No. 808,600.

PATENTED DEC. 26, 1905.

A. G. DAVIS.

TELEPHONY.

APPLICATION FILED MAY 15, 1903.

2 SHEETS—SHEET 1.

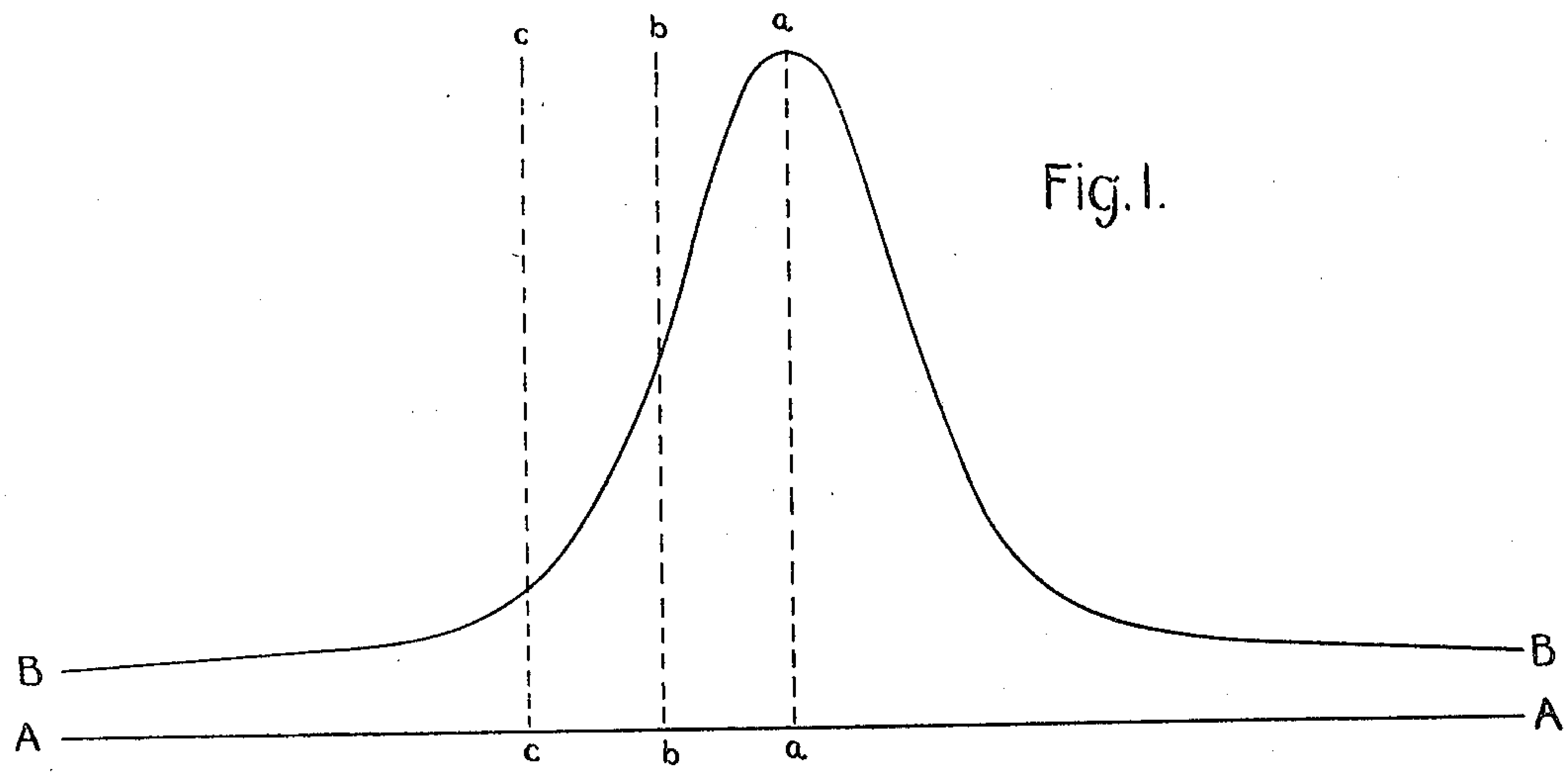

Fig.1.

