said conical outline having a height at its middle portion materially less than the diameter of said sound passage.

12. In a telephone receiver, an arcuate magnet having one bifurcated pole piece, polar extensions thereon, solenoids into

which said extensions project, an armature coöperating with said extensions, and a diaphragm connected to said armature.

13. In a telephone receiver, an arcuate magnet having a furcated pole piece, solenoids disposed adjacent the respective prongs of said pole piece, an armature, and a diaphragm connected to said armature.

14. In a telephone receiver, an arcuate magnet having a furcated pole piece, solenoids disposed adjacent the respective prongs of said pole piece, an armature, a diaphragm connected to said armature, and magnetic parts disposed in the interior of said solenoids to provide air gaps between the respective extremities of each of said solenoids.

In witness whereof, I subscribe my signature, in the presence of two witnesses.

HARVE R. STUART.

Witnesses:

WALDO M. CHAPIN,

WILLIAM C. LARY.