No. 658,301. **Patented Sept. 18, 1900.**

W. G. URMSON.

TELEPHONE RELAY.

(Application filed Feb. 5, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

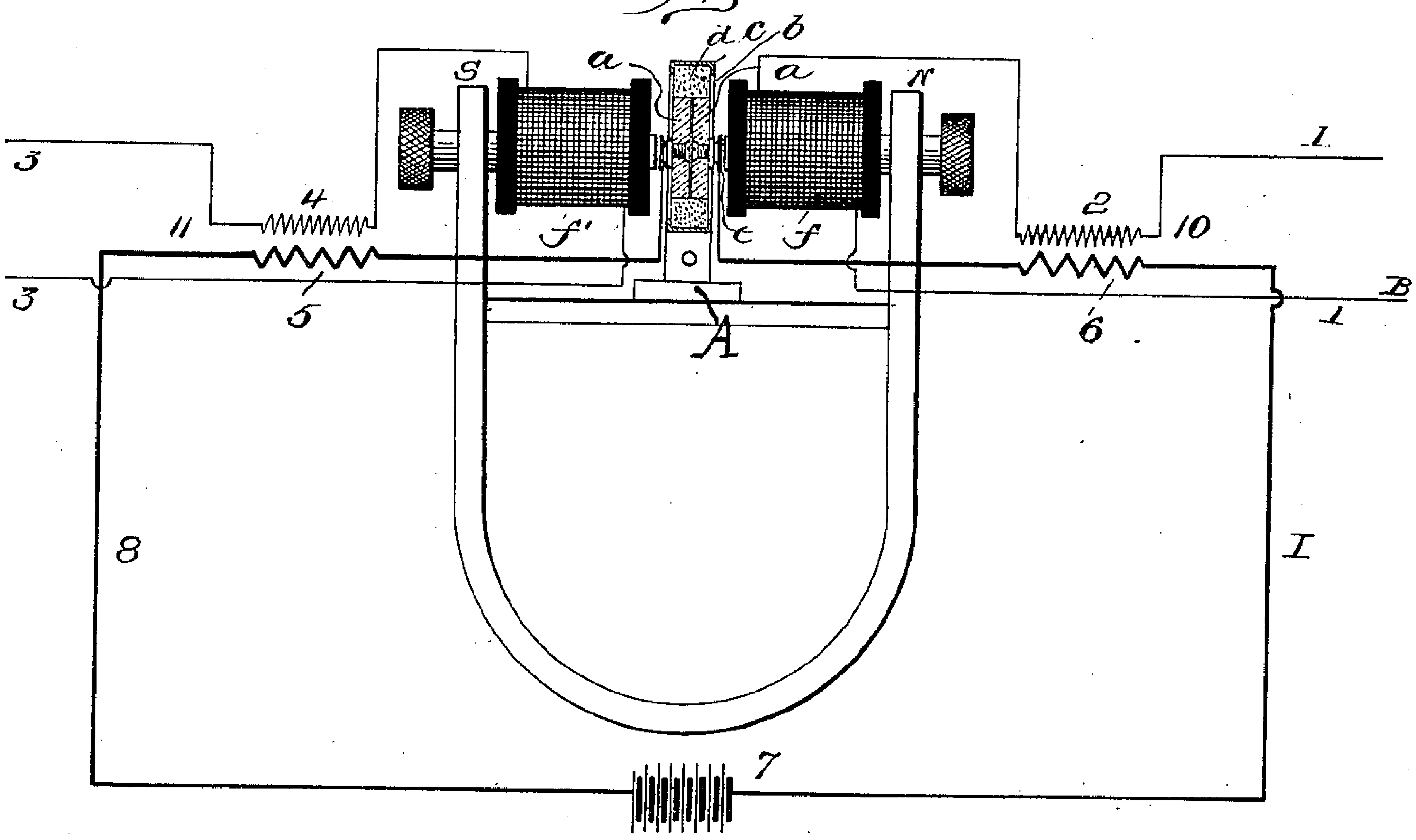

Fig. 2.

