

P. L. JENSEN & E. S. PRIDHAM.

TELEPHONE.

APPLICATION FILED APR. 22, 1912.

1,051,113.

Patented Jan. 21, 1913.

3 SHEETS-SHEET 1.

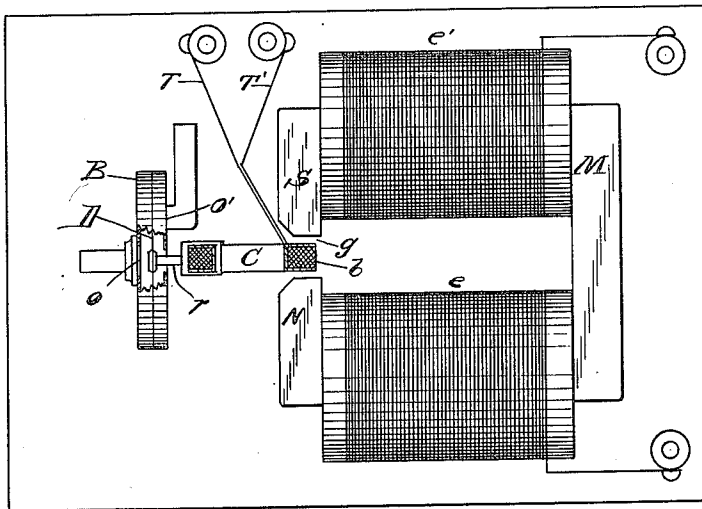


Fig. 2.

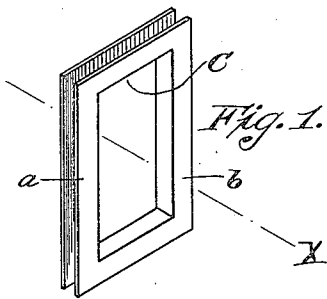


Fig. 1.

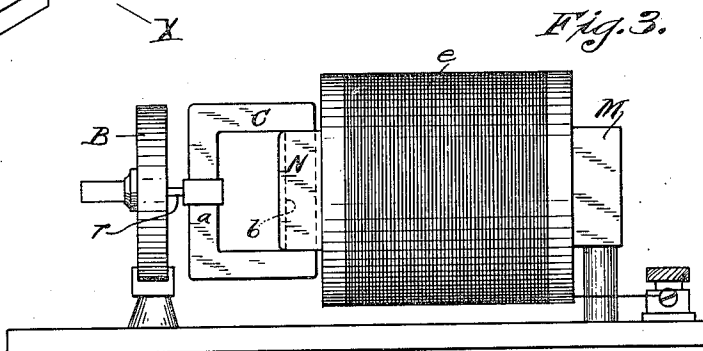


Fig. 3.

Witnesses;

F. E. Maynard.
Charles Pickles

Inventors,
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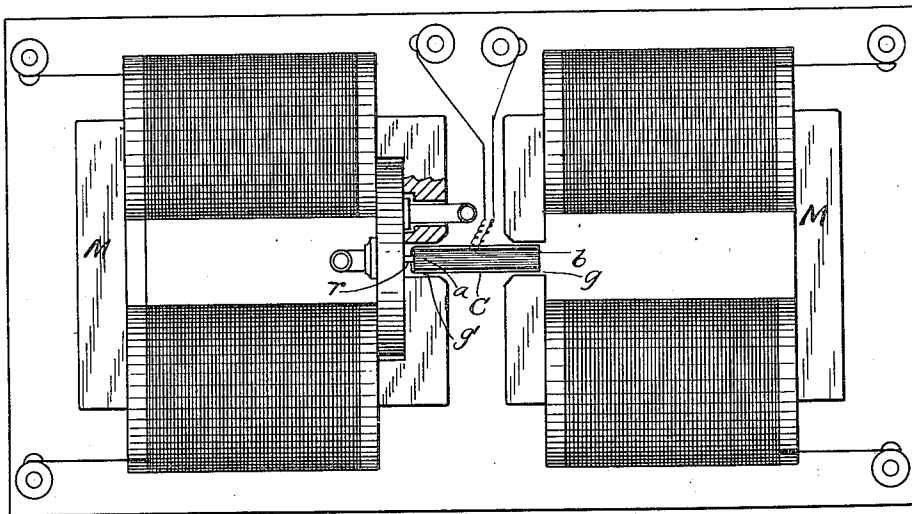


Fig. 4.