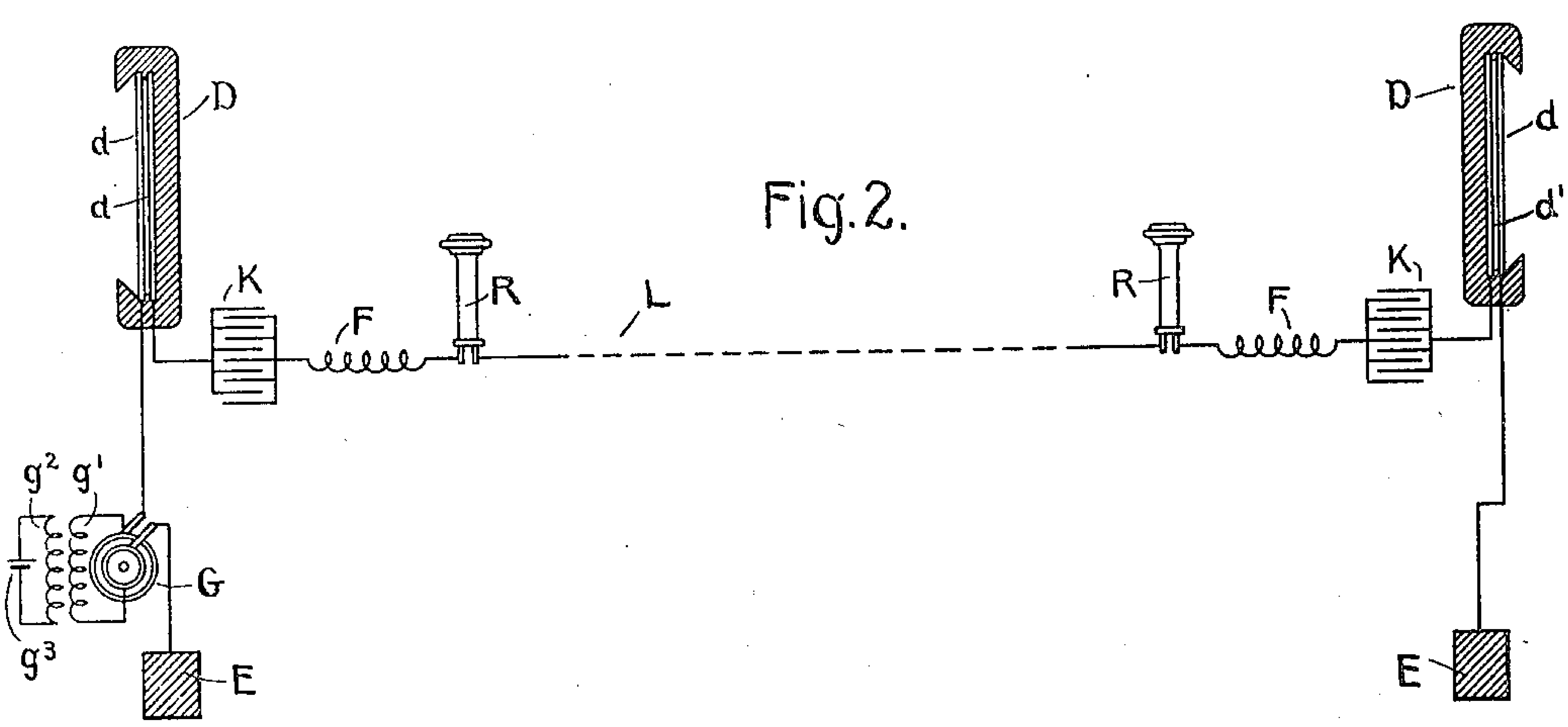

Fig.2.

