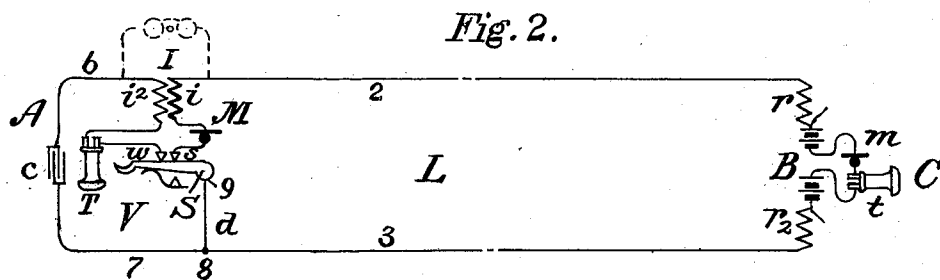
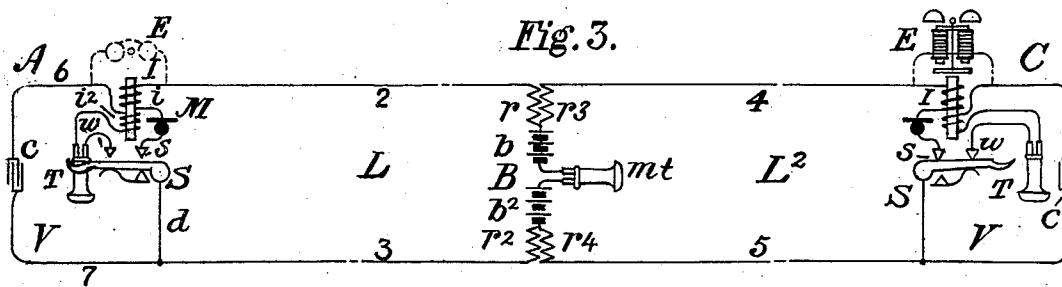
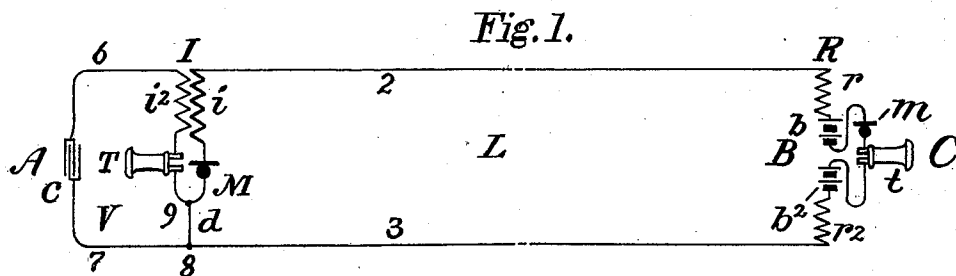


A. B. STETSON.
SUBSTATION TELEPHONE CIRCUIT.

APPLICATION FILED MAR. 31, 1903.

NO MODEL.



WITNESSES:

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ALMON B. STETSON, OF MALDEN, MASSACHUSETTS, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SUBSTATION TELEPHONE-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 732,795, dated July 7, 1903.

Application filed March 31, 1903. Serial No. 150,469. (No model.)

To all whom it may concern:

Be it known that I, ALMON B. STETSON, residing at Malden, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Substation Telephone-Circuits, of which the following is a specification.

This invention relates to variable-resistance transmitters and their operation, and especially concernssubstation or subscribers' station circuit arrangements for instruments of this character by means of which the disturbing effects which tend to be exercised by such transmitters on the associated receiver or receivers at the same station may be prevented or at any rate greatly reduced.

Sensitive and powerful transmitters such as are now employed not only reproduce the desired sounds or words in the receiver at the distant station, but also produce an echoing or resonant sound, colloquially termed the "side tone," in the associated receiver at the same or transmitting station. Moreover, in the operation of central-source telephone-exchanges involving toll or interurban lines it is often desirable in the interest of efficiency to supply the substation-transmitters with working current under higher voltage than has ordinarily been employed, and under such conditions the microphonic action is materially intensified, so that in addition to the side tone there is present an increased tendency to create and manifest in the home receiver buzzing and crackling noises and sounds, as well as to take up and reproduce all such sounds as are being produced in the immediate proximity of the instrument. The noise in the ear of the person using the telephone becomes under these circumstances so loud as to be both unpleasant and confusing and operates to disturb and disconcert the user, making it very difficult for him to follow the conversation or intelligently receive the message. To reduce such side tone and other disturbances to the lowest possible point and generally to prevent the disturbing effects attributable to undesigned or abnormal action of the transmitter from manifesting themselves in the associated or home

