(No Model.) 2 Sheets—Sheet 1.

J. W. GIBBONEY.

TELEPHONY.

No. 587,119. Patented July 27, 1897.

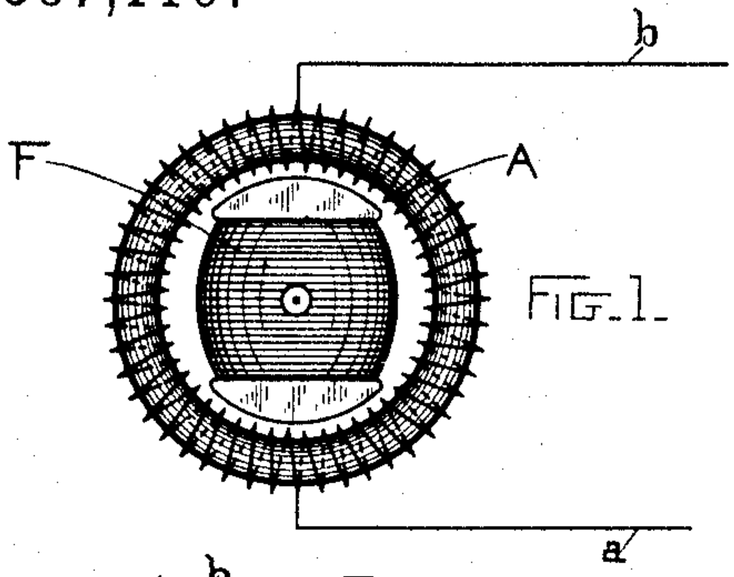


FIG. 1.

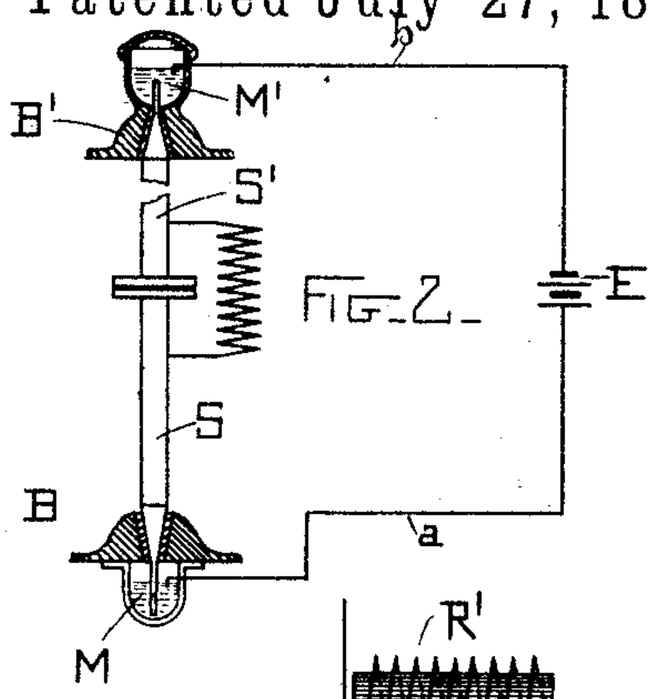


FIG. 2.

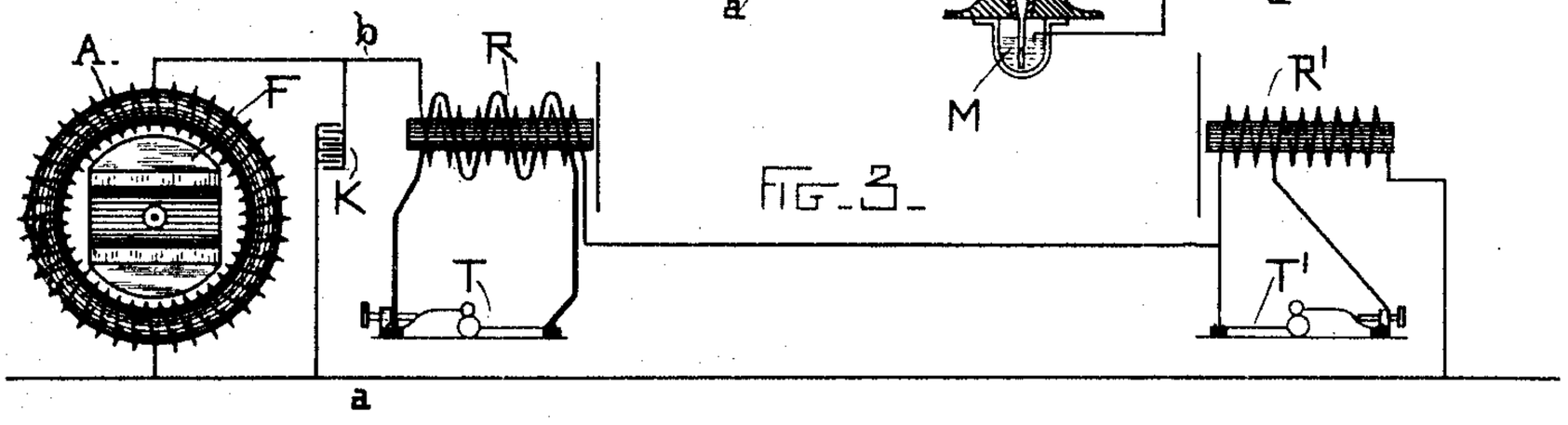


FIG. 3.