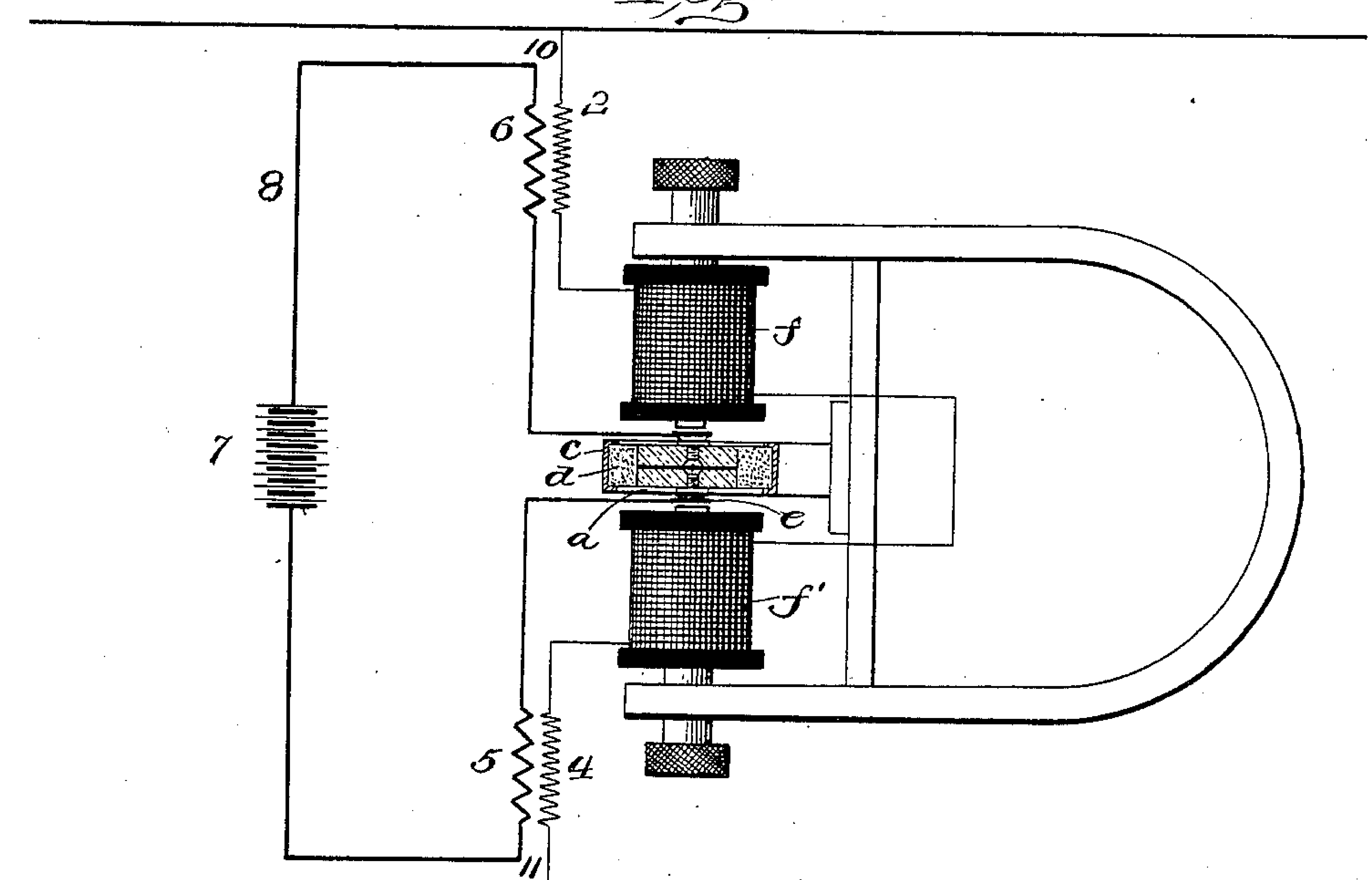

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Fig. 3.