receiver and to effect this without materially reducing the volume of transmission, are the objects of this invention. Attempts have heretofore been made to attain some of these objects by specially-designed induction-coils with associated balancing resistances, examples of this class of device and arrangement being disclosed by Letters Patent of the United States issued to Theodore Spencer, No. 501,472, dated July 11, 1893, and to Charles E. Scribner, No. 552,730, dated January 7, 1896; but such arrangements while fairly satisfactory with transmitters of moderate power operating under the local-battery conditions shown in said patents are not completely successful under present conditions and apparently are not of a character capable of improvement or further development in such manner as to meet such prospective conditions as are now in sight.

In the modern practice of a common and central battery exchange the substation apparatus comprises the call-bell, the telephone-transmitter and an associated induction-coil, the telephone-receiver, the regular suspension-switch serving as a support for the receiver when unemployed and operating by the displacement and replacement thereof, and a condenser. When the said switch is in its normal or resting position with the receiver suspended upon the hook, the circuit is through the call-bell and condenser, such circuit in virtue of the inclusion in it of the said condenser preventing the passage of the steady current of the central-station battery, but readily permitting the operation of the polarized bell by the alternating currents of the central-station call-generator. When now the receiver is taken from the hook for use and the switch in consequence moves to its second and working position, the telephone-circuits of the substation are brought into operative relation with the main or line circuit and the central source of current. Until recently the substation telephone-circuit arrangement thus established has been substantially that of the United States Patent to Charles E. Scribner, No. 669,710, of March 12, 1901. In this system (the switch being,

as assumed, in its second position) the main circuit is conductively closed through one winding of the induction-coil, and a local transmitting-circuit is established which contains the telephone-receiver, the condenser, and the other winding of the induction-coil. The transmitter is placed in a section of conductor which is common to and forms a part of both circuits and is therefore itself connected both in the local and main circuit; but its direct action is nearly altogether restricted to the local circuit, its effects upon the main circuit and the distant receiver being mainly exercised through the associated induction-coil. The source of transmitter-current is in the main circuit at the central station, and when the said main circuit is closed at the substation by the action of the switch in moving to its second position; as stated above, there is developed a steady current which flows through the main line, the substation-transmitter, and the main circuit-winding of the induction-coil. Differences of potential between the two sides of the transmitter are determined by the resistance variations produced in the operation of said transmitter and as a consequence waves or surges in the local circuit, which circulating in the second winding of the induction-coil induce similar currents in the first winding thereof, and these flowing through the main circuit act upon the distant receiver and cause it to reproduce the sounds whereby the transmitter was originally actuated.

In many respects the foregoing operative arrangement for the telephone-circuits of substations is highly efficient; but it has a serious disadvantage in that it is subject in a high degree to the side-tone fault, which the present invention aims to prevent or remedy.

In the said present invention the transmitter is removed from that section of conductor which is common to both main and local circuits, being thus entirely separated from the circuit which contains the receiver, and consequently from the receiver itself, being placed instead in the main circuit alone, together with one winding of the induction-coil. This change is the cardinal feature of the invention and is productive of decided advantage, since by it the unpleasant and annoying side tone is practically done away with without material loss in the volume or quality of transmission. The invention as organized in a subscribers' or substation telephone apparatus or system of circuits thus comprises the main circuit or that part or loop thereof which is within the station, an associated local circuit wholly within said substation, and an induction-coil and condenser, one winding of said induction-coil, together with the station telephone-transmitter, being serially arranged in the main-circuit loop, while the receiver and condenser are similarly connected, together with the other winding of the induction-coil, in the local circuit.

The invention also consists in associating the organization thus constituted with the telephone-switch, the said switch being placed in a section of conductor common to the main and local circuits and being thereby adapted to control them both.

It further consists in combining the entire substation apparatus as thus constructed and organized with the telephone apparatus and common source of current of the central station, these being connected with the same main circuit, and likewise in a combination of a talking-circuit extending between two substations through a central station, the several instrumentalities at both substations being arranged in conformity with the characteristic feature of the invention as stated above, and the said talking-circuit being made up of two component circuits independently supplied with transmitter-current developed from a source of current located at the central station.

