No. 644,561.

Patented Feb. 27, 1900.

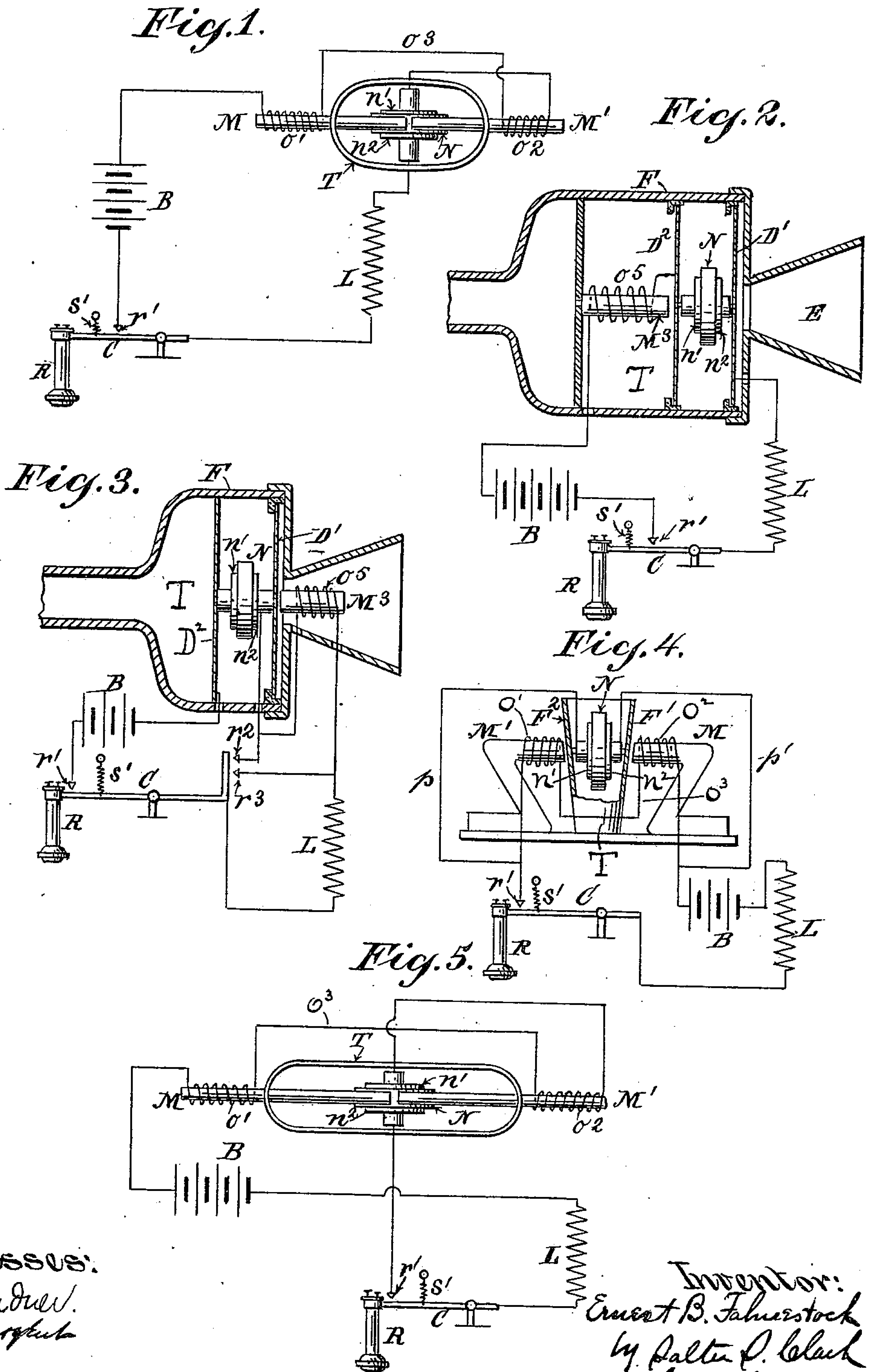
E. B. FAHNESTOCK.

MICROPHONE.

(Application filed Mar. 1, 1899.)

(No Model.)

2 Sheets—Sheet 1.



Witnesses:

D. W. Gardner.

Isaac Sargent

Inventor:

Ernest B. Fahnestock

by Walter D. Clark

his attorney

No. 644,561. Patented Feb. 27, 1900.