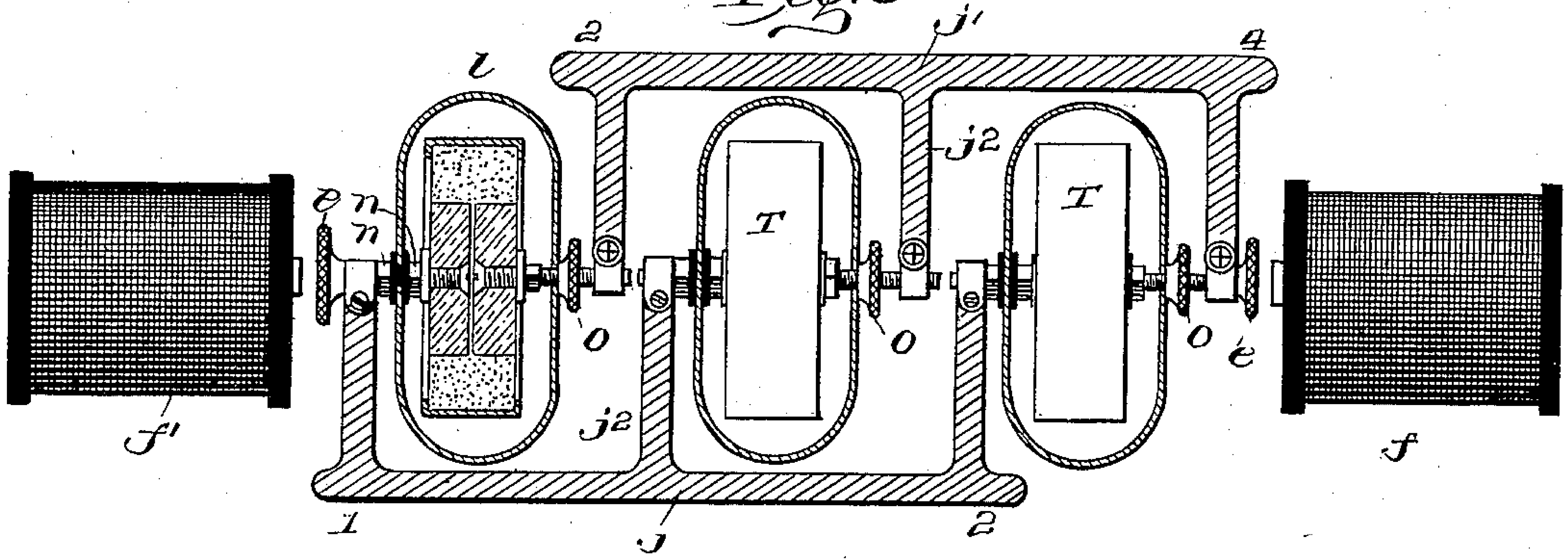


Fig. 4.

