(No Model.) 2 Sheets—Sheet 1.

J. TROWBRIDGE & S. SHELDON.

TELEPHONE.

No. 407,799. Patented July 30, 1889.

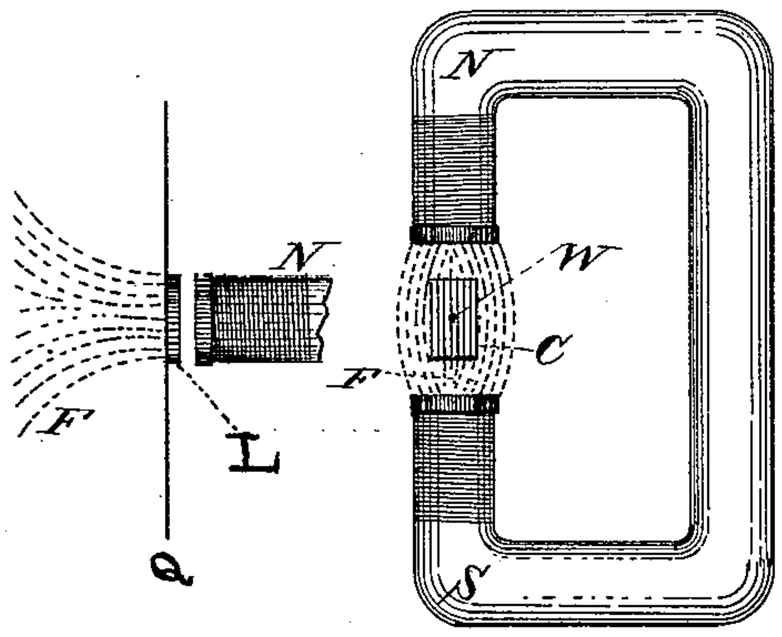


Fig. 1. Fig. 2.

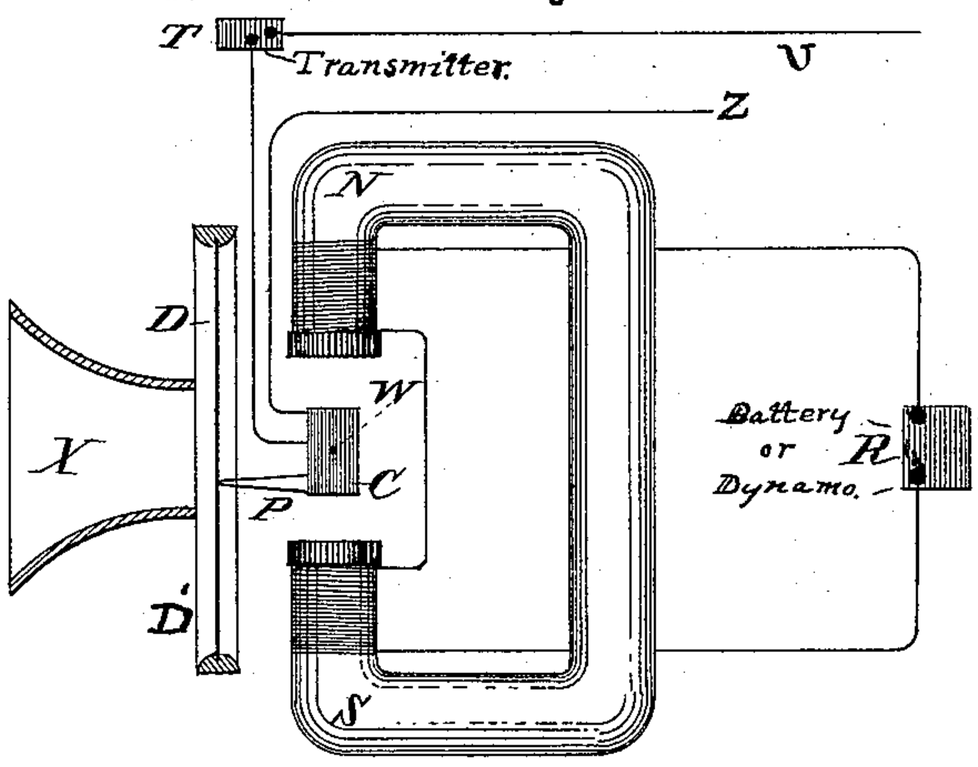


Fig. 3.

