March 21, 1933. J. W. GOODERHAM 1,901,958

SUBSTATION CIRCUIT

Filed March 2, 1931

FIG. 1

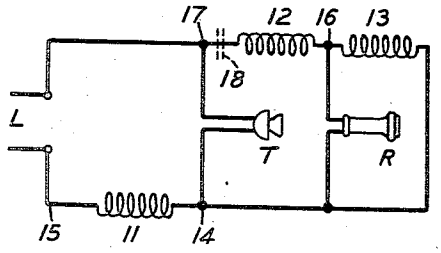


FIG. 1A

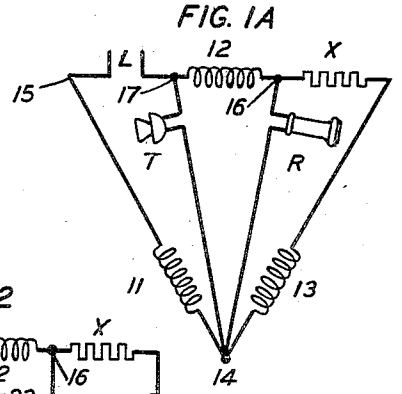


FIG. 2

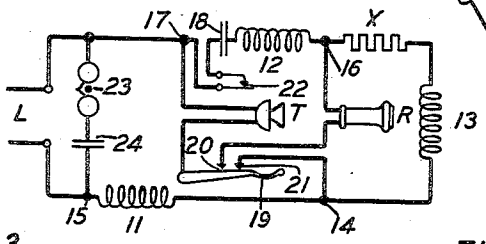


FIG. 3

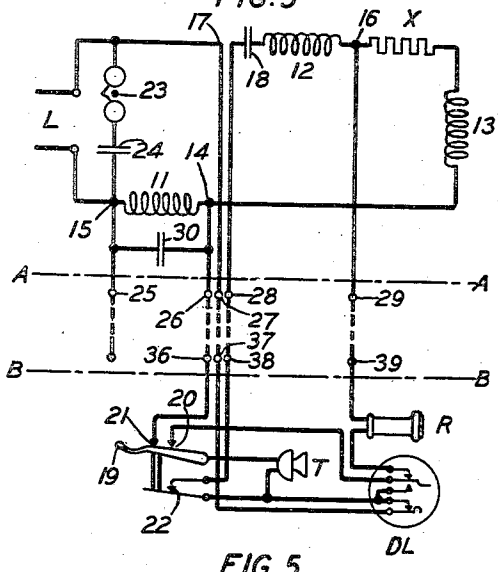


FIG. 4

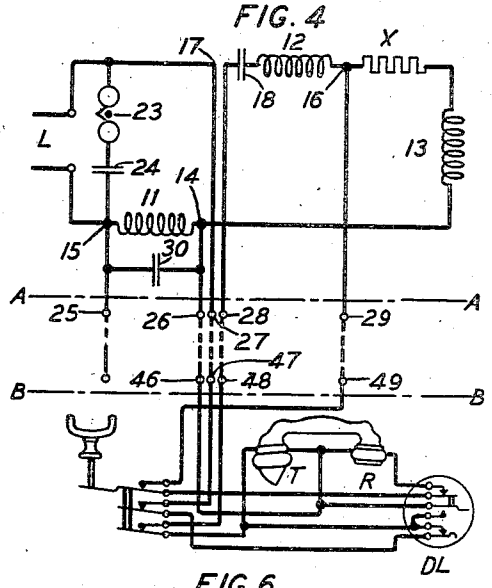


FIG. 5

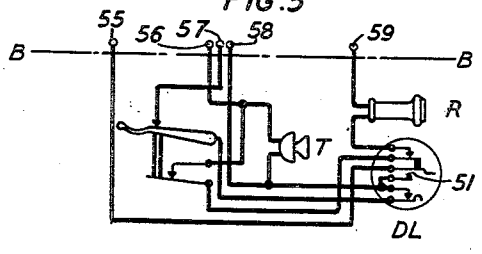
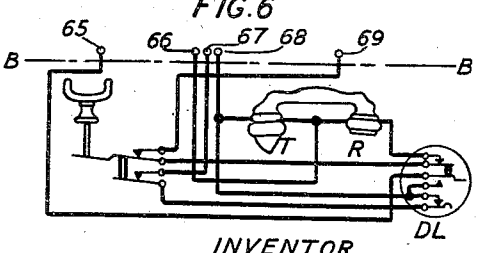


FIG. 6



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1,901,958

UNITED STATES PATENT OFFICE

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SUBSTATION CIRCUIT

Application filed March 2, 1931. Serial No. 519,406.