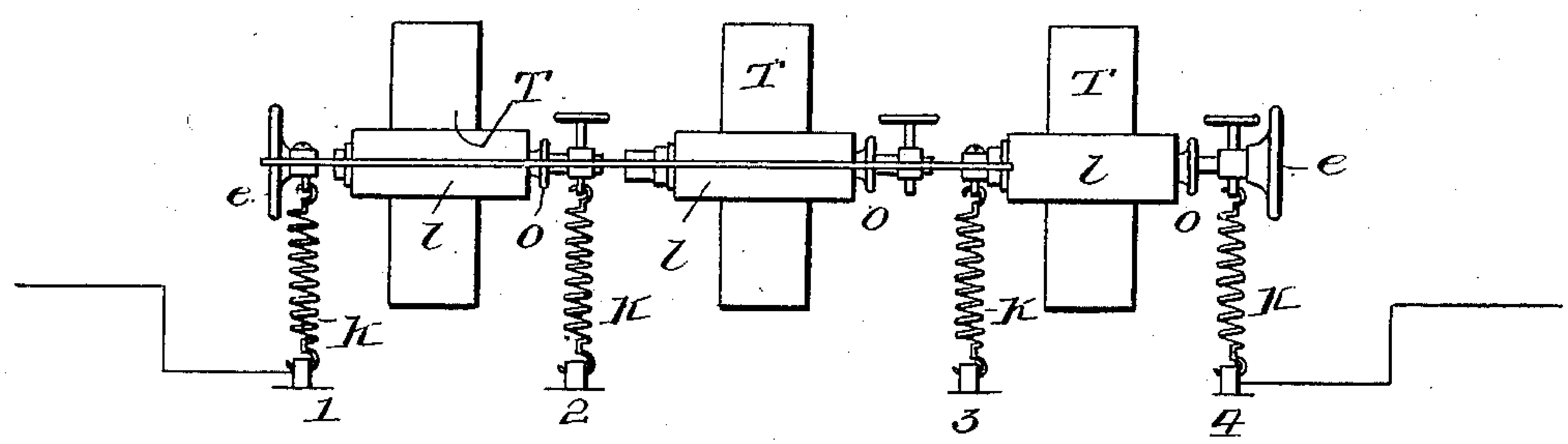
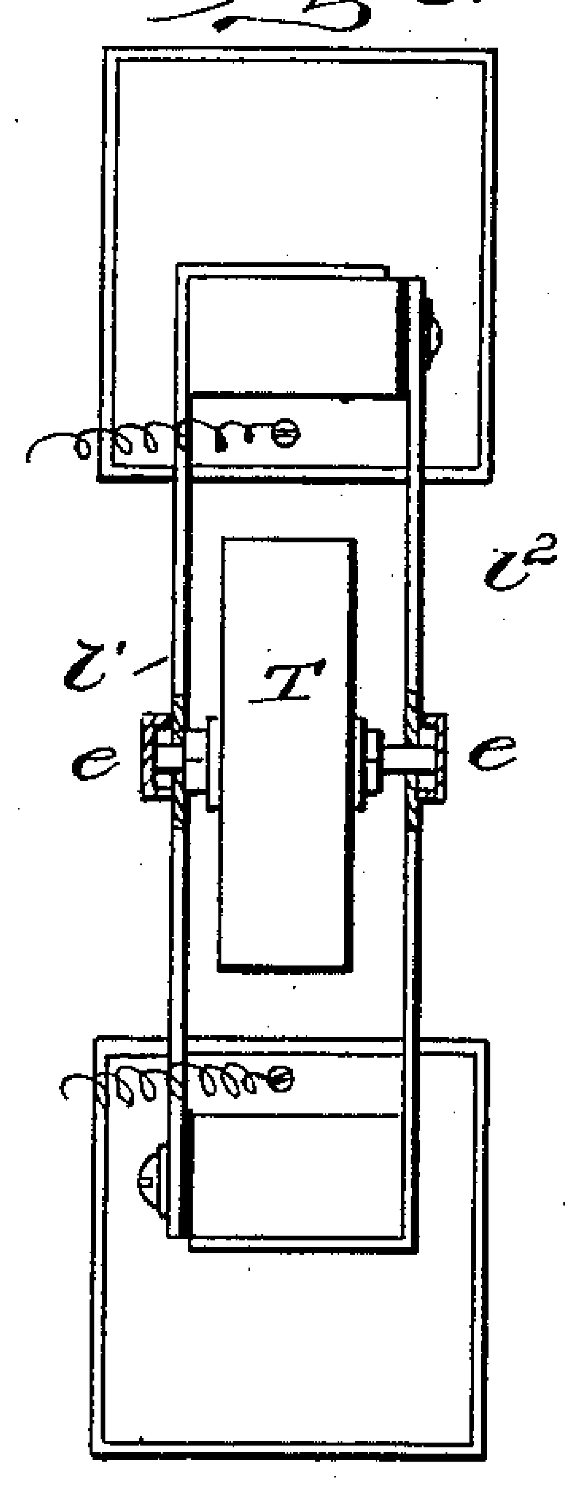


Fig. 5.



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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

WILLIAM G. URMSON, OF NEW BRUNSWICK, NEW JERSEY, ASSIGNOR OF THREE-FOURTHS TO JOHN W. PARSONS, HENRY A. HULL, AND JOSIAH TICE, OF SAME PLACE.

