

(Model.)

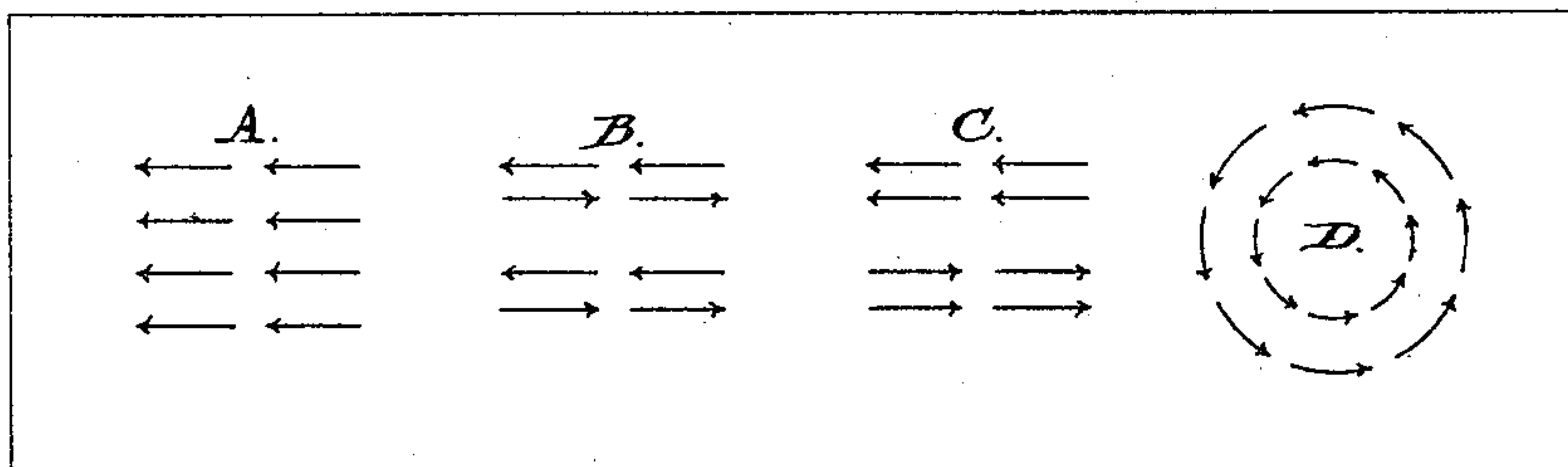
W. J. MORTON.

TELEPHONE.

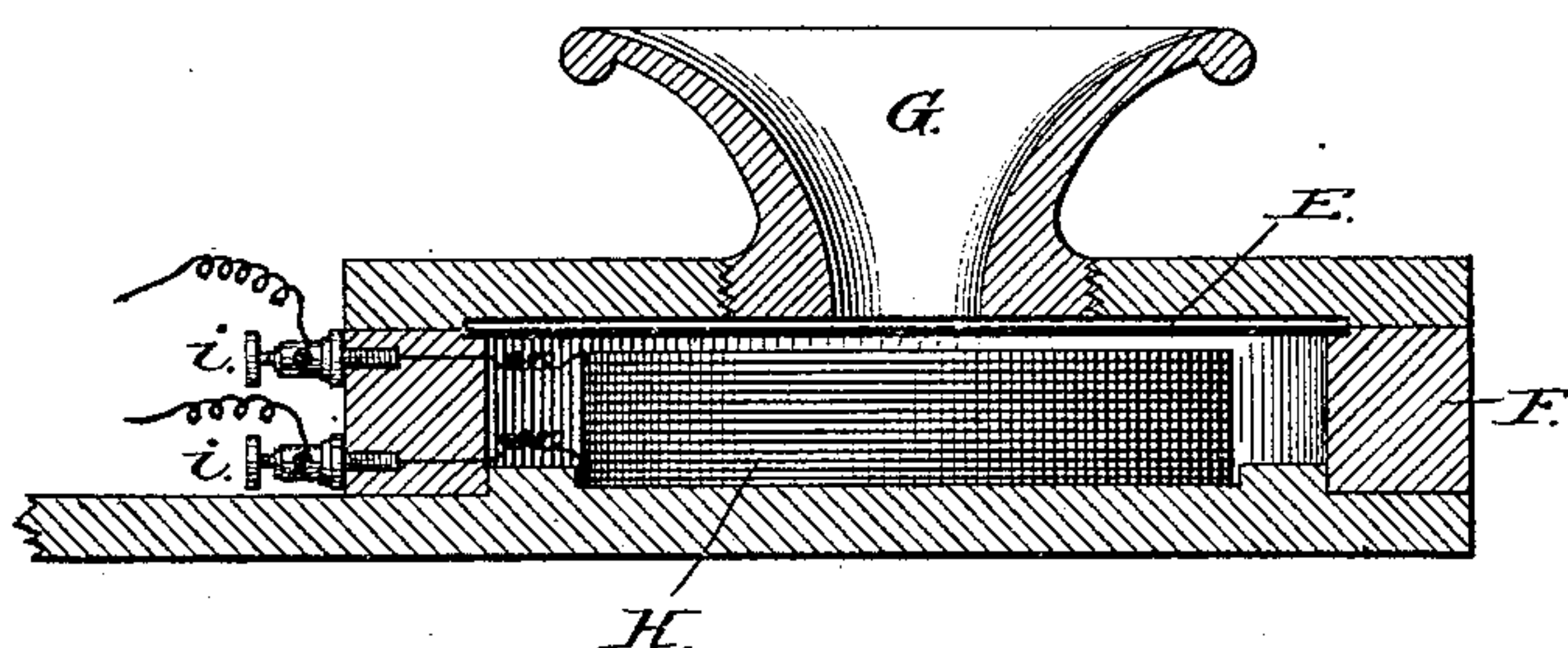
No. 354,169.