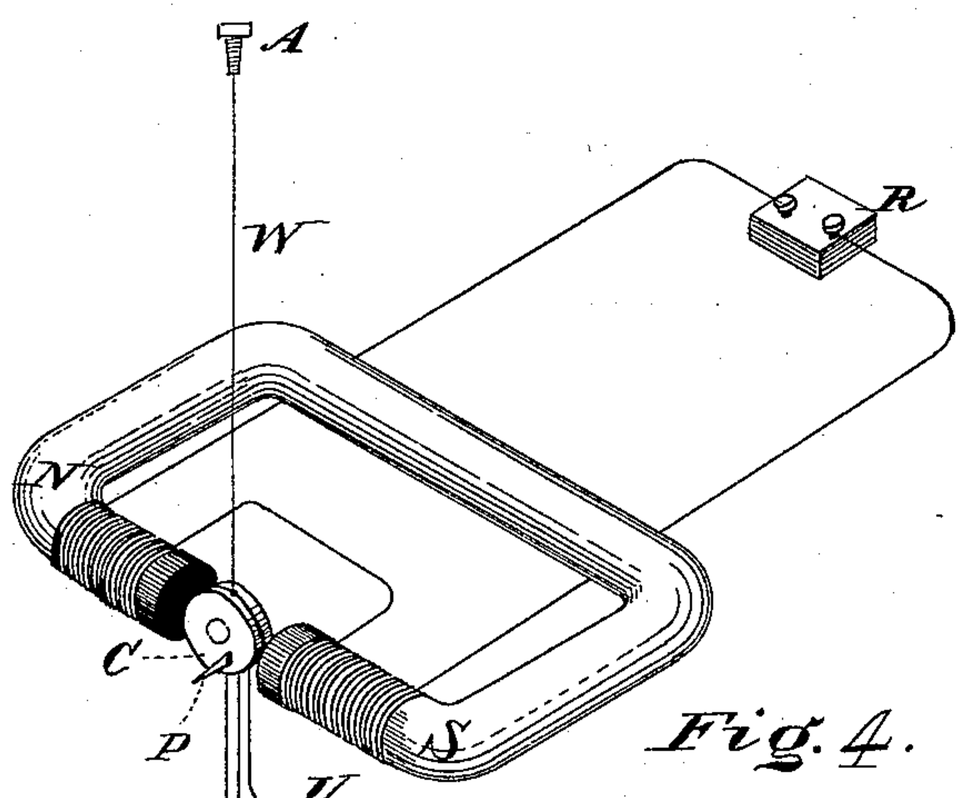


Fig. 4.