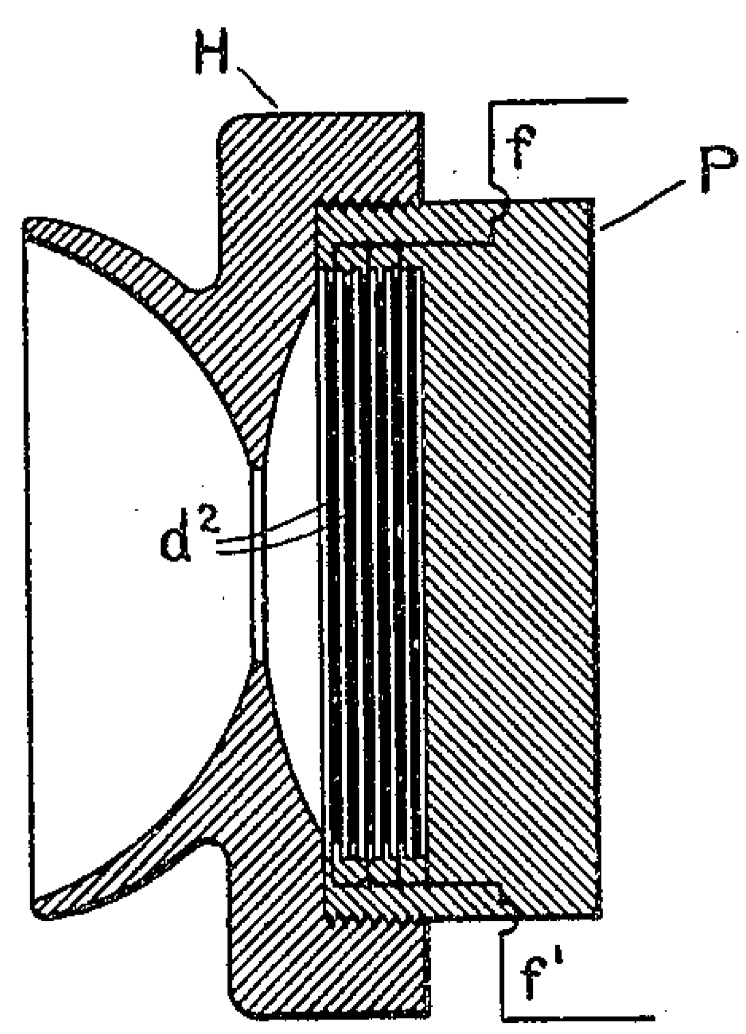

Fig.3.