Patented Dec. 14, 1886.

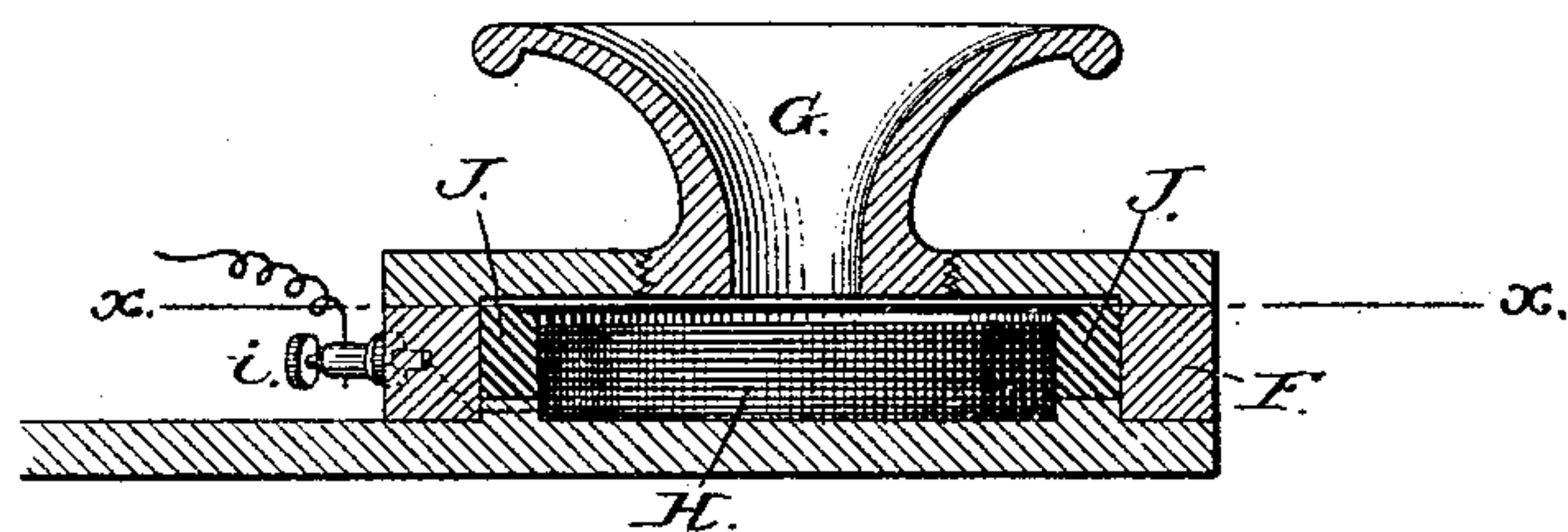
*Fig. 1.*



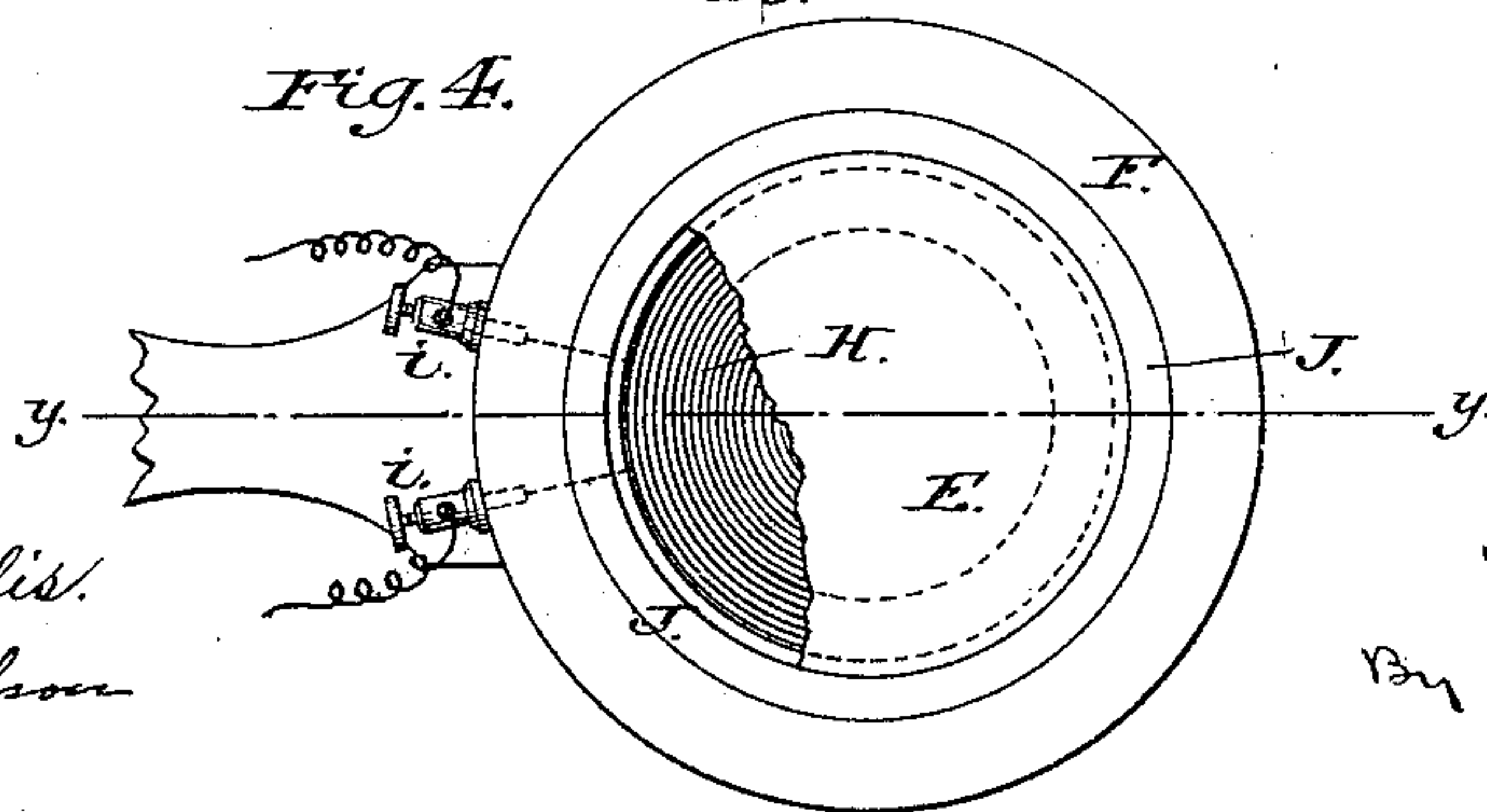
*Fig. 2.*



*Fig. 3.*



*Fig. 4.*



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# UNITED STATES PATENT OFFICE.

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## TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 354,169, dated December 14, 1886.

Application filed February 5, 1886. Serial No. 190,880. (Model.)

