No. 887,998. PATENTED MAY 19, 1908.

E. E. CLEMENT.

TELEPHONE AND CIRCUITS THEREFOR.

APPLICATION FILED JUNE 20, 1903.

2 SHEETS—SHEET 1.

Fig. 1.

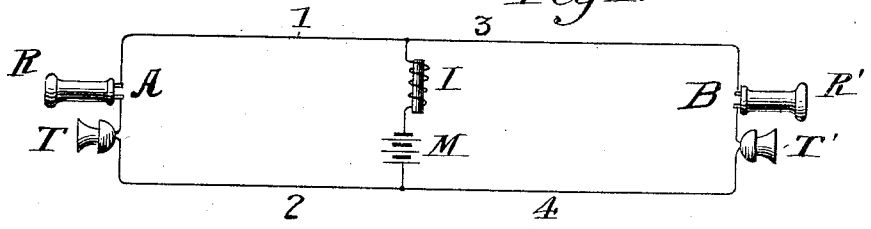


Fig. 2.

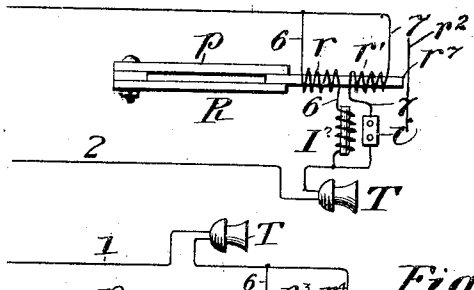
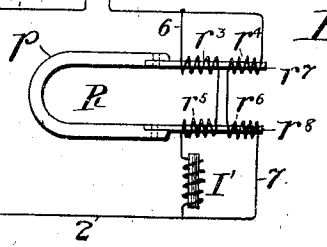


Fig. 3.



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Flora Raymond

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2 SHEETS—SHEET 2.

Fig. 6.

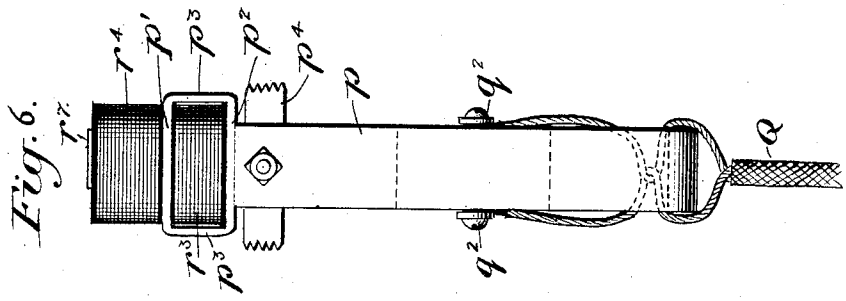


Fig. 5.

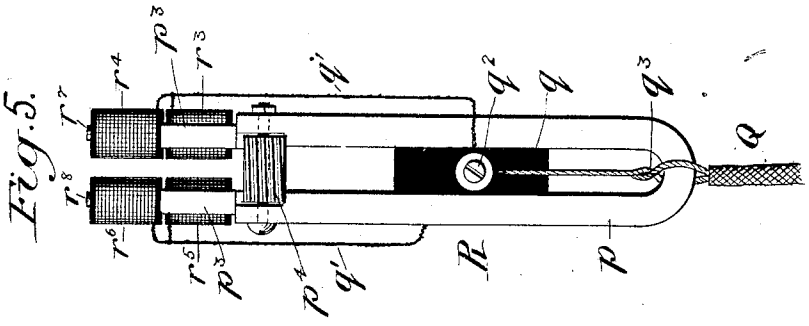
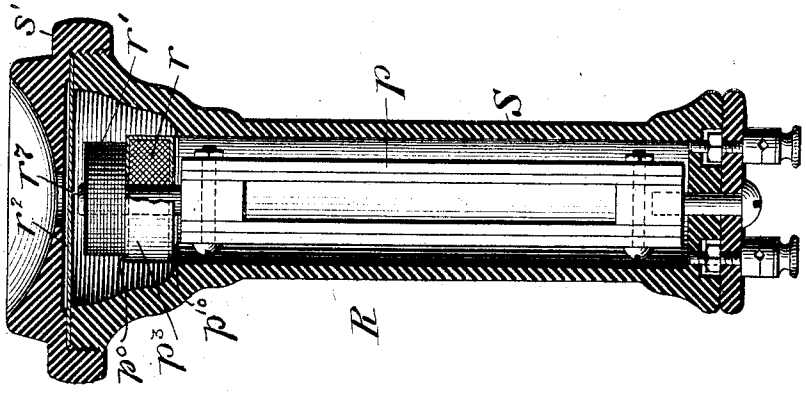


Fig. 4.