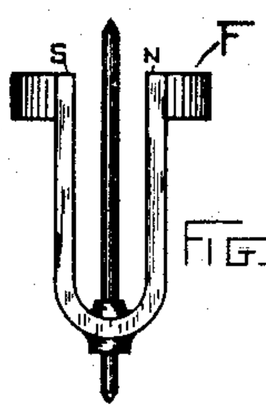


FIG. 4.

FIG. 5.

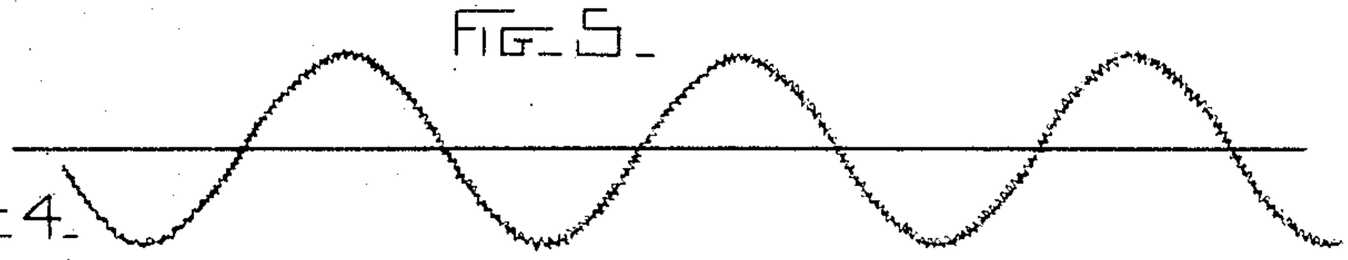


FIG. 7.

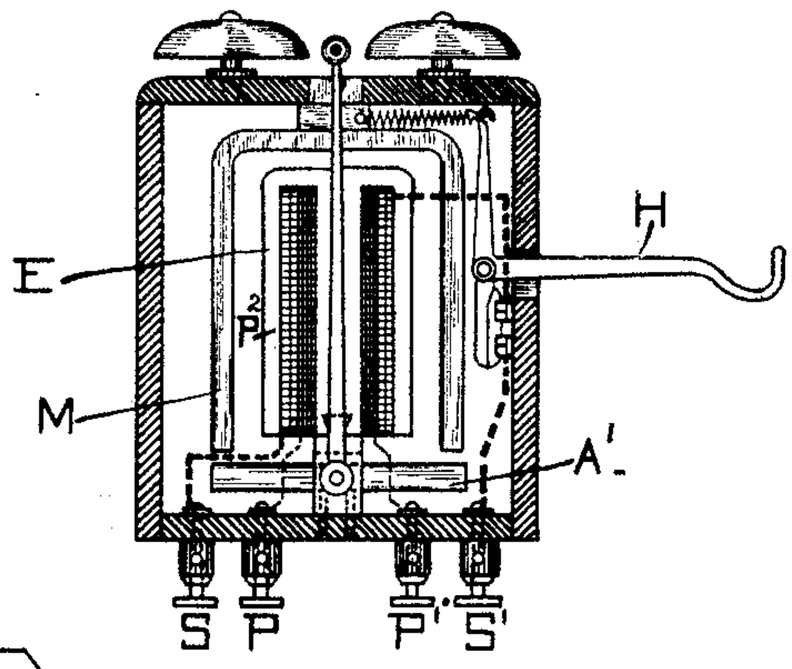
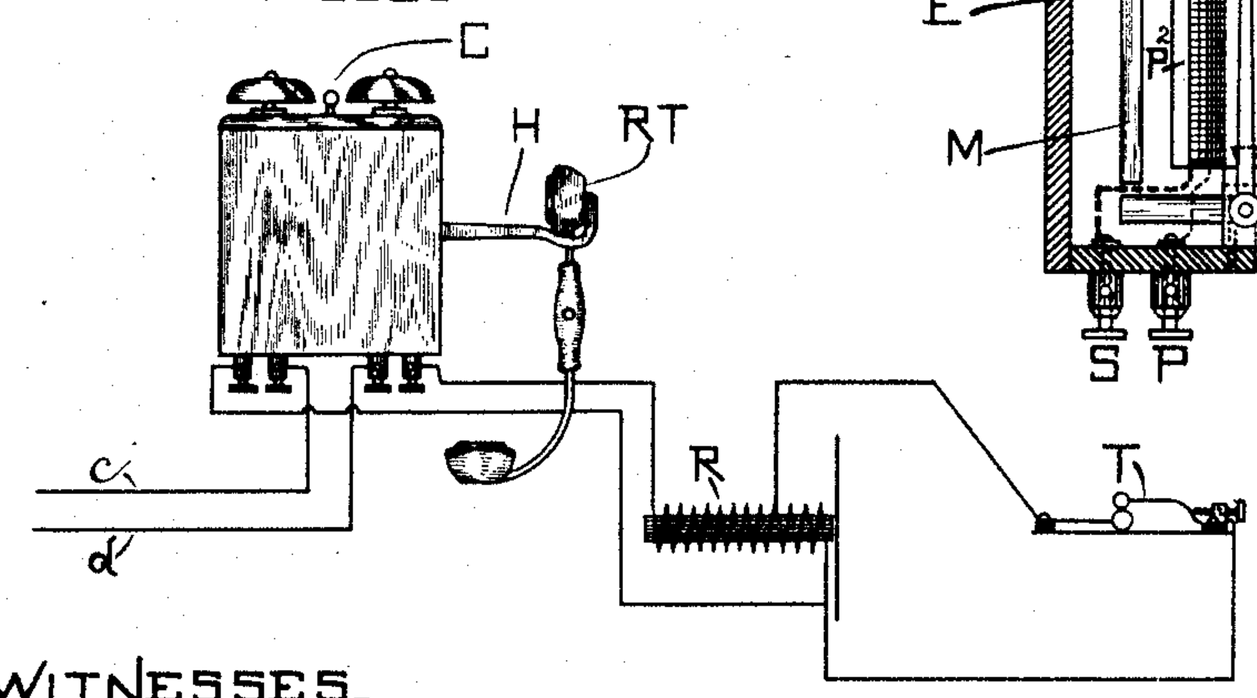