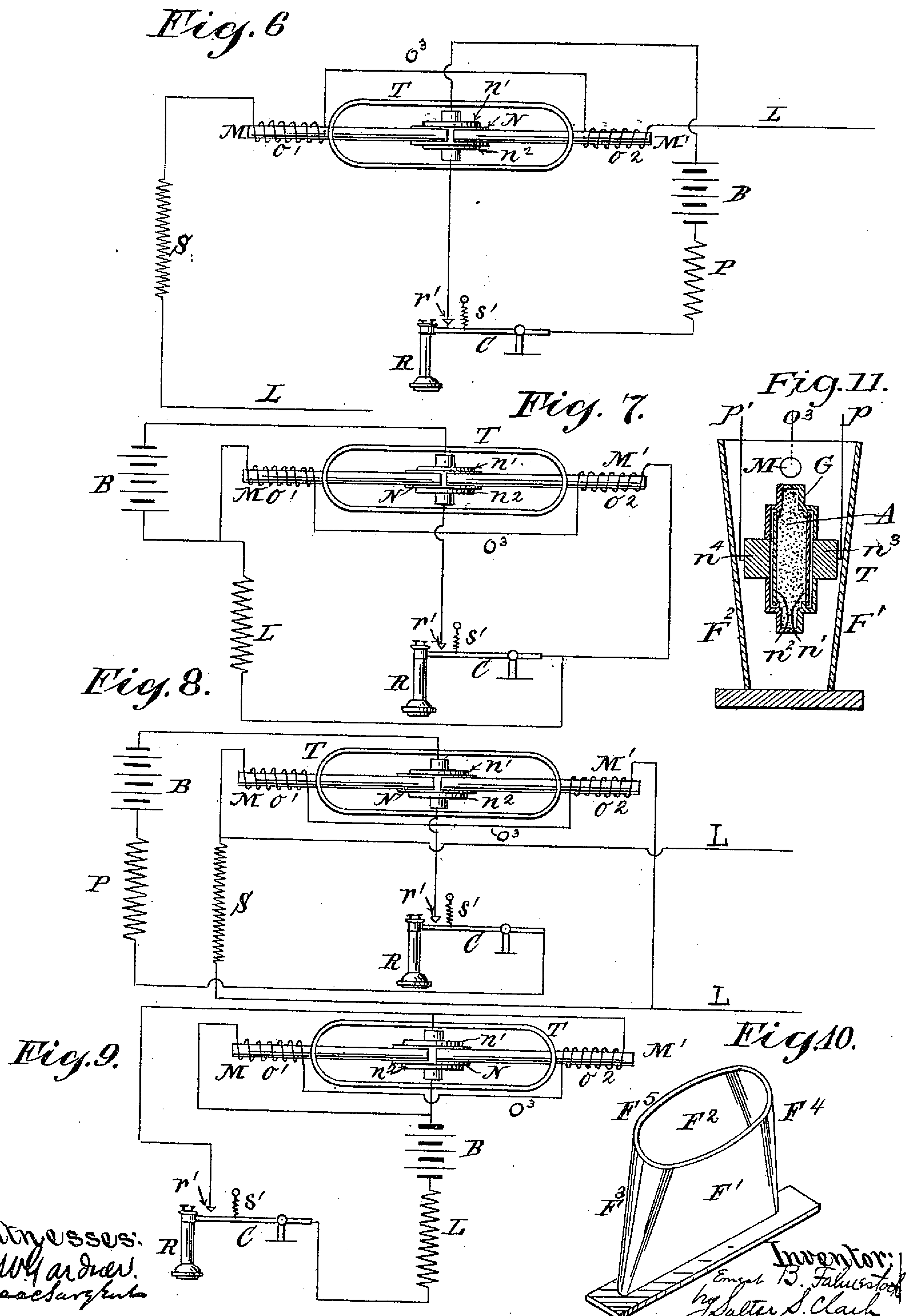
E. B. FAHNESTOCK.

MICROPHONE.

(Application filed Mar. 1, 1899.)

(No Model.)

2 Sheets—Sheet 2.



Witnesses:
D. W. Gardner
Isaac Sargent

Inventor:
Ernest B. Fahnestock
by Walter S. Clark
his attorney

UNITED STATES PATENT OFFICE.

ERNEST B. FAHNESTOCK, OF WASHINGTON, DISTRICT OF COLUMBIA.

MICROPHONE.

SPECIFICATION forming part of Letters Patent No. 644,561, dated February 27, 1900.

Application filed March 1, 1899. Serial No. 707,421. (No model.)

To all whom it may concern:

Be it known that I, ERNEST B. FAHNESTOCK, a citizen of the United States of America, and a resident of the city of Washington, District of Columbia, have invented certain new and useful Improvements in Microphones, of which the following, taken with the accompanying drawings on two sheets, is a description.