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Inventor:
Edward E. Clement.

UNITED STATES PATENT OFFICE.

EDWARD E. CLEMENT, OF WASHINGTON, DISTRICT OF COLUMBIA.

TELEPHONE AND CIRCUITS THEREFOR.

No. 887,998. Specification of Letters Patent. Patented May 19, 1908.

Application filed June 20, 1903. Serial No. 162,338.

To all whom it may concern:

Be it known that I, EDWARD E. CLEMENT, a citizen of the United States, residing in Washington, District of Columbia, have invented a new and useful Telephone and Circuits Therefor, of which the following is a specification.

My invention relates to telephone instruments, and the circuits interconnecting the same, and is particularly concerned with such instruments and circuits as are used in common battery systems.

It has for its object the improvement of both instruments and circuits to produce increased efficiency and decreased expense of production and maintenance, and while it is principally applicable to the subscriber's station apparatus, it will be sufficiently apparent from the detailed description hereinafter given that it may also be applied to portions of the central station equipment.

In common battery systems the current supplied for the subscribers' transmitters, as well as for signaling, is derived from the central station where is located a suitable source, usually a secondary battery. As metallic circuits are now exclusively prescribed by the rules of good practice, and as the transmitter in many cases has to vary directly the resistance of a circuit, comprising the line wires and a portion of the connections at central, as well as its own contacts and its correlated receiving apparatus, it has been found advantageous to raise the voltage of the current supply, until at present 50 volts has come to be regarded as the standard. Before this raising of the voltage, however, the problem of how best to connect the receivers in circuit had already been considered, and two solutions found, one or the other of which has been adopted by almost every operating concern. Even with the former difference of potential of 20 volts, it was thought inadvisable to place the receiver directly in the line circuit; hence one common method of connection has been to include one winding of an induction coil in the line, and the other winding in a local circuit with the receiver; and the other method has been to provide two paths for current, the receiver being included in one path conductively discontinuous and inductively continuous by reason of the inclusion of a condenser, the battery current taking the other path, and the transmitter as before being directly in the circuit. Some modifications of these arrangements have been worked out and used, wherein the transmitter forms a part of an inductively complete local circuit including the primary winding of an induction coil whose secondary is to line, the line having current supply branches to the local transmitter circuit. Such an arrangement is really a combination of both the others, the transmitter being associated with the induction coil instead of the receiver. The first of these arrangements is objectionable principally on account of the losses in the induction coil, which impair the efficiency of receiving, materially. The second arrangement is objectionable because of the condenser, which is expensive and liable to derangement and is also bulky. In the modified condenser arrangement employing a transmitter induction coil, the efficiency of transmission is high, but it has been found that this is not due to the condenser, as if the receiver and condenser branch is broken transmission remains excellent. In order to avoid the use of either of these some of the operating companies have limited themselves to the primal arrangement wherefrom all telephony has sprung, viz., that in which the receiver and transmitter are both included directly in the line. In such case it is well if the voltage is raised substantially, for the resistance of the receiver windings is a considerable part of the entire resistance of the circuit; but on the other hand, the higher the voltage and the more current thereby forced through the receiver windings to the transmitter, the greater the risk of depolarizing the receiver magnet or of buckling its diaphragm, or both.

By the use of my present invention I am enabled to dispense with the condensers or receiver induction coils, include the receiver directly in the line with the transmitter, reduce the resistance of its windings to one-half that usually employed, prevent any magnetic effect on its pole pieces by direct current, and for alternating currents or voice currents to maintain its efficiency at a very high percentage.

My invention consists essentially in placing two equal and opposite windings on the receiver poles, connected in parallel to the receiver terminals, the branch containing one winding being caused to present a high impedance to alternating or voice currents, both branches being otherwise balanced. The windings may be "twin", that is laid on together and in parallel throughout on one

spool, in which case a separate impedance coil is included in series with one of them; or they may be on separate spools slipped on the magnet poles end to end, in which case I preferably make the coil farthest from the end of the pole of high impedance, as by giving it more turns and surrounding it with a complete magnetic circuit, in which case no separate coil is needed, and the other winding on the pole piece, being nearest to its extremity, has the greatest efficiency in producing effects on the diaphragm.