Witnesses

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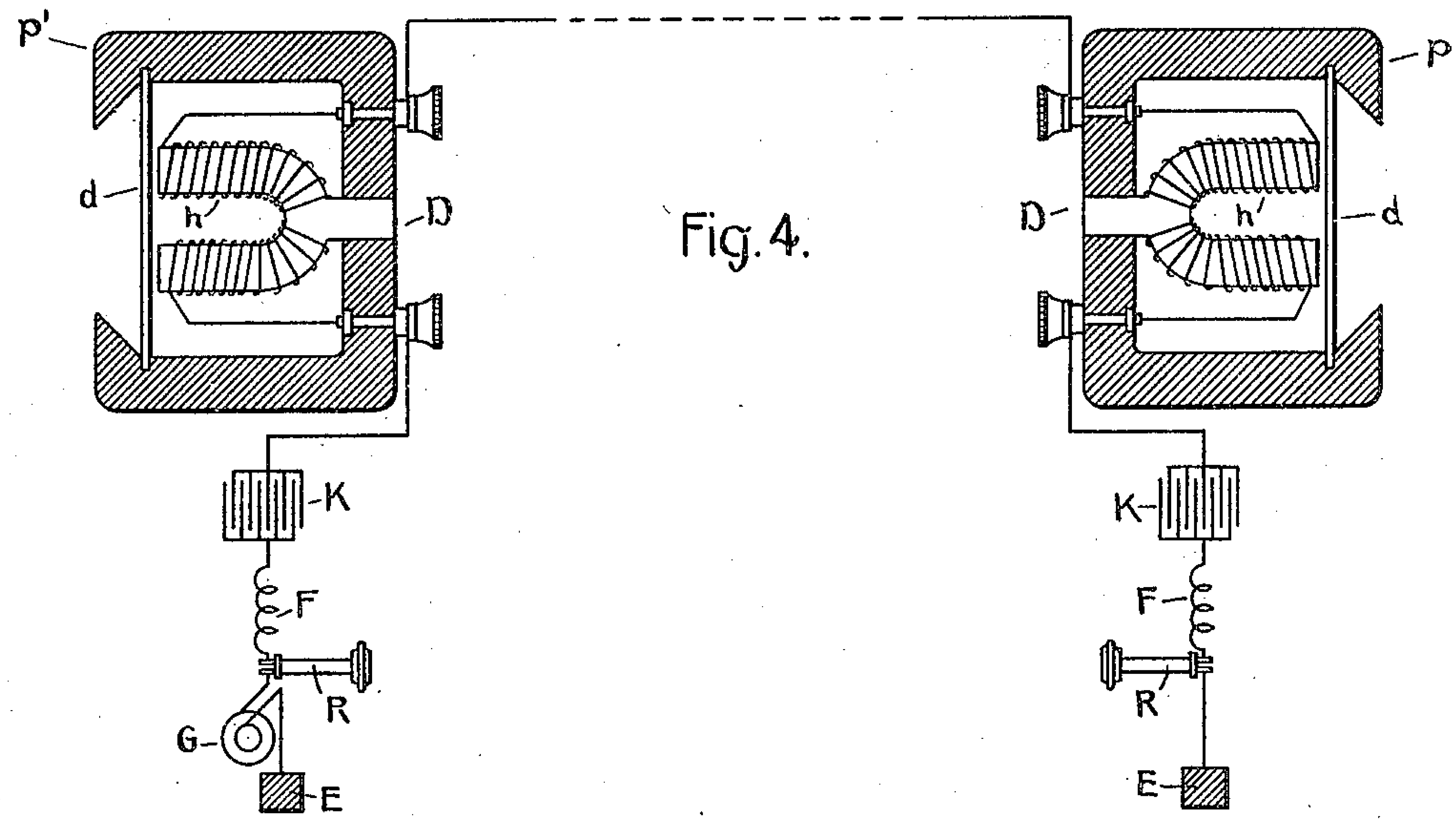

Fig. 4.