FIG. 6.



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(No Model.) 2 Sheets—Sheet 2.

J. W. GIBBONEY.

TELEPHONY.

No. 587,119. Patented July 27, 1897.

FIG. 8.

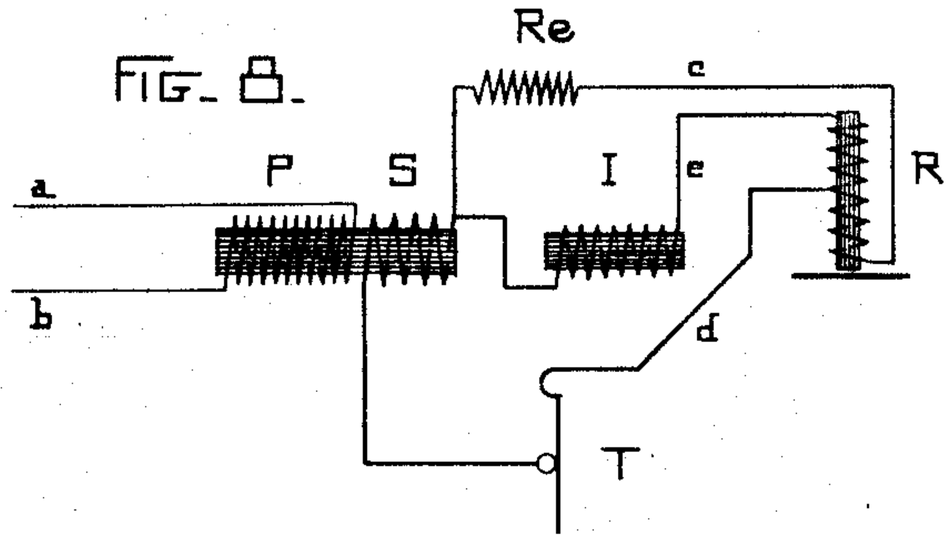


FIG. 9.

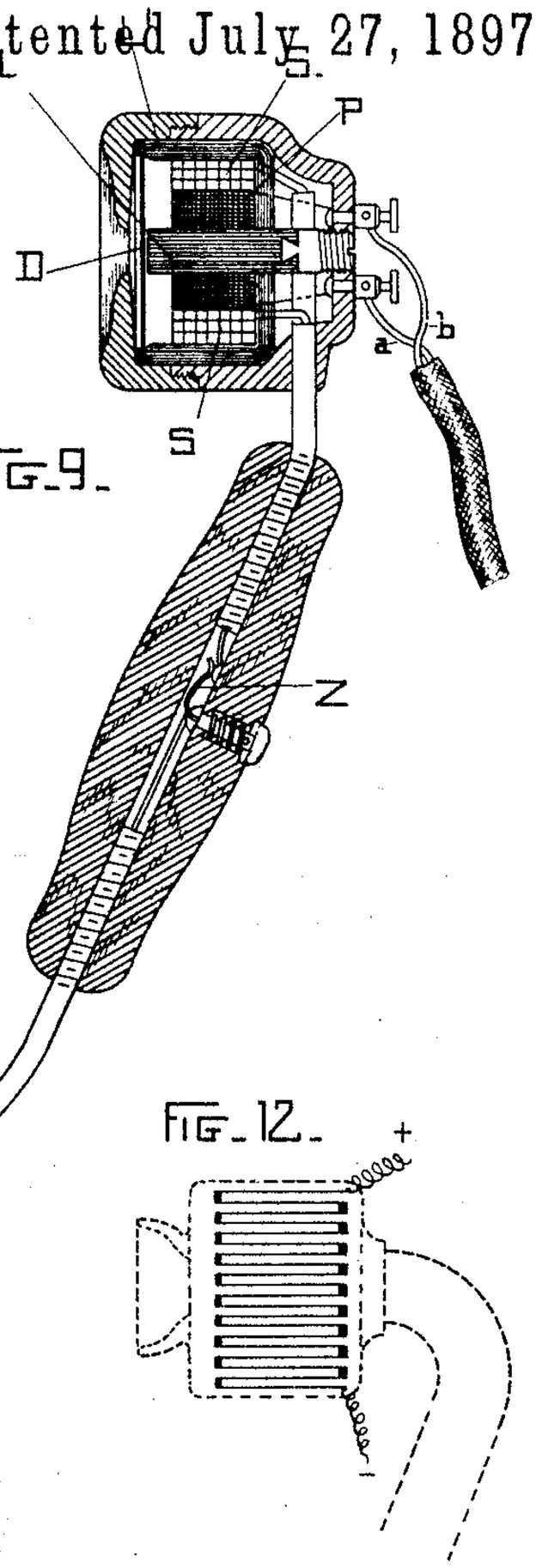


FIG. 12.