*To all whom it may concern:*

Be it known that I, WILLIAM J. MORTON, of the city, county, and State of New York, have invented a new and useful Improvement in Electro-Magnetic Telephones; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, making a part of this specification, in which—

Figure 1 is a diagram illustrating the molecular set and movements in a magnetized steel plate. Fig. 2 is a central transverse section of my improved telephonic transmitting or receiving instrument; Fig. 3, a similar view of a modification thereof in line *y y* of Fig. 4; and Fig. 4, a plan view of the same instrument with its upper plate and mouth-piece removed, in line *x x* of Fig. 3, a portion of the diaphragm being broken away to show the coil beneath it.

Hitherto the electric telephones in use have been constructed to embody in many varied forms of application either the principle of the microphone, in which variations of pressure between contact-points in a closed electric circuit are made to produce variations or modulations in the current, or upon the principle by which, if a body capable of inductive action, whether in the shape of a magnet or of a coil through which a constant current is passing, or of a core encircled by a helix, or other form whatsoever, be placed in inductive proximity to a closed circuit, the bodily movement of either to and from the other will occasion electrical undulations in said current. Practically the variations in pressure, or the vibrations or to-and-fro movements, have been obtained by means of a diaphragm or diaphragms moving bodily under the mechanical influence thereon of the voice or sound waves, and the desired result—viz., variations or modulations or undulations in the current—is due to a bodily motion of the diaphragm.

In my new electro-magnetic transmitting-telephone a variation or undulation of the current in a closed circuit is obtained independently of any inductive effect resulting from a bodily movement of the diaphragm upon which fall the sound-waves of the voice, and may be produced without any perceptible

movement whatever of the diaphragm by means of a neutral magnetized diaphragm, free from any trace of evident polarity, which when moved to and from the circuit will not produce a current therein nor have any inductive effect thereon. I say “may be,” for the reason that the principle upon which the diaphragm operates in influencing the current is not limited to the use of such a neutral body, but may be made to coact with a body capable of inductive influence when in motion. I employ also the term “bodily movement” in this connection to distinguish the integral movement of the entire mass of substance—as when a pail of water is swung to and fro in the hand—from the internal or molecular movement of the particles of the mass—as when the fluid atoms in the pail are agitated while the pail is at rest.

My invention consists, broadly, in the combination of a highly-magnetized neutral steel disk or plate, constituting in itself both a complete magnet and a diaphragm, with a coil of insulated wire placed in juxtaposition thereto and included in the main-line circuit.

The operation of the device is based upon the reciprocal influence which is created between a body whose molecules have previously received a permanent set (preferably so as to show no external polarity) and an electrical conductor brought into proximity thereto, whenever the arrangement of the molecules or their polarity is disturbed by a jar or shock imparted to the body, and upon the production of electro-magnetic currents in a telephonic circuit by a mechanical jar or trepidation of the molecules in a permanent magnet, which, by disturbing and altering their set or fixed mutual relations, shall change their polarity, and thereby create an induced current in the proximate electrical conductor. A bodily or mass movement of the entire diaphragm or any portion of it, without a disturbance of its internal molecular arrangement or polarity, will produce no effect upon the conductor, whereas a jar or shock which will disturb the molecular arrangement, without necessarily moving the whole body or any portion thereof, will induce electrical currents in the conductor. This movement of the molecules *inter se* is produced by



the jar which the impingement of the voice upon a magnetized diaphragm produces, the displaced molecules returning to their original position by reason of the normal set previously imparted to them.

My apparatus consists, in its simplest form, of a highly-magnetized steel diaphragm, constituting a complete magnet, and a coil of insulated wire brought into proximity thereto, the coil being included in the telephonic circuit.

My invention requires a plate or diaphragm of hard steel charged to its utmost capacity with magnetism, and preferably rendered neutral, so that it shall exhibit no polarity so long as it is in a quiescent state.