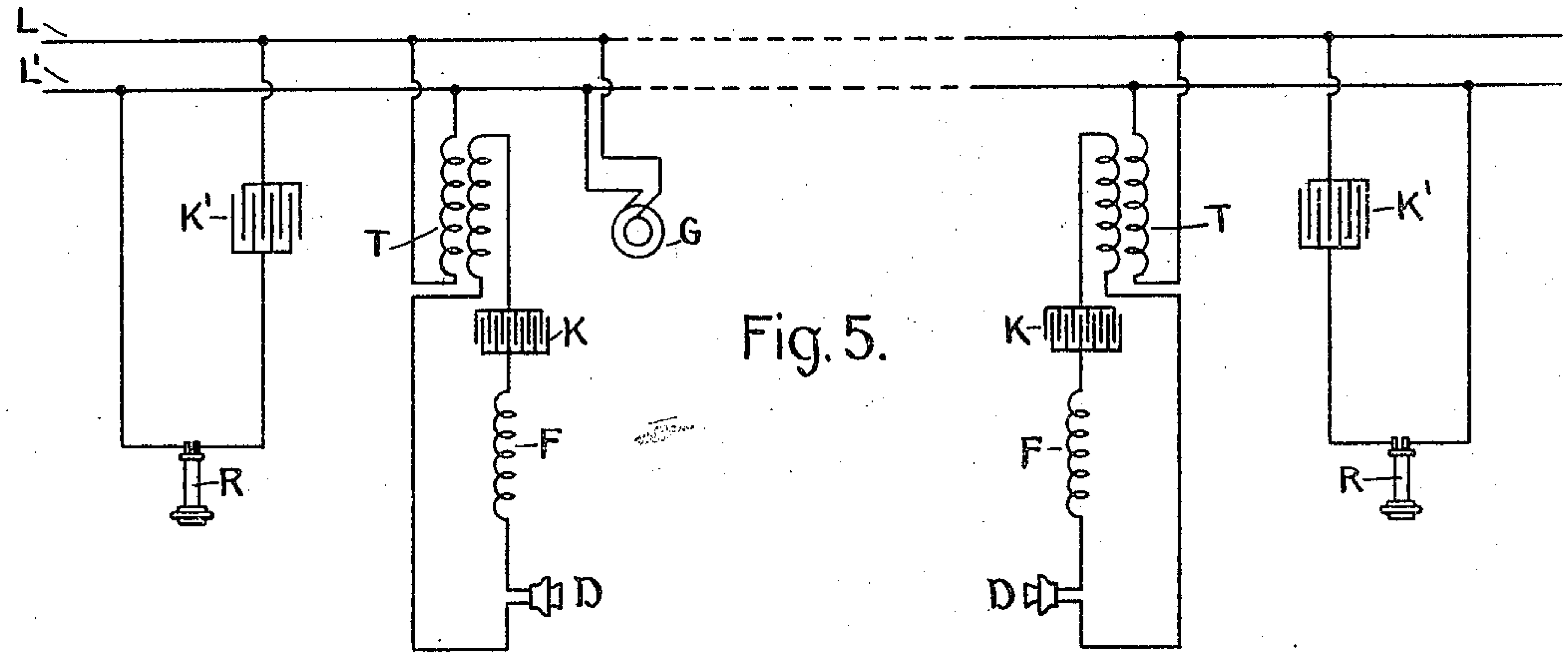

Fig. 5.