My invention is illustrated in the accompanying drawings, in which

Figure 1 is a diagram showing two subscribers' stations connected together, with a common source of energy, and the simplest mode of connecting the apparatus. Fig. 2 is a diagram showing a single pole receiver wound and connected at the subscriber's station according to my invention. Fig. 3 is a diagram similar to Fig. 2, showing the arrangements and connections of a bi-polar receiver. Fig. 4 is a sectional view of a single pole receiver embodying my invention, the magnet structure being shown in full lines, and Figs. 5 and 6 are similar views to Fig. 4, showing the mechanical construction and arrangement of a bi-polar receiver, the shell being removed in each case.

Referring to the drawings, in Fig. 1, 1—2 and 3—4 are the line wires leading to two subscribers' stations A and B, respectively. At station A, transmitter T and receiver R are included directly in the line circuit, and at station B, transmitter T′ and receiver R′ are likewise connected directly in the line circuit. At an intermediate point a talking battery M is bridged across the united circuits along with an impedance coil I. The current from this battery flows in both directions and supplies both substation transmitters, by the operation of which electrical waves are caused to pass in one direction or the other to affect the respective receivers, being choked out of the battery bridge by the impedance coil. This simple arrangement would be excellent in practice if the relation between the battery potential and the line resistances be such as to furnish a sufficient current flow and if this current flow did not injuriously affect the receiver. In attaining the necessary current flow it is desirable to keep the resistance of the receiver low, and yet in order to make it efficient for voice waves it should be wound with a sufficient number of turns to make its resistance somewhat high.

From the above diagram and the remarks made on the subject, the problem to be solved will have been rendered plain. It is this: to put the receiver in the line with the transmitter, as in Fig. 1, and yet keep the line resistance down and prevent the battery current from either depolarizing the receiver magnets or buckling the diaphragm. My solution of this problem is illustrated in Figs. 2 to 6.

Referring to Fig. 2, R is the receiver and T is the transmitter, as before. The transmitter is included directly in the line 1—2, but the receiver is included therein by means of two parallel branches 6 and 7. The receiver has a permanent magnet-structure p and a soft iron pole-piece r^7, upon which are wound the opposing coils r and r', connected in the branches 6 and 7, respectively, so that current coming from one line-wire and passing to the other will traverse these coils in relatively opposite directions. The branch 6 includes an impedance coil I^2, and the branch 7 includes a balancing non-inductive resistance i. The diaphragm of the receiver is indicated at r^2.

In ordinary practice the receiver winding approximates 100 ohms in resistance, and I preferably make each coil r, r' of approximately the standard number of turns and resistance. Now, suppose direct current coming from central to traverse line-wire 1, pass through the coils r and r' in parallel and oppositely, the branches 6 and 7 in parallel, and the coil I^2 and resistance i in parallel, the magnetic effects due to r and r' will be equal and opposite, and therefore their resultant will be zero, leaving the pole-piece r^7 unaffected, except by the permanent magnet. Suppose, however, that voice waves or alternating currents come over the circuits. Branch 6 will be practically impassable for them because of the high coefficient of self-induction of the coil I^2. They will therefore traverse the branch 7 and coil r' producing thereby substantially the same effect that they would in an ordinary receiver. Any slight leakage through the branch 6 would not affect the efficiency of the instrument through coil r, because as the coil r' is nearest the pole end, and as the coils are end on, any neutralizing effect would be infinitesimal. It is to be noted in this arrangement that for battery currents or direct currents the resistance of the receiver is divided by two, which is a long step toward raising the efficiency of transmission.

Referring now to Fig. 4, the usual rubber shell s with cap s' is shown in section, containing the magnetic structure p, its pole-piece and windings. The instrument shown is a single pole receiver the same as in Fig. 2, and a single soft iron pole-piece r^7 is shown provided with the two oppositely wound coils r and r'. Instead of making a separate impedance coil to choke out the voice waves from one of these windings, I prefer to construct the coil r so that it will have a very high coefficient of self-induction. This I accomplish by inclosing it in a soft iron jacket so as to give it a closed magnetic circuit. I may also give it a greater number of

turns with a correspondingly increased resistance. A convenient form of jacket comprises the punched out soft iron heads p^0—p^{10} and the tight fitting ring or sleeve p^3 compressed thereon. Sufficient iron should be employed in this magnetic circuit to insure a high retardation, and if desired both the heads and the sleeves may be protected against Foucault currents, but I have not found this to be essential. Two coils, r, r' are connected in parallel and their common wire connections conveniently terminate at the binding-posts as shown, on the end of the shell. The diaphragm r^2 is supported in front of the pole-piece beneath the cap s' in the ordinary manner.