TELEPHONE-RELAY.

SPECIFICATION forming part of Letters Patent No. 658,301, dated September 18, 1900.

Application filed February 5, 1900. Serial No. 4,060. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM G. URMSON, a citizen of the United States, and a resident of New Brunswick, in the county of Middlesex and State of New Jersey, have invented certain new and useful Improvements in Telephone-Relays, of which the following is a specification.

The object of my invention is to construct a telephonic repeater which shall act in all respects as does a telegraph-repeater and which when inserted between the terminals of a telephone-line will repeat in amplified form telephonic currents arriving from either direction and will send them out in such amplified form in the opposite direction.

My invention may also be used as a booster—that is to say, as an instrument which is inserted in a bridge across the telephone-circuit between the telephone terminal stations and which operates on the current which has arrived from the transmitting-station and sends out such currents in amplified form to the receiving-station.

I have discovered that in telephonic repeaters a microphone which is adjusted by tension as distinguished from compression and which has an air-space between the electrode gives altogether remarkable and striking results. I refer, for instance, to such a microphone as is shown in the Patent No. 557,588 to Lockwood. The characteristic of such microphone is to be found in the fact that the electrodes are separated by an air-space, but are surrounded by granular material, the electrodes being held apart by suitable tension devices acting on the plates or diaphragms to which they are secured. Motion of the electrodes toward or from each other in such a construction is very free, being merely retarded by the friction of the granular material, which acts as a bridge between the electrodes. I regard the discovery of the peculiarly-efficient action of such type of microphone in a repeater as an important part of my invention.

Another important feature of my invention lies in the fact that I use electromagnets on the opposite sides of the microphone and combine such electromagnets each with an induction-coil the primaries of which are connected in a common local-battery circuit including the microphone. As will be explained later on, I secure hereby not only the double action of two electromagnets on a common microphone, but also a building-up effect of the current through the induction-coils and microphone. I may mount the electromagnets on the opposite poles of a permanent magnet, and thus act to increase and decrease the inherent magnetism of the poles by the telephonic currents. So, too, I may use a pair of magnets on each pole and connect them oppositely in pairs.

Aside from the electrical features to which I have above referred my invention relates to certain improved mechanism by which I secure the adjustment at the proper tension of the electrodes of the microphone which are separated by an air-space. It is necessary for proper operation that these electrodes be adjusted to a very precisely determined position—a critical point of poise. At such position of adjustment the microphone will act with great force and snap. The means of adjustment which I have invented permit of this ready adjustment.

In the drawings, Figure 1 represents a diagram of the circuit connection of my system when used as a repeater. Fig. 2 shows a diagram of these same circuit connections when my device is used as a booster. Fig. 3 shows a plan of the adjusting devices for a series of microphones. Fig. 4 shows a side elevation of the same, and Fig. 5 shows a plan of an adjusting device for a single microphone.

In Fig. 1 there is a permanent horseshoe-magnet N S, on the poles of which are mounted two electromagnets *f f'*. Between these electromagnets and on a base-plate A there is secured in any convenient manner a microphone composed of two electrodes *a a*, each attached to diaphragms *b b*, which are preferably of mica, said diaphragm being surrounded by an annular shell *c*, which parts inclose an amount of granular material *d*, which is, however, not permitted to fall into the space between the electrodes. The electrodes are held apart at a very precisely determined position of adjustment by suitable tension devices as distinguished from compression devices, a preferred form of which tension devices will be described later on. Soft-iron armatures *e* are secured to the diaphragms or the electrodes. The pole-pieces of the electromagnets *f f'*, acting on the armatures *e*, tend to pull the diaphragms apart. This tendency is balanced by the tension devices. It will therefore be seen that under normal conditions the electrodes of the microphone are in a very delicate position of poise and at what might be called a "critical" point of poise, so that the slightest variation in the electromagnetic force of the pole-pieces will produce most pronounced effects.