My invention relates to that form of microphone which uses powdered carbon or equivalent material, and has for its main object the unpacking of the powdered material and keeping it continually in an unpacked condition.

It consists in general of an electromagnetic device arranged to move or vibrate some portion of the microphone-case which incloses the powdered material and by this means to loosen it and place it in an unpacked condition if it has become packed. It is applicable to all situations in which the microphone is or may be used in connection with an electrical circuit, to transmitters, to telephone-relays, &c.; but in the drawings I have shown it applied to transmitters only.

The principle of the device is applicable to any form of transmitter, and the operating-electromagnet may be energized in a variety of ways, either from a special circuit of its own or as a part of the line-circuit or as a part of the local circuit where an induction-coil is used. It may also be operated in series with the microphone, in shunt with the microphone, in shunt with the line, &c. A variety of these different applications are illustrated in the drawings.

In the accompanying drawings, Figures 1 to 9, inclusive, show the device as connected with a telephone and its microphone. Fig. 10 is a perspective of a transmitter, and Fig. 11 is a detail of the microphone. Figs. 1, 4, 5, 6, 7, 8, and 9 show it as applied to the transmitter shown in Fig. 10, being one in which the sound-receiving part (the vibrating part) is somewhat in the shape of a bell; Figs. 2 and 3 as applied to the ordinary transmitter, in which the vibrating part is a flat diaphragm.

In all the figures except 10 and 11, B is the battery or other source of electrical energy; R, the receiver, hanging upon the lever C to break the circuit when the telephone is not in use; r', the contact through which the lever C completes the circuit by means of spring s' when the receiver R is taken down; L, the line, and T the transmitter, containing within it the microphone N.

In Fig. 10, being a perspective of the bell-shaped transmitter, the opening through which the sound of the voice enters is elliptical. (See F^5.) F' F^2 are the two sides approaching each other from the edge F^5; F^3 and F^4 being the ends of the same.

In Fig. 11 (an ordinary microphone) G is a case, within which are arranged two diaphragms n' n^2, connected therewith in such manner as to take up the sound-vibrations, but insulated therefrom. A is the granular material lying within the case G between the diaphragms n' n^2 and in electrical contact therewith, and the parts n^3 n^4 being attached to the diaphragms or electrodes n' n^2 and also to the sides F' F^2, respectively, of the transmitter serve to transmit the sound-vibrations from the transmitter T to the carbon material A, wires p p' making the electrical circuit from the source of energy B through the microphone.

In all the views except Figs. 2, 3, and 4, M M' are two similar magnet-cores affixed, respectively, to the ends F^3 F^4 of the transmitter T, wound with the coils O' O^2, (which are connected by the wire O^3,) the coils O' O^2 to be connected electrically with some source of energy, such as the battery, the secondary, &c. The coils O' O^2 may be wound in opposite directions, as shown in the drawings, or in the same direction.

In Figs. 2 and 3 the microphone is placed between two diaphragms D' D^2, supporting it, and a single magnet M^3, operating upon one of them, takes the place of the two magnets in the other figures. F is the transmitter-case; E, the mouthpiece; O^5, the coil magnetizing M^3. The diaphragm D' is insulated from the case F, and in Fig. 2 D^2 is also insulated.

In Fig. 4 the magnets M M' instead of acting upon each other act directly upon the sides F' F^2 of the transmitter.

The principle of operation of the magnets M M' is that since they tend to attract or repel each other they will, when energized, exert a certain mechanical force upon the sides F' F^2 of the transmitter T, and therefore through the flexibility of these sides upon the diaphragms or electrodes n' n^2 of the microphone N. If now the current through the magnets M M' is made to vary either up or down, the result will be a certain mechanical movement of the microphone-diaphragms n' n^2 inward or outward and a vibration thereof. This vibration being much stronger than the sound-vibrations loosens the carbon material and unpacks it.

Taking up now the different ways shown of connecting up the magnets, Figs. 1, 2, 3, and 5 show them in series with the microphone and line, Figs. 4 and 9 in shunt with the microphone, and Fig. 7 in shunt with the line. Figs. 6 and 8 show the device in use with a line containing an induction-coil, P being the primary and S the secondary, Fig. 6 showing the magnets connected in series with the secondary and Fig. 8 in shunt with the secondary.

When arranged in shunt, the magnets are to be wound to a much higher resistance than when in series. The operation differs also in these two cases.