In the drawings which accompany this specification, Figure 1 is a diagram representing a single telephone-circuit extending between a central and a substation and having the several substation appliances and connections organized in conformity with the invention. Fig. 2 represents a similar circuit, showing the substation arrangement or system carried out more in detail; and Fig. 3 is a diagram illustrating the invention as applied to a talking-circuit formed of two component substation-circuits switched together at a central station.

In all of the figures, L is a main telephone-circuit extending between two stations A and C, the latter being shown as a central station and the former as a subscriber's station or substation.

The essential elements of the telephone or talking circuit system at the substation comprise the telephone-transmitter M and receiver T, the induction-coil I, the condenser c, and the suspension or telephone switch S. As indicated in Figs. 2 and 3, there is also the usual call-bell E, which, however, is but incidentally concerned in this invention and is in working relation to the main circuit only when the line is at rest, being shunted and placed out of operative relation in a well-understood manner when the main circuit is closed through the transmitter. The impedance of the call-bell magnets is so high that when thus shunted, as shown in Figs. 2 and 3, it does not in any degree affect the transmission and reception of voice-currents.

V is a local circuit contained wholly in the substation.

When the line is unemployed, the substation telephone-receiver T is suspended upon the hook or yoke of the telephone-switch S, which is therefore held in its lower and normal position. The said switch is provided with two contact points or stops, one of which, s, is a terminal of the main circuit, while the other, v, is a terminal of the local circuit. In

the said lower position of the switch S it does not make contact with the terminals *s* and *w*, and the main and local circuits are open at these points. At this time the main circuit L, though incomplete conductively and therefore impassable to steady currents, has an electrostatic extension through the bell E and condenser *c*, and the alternating call-currents transmitted from the central station are thus enabled to operate the bell in the usual manner; but when the receiver T is displaced or taken up from the switch S the latter moves to its upper or working position and into contact with the points *s* and *w*, shunting the bell E and closing the main circuit L and the local circuit V, both of which it thus controls at the points *s* and *w*, respectively. The main circuit thus established contains one winding *i* of the induction-coil I and the transmitter M and is traceable from its main conductor 2 by way of the said induction coil-winding *i*, transmitter M, switch-point *s*, switch S, and conductor *d* to the other main conductor 3. The receiving-telephone, the condenser, and the other winding *i*² of the induction-coil are all connected in the local circuit V when the same is closed, as described, at the point *w*, and the said local circuit, beginning at point *w*, may be traced through the receiver T, the coil-winding *i*², conductor 6, condenser *c*, conductor 7, point 8 on main-circuit conductor 3, conductor *d*, and switch S back to the said point *w*.

It is apparent that the conductor-section *d*, extending from the point 8 of main conductor 3 and local conductor 7 to the switch S at point 9, is common to the main and local circuits, and the said switch S, being a part thereof, is also common to and enabled to control both of the said circuits.

At the central station *r* and *r*² are the two halves of one winding of the repeating induction-coil R, *b* and *b*² are the two portions of a central battery B, and *m* and *t* respectively represent the central-station transmitter and receiver connected between the two halves *b* and *b*² of said battery. The coil-winding is shown as being split, so that one-half thereof is on each side of the battery in the usual manner to aid in electrically balancing the two sides of the metallic circuit, and the said battery in like manner is split, so that one-half thereof shall be on each side of the centrally-placed telephone instruments for the same purpose. This precise arrangement of the central-station devices is not, however, in any sense essential to the invention, and the battery, if desired, may be closed up and the telephones in any usual manner may be placed in a separate bridge of the circuit or switching devices and provided with a key or switch to establish or disestablish its connection with said circuit.

In Fig. 3 the receiver *m t*, shown as being placed alone between the two halves of the split battery and induction-coil, may be regarded as symbolizing the operator's tele-

phone instruments complete. The call-bell, which in Fig. 2 and at station A, Fig. 3, is indicated by dotted or broken lines, is at station B of Fig. 3 indicated more completely, and in the said Fig. 3 the switch at station A is shown as being in its lower or normal position, while at station B the receiver has been removed from the switch, which accordingly has moved to its upper and operative position.