While I prefer the construction of microphone above described, I may also use such similar construction as is described in Lockwood's patent, No. 528,640, of November 6, 1894, and where it is not especially mentioned in the claims other types of microphones may also be employed, but not with such good effect.

The line 1 passes through the fine-wire secondary 2 of an induction-coil 10, through the electromagnet *f*, and back to the original stations or to ground. The line-wire 3 passes through the fine-wire secondary 4 of an induction-coil 11, thence through the electromagnet *f'*, and back to the station from which the line came or else to ground. The local circuit 8, in which is found the battery 7, contains two primaries 5 6, shown as in series with each other, which coöperate, respectively, with the secondaries 4 2 in the lines 3 1. As is well understood, the phase of the current coming over the line 1 and passing through the secondary coil 2 is one hundred and eighty degrees apart from the phase of the current which is thereby generated in the primary coil 6. The phase of the current in the coil 6 is the same as the phase in the coil 5, and this again is one hundred and eighty degrees apart from the phase induced in the coil 4. It follows that the phase of the current in the coil 2 of the line 1 is the same as the phase of the current in the coil 4 of the line 3. It is to be noted that the local-battery circuit 8 passes not only through the primaries 5 6 of the induction-coils 10 11, but also through the microphone-electrodes *a a* and the granular material *d* surrounding them. The electromagnets *f f'* must act in conjunction—that is, both electromagnets must act to pull apart the electrodes at the same time. Since the phase of the currents in these electromagnets is the same, as I have above explained, and since these electromagnets have pole-pieces which are of opposite polarity, it is therefore necessary that the windings of these electromagnets should be oppositely connected, and this is indicated in the drawings. When the current comes over the line 1 and passes through the electromagnet *f*, the current which is induced by means of the two induction-coils 10 11 into the electromagnet *f'* will cause both of these magnets to act simultaneously either to increase their magnetisms to simultaneously pull the electrodes apart or to decrease their magnetisms to allow the electrodes to move together. In either case the variation of the resistance brought about in the local circuit 8 by the operation of the microphone will act to reinforce the variation of current already brought about in the local circuit by the inductive action of the induction-coils 10 11. Thus if there be an increase of the current in the line 1 and electromagnet *f*, which by the inductive action of the coil 10 will generate a decreasing current in the local circuit 8, the same increase of current in the electromagnet *f* will act to pull apart the electrodes *a* to increase the resistance of the microphone and to diminish the current flowing in the local circuit. I thus get by the action of the microphone and its operating-magnets and the induction-coils what I term a "building-up effect," which is most marked and striking and which adds much to the efficiency of my repeater.

It is clear that the action of the arrangement shown in Fig. 1 is reversible. Weak telephonic currents which arrive over the line 1 are converted into strong telephonic currents which depart over the line 3; but at the same time weak telephonic currents which arrive over the line 3 may be converted into strong telephonic currents which go out on the line 1.

While I have shown a single electromagnet on each side of the microphone, it is clear that a pair of electromagnets might be used instead of a single electromagnet. Such magnets might be connected in parallel or in series, or the magnet *f* on the north pole of the horseshoe-magnet might be connected in series, but in the opposite direction, with a magnet on the south pole of the horseshoe-magnet. Such manifest variations in the number of magnets employed and their connections manifestly fall within the scope of my invention.

The arrangement shown in Fig. 2, which is of the booster type, will need but little additional explanation. We have the same microphone, the horseshoe-magnet N S, the electromagnets *f f'*, mounted thereon, the induction-coils 10 11, and the local circuit 8, with a battery 7. In this system, as in that of Fig. 1, current passing through coil *f*, which acts to increase the north magnetism of its core, corresponds to current passing through the magnet *f'*, which acts to increase the south magnetism of its core. This means that the connection of the bridge-line with the electromagnets *f f'* must be such as to pass the current oppositely through the windings of these magnets. The current in the secondary 2 is in the same phase with the current in the secondary 4. The current in the primaries 5 and 6 is one hundred and eighty degrees apart in phase from the current in the secondaries. It will be seen, therefore, that the conditions of the circuit arrangements of Fig. 1 are substantially reproduced. An increase of current in the bridge-wire and secondaries 2 4 causes a pulling apart of the electrodes of the microphone and a consequent decrease of the current in the local circuit 8. This builds up with a decrease of current in said local circuit, brought about by the inductive action of the induction-coils which is in proper phase therewith. I lay particular stress upon the fact that the secondaries 2 and 4 are in a bridge-wire across the telephone-circuit and are not in series in the telephone-line. The resistance to the telephonic current is thereby reduced.