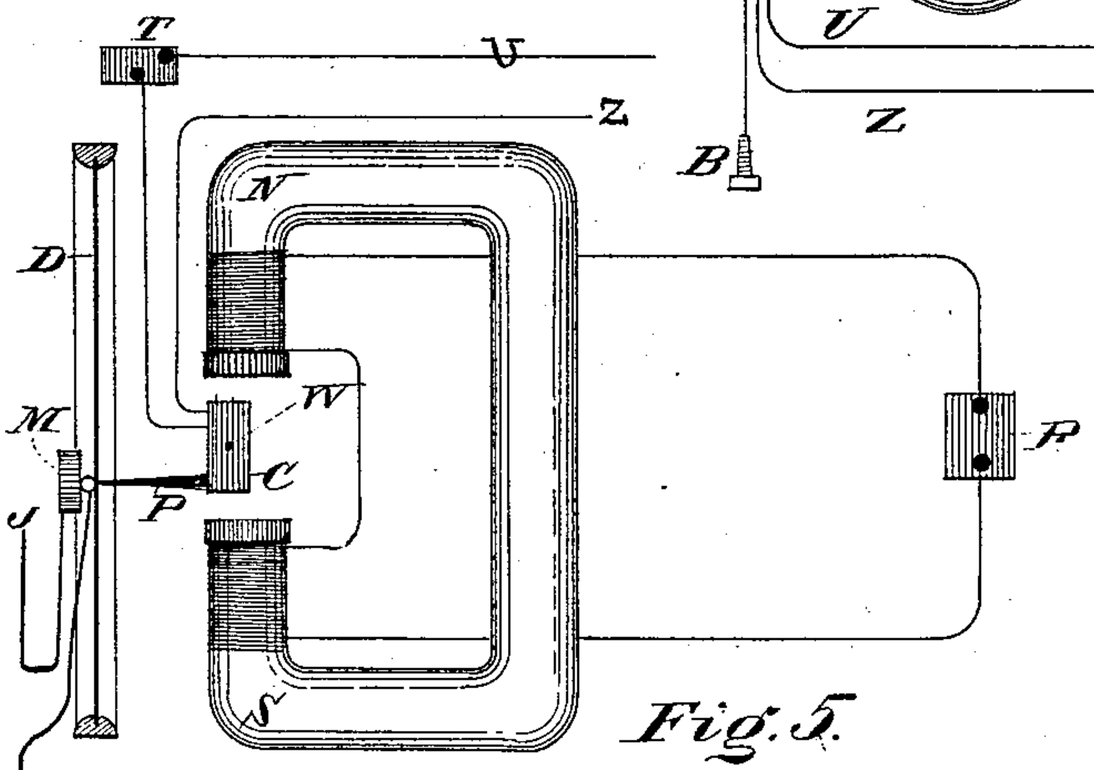


Fig. 5.

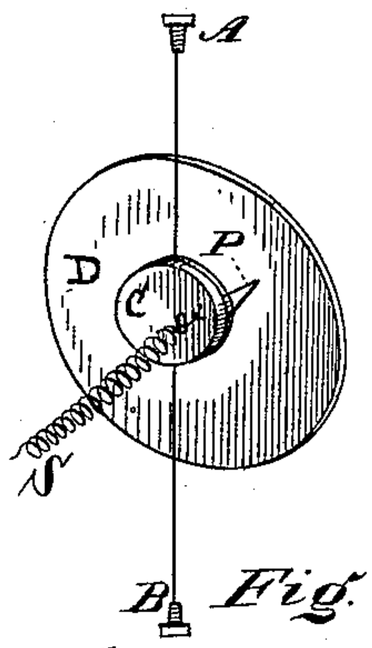


Fig. 6.

Witnesses:
E. C. Batchelder.
John M. Batchelder.