When the magnet is arranged in series with the microphone, it is to be so wound that when the microphone material is in an unpacked condition the magnet will have its least energy and the packing will increase its energy, but when arranged in shunt with the microphone or the line (or primary) it is to be wound so as to have its greatest energy when the microphone is unpacked.

The operation in the different figures is as follows:

In Fig. 1 (series with microphone) when the receiver R is taken down the circuit is complete through battery B, line L, microphone N, and coils O' O^2. If now the microphone material is in a packed condition from any cause, becoming thereby a better conductor, it allows the passage of more current. Such current energizes the cores M M', and the result is a mechanical movement (inward in this case) of the microphone-diaphragms n' n^2. This action, which usually comes as a slight shock, produces more of a motion in the microphone-diaphragms than the sound-waves do, changes the position of the granular material, and loosens them. Any loosening of the grains increases their resistance and so produces another variation in the magnet, so that a certain vibrating motion of the microphone-diaphragms may be set up. Reaching the point of complete unpacking, the current through the coils O' O^2 reaches its lowest point, and this may be so arranged that at such point the magnets M M' produce practically no effect upon the transmitter; but the operation repeats itself as soon as there is any tendency to repack, so that the device when operated from some portion of the telephone-circuit is automatic, the electrical condition brought about by the packing being used to cure the packing.

In Fig. 2 (series with the microphone) the operation is the same as in Fig. 1, the magnet being wound so as to have its least energy when the microphone is unpacked, and the packing of the microphone allowing the passage of more current through the magnet, and thereby increasing its energy. Thus when the microphone is in a packed condition if the receiver R is taken from the hook a magnetizing-current will pass through the coil O^5, energizing the magnet M^3 and attract the diaphragm D^2, which being attached to the microphone-diaphragm n' causes a vibration therein which unpacks the microphone.

In Fig. 3 the operation is just the same as in Fig. 2, except that the magnet M^3 when energized operates upon the speaking-diaphragm D'. This figure also shows an arrangement intended to overcome any possible continuous singing of the telephone. When the lever C is released by the lifting of the receiver R, it first completes the circuit through the lever C and contact r'; but the lever C is so arranged that after making the circuit through contact r' it makes another circuit through the two contacts r^2 r^3, by which means the coil O^5 is cut out of the circuit. That part of the lever C by which the contact is made through the points r^2 r^3 is insulated from the rest of the lever C, so that the effect of making the circuit through r^2 r^3 is to make a short circuit there and so practically cut out the magnet M^3 the instant after it has done its work.

In Fig. 4 (shunt with the microphone) the operation of the magnet is just the opposite from that where the magnet is in series with the microphone and line, the magnet itself being wound to a much higher resistance and being at its greatest energy when the microphone is unpacked. The operation of this action will be as follows: When the receiver R is taken down, the circuit becomes complete through the battery B, line L, and microphone M, the coils O' O^2 also taking a portion of the current. If the microphone is packed, the coils, though at their lowest energy, have sufficient energy to produce a slight shock upon the microphone-diaphragms N' N^2. This shock changes the position of the microphone materially and tends to unpack them. This unpacking, by increasing the resistance of the microphone, shunts more of the current through the coils and so increases their energy. The result is a series of shocks increasing in power until the microphone is entirely unpacked. Any tendency to repack produces a repetition of the process. The continual tendency of the microphone to repack and the consequent action of the coils may produce a greater or less vibratory motion of the microphone-diaphragm; but this will not be objectionable even for telephone purposes if the fundamental note is sufficiently high.

Fig. 5 is the same as Fig. 1, except that Fig. 1 represents a different form of mouthpiece in the transmitter, having the sides F' F^2 completely oval—that is, slightly curved instead of straight. This insures more certain action on the part of the magnet M M′ in drawing out or in the sides of the transmitter.

In Fig. 6 (series with the secondary of the induction-coil) the magnet-coils O′ O^2 should be wound to a higher resistance than when used in the primary circuit. Taking the receiver off the hook, if the microphone is packed an excess of current will flow in the primary, thereby inducing a strong current in the secondary S. The magnet M M′ being thereby energized, a shock is imparted to the microphone, which tends to unpack it.

In Fig. 7 (shunt with the line) the coils O′ O^2 have their greatest energy when the microphone is packed; but taking only a portion of the current should be wound to a slightly-higher resistance than in Fig. 1. The circuit being made by the taking of the receiver R from the hook, the amount of currrent flowing through the microphone N will depend upon its condition. If unpacked, its resistance will be greater, and a correspondingly-smaller current will flow through the coils of the magnet. If the microphone is packed, a greater amount will flow through the magnet-coils and so produce the shock which unpacks the microphone.