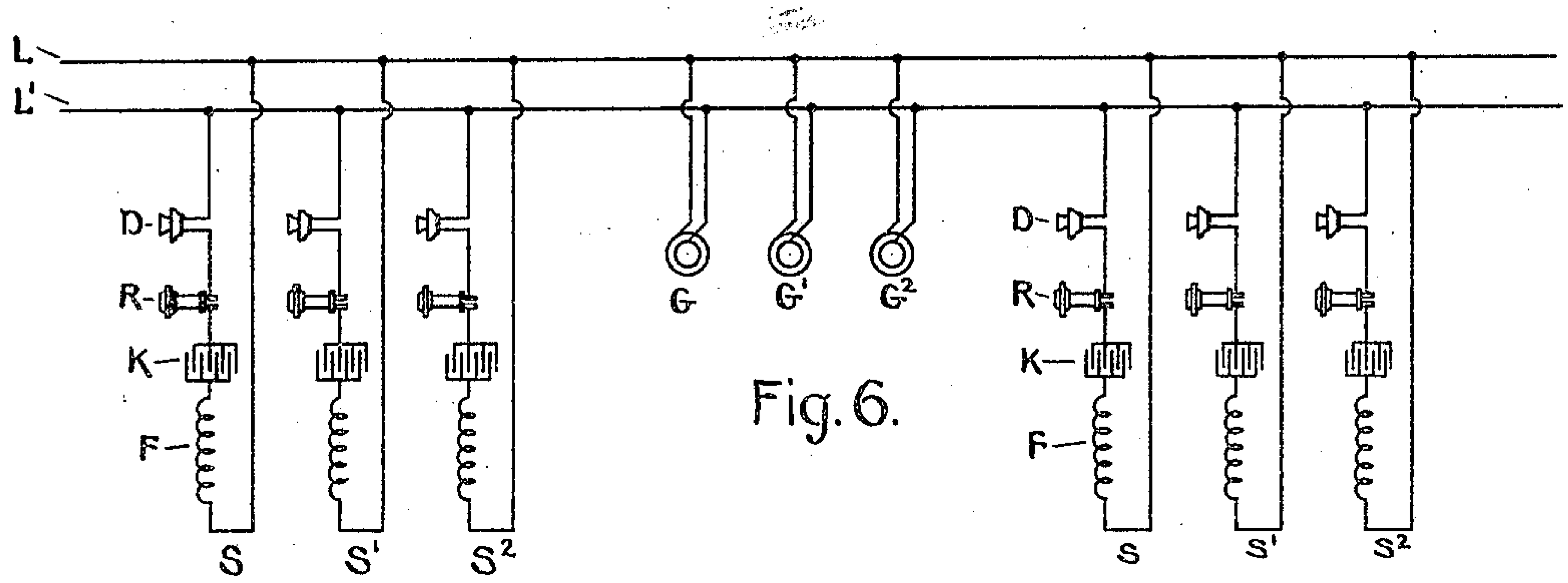

Fig. 6.

Witnesses.

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UNITED STATES PATENT OFFICE.

ALBERT G. DAVIS, OF SCHENECTADY, NEW YORK.

TELEPHONY.

No. 808,600. Specification of Letters Patent. Patented Dec. 26, 1905.

Original application filed April 22, 1897, Serial No. 633,258. Divided and this application filed May 15, 1903. Serial No. 157,246.

To all whom it may concern:

Be it known that I, ALBERT G. DAVIS, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Telephony, of which the following is a specification.

This case is a division of my pending application, Serial No. 633,258, filed April 22, 1897.

My invention relates to the transmission of sounds by electricity, and comprises certain new and useful methods of telephony.

The fundamental idea of my invention consists in producing the required variations in the line-current, not by varying the resistance of a microphone-contact, as in the ordinary telephone systems, nor by inducing current in a coil by the variation of the flux passing therethrough, as in a magneto-transmitter, but by making and breaking gradually and to a greater or less extent the resonance of a tuned circuit. By using the term "making and breaking" I do not wish to imply that there is at any time a discontinuous variation in the current, but, on the contrary, the variation is, as will be shown later, continuous and progressive and suitable for the reproduction of speech.

It is known that when a constant alternating electromotive force is applied to a circuit of constant resistance the current flowing will be a function of the self-induction and the capacity. There are certain values of self-induction and capacity with which for a given frequency the circuit becomes "resonant" and a current flows greatly in excess of the current which would flow in either the self-induction or the condenser alone. On either side of this critical point—that is to say, if either the self-induction, the capacity, or the frequency be varied—the current falls off rapidly; but the rate of fall depends, other things being equal, on the resistance of the circuit.

In practicing my invention I prefer to tune the transmitter-circuit so that the current is a little below its maximum value—that is, so that the circuit is nearly but not quite resonant—and to vary the constants of the circuit by the action of the transmitter so as to cause variations in the current corresponding more or less exactly to the air vibrations to be reproduced. These variations may be caused to produce sound in any suitable receiver. This involves the use of a source of alternating current, and it is obvious that with any commercial frequency the currents produced by that source would be heard in the receiver. If the frequency were badly chosen, the sounds thus produced would be very annoying, and I therefore prefer to use a generator of a rather low or rather high frequency. Though it is in some respects preferable, it is not necessary that this frequency should be either above or below the audible limit. My invention also contemplates multiplexing the system thus constituted and also comprises various other features, to be hereinafter more particularly pointed out and claimed.

In the drawings attached to this specification, Figure 1 is a view showing the general form of the current-curve of a nearly-resonant alternating-current circuit, with constant electromotive force as the reactance varies. Fig. 2 is a diagram of my improved system in a simple form. Fig. 3 shows in section a transmitter adapted for use with my improved system. Fig. 4 shows my system in a form very similar to that shown in Fig. 2, but with a different form of transmitter. Fig. 5 shows a system differently arranged. Fig. 6 shows a multiplex system.