Inventors:
John Trowbridge.
Samuel Sheldon

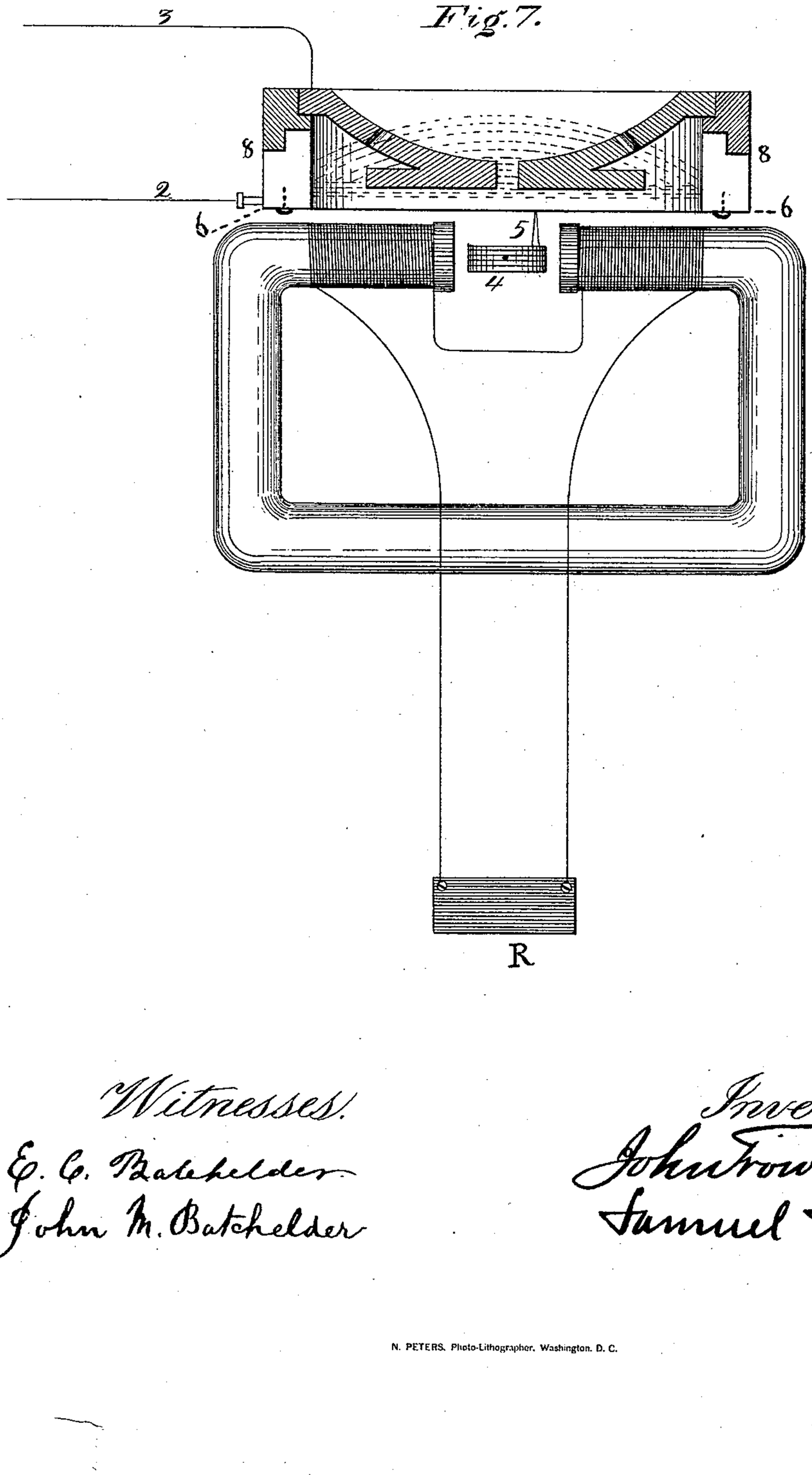
(No Model.) 2 Sheets—Sheet 2.

J. TROWBRIDGE & S. SHELDON.

TELEPHONE.

No. 407,799. Patented July 30, 1889.

Fig. 7.



Witnesses:
E. C. Batchelder
John M. Batchelder

Inventors:
John Trowbridge.
Samuel Sheldon

UNITED STATES PATENT OFFICE.

JOHN TROWBRIDGE AND SAMUEL SHELDON, OF CAMBRIDGE, MASSACHUSETTS.

TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 407,799, dated July 30, 1889.

Application filed December 17, 1888. Serial No. 293,902. (No model.)

To all whom it may concern:

Be it known that we, JOHN TROWBRIDGE and SAMUEL SHELDON, citizens of the United States, residing at Cambridge, in the county of Middlesex and State of Massachusetts, have invented a new and useful Improvement in Telephones, of which the following is a specification.

The object of our invention is to increase the strength of telephonic currents, the same being fully set forth in this description and in the drawings hereto annexed.

The letters of reference relate to the same parts in all of the figures.