When a neutral diaphragm is employed, its neutrality is obtained by producing throughout its mass a closed circle of mutual attraction between its molecules. This result is accomplished by a superposition of magnetism in its magnetization. The magnetism is superposed upon the diaphragm in manner as has heretofore been described by Prof. D. G. Hughes, F. R. S., of England, (see his paper read before the meeting of the Institute of Civil Engineers, London, May 24, 1883, and published in their proceedings,) by first magnetizing the plate in a given direction with a strong magnetic directing-power, and then similarly in the opposite direction. This process is repeated, and a layer of exterior magnetism is thereby repeatedly superposed upon one of a contrary name at a greater depth, their mutual attractions being satisfied in short circles until the largest possible number of such distinct symmetrical arrangements are thus obtained upon the plate. The effect of this superposition of alternate layers of magnetism of contrary names, as illustrated by Prof. Hughes, is shown in the diagram, Fig. 1. The arrows represent the molecules of the mass which can be rotated each upon its axis by mechanical jar or shock, or by physical forces—such as magnetism or electricity—and which possess each an inherent polarity. The magnetism of the mass becomes evident when these molecules or polarities have all rotated symmetrically in a given direction, as at A, producing a north pole if thus rotated in one direction and a south pole if in the opposite. It becomes neutral when each pair of molecules in the mass are disposed to satisfy their mutual attraction, as at B, or when a lower series of molecules are set in the opposite direction to the upper series, as at C, whereby the mutual attraction is satisfied in a short circle. In either case there will be an external neutrality of the mass, so that it will exhibit no apparent polarity. D illustrates the molecules arranged to satisfy their mutual attraction in a ring, which may be very strongly magnetic, yet will exhibit no trace of magnetism until it is divided, the internal molecules acting as an armature to close its circle of attraction within itself until broken.

The permanency of the magnetism is depend-

ent upon the molecular rigidity of the atoms and their bound condition, for the molecules when perfectly free to move invariably take the polarity of the external directing-force—such as that of the earth; hence the diaphragm must be made of very hard steel, whose molecules or polarity, when once set in a given direction by a powerful magnetic force, will so remain unless influenced by a similar powerful force. These molecules, however rigid in their set, retain, nevertheless—as has been demonstrated by Prof. Hughes—each “a small field of its own, through which it can move with excessive freedom, trembling, vibrating, or rotating through a small degree with infinitely less force than would be required to rotate it permanently on either side,” so that by a mechanical jar, shock, or vibration of the mass they may be partially deflected on either side sufficiently far to disturb their symmetrical arrangement and produce evident polarity in the mass, which will disappear, however, so soon as the trepidation of the mass ceases, so that they may resume their equilibrium or normal set, and thereby satisfy their mutual attraction.

The diaphragm of hard steel is preferably made extremely thin, in order to obtain the maximum effects of the superposed magnetism and its double polarity, which in thicker plates is “masked more or less by the comparatively neutral state of the interior. The exterior molecules reacting upon those of the interior allow them to complete in the interior their circle of attractions.” Its thinness, moreover, facilitates the jar or trepidation thereof by the voice-waves required to obtain a molecular rotation or deflection therein.

In the accompanying drawings, E, Fig. 2, represents a diaphragm consisting of a magnet constructed of thin hard steel, and prepared, as above described, so as to be free from polarity or evident magnetism, and yet be in fact very powerfully magnetized. This neutral magnetized diaphragm is fitted in a suitable case, F, constructed with a convenient mouth-piece, G, in the customary manner, to form a telephonic transmitting-instrument, and the instrument is fully completed by securing under the diaphragm E a simple coil, H, of insulated wire, whose ends are connected by means of binding-posts *i i* in the case to the main-line wires extending to a counterpart receiving-instrument, which, being constructed in the same form, need not be further described.

The shape of the thin steel plate constituting the diaphragm E is immaterial. It may be circular or angular in its configuration. Two or more coils H may be employed if connected in one circuit, and one or more coils in a circuit may be inserted between two diaphragms, one of which is presented to the mouth-piece G.

While my invention is best defined and illustrated in the construction of an apparatus in which the magnetism of the diaphragm is externally neutral and non-apparent, it is evi-



dent—in view of the fact that the current is produced or modified in the electrical conductor by the rotation of the molecules of the diaphragm *inter se*, and not by their bodily movement in mass—that it is not necessarily limited to such a construction, but that it covers equally a permanent magnet in the form of a thin steel plate or diaphragm having apparent magnetism, but whose molecules are so fixed by their rigidity as that their polarity will not be destroyed by repeated shocks or vibrations.

A movement or vibration of the diaphragm in my instrument bodily to and from the conductor will not produce a current, while mechanical jar or shock of the diaphragm by the voice sufficient to cause a movement of its molecules will produce a current, and this movement of the molecules which will produce a current will occur in a diaphragm having evident polarity, as well as in a neutral diaphragm; hence I claim as new in a transmitting-telephone the production of electromagnetic currents created by mechanical jar or vibration of the molecules of a permanent magnet, whether it exhibits evident polarity or not.