FIG. 10.

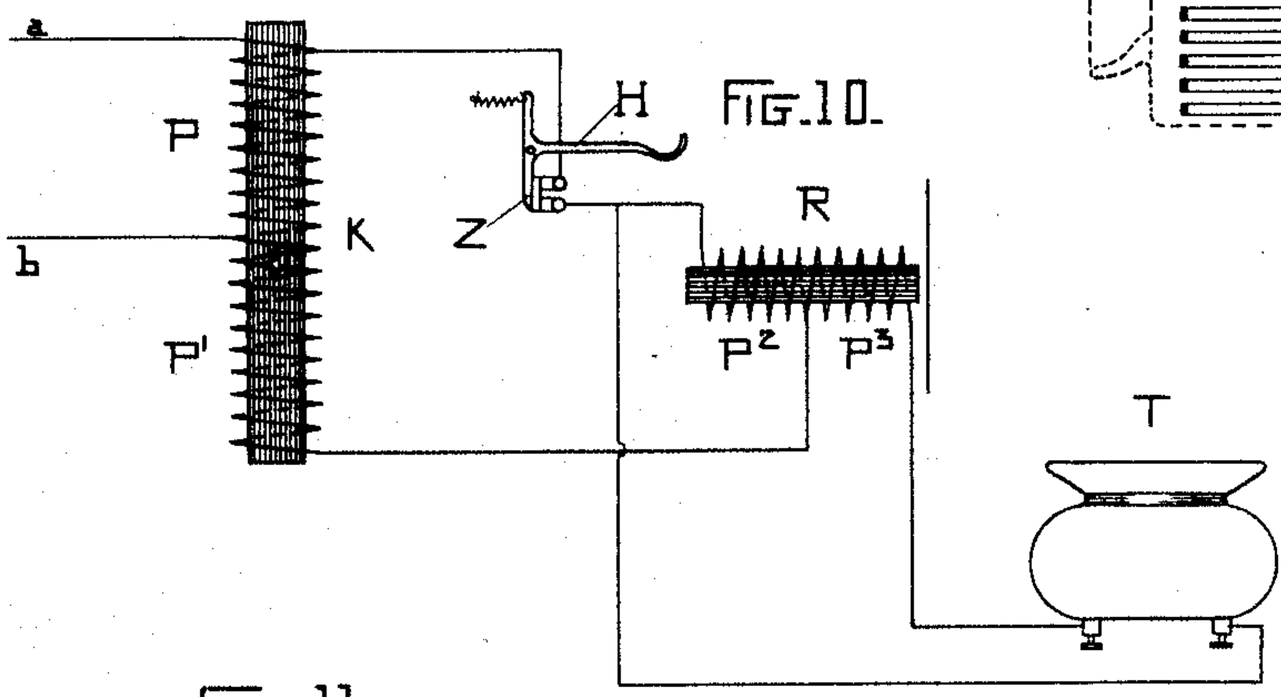
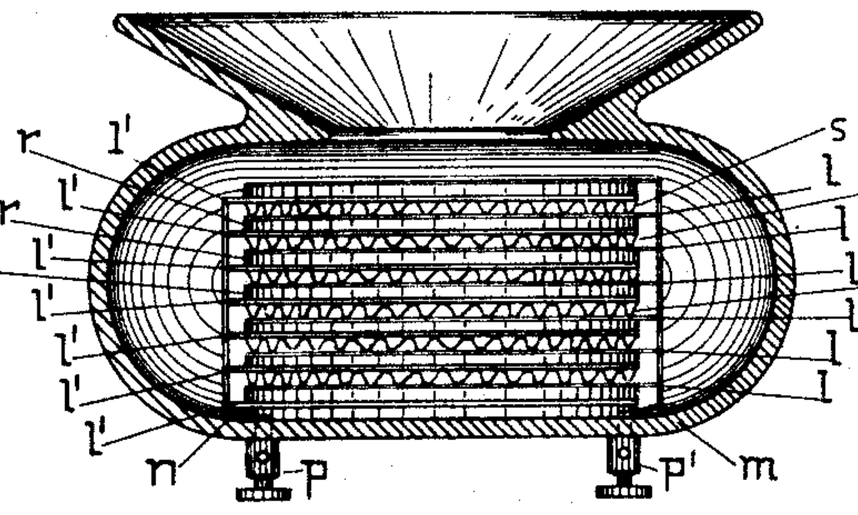


FIG. 11.



WITNESSES—
Henry A. Westendarp.
Benjamin B. Hull

INVENTOR—
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UNITED STATES PATENT OFFICE.

JOHN W. GIBBONEY, OF LYNN, MASSACHUSETTS, ASSIGNOR OF ONE-HALF TO THOMAS J. JOHNSTON, OF SCHENECTADY, NEW YORK.

TELEPHONY.

SPECIFICATION forming part of Letters Patent No. 587,119, dated July 27, 1897.

Application filed July 26, 1895. Serial No. 557,215. (No model.)

To all whom it may concern:

Be it known that I, JOHN W. GIBBONEY, a citizen of the United States, and a resident of Lynn, in the county of Essex and Commonwealth of Massachusetts, have invented certain new and useful Improvements in Telephone Apparatus, which I will now describe in the following specification and then particularly set out in the claims thereof.