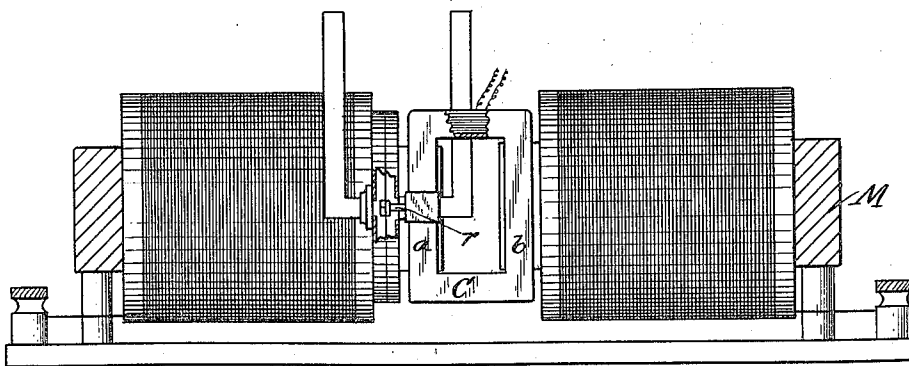


Fig. 5.

Witnesses,

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3 SHEETS—SHEET 3.

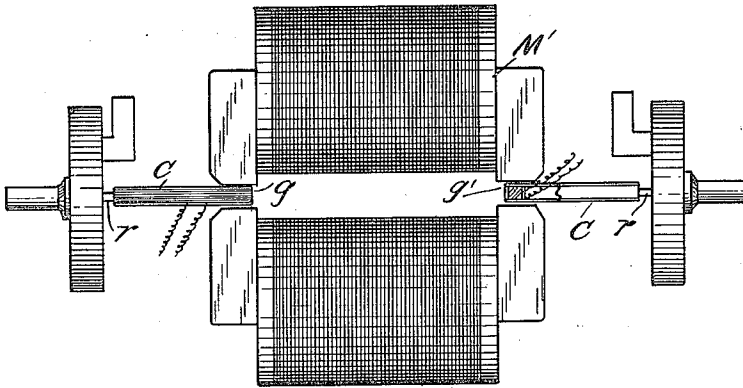


Fig. 7.

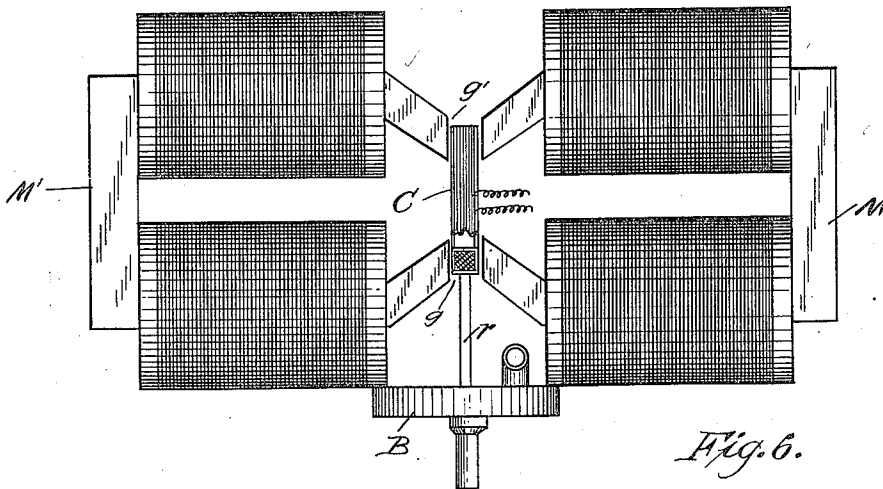


Fig. 6.

Witnesses,

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Their atty.

UNITED STATES PATENT OFFICE.

PETER L. JENSEN AND EDWIN S. PRIDHAM, OF NAPA, CALIFORNIA, ASSIGNORS TO
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TELEPHONE.

1,051,113.

Specification of Letters Patent.

Patented Jan. 21, 1913.