This invention relates to circuit arrangements for signaling systems wherein signals may be transmitted from or received at the same station. More specifically, this invention is embodied in a subscriber's telephone station or substation, as it is more commonly called, and more particularly in the combination of a substation and a telephone line.

The particular substation herein illustrated and described is a modification of a general type described in U. S. Patent 1,254,471 issued to George A. Campbell, January 22, 1918, and particularly the form shown in Figs. 4 and 4A of the said patent.

As stated in the patent to Campbell referred to above, telephone substations of the type therein disclosed comprise a transmitter, a receiver, a balancing network consisting in the simplest form of an auxiliary resistance and a transformer having a plurality of windings which, in combination with a telephone line are so designed that (1) the transmitter and receiver shall be conjugate, that is, there shall be negligible side tone in the receiver in consequence of the actuation of the transmitter by sound waves; (2) the line and auxiliary resistance shall be conjugate in order that a negligible amount of the energy absorbed by the substation from the line shall be wasted in said auxiliary resistance; (3) for a given line having a definite impedance, the telephonic energy delivered by the transmitter shall be a maximum; (4) the amount of energy delivered by the line to the substation shall be a maximum, in other words, the impedance of the substation as seen from the line shall be numerically equal to the impedance of the line; (5) at a small sacrifice of efficiency it shall be possible to discriminate effectively against disturbing line noise as distinguished from the telephonic signals from the communicating station.

A substation satisfying the above mentioned requirements is ideal in that its overall efficiency from the transmitter of one station to the receiver of the communicating substation is the theroretical maximum which cannot be exceeded by any two similar invariable substations whether satisfying the requirement of transmitter and receiver conjugacy or not. It is further ideal in that a minimum number of elements is employed since at least one auxiliary element is necessary to secure freedom from side tone.

It is an object of the present invention to adapt a circuit of the general type mentioned above to particular system requirements with economy of parts and simplification of wiring and assembly.

In the case of a common battery, anti-side tone substation circuit, it is desirable from a transmission standpoint that the capacity of the condenser, which is necessary to maintain all direct current from the line through the transmitter, be larger than the capacity of the condenser which is connected in series with the ringer. This requirement means that two condensers must be employed in the substation circuit.

In the case of a substation it is usual to provide a box which is commonly called a subset and in which is housed the ringer, the induction coil or transformer and the balancing network. This subset is connected by means of a cord having a plurality of conductors to a desk stand or handset which comprises the switchhook, receiver, and transmitter, and in the case of dial systems also includes the dial.

The invention provides a circuit in which these features are present and in which a minimum number of conductors is used for connecting the subscriber's set to the handset or desk stand.

Another object of the invention is the provision of means for decreasing interference effects on neighboring electrical circuits (e. g. radio sets) caused by the pulsations transmitted over the line when a dial is operated at the substation.

Other and further objects of the invention will be clear from the following description when read in connection with the accompanying drawing, in which:

Figs. 1 and 1—A are schematic diagrams illustrating the fundamental type of substation of which the substations illustrated in succeeding drawings are modifications;

Fig. 2 is a diagram showing the circuit of Fig. 1 in greater detail;

Fig. 3 is a practical arrangement of a substation fundamentally like that of Fig. 2 in which a so-called desk stand or wall set equipped with a dial is used;

Fig. 4 is a practical arrangement of a substation fundamentally like that of Fig. 2 in which a so-called hand set equipped with a dial is used;

Fig. 5 is a modification of the desk stand or wall set circuit connections shown in Fig. 3; and

Fig. 6 is a modification of the hand set circuit connection shown in Fig. 4.

Referring to Figs. 1 and 1—A, a telephone line L is connected to a substation comprising a transmitter T, a receiver R, and a three-winding transformer having two low resistance windings 11 and 12 and a high resistance winding 13 (which may include an auxiliary resistance X), said windings being on a common core and preferably having very small leakage. One terminal of the transmitter T, receiver R, high resistance winding 13 and low resistance winding 11 are connected together at a common point 14. The other terminal of the low resistance winding 11 is connected to one side of the line L at 15, the other terminal of the receiver R and the other terminal of the high resistance winding 13 (when the auxiliary resistance X is part of the winding 13) are connected together and to one terminal of the low resistance winding 12 at 16. The other terminal of the low resistance winding 12 is connected to the other terminal of the transmitter T and the other side of the line at 17. When it is desired to exclude the battery supply current from the receiver R and winding 12, a condenser 18 may be inserted preferably between the winding 12 and the connection of the transmitter T and the line L at 17.