The present invention concerns improvements in a telephone system, such as that which has been described in my Patent No. 481,529 and in the patent to Elihu Thomson, No. 481,878; and it consists, first, in an arrangement for polarizing the cores of the magnets of the receiving-telephones, so that a soft-iron core may be used instead of a permanent-magnet core, thus saving expense in manufacture.

It further consists in a novel arrangement of a receiving-telephone in such a system, whereby alternating or varying currents of a period or rate of alternation, such as would ordinarily produce audible and annoying acoustic vibrations in the receiver apparatus, may be employed to operate the transmitters, receivers, and signaling apparatus, and which currents, used in accordance with the improvements herein described, will produce no noise, or, at the most, will have an inappreciable or insignificant influence upon the telephone-receivers, and therefore do not interfere with the transmission of speech.

In operating by the system described in the patents referred to difficulty has arisen in using alternating waves of a period below audibility, as such waves do not produce a continuous effect upon the receiver, and the speech-waves are therefore transmitted with a small loss of continuity at times. Although it is possible to operate commercially a system by the methods pointed out in such patents, yet I prefer the method and apparatus of the present application, inasmuch as by this the difficulty just pointed out is overcome.

My invention also consists in improvements in transmitters and receivers, signaling apparatus, &c., operating by alternating currents in whole or in part embodying certain novel arrangements of circuits and constructions peculiarly adapted for use in an alternating-current system of telephony.

My invention is illustrated in the accompanying drawings, wherein—

Figure 1 shows a suitable generator for supplying the alternating currents used in the system. Fig. 2 shows the circuit connections for the field-magnet of the same. Fig. 3 shows a telephone-circuit, including the generator and two connected subscribers' stations, together with a novel arrangement of receiver and transmitter, forming a part of the present invention. Fig. 4 shows the field-magnet of the generator, Fig. 3. Fig. 5 shows the character of the currents used in the system. Figs. 6 and 7 show improvements in the calling bell or signal at a subscriber's station and a convenient way of obtaining the currents suitable for the subscriber's transmitting and receiving apparatus. Fig. 8 illustrates diagrammatically my improved method of operating receivers when the alternating currents are of rather high period or of audible period and shows how their effects are eliminated in the receiver. Fig. 9 illustrates a useful arrangement of the receiver and transmitter operating on an alternating-current system connected relatively, as in Fig. 3, and also certain improvements in the receiver itself adapting it for use with alternating currents. Fig. 10 shows a modification of the circuits for obtaining the high-potential currents required for an electrostatic transmitter, and Figs. 11 and 12 show improved electrostatic transmitters for use in the system.

In Fig. 1, A represents a Gramme-ring armature entirely covered with its winding of coils and having two leads *a b* taken out at opposite points. This armature is preferably stationary, and inside thereof there revolves a field-magnet F. The coils of the field-magnet F may receive current from any suitable source, as a battery E, Fig. 2, or from a separate exciter or a commuted portion of the current from the winding A. In any case I prefer to avoid the use of collector-rings and brushes to lead the current to the coil upon F, as variations of contact between the brushes and rings are apt to cause variations of current and magnetic effect in F, which may be reflected more or less into the arma-

ture-circuit inductively. Instead I may employ mercury-cups at either end of the shaft, dipping or projecting into which mercury is a prolonged end of the shaft, or the mercury-cups may be situated both at one end of the shaft. In the first case the shaft is made in two parts bound together with intervening insulation, and between these two parts the field-coils of F are connected. A simple contact-spring might of course be used instead of the mercury-cups. In this way the current is maintained perfectly constant. Instead of the battery E, I can also employ, and, in fact, prefer to employ where possible, a small separately-running exciter-dynamo having a commutator, and to prevent the fluctuations of current produced when the brushes pass from segment to segment on the commutator being reflected into the armature-circuit I place in the circuit between the exciter-dynamo and the field F a self-induction coil of relatively large amount or value, which smooths out such fluctuations and maintains the current steady. In addition thereto I prefer to place in shunt to the terminals of the field F a polarization-cell, which also tends to eliminate the fluctuations of current in the exciter-circuit. Of course a permanent magnet, if it be sufficiently powerful, may be used, as shown in Figs. 3 and 4, but as the speed of the generator is necessarily low on account of the low periodicity of current employed the former arrangement is preferred as being more powerful and increasing the capacity of the generator.

The character of the main generated current is that of the main outline of the wave, Fig. 5—namely, that of a sine-wave—while the shape of the wave in its modified form, as produced by speaking into a transmitter, is roughly indicated by the smaller waves superimposed upon the main wave.