It is well known that the feeble character of these currents prevents their being used, even with the most powerful form of transmitter, to a distance commensurate with that reached by the Morse system of telegraphy. One of these limits consists in the practical difficulty of using electro-magnets in the place of the permanent magnets now employed on all telephones. The magnetic field in which the iron diaphragm of the telephone moves is thus limited to a certain amount which cannot be exceeded when permanent steel magnets are used, as is the case on all telephone-lines.

Our invention enables us to employ electro-magnets of great power instead of permanent magnets, and thus to increase the strength of the magnetic field to any extent. We have employed the current from a powerful dynamo-machine as well as that from batteries.

In the telephonic relay constructed by us the small coil through which the feeble telephonic currents arrive is not fixed in position upon the magnet, as in the ordinary Bell telephone, nor is it fixed to a diaphragm, as in certain forms of telephones—for instance, as in that of E. W. Siemens. (See United States Patent No. 149,797, issued April 14, 1874.) It is a coil free to move between the poles of an electro-magnet, the strength of which can be increased to any extent. This coil C is placed with respect to the surrounding magnets similarly to the movable coil in any form of Weber's electro-dynamometer. When a current passes through this coil suspended between the poles of a powerful electro-magnet, it tends to turn, so as to embrace the greatest number of lines of magnetic force. The turning effect is proportional to the product of the current in the suspended coil and the strength of the magnetic field in which the coil is placed. Since the strength of the field can be enormously increased, a small current in the coil is made to produce a large movement of the coil. The edge of the coil is provided with a small button P, which presses against a flexible non-magnetic diaphragm of mica, thin brass, or any suitable material. The electrical undulations produced at a distant station in the coil are transformed into sound-vibrations. Thus the feeblest electrical undulations are exalted by our apparatus into vibrations which are heard at a considerable distance from the diaphragm, against which the little button or pin of the suspended coil C impinges.

It will be seen that the action of our suspended coil is not a rectilinear one, as in the Siemens telephone before referred to, but is a rotary one. This rotary motion of the coil C is one of the essential features of our invention.

The arrangement of the movable coil with respect to a magnetic field which can be increased to any extent, the movable coil not being fixed to any diaphragm, but pressing lightly against one, constitutes another important feature of our invention.

On sheet 1 of the drawings, Figure I shows the position of the coil relative to the magnetic field in the Siemens patent, referred to on page 3, line 15, of the specification. Fig. II shows the position of the coil in our invention relative to the magnetic field. Fig. III is a horizontal section of the telephonic receiver connected and ready for use. Fig. IV shows the mode of suspension of the coil and its position relative to the magnetic field. Fig. V shows the position of a microphonic contact in reference to the diaphragm and relay-circuit. Fig. VI shows the position of the spiral spring S and the suspended coil C. On sheet 2, Fig. VII represents the position of our coil

as applied to the apparatus of Hunning and Keller, referred to on page 5 of the specification, on lines 24, 25, and 26.

In the Siemens type of telephone, and in all telephones in which the iron vibrating plate of the ordinary Bell telephone is supplanted by a non-magnetic diaphragm carrying a coil, the windings of said coil are parallel to the windings of the electro-magnet. The lines of force of the magnetic pole N (shown by dotted lines F, Fig. I) pass perpendicularly through the plane of the windings of the small movable coil L, which is fixed upon the diaphragm Q. Since the small coil L, therefore, embraces the lines of force of the electro-magnet N, very great inductive disturbances result from fluctuations of the battery or dynamo, which excites the electro-magnet. With even a feeble dynamo-electric-machine current exciting the magnet N it is impossible to transmit speech by telephones of the Siemens type. The noise of the commutator completely obliterates the telephonic sound-waves.

In our method the small movable coil C, Fig. II, does not embrace the lines of force (shown by dotted lines F) of the magnet N S even during the greatest rotary movement of the vibrating coil C when transmitting speech. The lines F of magnetic force proceeding from the poles N and S are parallel to the planes of winding of the small coil C, and even when the electro-magnet is excited by the strongest current which any dynamo-machine is capable of giving no disturbances occur from the dynamo to prevent the transmission of speech.