In this invention the transmitter M acts directly upon the main circuit, throwing the supply-current into the necessary undulations or variations for the operation of the distant receiver, which, as in the case illustrated by Figs. 1 and 2 of the central-station operator's instrument, may also be directly in the same main circuit or, as in the cases illustrated by Fig. 3, may be at the central station bridged between the main conductors of the through talking-circuit or either component circuit thereof and at the distant substation connected in the local circuit associated with and inductively related to the component main circuit extending from the central station to the said distant substation. In all cases, however, the substation-receiver is in such a local circuit and becomes responsive to the distant transmitter only through and by means of the interposed induction-coil I. In previous systems of substation-circuits the transmitter of the substation, being in a conductor-section common to both main and local circuit, was in a position to act upon its associated receiver both directly and inductively, the result being that the side tone was very loud and piercing; but in the system of the present invention, where the transmitter is in the main circuit only, it does not directly act upon the home-receiver, and the side tone therefore is no longer of a piercing and annoying character, being, in fact, so reduced as to be negligible. At the same time there is no material loss in transmission.

In arranging the substation organization of this invention good results have been obtained by employing a standard seventy-five-ohm receiver and an induction-coil with a main-line winding *i*, having seventeen hundred turns of No. 26 wire and a resistance of seventeen ohms, and a local-circuit winding *i*², made with fourteen hundred turns of No. 31 wire, giving a resistance of twenty-six ohms. It has, however, been found that the proportions and magnitudes of said induction-coil may be varied within limits of considerable width without material difference in the volume or clearness of the reproduced speech.

The employment of the condenser *c* in the local circuit is advantageous in the highest degree, since its presence largely counteracts the impedance of the said circuit and the appliances included therein and improves the quality of the reproduced words by adding sharpness and clearness thereto.

The invention having thus been described, it is claimed as follows:

1. A telephone-circuit arrangement or system for a subscriber's station or substation, consisting of a main circuit extending outward from said station to a distant station; a telephone-transmitter connected in said main circuit only; an associated local circuit; a condenser, and a telephone-receiver connected in said local circuit; and an induction-coil having its windings in the said main and local circuits respectively.

2. A telephone-circuit arrangement or system for a subscriber's station or substation consisting of a main circuit extending outward from said station to a distant station; an associated local circuit; a telephone-transmitter in a part of said main circuit distinct from the local circuit; a condenser and a telephone-receiver in a part of said local circuit distinct from the main circuit; and an induction-coil having its windings in said main and local circuits respectively.

3. The combination in a telephone-exchange substation apparatus and circuit arrangement, of a main circuit or the station-section thereof; a telephone-transmitter, and one winding of an induction-coil, included serially therein; an associated local circuit set off or looped from two points of the conductor of said main circuit, and formed in part of the portion of said conductor included between said points but not containing the transmitter; and a condenser, a telephone-receiver, and the other winding of said induction-coil, connected in said local circuit; substantially as set forth.

4. The combination in a telephone-exchange substation apparatus and system, of the circuit connections of a main-circuit loop; a telephone-transmitter, and one winding of an induction-coil included serially in a part of said main-circuit loop distinct from the associated local circuit; an associated local circuit; a condenser, a telephone-receiver, and the other winding of said induction-coil all connected serially in said local circuit; a section of conductor common to the main and

local circuits; and the telephone-switch in such common section of conductor controlling both of the said circuits; substantially as set forth.

5. The combination with a main telephone-circuit extending between a central station, and a substation; a source of current such as a battery, connected therein at said central station; an associated telephone outfit, comprising a transmitter and receiver at both of said stations; of an associated local circuit, a condenser, and an induction-coil all at said substation; the substation-transmitter and one winding of the said induction-coil being included in the main circuit only, and the substation-receiver the condenser and the other winding of said induction-coil in the said local circuit; substantially as and for the purposes set forth.

6. In a telephone system, the combination with a talking-circuit extending between two substations through a central station, and formed of two component substation-circuits united for through communication at said central station; a telephone outfit comprising a transmitter and receiver at each substation; and a battery or like source of current associated with said component circuits at said central station, and adapted to supply current independently to the substation-transmitters of each; of an associated local circuit, a condenser, and an induction-coil, at each substation; the station telephone-receiver, the condenser and one winding of the said induction-coil being all included in said local circuit, and the transmitter and the other winding of said induction-coil being included in the main component circuit only, at each substation; substantially as set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 16th day of March, 1903.

ALMON B. STETSON.

Witnesses:

GEO. WILLIS PIERCE,
JAMES E. LYNCH.