In my former patent referred to above I show a transformer whose primary coil is included in the main circuit and whose secondary winding is closed through any suitable form of transmitter. I am able to dispense with this transformer altogether, as the core of the receiving-telephone may be used instead, and save an extra piece of apparatus and the extra resistance and self-induction thereby introduced in the circuit. To make such use of the receiver-magnet core, it is only necessary to provide thereon a local modifying-circuit including the transmitter. Thus in Fig. 3 the magnet-core of the receiver R has two windings upon it, one a fine winding in the main-line circuit and the other a coarser winding including the transmitter T. The latter constitutes a closed-circuited secondary around the core of the receiver R, and therefore varies the main or principal current in accordance with the current which can be induced in such secondary circuit. The resistance of this circuit varies with the resistance of the contact, self-induction, or static charge of the transmitter T, and therefore if the diaphragm of the transmitter be spoken against the main wave will be inductively modified and will have superimposed upon it much quicker waves or undulations, corresponding to the acoustic vibrations or the movements of the diaphragm. These vibrations are reproduced in any suitable receiver included in the circuit. The main alternating wave is represented by the larger sinuous line in Fig. 5 and in its form as modified by the acoustic vibrations by the smaller transverse waves superimposed thereon, it being understood, of course, that the representation of the current corresponding to the sound-waves is not accurate, but merely explanatory. This matter is, however, fully described in the two patents above referred to. The receiver R′ in Fig. 3 has its local circuit arranged somewhat differently from that of R, but it operates upon the same principle of changing the inductive effects by varying the resistance in a closed circuit, this circuit including a transmitter. In this case the receiver-magnet core has but one winding, and the transmitter is adapted to shunt a part of the current passing through all or some of the coils. The action is of course to vary the inductive effects, as before, by diverting a portion of the main current from some or all of the coils upon the core of the receiver R′, and the arrangement is the equivalent of that of the receiver R. If the transmitter T′ were one adapted for currents of low potential relatively, it would be necessary usually to place it in a secondary circuit of coarser winding than that of the main circuit, and this is shown in Figs. 6 and 7. The main line leading from the station and including a connected subscriber's station is shown at *c d*. It leads to two binding-posts P P′, Fig. 7, and then to a primary coil of a transformer the secondary coils of which go to the binding-posts S S′. The secondary circuit passes to the telephone-receiver R and transmitter T.

An ordinary carbon transmitter which is adapted for currents of low voltage may be used with advantage and be placed in shunt to all or some of the coils upon the receiver R. This affords a simple construction of apparatus. The transformer for accomplishing the reduction of potential in the main alternating current need not have a special winding, as the winding upon the magnet which operates the calling-bell may also be the primary winding of such transformer. Thus E represents a core of laminated iron sheets of soft iron having three legs, surrounding the middle one of which is the winding. Outside the whole is a permanent magnet with its poles arranged to polarize the armature A′, pivoted at its center upon a prolongation of the middle leg of the core of the transformer and carrying the bell-hammer. When the calling-currents or currents of extra strength are sent through the primary coil P^2, the ends of the armature become alternately of oppo-

site polarity and are successively attracted and repelled from the permanent magnet in the usual manner in a rapid vibratory movement. The ordinary line-current or what may be called the "initial working current" is not powerful enough to affect the armature, while the fluctuations of the main wave representing the acoustic vibrations are efficiently transmitted by induction to the local circuit.

In Fig. 8 is shown that part of my invention which enables alternating currents having a higher frequency than those which have been heretofore specified to be used in the operation of a system of telephony in accordance with the principles set out in the patents referred to. Such higher-period currents could not usually be employed on account of the fact that they would produce an audible tone in the receiver and interfere with speech, but by the construction illustrated diagrammatically in this figure it will be shown that the effects of the main current can be entirely or almost eliminated in the receiver while it may still be used to operate the system. P is the primary winding, coming from the central exchange, and S a secondary winding wound upon a suitable iron core, and this core may be, if desired, the core of the magnet which operates the calling-bell, as in Fig. 7. The circuit from the coil S is branched, one part going through a self-induction coil I of considerable amount and the conductor *e* to the receiver R and the other branch going thereto by the conductor *c*, having no self-induction coil, but having, preferably, a resistance R*e*, equal in amount to the ohmic resistance of the coil upon the core I. The return-conductor *d* may include a transmitter T. The magnetizing effects of the coils of wire between *c d* and *e d* are opposed, so that any current passing equally from the coil S through *c e* will have little or no influence upon the diaphragm of the receiver. If now with a proper selection of inductance at I and a balancing of the effect of the coils upon R alternating currents of comparatively low frequency be passed through the coil P as coming from a central exchange, the secondary currents induced in S pass almost equally by way of the conductors *c d*, and will therefore, as explained, have little or no effect in producing audible tones in the receiver, but the variations or undulations of current corresponding to acoustic vibrations at any transmitter will be of much higher frequency and will meet a large opposition at the coil I. They will therefore pass mainly by way of the conductor *c*, and will affect the receiver-diaphragm. Instead of employing a resistance R*e* to balance the resistance of the coils upon the core I the resistance of the circuit S *c d* may of course be selected to equal that of S I *e d*. There will occur with this arrangement of circuits a slight lagging effect upon the main alternating-current wave flowing through the coil I, and there will therefore be movements of the receiver-diaphragm corresponding to the resultant magnetizing influence of the two currents or divided current passing by the conductors *c* and *e*, but the amplitude of vibration of the diaphragm will be so largely reduced that alternating currents of quite high frequency may now be used without annoyance or interference with speech occasioned thereby, as is evident. It is of course also evident that the variations of current produced by the transmitter T will now occur mainly in the circuit S *c d*.