Application filed April 22, 1912. Serial No. 692,513.

To all whom it may concern:

Be it known that we, PETER L. JENSEN, subject of the King of Denmark, and EDWIN S. PRIDHAM, a citizen of the United States, residing at Napa, in the county of Napa and State of California, have invented new and useful Improvements in Telephones, of which the following is a specification.

This invention relates to the class of instruments employed in telephony for transforming received current variations into sound vibrations.

The object of the present invention is to provide an instrument whereby, on account of its sensitiveness and its great clearness of articulation, speech may be transmitted to greater distances and with more satisfaction than with instruments now in use.

If a wire-carrying current is disposed in a magnetic field so as to cut transversely the lines of force of the field a force acts upon the conductor due to the reaction of the lines of force caused by the current flowing in the conductor with the lines of force of the magnetic field. The magnitude of the force acting on a conductor carrying current when disposed in a magnetic field at right angles to the lines of force of the field is the product of three factors; L , the length of the conductor perpendicular to the lines of force, H the strength of the magnetic field, and I , the strength of the current flowing in the conductor, the equation being: $L \times H \times I$ equals F . It is obvious that if L and H are constant and I is a varying factor, then F will vary with I . Moreover, if L and H are made large factors F may be comparatively large even when I becomes very weak.

In the telephonic transmission of speech I is a varying factor and is generally weak, and in long distance telephony I becomes exceedingly weak.

Upon the foregoing principle this invention is essentially based; and it consists of disposing different portions of the conductor through which telephonic currents may pass to the influence of magnetic lines of force so that the force developed when current flows through the conductor actuates a diaphragm. This being accomplished

by means of an apparatus wherein different portions of a very long conductor are exposed to the influence of a powerful magnetic field. This conductor is entirely free to move in the magnetic field and is rigidly attached to a diaphragm, so that any force acting on the conductor is transmitted to the diaphragm.

In telephony it is essential to utilize to the greatest possible extent the force produced by the weak varying currents representing the voice variations. With this end in view we have devised the invention which is the subject of this specification.

In order to produce an intense magnetic field a narrow air-gap is cut in a magnetic circuit energized by a source of constant current. In this air-gap there are disposed portions of a very long conductor in which current is flowing in the same direction so as to cut transversely the lines of force of the air-gap. This conductor is wound upon a thin, flat rectangular frame of mica, hard rubber, or any other suitable material. We have found it more satisfactory to construct this frame out of insulating material to prevent the formation of useless induced currents. This frame carrying a conductor is rigidly attached by an arm to a diaphragm.

When current flows through the conductor it will be seen that in the side of the frame disposed in the magnetic field the current is all flowing transversely across the lines of force in the same direction. The force developed tends to move the frame at right angles to the direction of the lines of force and at right angles to the length of the conductor acted upon. In practice, in order to increase the efficiency of the instrument, we have disposed both sides of this frame carrying the conductor in magnetic fields the direction of the lines of force being such as to produce an additive effect upon the diaphragm when current flows through the conductor. If we consider the axis of this rectangular frame as being perpendicular to the plane of the winding of the conductor, then the force developed when current flows through the conductor moves the frame at right angles to this axis and at right angles to the direction of the lines of force in the

air-gap, and at right angles to the length of the included side.

The invention consists of the parts and the combination and construction of parts as hereinafter more fully described and claimed, having reference to the accompanying drawings, in which—

Figure 1 shows a view of the frame on which the conductor is wound. Fig. 2 shows a cross-section view of the instrument. Fig. 3 shows a view of the instrument in vertical plane. Fig. 4 shows a cross-section view of a modification of the instrument. Fig. 5 shows a view in vertical plane of Fig. 4. Fig. 6 shows a modification of the instrument. Fig. 7 shows a modification.