Another part of our invention consists in the employment of a microphonic contact which rests upon the diaphragm against which our movable coil impinges. This microphone is connected with a relay or local circuit in which there are batteries and telephones, and enables one to increase and retransmit the feeble telephonic currents which arrive in the movable coils.

The position of a suitable transmitter to enable one to transmit messages to a similar apparatus at the end of the main line opposite to that at which the messages are received by our apparatus is shown in Figs. III and V at T.

In our use of the instrument we place the small coil C upon a wire W, that is held at the top and bottom by the screws A and B. By turning these screws the attached button or pin P is made to press lightly and with suitable directive force upon the diaphragm D D′.

In Fig. III, N S represent the electro-magnet, the strength of which can be regulated by the local batteries or the dynamo R. C is the small suspended coil through which passes the feeble telephonic currents of the main line on the wires U Z, which are connected at opposite ends of the small wire W of the movable coil. This coil presses upon the diaphragm D D′, Fig. III, by means of the small pin, button, or projection P, attached, eccentrically, near the periphery of the coil. The torsion-wire W, upon which the small coil C is placed, is shown in Fig. VI and in Fig. IV, and suitable torsion is given by the adjusting-screws A or B. This torsion may be aided by a small spring S, applied against the coil opposite to the button P. When the torsion-wire W is placed in a horizontal position, the force of gravity may be employed to aid in the adjustment of the coil and button against the diaphragm D. A suitable trumpet-shaped ear-piece X, Fig. III, is placed opposite the diaphragm D and contact-pin P.

Upon the diaphragm D, Fig. V, opposite to the small movable coil C, there is placed a microphonic contact-piece M, which transmits the vibration given to the diaphragm by the coil C to a relay-circuit, which is connected by the wires J and K to the microphonic contact M.

In the references herein made to the feeble currents of electricity generated by the vibration of a flexible disk or diaphragm, as used in telephones, it is to be understood that our instrument or apparatus is to be used for increasing or re-enforcing the effect of weak currents produced by any kind of electrical generators or instruments. By this increase of force at the terminal station of the line-wires we secure mechanical or acoustic effects for the production of visible symbols or audible tones.

On Sheet 2, Fig. VII, is shown the manner of using the suspension-wire W, Fig. IV, when in a horizontal position. The upper part of the figure represents the apparatus of Hunning. (See United States Patent, dated November 29, 1881, and that of Keller, dated February 2, 1886.) The diaphragm or tympanum 6 forms the base of a box 8, that contains granular conducting material. Our coil 4 and its attached button or contact-pin 5 is placed opposite to the middle of the disk or bottom 6 of this box, so that when connection with electrical currents is made the coil 4 turns, and the button or pin 5 impinges upon the disk 6 of the microphonic apparatus hereinbefore referred to, and causes changes in the electrical resistance of this apparatus, thus transforming the electrical undulations on the main line into corresponding but stronger undulations in the local or relay circuit, of which the terminals are 3 and 2.

We claim—

1. In a telephonic receiver, the combination of a small movable coil, through which the feeble telephonic currents are passed, and a fixed electro-magnet, the strength of which can be increased indefinitely, said movable coil being so placed in respect to the said fixed magnet as to embrace the fewest possible lines of force of the fixed electro-magnet— that is, it is in the magnetic field and substantially parallel with the direction of the

lines of force, substantially as herein set forth and described.

2. The combination of a small movable coil held upon a horizontal wire and a microphonic contact, the small coil being placed between the poles of a strong electro-magnet, in the manner hereinbefore described, and pressing, by means of a button placed eccentrically, upon a microphonic contact placed horizontally, as herein described.

JOHN TROWBRIDGE. [L. S.]
SAMUEL SHELDON. [L. S.]

In presence of—
E. C. BATCHELDER,
JOHN M. BATCHELDER.