In Figs. 3 and 4 I show a means for adjusting to the point of critical poise a series of microphones of the type which I prefer to employ. There is a pair of brackets j j', having arms j^2, which are supported on short stiff spiral springs k. In this manner the brackets j j' are supported with a reasonable amount of rigidity and are capable of moving back and forth under the action of the electromagnets f f'. The microphones T are preferably of the construction which I have before described. They are supported each between the opposite arms of an oval elastic spring l. This spring has a definite position of rest to which it tends to return. Short screws are secured to the centers of each of the diaphragms of the microphone. The screws on one set of diaphragms pass through apertures in the oval or other-shaped spring l and are secured to them by nuts n. In order that the microphone may not be short-circuited by the spring l, I use insulating material between the nuts n, screws, and springs l. Thumb-nuts o, acting on the screws of the other set of diaphragms, serve to regulate the tension of the springs l, and thus the tension of the diaphragms of the microphones. One set of screws is secured to the arms of the bracket j on one side of the apparatus, and the other set of screws is secured to the arms of the bracket j' on the opposite side of the microphone. Armatures e are secured to the brackets j j'. It is clear when the electromagnets f f' are energized the brackets j j' are pulled in opposite directions and the diaphragms of the microphones are pulled apart. When the magnetism of the electromagnets f f' decreases, the diaphragms of the microphone are moved toward each other by the resiliency of the oval springs l.

The point of the construction which has just been described is the function which it possesses of enabling a series of microphones, which are connected in series or parallel in a circuit, to have the tension of their respective electrodes readily adjusted each independent of the other and without interfering with the other. I have previously emphasized the fact that there is a particular position of poise at which the action of these microphones is most pronounced. It is necessary to adjust the microphones to this position of tension or poise. The arrangement shown in Figs. 3 and 4 enables this to be done with great readiness.

In order to adjust the microphone to the critical point of poise, I proceed as follows: I adjust the microphone with the tension devices and ascertain its sensitiveness by touching it or by talking or breathing against the variable resistance, a telephone-receiver having been inserted in the line 1 1 or in the line 3 3. The pole-pieces s s are then moved to or from the armatures e e until a singing is heard in the receiver, this being a position of equipoise between the pull of the tension devices and the opposing pull of the electromagnet. The equipoise is then destroyed, and the critical point of poise is found by moving the pole-pieces slightly either way until the singing ceases. The equipoise is thus destroyed and a critical point of poise is found—that is, a position where the impulses given by the pole-pieces are repeated and amplified; but there is no singing, because the operation effected between the tension devices and the pole-pieces is no longer automatic, but must be produced by an outside force, as from the transmitting instrument in circuit with the coil around the pole-piece. The very amplification and building up of the impulses which produces the singing at the position of equipoise thus acts to amplify the speech-currents at the critical point of poise.

In Fig. 5 there is shown a pair of parallel spring-arms l' l^2, mounted on suitable supports, which insulate the springs from each other. The microphone T is secured in a rotatable fashion in an aperture in the spring-arm l', and the screw, which is secured to the opposite diaphragm, works in a threaded aperture in a spring-arm l^2. By rotating the microphone bodily the action of the screw and thread presses the spring-arms l' l^2 apart or together and adjusts the diaphragms of the microphone to the proper position. Armatures e coact with the electromagnets.

The results which have been attained with the electrical apparatus described in this application have been remarkable, and conversation has been carried on over an amount of wire much greater than was heretofore possible.

For convenience I shall use the term "telephonic relay" to apply both to the repeater construction of Fig. 1 and to the booster construction of Fig. 2, so I use the word "microphone" to cover any suitable variable resistance.