As a modification, the magnetized steel diaphragm E may be placed upon a magnetized ring, J, of steel, fitted in the case F, as illustrated in Fig. 3. In this device the steel ring may be magnetized, either to exhibit evident polarity or otherwise, so as that the mutual attraction of its molecules shall be satisfied, as illustrated at D in the diagram, Fig. 1, in which case, although powerfully magnetized, it will be found perfectly neutral in all parts of its closed circle and contain no external magnetism. The ring, when thus combined with the diaphragm, serves as a reservoir of magnetic force. So soon as a change of polarity takes place in the diaphragm the evident magnetism of the diaphragm will instantly so far disturb the mutual attraction of the molecules in the ring as to break up their symmetrical arrangement, and thereby produce strong polarity in the ring, which will act, in conjunction with that of the diaphragm, to influence the electric conductor to an extent which the diaphragm itself could not.

I am aware that a magnetic telephone has heretofore been constructed in which a thin vibrating plate or diaphragm connected to or made to form a metallic extension of one pole of a magnet is combined with a coil encircling the opposite pole and brought into inductive proximity thereto, the induced currents in the line being produced by the vibration of one pole of a magnet or magnetic system in the field of the other pole; also, that two such diaphragms, one of which is made to serve as a common north-pole piece and the other a common south-pole piece for a number of magnets arranged radially around and connected with the diaphragm, or for a single magnet, have been combined with an interposed coil connected with the line-circuit, whereby inductive

currents are produced in the coil by the vibration of the diaphragm. I am also aware that a telephonic receiver has been constructed of a non-polarized diaphragm (that is to say, a simple iron plate, which is not in contact or in connection with a magnet, nor in any sense magnetized) placed in combination with a coil of wire without a core through, which a current of electricity is made to pass, the undulations in the current operating by induction upon the iron plate to cause its vibration. My invention differs from all these in that my diaphragm does not constitute one pole of a magnet, nor is it a simple unmagnetized plate; but it is in and of itself a complete magnet, which, while it may exhibit polarity, is preferably made strongly magnetic without evident polarity; and it differs, furthermore, from all other telephones, in that the diaphragm is in itself incapable of inductive action, and will not produce a current when moved to and from an electrical conductor, the effect of the diaphragm upon the conductor, or vice versa, being produced by the independent movements of the distinct magnetized molecules in its mass, independently, and if need be in the entire absence, of any direct movement of the mass. The relation of the magnetized molecules in the diaphragm of the transmitter is simply changed by the shock or jar of the voice impinging thereon, and the changes in the relation of the molecules of the diaphragm produce, when they occur, an inductive influence upon the proximate electrical conductor which no bodily movement of the diaphragm can exert, while, conversely, the change of relation in the molecules of the diaphragm in the receiver produced by the fluctuations of the electrical current in the proximate conductor will, upon the principle of the well-known "Page effects," reproduce the sounds which influenced the transmitter.

I claim as my invention—

1. The combination of a steel plate or diaphragm permanently magnetized to constitute independently in itself a complete magnet, with a coil included in an electric circuit and placed in proximity to said plate or diaphragm-magnet, whereby the fluctuations in magnetic force created by the movement and change in relation of the several molecules comprised in the steel plate or diaphragm by a jar or percussion thereof shall occasion electrical undulations or modulations in the circuit, substantially in manner as set forth.

2. In an instrument for transmitting or receiving sound, speech, or signals, the combination, with a wire coil in an electrical circuit, of a magnetized steel plate or magnet whose polarized molecules are disposed to satisfy their mutual attraction within itself, substantially in the manner and for the purpose herein set forth.

3. The combination, in an electrical circuit, of two or more telephonic instruments consisting each of a steel plate or disk permanently magnetized to constitute independently



and in itself a complete magnet, and a wire coil placed in inductive proximity thereto and included in the circuit, said permanent magnet serving as the metallic diaphragm of the instrument, substantially in manner as set forth.

4. In an instrument for transmitting or receiving sounds, speech, or signals, the combination of the case F, the mouth or ear piece G, the coil H, and the permanent magnet of thin steel serving as a diaphragm, substantially in the manner and for the purpose set forth.

5. The combination, with a steel diaphragm constituting in itself a complete permanent magnet, of a wire coil and an annular steel magnet, substantially in the manner and for the purpose herein set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM J. MORTON.

Witnesses:

J. F. ACKER, Jr.,  
JOHN A. ELLIS.