In Fig. 8 (in shunt with the secondary) the magnet-coils O′ O^2 should be wound to a comparatively-high resistance and so as to receive a small portion of the current from the secondary. This small current slightly energizes the magnet and so imparts a shock to the microphone, which partially unpacks it, and thereby produces a change in the primary current, which, reacting upon the secondary, affects the coils to produce another shock, and so on.

In Fig. 9 (shunt with the microphone) the operation is the same as in Fig. 4, the magnet-coils O′ O^2 being wound so as to have their least strength when the microphone is packed, but a sufficient strength to produce something of a shock when the receiver is taken from the hook and their energy increasing as the unpacking progresses.

In most of the figures I have, for the sake of simplicity, shown the device as connected with the line without an induction-coil; but if the line were to be over a certain length it would of course be better to use an induction-coil and so connect the magnetic device with the primary. In all the figures where L represents the line it may be taken also to represent the primary of the induction-coil. That connection of the device in which the magnet-coils are connected in shunt with the microphone is distinctly better than where it is connected in series. In such form the magnetic action tends to assist the sound-waves, acting in the same direction. This gives the voice its full effect without muffling.

The device in its several forms can also be used in a circuit which is complete at all times—that is, which is not broken by hanging the receiver up as usual—if, for instance, in Fig. 1 the contact r' is at all times in contact with the lever C.

It is theoretically possible for the packing of the microphone material to progress so slowly and evenly that no shock is produced upon the sides F′ F^2 of the transmitter or the microphone-diaphragms n' n^2, but practically the packing does not so occur, but rather by little starts which do produce sufficient variations in the electromagnets to give the unpacking shocks. The slight jars felt in every building, even an unoccupied one, are enough to cause this; but the form in which, as shown in the drawings, the electromagnet-circuit is broken (as by hanging up the receiver) is the best, for then the electromagnet each time the circuit is made feels the complete variation between no energy and the whole energy of the circuit it is in, which of course is very much greater than any changes due only to changes in the microphone.

I claim as my invention—

1. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, and an electromagnet separate from the telephone receiving-magnet; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same.

2. The combination of a microphone consisting of non-magnetic granular material held between flexible diaphragms, and an electromagnet separate from the telephone receiving-magnet; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet vibrate the flexible diaphragms of the microphone, and so produce a mechanical movement of the granular material sufficient to unpack the same.

3. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit of which the microphone forms a part, and an electromagnet separate from the telephone receiving-magnet; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same.

4. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit of which the microphone forms a part, and an electromagnet separate from the telephone receiving-magnet and within the telephone-circuit; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same.

5. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit

of which the microphone forms a part, an electromagnet separate from the telephone receiving-magnet, and a device to break the circuit of the electromagnet when the telephone is not in use; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same.

6. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit of which the microphone forms a part, an electromagnet separate from the telephone receiving-magnet and within the telephone-circuit, and a device to break the circuit of the electromagnet; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same.

7. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit containing an induction-coil, and an electromagnet separate from the telephone receiving-magnet; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same.

8. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit containing the microphone and also containing an induction-coil, and an electromagnet separate from the telephone receiving-magnet, and within the secondary circuit; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same.

9. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit of which the microphone forms a part; and an electromagnet separate from the telephone receiving-magnet, and connected in shunt with the microphone; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same.

10. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit of which the microphone forms a part, and an electromagnet separate from the telephone receiving-magnet, and within the telephone-circuit; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same; and a device to cut out the electromagnet when the microphone is being used.

11. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit of which the microphone forms a part, and an electromagnet separate from the telephone receiving-magnet; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same; and the sound-receiving chamber of the transmitter being bell-shaped with approaching sides, between which is placed the microphone.

12. The combination of a microphone consisting of non-magnetic granular material held between diaphragms, a telephone-circuit of which the microphone forms a part, and an electromagnet separate from the telephone receiving-magnet; such electromagnet and the microphone being so connected that changes in the strength of the electromagnet produce a mechanical movement of the granular material sufficient to unpack the same; the sound-receiving chamber of the transmitter being bell-shaped with approaching sides, between which is placed the microphone; and the electromagnet consisting of two electromagnet-cores attached to opposite sides of the bell-shaped mouthpiece.

In witness whereof I have set my hand, this 25th day of February, 1899, in the presence of two witnesses.

ERNEST B. FAHNESTOCK.

Witnesses:
H. H. KELLOGG,
SALTER STORRS CLARK.