There are some connections in which I should not use fine wire for my coils 2 4. Thus I may use magneto-transmitters at the subscribers' stations and dispense with the batteries at these stations. In this case my repeater would be at the central office and there would be switching devices to switch the calling-subscriber to the line-circuit going to one side of the repeater and the called subscriber to the line-circuit going to the other side of the repeater. In such case it will be advisable to reduce the line-resistance by not having high resistance or fine wire in the coils 2 4.

What I claim is—

1. A telephonic relay comprising the combination of a microphone having electrodes separated by an air-space, conducting material surrounding the electrodes, tension devices for holding the electrodes in a position of poise and an electromagnet for varying the action of the tension devices, substantially as described.

2. A telephonic relay comprising the combination of electrodes separated by an air-space, granular material surrounding and bridging the electrodes, tension devices for holding the electrodes in a position of poise and an electromagnet for acting on the tension devices to vary the current in the microphone, substantially as described.

3. A telephonic relay comprising the combination of a microphone, coacting electromagnets on opposite sides thereof, secondary coils in circuit with each electromagnet and primary coils, coöperating with the secondary coils, in a common local circuit, substantially as described.

4. A telephonic relay comprising the combination of a microphone having a pair of electrodes separated by an air-space, conducting material surrounding the electrodes, tension devices for holding the electrodes in a position of poise, coacting electromagnets situated on opposite sides of the microphone, secondary coils in circuit with each electromagnet and primary coils, coöperating with the secondary coils, in a common local circuit, substantially as described.

5. A telephonic relay comprising the combination of a microphone, a bipolar permanent magnet and coacting electromagnets mounted on the poles thereof and acting on the opposite sides of the microphone, substantially as described.

6. A telephonic relay comprising the combination of a microphone, a bipolar permanent magnet, coacting electromagnets mounted on the poles thereof and acting on the opposite sides of the microphone, secondary coils in circuit with each electromagnet and primary coils, coöperating with the secondary coils, in a common local circuit, substantially as described.

7. A telephonic repeater comprising the combination of a microphone, coacting electromagnets on the opposite sides thereof, secondary coils in circuit with each electromagnet and the incoming and outgoing lines respectively and primary coils, coöperating with the secondary coils, in a common local circuit, substantially as described.

8. A telephonic relay comprising the combination of a microphone having a pair of electrodes separated by an air-space, conducting material surrounding the electrodes, tension devices for holding the electrodes in a position of poise, a bipolar permanent magnet and coacting electromagnets mounted on the poles thereof and acting on the opposite sides of the microphone, substantially as described.

9. In a telephone-relay, a microphone having a pair of separated electrodes, conducting material surrounding the electrodes, spring-arms and adjustable devices for securing the electrodes to the spring-arms in a position of poise, substantially as described.

10. In a telephone-relay, a microphone having a pair of electrodes, spring-arms surrounding the microphone and adjustable devices securing the electrodes to the opposite arms, substantially as described.

11. In a telephone-relay, a microphone having electrodes, a spring, having one arm secured to one electrode, and a screw and thumb-nut for adjustably securing the other electrode to the other arm in a position of poise, substantially as described.

12. In a telephone-relay, a pair of brackets having arms, springs on which the brackets are supported and a series of microphones supported respectively between opposite arms of the brackets, substantially as described.

13. In a telephone-relay, a pair of brackets having arms, supporting devices for the brackets, a series of microphones, a spring surrounding each microphone having its opposite arms adjustably secured to the electrodes thereof, and connections between the bracket-arms and electrodes, substantially as described.

14. In a telephone-relay, a pair of brackets having arms, supporting devices for the brackets, a series of microphones having screws projecting from its opposite electrodes, a spring surrounding each microphone having one arm rigidly connected to one screw and the other arm adjustably connected to the other screw, and connections between the bracket-arms and the screws, substantially as described.

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

WM. G. URMSON.

Witnesses:
WM. A. GROBEN,
JOHN FLORANCE.