The theory of operation of the fundamental type of substation shown in Figs. 1 and 1—A is the same as that described for Figs. 4, 4*a*, 5 and 6 in the above mentioned Campbell Patent 1,254,471 except that the fact that the low resistance winding 11 has been placed in the opposite side of the line must be taken into consideration. This low resistance winding 11, when located as shown in Figs. 1 and 1—A simplifies the construction of the induction coil in that it can be made with but four external connections and also simplifies the switchhook and cording arrangements which can be used with the circuit.

Fig. 2 shows the circuit of Fig. 1 to which has been added a switchhook 19, contacts 20 and 21 and a pair of contacts 22. When the receiver R is removed from the switchhook 19, the contacts 20 and 21 are in contact with the switchhook 19 and the pair of contacts 22 are closed as shown. Placing the receiver R on the switchhook 19 opens the normally closed contacts 22 thereby opening the circuit from the line L through the condenser 18, winding 12, auxiliary resistance X, winding 13 and winding 11, and also opens the circuit of the transmitter T and receiver R. A calling device 23 is bridged across the line L in series with a condenser 24. This condenser preferably has a capacity between ½ mf. and 1 mf.

An induction coil which has been found satisfactory for this type of subscriber's set was wound on a spool and mounted on a closed core of laminated silicon steel. The inner winding 11 comprised approximately 940 turns having a resistance of approximately 24 ohms, the inner terminal being arranged to be connected to the line L at 15 and the outer terminal connected to the inner end of the middle winding 13 at 14. The middle winding 13 and the auxiliary resistance X comprise approximately 245 turns having a resistance of approximately 50 ohms, the outer terminal being arranged to be connected to the inner terminal of the outer winding 12 at 16. The outer winding 12 comprises approximately 565 turns having a resistance of approximately 21 ohms. The middle winding 13 was wound in an opposite direction to that of the inner winding 11 and the outer winding 12. A condenser having a capacity of approximately 2 mf. has been found satisfactory for the condenser 18.

The substation in Fig. 3 comprises a so-called subscriber's set (shown above the line A—A) and a so-called desk stand (shown below the line B—B). The subscriber's set, and desk stand are connected together by means of a cord. The subscriber's set houses the signaling device 23 with its associated condenser 24 and the induction coil of the type described above in connection with Fig. 2 and its associated condenser 18. It is connected to the line L and provided with five terminals 25, 26, 27, 28 and 29 in addition to the line terminals. The desk stand comprises the receiver R, transmitter T, switchhook 19 with its associated contacts 20 and 21 and pair of contacts 22 and a dial DL, preferably of the type described in U. S. Patent 1,353,612 to Reeves, September 21, 1920. The desk stand is provided with four terminals 36, 37, 38 and 39. The terminals 26, 27, 28 and 29 of the subscriber's set are connected to the terminals 36, 37, 38 and 39 of the desk stand respectively by means of a four conductor cord. The terminal 25 of the subscriber's set is not used when the subscriber's set is connected to a desk stand of the type shown in Fig. 3 and its use will be described later in connection with Fig. 5. A condenser 30, the capacity of which is relatively small, is connected in shunt to the winding 11 of the induction coil when desired. This condenser reduces the interfer-

ence on neighboring radio sets caused by the pulsations transmitted over the line from the substation when the dial DL is operated.

The substation in Fig. 4 is similar to that of Fig. 3 except that a combined transmitter and receiver TR with its associated cradle contact switching mechanism of a type well known in the art are employed.

The desk stand in Fig. 5 is in general similar to that of Fig. 3. It is provided with five terminals 55, 56, 57, 58 and 59 which are connected (not shown) to terminals 25, 26, 27, 28 and 29 respectively of the subscriber's set of Fig. 3 by means of a five conductor cord. The switchhook contacting arrangement and the dialing contact arrangement have been modified so that the winding 11 will be included in the path which short-circuits the transmitter T when the dial DL is operated to transmit dialing impulses over the line. This short-circuiting path may be traced from the transmitter T, terminal 56, cord conductor to terminal 26, coil 11 at 14, the other terminal of coil 11 at 15, terminal 25, cord conductor to terminal 55, dial contact 51, to transmitter T. This short-circuiting of the winding 11 during dialing has been found to reduce the interference effects on neighboring radio sets caused by the operation of the dial. With a desk stand of the type shown in Fig. 5, the condenser 30 connected across the winding 11 on the induction coil may be omitted.