Referring to Fig. 1: C is a thin, flat, rectangular frame made of mica, hard rubber or any suitable material. Upon this frame and fixed to it are wound many turns of wire. This frame is made very thin and flat in order to reduce the width of the air-gap in which it is to be disposed, to a minimum consistent with a free movement of the frame in this air-gap. The two long sides of this frame may be designated as *a* and *b*, and shall be known as the active sides. The essential features of this frame upon which the conductor is wound are that it is light and strong and very flat, presenting a very narrow surface to the air in the direction of its motion. The direction of motion that this frame is designed for is important. If we consider the axis of the coil as being perpendicular to the plane of the winding of the conductor on the frame, then the direction of motion that the frame is designed for is perpendicular to this axis and at right angles to the long side of the frame. This axis of the frame C is designated by the letter X and will hereafter be known as the axis of the frame. It will be seen that if a conductor is wound continuously upon this frame and current passed through this conductor that the current passing through the portions of the conductor occupying the side (*a*) will be in one direction and the current flowing in the side (*b*) will be in the opposite direction.

Referring to Fig. 2 a simple form of the invention is shown in which M is a magnetic circuit energized by the coils *e—e'*. N—S are pole pieces of the magnetic circuit M. *g* is an air-gap in the magnetic circuit M. In order to produce an intense magnetic field the magnetic circuit is energized by a strong constant current and the air-gap *g* is made very narrow. Within this air-gap *g* is disposed a side *b* of the frame C so that the conductors cut transversely the lines of the force of the field. The position of the frame C carrying the conductor is such that the lines of force in the air-gap *g* cut the side *b* at right angles to its length and also at right angles to the

plane of the winding. It is to be noted that the conductor wound upon the frame C is the sole conducting path within the air-gap, it is free to move within the air-gap and is connected to the telephone circuit by means of flexible leads through the terminals T—T'. The frame C carrying the conductor is held in position and attached to a diaphragm D inclosed in sound box B by a rigid connection *r*. It will be seen by what has gone before, that when current flows through the conductor a force will be developed due to the reaction of the lines of force around the conductor with the lines of force in the air-gap *g* which will tend to move the conductor in reference to the lines of force of the field existing in *g*. Since the conductor is firmly attached to the frame C which in turn is connected to the diaphragm D by the rod *r*, any force acting on the conductor is transmitted to the diaphragm D. The advantages of this construction are that a very powerful magnetic field may be maintained in the air-gap *g*, a large amount of active conductor may be disposed in the field, so that the weak varying currents representing the speech variations are utilized to a very high degree. Also that the speech reproduction is free from the effects of magnetic hysteresis which has a detrimental effect in the ordinary receiver.

Referring to Fig. 3, a vertical view of Fig. 2 is shown. In this view the supports for the sound box B are shown.

In Fig. 4 a view of a modification of the instrument is shown in which both sides *a* and *b* of the frame C are exposed to the influence of magnetic lines of force, the side *a* being disposed in the air-gap *g'* of the magnetic circuit M' and the side *b* in the air-gap *g* of the magnetic circuit M, the direction of the lines of force in the respective air-gaps being such that an additive effect is produced when current flows through the conductor wound on the frame C. In this instrument the sound box containing the diaphragm is disposed behind the pole pieces of one of the magnetic circuits and the frame C is attached to the diaphragm by a short rod *r*. One of the essential features of this instrument is the construction and use of the diaphragm in the sound box. The diaphragm divides the sound box into two air chambers and from these two air chambers tubes are led one from each side. The diaphragm is actuated by the movement of the coil transmitted by a rigid piece, which moves through a small opening in one of the air chambers to the center of the diaphragm.

We have found in practice that the use of the sound box with openings on either side of the diaphragm greatly increases the efficiency of the instrument. This construc-

tion is shown in Fig. 2, in which B is the sound box showing the openings o and o' , to which listening tubes are connected.

Fig. 5 shows a view in a vertical plane of Fig. 4.

In Fig. 6 a view of the instrument is shown in which by the use of a magnet of peculiar construction a better disposal of the sound box is obtained. In this instrument the magnetic circuit $M-M'$ is cut to produce the air-gaps $g-g'$. In this instrument the force tending to move the conductor acts in the same direction with respect to the lines of force as in the previously described instruments.

In Fig. 7 a modification of the invention is shown in which a magnetic circuit $M-M'$ is provided with a plurality of air-gaps $g-g'$, in which independent conductors are disposed each actuating independent diaphragms.

It is to be noted that in all the types of instruments shown that the frame carrying the conductor is so mounted that when current flows through the conductor the force developed tends to move the coil in a direction perpendicular to the direction of the lines of force and parallel to the plane of the winding of the coil, and at right angles to the length of the included side.