In Fig. 1, A A is the base-line, and B B is the curve of current with constant-frequency impressed electromotive force and resistance as the self-induction or capacity varies. It will be seen that the current is at a maximum when the reactance has the value corresponding to the line *a a*—the resonant condition. At *b b* the current has dropped from its maximum value, while at *c c* the reactance has choked the current down to a very small value.

Referring now to Fig. 2, it will be seen that at each end of the line a transmitter D, a condenser K, a self-induction coil F, and a receiver R are connected between the earth or return wire E and the line L. An alternating-current generator G, producing currents of the frequency ω, is inserted in series with the line at some convenient point. This generator is indicated in diagram only, the armature-winding being lettered g', the field-winding g^2, and the exciter, preferably a primary or secondary battery or some other source of current without a commutator, g^3. This generator is preferably designed so as to give as nearly as possible a true sine wave. The receivers R may be of any preferred type; but when the frequencies used are high they should preferably be formed without iron cores, as is now well understood in the art.

For any moderate frequency I prefer to use the regular magneto-receivers. The transmitters are so arranged that they vary the capacity or self-induction of the circuit rather than its resistance. They may be, as shown at D, the well-known "condenser-telephones," consisting of two thin metal plates *d d'*, supported in close proximity by a suitable case. K and F are condensers and coils, so adjusted that the current in the line is maintained when no sound is emitted before the transmitters at the value corresponding to a point on the resonance-curve below the peak, as *b b*, Fig. 1. In the normal operation of the system this current will flow through both transmitters and both receivers, but will not, if it is of the proper frequency, cause troublesome sounds in the receivers. If, now, sound is produced against one of the transmitters D, the total reactance of the circuit will be varied and the current will tend to vary between certain values, depending on the constants of the circuit. I prefer to so design the system that these values are well within the extreme permissible limits *a a* and *c c*. These variations correspond very closely to the variations which would be produced by a microphone under similar circumstances, but may be made very much larger, owing to the peculiar shape of the resonance-curve and owing also to the fact that no microphonic noises are produced, so that the exciting-current may be given a comparatively large value.

In order to increase the capacity and the variations of the capacity of the transmitter, I may make use of the form shown in Fig. 3, in which P is a case, preferably heavy and solid at the rear, provided with a cover H and a recess for the plates d^2. These latter are packed closely together, separated, preferably, by extremely-thin sheets of soft rubber or similar material. Alternate plates are connected together, and the two terminals are carried out at *f f'*. It will be seen that I thus provide a condenser-telephone of great power very suitable for use with my improved system.

Fig. 4 shows a system in which the transmitter D is arranged to vary the self-induction rather than the capacity of the circuit. Otherwise the arrangements are very similar to those shown in Fig. 2. Each transmitter consists of a case P', containing a core *h*, preferably of a horseshoe form, as shown, wound with wire and placed with its ends in close proximity to the diaphragm *d*, which is preferably of soft iron and rather thick. It will be obvious that any variation of the position of the plate *d* will cause a variation in the reluctance of the magnetic circuit and in the self-induction of the electric circuit. This will vary the reactance, and therefore the current, as does the variation of capacity in the form shown in Fig. 2. It should be understood that wherever hereinafter I refer to or show a transmitter without specifically stating its character I may use either of the forms shown or any other instrument which will act to vary the resonance in accordance with the voice vibrations. It is also evident that either of the transmitters described will act as receivers, though I prefer to use separate receivers, and that while I prefer to use a condenser K and a coil F at each end of the line, yet in the forms thus far described I may dispense with either set. Nor is it necessary to use a separate coil F, as the receivers themselves may be constructed to furnish sufficient self-induction for the purposes to be attained. It is only necessary that the total self-induction and capacity be such that the circuit is nearly resonant.