In Fig. 9 I illustrate a complete telephone instrument, having the receiver and transmitter combined in portable form and adapted to operate upon the alternating-current system, as shown in Figs. 3 and 6. The telephone-receiver has two sets of coils, as before, one included between the line electrodes or terminals *a b* and the other leading along the handle of the instrument to the transmitter, which modifies the main current, or, as it were, allows only the current from the generator at the central station to flow through the connected subscriber's circuits as an alternating current having impressed thereon smaller variations corresponding to the sounds receiver by the transmitters, the transmitters acting to vary the apparent resistance of the circuit, as already explained. The iron core of the receiver is composed of laminated iron, so as to permit quick changes of magnetic condition, avoiding hysteresis. P is the primary winding or coil connected between the line-terminals *a b*, and a secondary of coarser wire S leads to the transmitter T. The iron of the receiver consists of an outer cup L, which may be formed by a punch and die, and may consist of several pieces lying one within the other, and an inner core-piece L, also built up, preferably, of laminæ, or both may be made of very soft iron, although the laminated structure is of course the best. The inner core has secured to it, as by dovetailing, an extension of solid metal, which is screw-threaded so that the inner core may be advanced or retracted from the diaphragm for the usual adjustment. It will be seen that the magnetic circuit is almost closed, and therefore the receiver is a very efficient transformer. It is of course evident that instead of using a fine-wire primary and a coarse-wire secondary upon the receiver, as shown, there may be employed but one coil, connected as shown in Figs. 6, 7, 8, and 10.

In my prior patent referred to I have shown that I can transform the work-current from the generator at the central station by step-up transformers, so that electrostatic transmitters may be employed. I show in Fig. 10 an arrangement of the circuits adapted therefor and which may be regarded as a modification of the arrangement Figs. 6 and 7. The core K may be the core of the bell-magnet, as in Fig. 7, and the main circuit passes through a part P thereof between the lines *a b*. The receiver R is then connected through

all of the winding upon the core K—that is, through P and P′—and will therefore be supplied with current of a potential depending upon the relative number of turns in P and P′. The receiver R is likewise wound with a coil wound in two sections P^2 P^3, one section only, as P^2, being connected through P P′, while the electrostatic transmitter T is connected through both windings P^2 P^3, and is therefore supplied with currents having a very high potential because of this double transformation upward. The transmitter T will operate efficiently if constructed as shown in Fig. 11. It consists of a number of thin laminæ of conductor connected in multiple to one side of the circuit, opposed (with a free air-space intervening) to a number of other plates connected to the opposite pole of or conductor of the circuit, the latter plates being of thicker material, so as to have considerable rigidity, or being backed with a stiffening material, and the former being made quite thin and flexible, so as to respond readily to the vibrations of air produced by sounds. The thin laminæ are indicated at *l l l*, &c., and the thicker laminæ or rigidly-held laminæ at *l′ l′ l′*, &c. Between one side of a thick lamina and the side of the adjacent thin lamina is interposed an insulating separating-ring *s s s*, &c., which is corrugated, as shown, or has numerous openings therethrough to permit the free entrance of air. Between the other side of the heavy lamina and the adjacent side of the thin lamina are other insulating separating-rings *r r r*, &c., and these latter are solid, so as to entirely close in the space between the laminæ. All of the thin laminæ are connected, as by a conductor *m*, to one side of the circuit, as at *p′*, and all of the heavier laminæ by a conductor *n* to the other side of the circuit at *p*. This construction enables all the thin condenser-sheets to move in free air toward the sheet of opposite polarity, the air having access to one side thereof only, while the capacity of all the thin sheets acting in multiple is utilized. A heavy lamina is located at the top near to the mouthpiece, preferably, so that the transmitter cannot be injured by objects passed in through the opening by maliciously-disposed or inquisitive persons.

In Fig. 12 the arrangement just described is somewhat modified, so that the condenser can be used both as a transmitter and receiver. All of the condenser-sheets are made thin and flexible in this case and are separated by insulating separating-rings, so that the sheets are sustained at a slight distance apart. Openings are provided in these rings, so that one side of each positive plate and the opposite side of each negative plate have free air communication to the ear, while the adjacent sides of each positive and negative plate have similarly free communication with a mouthpiece V, Fig. 9, it being understood that the terms "positive" and "negative" are used in the ordinary signification with reference to the charged plates, as of course the charge in the present case would be changing with the changes of current. By this arrangement the alternating current, having been suitably transformed upward to a very high potential, changes in the capacity of the sheets as they move toward and from each other when words are spoken into the mouthpiece V are reflected into the principal circuit, as shown in the previous figures, while the variations of the principal current produced by the distant transmitter cause a bodily movement of such sheets by electrostatic attractions and repulsions and thus set up sonorous vibrations in the air and repeat the sounds from the distant transmitter.

In the case of the construction Fig. 9, in which the entire magnetic structure of the receiver is made of laminated iron, the polarization of the core, which is necessary to prevent the raising of the pitch to the octave, is accomplished by the main or principal current itself, which is lowered in frequency until it is no longer heard in the receiver.

I believe myself to be the first to employ for telephonic transmission of sounds an alternating current, having a rate of alternation ordinarily audible in a telephone-receiver, by superposing upon such a current the sound-vibrations to be transmitted and then avoiding the annoying fluctuations of the receiver by neutralizing therein the main transmitting current, leaving only the superposed vibrations or variations of current to affect the diaphragm.

It is manifest that the ordinary alternating current is best adapted for this purpose, and I prefer that to all other forms; but I have spoken throughout my description and in my claims of a "harmonically-varying" current, meaning by this a current having a reasonably definite rate of change or periodicity, however this may be accomplished, as an equivalent of the alternating current, which I prefer. I have mentioned this latter form of electric energy because, manifestly, the principles of my invention permit the use of the same means for neutralizing the effect thereof upon the receiver as if the ordinary alternating current were employed, and I therefore consider this within my invention.