The coil is connected to the diaphragm so that all bearings are obviated, thus every part of movement is transmitted accurately to the diaphragm. There are no cores in the fields and no core in the coil to allow effects of hysteresis to disturb the vibrations.

Having described our invention and the manner in which it is to be used we claim and desire to secure by Letters Patent:

1. In a telephone receiving apparatus, the combination of a magnet provided with a narrow air gap, a coil of a number of turns or wire adapted to be included in the main line circuit for the passage of telephonic currents, and mounted with one side only of its convolutions directly in the air gap to vibrate bodily as a unit in a direction perpendicular to the axis of said coil and at right angles to the direction of the lines of force in said air gap, and a diaphragm actuated directly by the vibrations of said coil to produce sound waves.

2. A telephone receiving apparatus comprising a magnet provided with a narrow air gap, a coil of a number of turns of wire adapted to be included in the main line circuit for the passage of telephonic currents, one side of the convolutions of said coil being disposed directly in said air gap so that the lines of force uniformly cut said part transversely, a diaphragm rigidly connected with and supporting said coil to permit a bodily movement as a unit in a direction perpendicular to the axis of said coil, perpendicular to the direction of the lines of

force in said air gap, and substantially parallel to the plane of the windings of said coil.

3. A telephone receiving apparatus comprising a magnet provided with a narrow air gap in which a uniform intense magnetic field is maintained, a diaphragm mounted in a sound box, a flat coil of a number of turns of wire adapted to be included in the main line circuit for the passage of telephonic currents, said coil being mounted with one side of its convolutions directly in the air gap by a rigid connection to said diaphragm, whereby the coil may move bodily as a unit in unison with the diaphragm in a direction perpendicular to the axis of the coil and at right angles to the direction of the lines of force intersecting the side of the coil located in the air gap.

4. A telephonic receiving apparatus comprising a magnet provided with pole pieces having oppositely directed faces forming a narrow air gap in which a uniform intense magnetic field is maintained, a conductor wound as a flat substantially rigid coil of a number of turns with the opposite sides of said coil widely separated, one side of said coil being located directly in said air gap so as to intersect transversely the lines of force and the opposite side of said coil being spaced away from said air gap and substantially uninfluenced by the lines of force in said air gap, said coil being free to vibrate bodily as a unit in a single plane and mounted to move in a plane at right angles to the direction of the lines of force but parallel to the plane of the windings, and a diaphragm actuated by the movements of said coil.

5. In a telephonic receiving apparatus, the combination with magnets having oppositely disposed pole pieces forming two narrow air gaps in the same plane and in which substantially uniform intense magnetic fields are maintained, of a flat substantially rigid coil of many turns adapted to be included in the main line circuit for the passage of telephonic currents, diametrically opposite sides of said coil being located directly in the respective air gaps, a diaphragm, and means for supporting said coil for bodily movement as a unit in a plane coincident with the plane of the air gaps.

6. A telephonic receiving apparatus, embodying magnets with pole pieces having oppositely disposed faces forming a plurality of narrow air gaps in the same plane and in which uniform intense magnetic fields are maintained, a coil of many turns adapted to be included in the main line circuit for the passage of telephonic currents, said coil having its diametrically opposite sides located directly in the respective air gaps and movable bodily as a unit in a plane perpen-

dicular to the axis of the coil, a diaphragm, and a rigid connection between the diaphragm and coil, substantially as described.

7. A telephonic receiving apparatus embodying magnets having pole pieces with oppositely disposed faces forming two separated narrow air gaps in which uniform intense magnetic fields are maintained, a substantially rigid flat coil of many turns adapted to be included in the main line circuit for the passage of telephonic currents, said coil being mounted with its diametrically opposite sides in the respective air gaps, a diaphragm extending in a plane parallel with the axis of the coil and a direct

rigid connection between said diaphragm and coil forming the sole support for the coil, whereby the coil is free to vibrate bodily as a unit in a plane at right angles to its axis and at right angles to the plane of the diaphragm, substantially as described. 20

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

PETER L. JENSEN.
EDWIN S. PRIDHAM.

Witnesses:

JOHN H. HERRING,
GENEVIEVE S. DONELIN.