Referring now to Fig. 3, I have shown a circuit arrangement similar to that in Fig. 4, but with a double pole-receiver connected up instead of the single pole-receiver. The horseshoe magnet p has soft iron pole-pieces r^7, r^8, which carry opposed windings, lettered r^3, r^4, r^5, r^6, respectively, r^3 and r^5 constituting one pair, and r^4 and r^6 the other. These respective coils, and the respective pairs, oppose each other in their magnetic effects, for direct current. The impedance coil I' being included in branch 6, however, chokes all voice currents into the other branch 7.

The mechanical construction of the bi-polar receiver is shown in Figs. 5 and 6. Here p is the permanent magnet, carrying soft iron pole-pieces r^7 and r^8. Between the limbs of the magnet a block of insulation q is fitted with the binding screws q^2 to which the ends of the cord Q are led. The pole-pieces carry the windings r^3, r^4 r^5 and r^6, as shown in Fig. 3, r^4 and r^6 being next to the ends of the pole-pieces. Each coil, r^3 and r^5 has a closed magnetic circuit comprising the core and a built up or laminated ring of soft iron whose members p', p^2 are in close contact with the cores, and are connected by side members p^3.

Between the ends of the magnet-limbs a distance piece or block p^4, preferably of non-magnetic material, such as lead or brass, has its ends threaded for the purpose of screwing into the rubber shell, which is not shown, in a well understood manner. The diaphragm lies in front of the pole-pieces as usual, and the connecting wires q'—q' to which the pairs of coils are connected in parallel, pass to the screws q^2, there making connection with the cord conductors.

The reason I prefer not to incase each coil of my bi-polar receiver entirely in iron is that I thus bring the magnetic circuit too near to continuity between the coils, and I prefer to use the iron rings shown, set flatwise to each other, because thus a wider air gap is maintained between the coils, and the lines of force through the diaphragm are not decreased.

While I have described my improved receiver as used in connection with common battery circuits, I wish it to be understood that it is equally efficient, and may be useful, in circuits of all types. Its cost is but a trifle more than that of the ordinary receiver, its efficiency is quite as high, and it can be used as a standard article on all lines with equal success.

I do not wish to limit myself to the specific mechanical construction shown, but wish it to be fully understood that I am well aware of many variations that might be made without departing from the spirit of my invention. I believe I am the first to successfully produce a metallic circuit wherein a receiver may be included directly, being neutral for continuous currents but active for alternating currents.

When my arrangement is employed in common battery systems a very important advantage attained is the total or substantial absence of the sharp "clicks" due to the making and breaking of battery circuits in making connections. Even where there is self induction in the circuit the clicks are reduced to the faintest sounds possible.

I do not intend to abandon any of the matters canceled herefrom, but shall file a divisional application covering the same.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States is:—

1. In a telephone exchange system, a central office, a plurality of line circuits extending therefrom to substations, a common source of direct current supplying energy over said lines to the substations, and means at each substation to utilize said energy comprising the following instrumentalities: a pair of parallel bridges across the line, a transmitter connected in series with the line and both bridges, a receiver having a permanent magnet and an elongated iron pole-piece thereon with two differential windings on the pole-piece, one of said windings being nearer the end of the pole than the other and having its magnetic circuit passing through the diaphragm of the receiver only, while the other winding has such an arrangement of its coils and magnetic circuit as will offer impedance to alternating currents.

2. In a telephone system, a pair of subscribers' stations connected together for conversation, a common battery bridged across the connected lines to supply current to them both, means to prevent leakage of voice currents through the battery bridge, and means at each substation to utilize the battery current comprising the following elements: a pair of parallel bridges across the line, a transmitter connected in series with the line and both bridges, a receiver having a permanent magnet and an elongated iron pole-piece thereon with two differential windings on the pole-piece, one of said wind-

ings being nearer the end of the pole than the other and having its magnetic circuit passing through the diaphragm of the receiver only, while the other winding has an iron return-circuit for its lines of force whereby it will offer high impedance to alternating currents.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

EDWARD E. CLEMENT.

Witnesses:
FRANK D. ORME,
FLORA RAYMOND.