The hand set in Fig. 6 is in general similar to that of Fig. 4. It is provided with five terminals 66, 67, 68, 69 and 70 which are connected (not shown) to terminals 25, 26, 27, 28 and 29 respectively of the subscriber set of Fig. 4 by means of a five conductor cord. Provision is made in the circuit arrangement for the hand sets of Fig. 6 to include the winding 11 of the induction coil in the short-circuiting path for the transmitter during dialing in a manner similar to that employed in the desk stand of Fig. 5.

The invention is also capable of other modifications and adaptations not specifically referred to but included within the scope of the appended claims.

What is claimed is:

1. A signaling circuit including in series four components, the first of said components including a line, the second of said components including a winding of a transformer, the third of said components including a receiving instrument in parallel with a series arrangement of a balancing impedance means and a second winding of said transformer, the fourth of said components including a third winding of said transformer, a transmitting instrument connected in shunt with a series connection of said first and second components, said three windings being terminated on four terminals and having a common magnetic field, a contact common to said transmitting instrument, said receiving instrument and two of said transformer windings, a shunt circuit for said transmitting instrument, an impulse sending device and contacts controlled by said device for opening the circuit of said receiving instrument and closing the shunt circuit whenever said device is moved from normal.

2. A signaling circuit including in series four components, the first of said components including a line, the second of said components including a winding of a transformer, the third of said components including a receiving instrument in parallel with a series arrangement of a balancing impedance means and a second winding of said transformer, the fourth of said components including a third winding of said transformer, a transmitting instrument connected in shunt with a series connection of said first and second components, said three transformer windings being terminated on the four terminals, a contact common to said transmitting instrument, said receiving instrument said second winding and said third winding, normally open circuits for said transmitting instrument and said receiving instrument and said line, and means for closing said circuits.

3. A telephone system adapted for use with a common battery system including in series four components, the first of said components including a line, the second of said components including a winding of a transformer, the third of said components including a receiving instrument in parallel with a series arrangement of a balancing impedance means and a second winding of said transformer, the fourth of said components including a third winding of said transformer, a transmitting instrument connected in shunt with the series connection of said first and second components, said three transformer windings being terminated on four terminals, a contact common to said transmitting instrument, said receiving instrument, said second winding and said third winding, normally open circuits for said receiving instrument and said transmitting instrument, means for closing said circuits, an impulse sending device, means actuated by said device for transmitting impulses, and means actuated during the operation of said sending device for opening the receiving instrument circuit and shunting the transmitting instrument circuit and one of the windings of said transformer.

4. A signaling circuit comprising a transformer, a path for the transmission and reception of signals, a path including a transmitting apparatus, a path including a winding of a transformer, a resistance and a receiver, said receiver being included in a path shunted about said winding of said transformer and said resistance, said last men-

tioned path and a second winding of said transformer being included in a series circuit, said series circuit being shunted about said transmitting apparatus, said first mentioned path and a third winding of said transformer being included in a series circuit shunted about said transmitting apparatus, said three transformer windings being terminated on four terminals, said third winding of said transformer, said receiver, said transmitting apparatus and said first mentioned winding of said transformer having a common contact with respect to alternating signaling current.

5. In a two-way signaling system, a circuit for the transmission and reception of signals, a normally open transmitting circuit proper, a normally open receiving circuit proper, a balancing circuit, a transformer with three windings terminated on four terminals, said elements being so proportioned and related that said receiving circuit and said transmitting circuit proper are conjugate, contacts actuated by a switchhook for closing said normally open transmitting and receiving circuits, a receiving instrument in said receiving circuit, said receiving instrument being connected, through switchhook contacts, from a point common to two of said windings to a point common to a different pair of said windings.

6. A circuit according to claim 1 in which said transmitter, receiver, contacts and impulse sending device are grouped together and separated from said transformer, and a four-conductor cord interconnects the elements so grouped and the windings of said transformer.

In witness whereof, I hereunto subscribe my name this 27th day of February, 1931.

JOHN W. GOODERHAM.