The forms thus far described are open to the objection that they require that the capacity and self-induction of the line should be kept substantially constant. While this is practicable with short lines, it is exceedingly difficult when the lines extend beyond a certain length. I therefore prefer to use in most cases instead of a series system a multiple system with each station independently resonated. Such a system is shown in Fig. 5, in which G is the generator, connected across the lines L L' and preferably of high internal resistance. In the particular form shown in this figure the receivers R are branched independently across the lines and may, if preferred, be provided with condensers K' of sufficient power to facilitate the passage of current through them. These receivers should, however, be so arranged that the current flowing through them is not large in comparison with the current which flows through the transmitter-circuits.

The transmitter-circuits are constructed as follows: In multiple with the lines are transformers T T, each of whose secondaries is connected to a tuning combination K F and a transmitter D. In the normal operation of the system thus constituted current of constant volume flows through all four branch circuits, and the terminal voltage of the generator is constant. Suppose, however, that sound is produced against one of the transmitters D. This will vary, as before explained, the current in the local circuit of that particular transmitter, which in turn will vary the current taken by the primary of the corresponding transformer. The result will be to vary the terminal voltage of the generator and the current in the receivers, so that the sound will be reproduced in the receivers. This system lends itself readily to multiplex work, as shown in Fig. 6, in which a plurality of generators G G' G^2, producing currents of the frequencies ω ω' ω^2, are shunted across the mains L L'. Six substations S S' S^2 *s s'* s^2 are shown, each comprising a transmitter D, a receiver R, and a tuning combination F K in series. The circuits of the stations S and s are tuned to the position b b (see Fig. 1) on the resonance curve of the currents of the generator G, which currents are of the frequency ω. The circuits of S′ and s' are tuned in the same way to the frequency ω', and the circuits of S^2 and s^2 to ω^2. Each pair of stations S s, S′ s', S^2 s^2, &c., is therefore independent of all the others. The currents normally flowing through any of the stations, as s, may be varied by agitating the transmitter-plate at the coördinate station, as S, in such a manner as to reproduce in the receiver at the station s the sounds produced against the transmitter at S.

It will be obvious that the invention herein set forth may be modified in various ways and that important changes may be made without departing from the spirit of my invention.

The apparatus herein shown and not claimed in this case is reserved for the parent case, Serial No. 633,258, filed April 22, 1897.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The method of creating a telephonic current, which consists in impressing an alternating electromotive force on a circuit, and varying the reactance of the circuit around a point near but not at the resonance-point in substantial accordance with the sound to be transmitted.

2. The method of transmitting speech by electricity, which consists in generating an alternating current, passing it through a circuit tuned nearly but not exactly to resonance, and varying the reactance of the circuit in substantial accordance with the speech-wave.

3. The method of transmitting speech by electricity, which consists in generating alternating current, shunting said alternating current by a circuit tuned nearly but not to resonance, and varying the resonance of said circuit in substantial accordance with the speech-wave.

4. The method of transmitting speech by electricity, which consists in generating an alternating current, impressing it upon a circuit or portion of a circuit, and progressively varying the coefficient of self-induction of the said circuit by the action of a transmitter furnishing the inductance for said circuit.

5. The method of multiplex telephony, which consists in impressing upon a line a plurality of alternating waves of different frequencies, and gradually and progressively varying said waves in accordance with the sound-waves to be transmitted by varying the reactance of a transmitter-circuit around a point near to but not in resonance with one of said frequencies.

6. The method of multiplex telephony, which consists in generating a plurality of alternating currents, varying said currents in accordance with the sounds to be transmitted. by progressively varying the reactance of the transmitters, adjusted near to but not at the resonance-point, and causing the said currents, thus varied, to actuate receivers.

7. The method of multiplex telephony which consists in progressively varying the resonance of a plurality of branch circuits or local circuits, tuned to different frequencies, by the action of transmitters which furnish the inductance for said circuits, in accordance with the sound-waves to be transmitted.

In witness whereof I have hereunto set my hand this 13th day of May, 1903.

ALBERT G. DAVIS.

Witnesses:
BENJAMIN B. HULL,
MARGARET E. WOOLLEY.