It is equally manifest that extensions upon and improvements of the means herein described would be subordinate to the particular invention set out, and this whether more than one current was used or only a single alternating current.

In my application, Serial No. 601,437, filed August 3, 1896, I have shown how the principles of my fundamental invention may be extended to polyphase currents of the alternating or varying type, and that application I consider an amplification and explanation of the same general principles set out in this.

Having thus described my invention, what I claim is—

1. The art of operating a telephone-re-

ceiver, consisting in passing through coils wound thereon an alternating current or currents periodically changing in value and capable of producing audible vibrations in the receiver, such current furnishing energy for operating the transmitting-circuits, modifying such current by a suitable transmitter, and neutralizing the effect of the periodic current in the receiver.

2. The improvement in the art of telephoning herein described, consisting in supplying a receiver with a main alternating current or a current of periodically-changing value furnishing the energy for operating the transmitting mechanism and having superimposed thereon undulations corresponding to the sound-vibrations to be transmitted, and neutralizing the effect of the main current in the receiver, whereby the superimposed undulations become more audible.

3. The art of telephonically transmitting sound, which consists in supplying an electric circuit with harmonically-varying waves furnishing the energy for operating the transmitting-circuit and of a period ordinarily audible in telephone-receivers, superimposing upon such waves other waves of a form corresponding to the sound-vibrations to be transmitted, and suppressing the main harmonically-varying waves in the receiver, leaving the sound-vibrations mainly audible therein.

4. The art of transmitting vocal or other sounds electrically, which consists in passing over a circuit alternating-current waves of a definite period and of selected and fundamental character with respect to the other waves in the line, such fundamental waves being perceptible by audition in telephone-receivers, causing said fundamental waves to directly or inductively furnish energy to the circuits containing the transmitters, modifying said current-waves in correspondence with the acoustic vibrations desired to be transmitted, and, lastly, neutralizing or weakening the effect of the fundamental current-waves in the telephone-receivers of the system while preserving the vocal or superimposed modifications as impressed by the transmitters.

5. The combination in a telephone system, of a source of harmonically-varying current primarily audible in telephone-receivers and furnishing the main initial transmitting-current for the system, transmitters for modifying said current in correspondence with acoustic vibrations, and means for preventing the main or principal current from producing annoying fluctuations in the receivers.

6. In a telephone system, the combination of a source of harmonically-varying currents furnishing initial energy for operating the transmitters and of a frequency ordinarily audible in telephone-receivers, a transmitter for imposing upon such currents modulations or variations corresponding to sound-waves, and a receiver adapted to respond faintly or not at all to the main fundamental waves and readily responsive to the variations of current caused by sound-waves.

7. In a telephone apparatus, the combination of a source of alternating or periodically-varying current, a transmitter for modifying said current whereby there are superimposed thereon undulations of current corresponding to the sounds received by the transmitter, a receiver having two sets of coils or coil-circuits thereon adapted to convey the main generated current and having their magnetizing actions opposed, and an artificial self-induction in one of said receiver-circuits.

8. The combination in an electromagnetic instrument, of a core of magnetic material, an armature therefor, two differential windings on the core, the said windings being in parallel branches of the circuit, and one of said branches being characterized by high self-induction.

9. The combination with a telephone-receiver having upon its magnet-core two coils or coil-sections adapted to be connected with a source of alternating or periodically-varying current and to act in opposition in magnetizing said core, of an artificial self-induction in the circuit of one of said coils or coil-sections, whereby said receiver becomes unresponsive, or nearly so, to current below a predetermined frequency or periodicity.

10. The combination in a telephone apparatus, of a magnetic calling or signaling device having a winding connected in the line-circuit forming the primary winding, and a local secondary circuit also wound thereon deriving current by induction from the primary circuit, the local circuit including a transmitter.

11. The combination in a telephone apparatus of a bell-operating magnet having upon its core a primary coil in the main-line circuit, and a transmitter and receiver in a local circuit of coarser wire forming a secondary to said primary coil.

12. In an alternating-current-system telephone apparatus, the combination of a magnetically-operated signal or calling apparatus wound with coils connected in the line-circuit, a coarse-wire secondary circuit in inductive relation thereto, a receiver-telephone in such secondary circuit, and a transmitting apparatus in a circuit local to some or all of the coils of the said receiver.

13. The combination in a telephone apparatus, of a polarized armature operating the bell-hammer, a coil traversed by the main alternating or varying current for energizing said armature, a secondary coil or circuit including the receiver and transmitting apparatus, and a separate laminated core for said coils.

14. The combination with the laminated core having the primary and secondary coils wound thereon, of an armature free to vibrate at one end of said core, and an outer magnet having its opposite poles adjacent to the ends

of such armature, the coils imparting an alternating polarization to the armature.

15. The combination with a laminated core having primary and secondary coils wound thereon, of an armature free to vibrate and attached to one end of the core, and an outer permanent magnet disposed to affect the armature and having a free air-space between it and the laminated core.

16. A generator for use in a telephonic transmitting system, comprising a stationary armature having substantially a continuous winding, and a revolving field-magnet coil carried upon a shaft having reduced portions at each end making connection through mercury-cups to a source of current connected to said cups; said shaft being divided into two portions electrically insulated from each other and said field-magnet coil having its terminals connected respectively to said shaft portions.

Signed at Lynn, Massachusetts, this 20th day of February, 1894.

JOHN W. GIBBONEY.

Witnesses:
GEORGE H. ALTON,
CHARLES E. HARTHAN.