F. M. SLOUGH.

TELEPHONE SYSTEM.

APPLICATION FILED JAN. 31, 1916.

1,282,966. Patented Oct. 29, 1918.

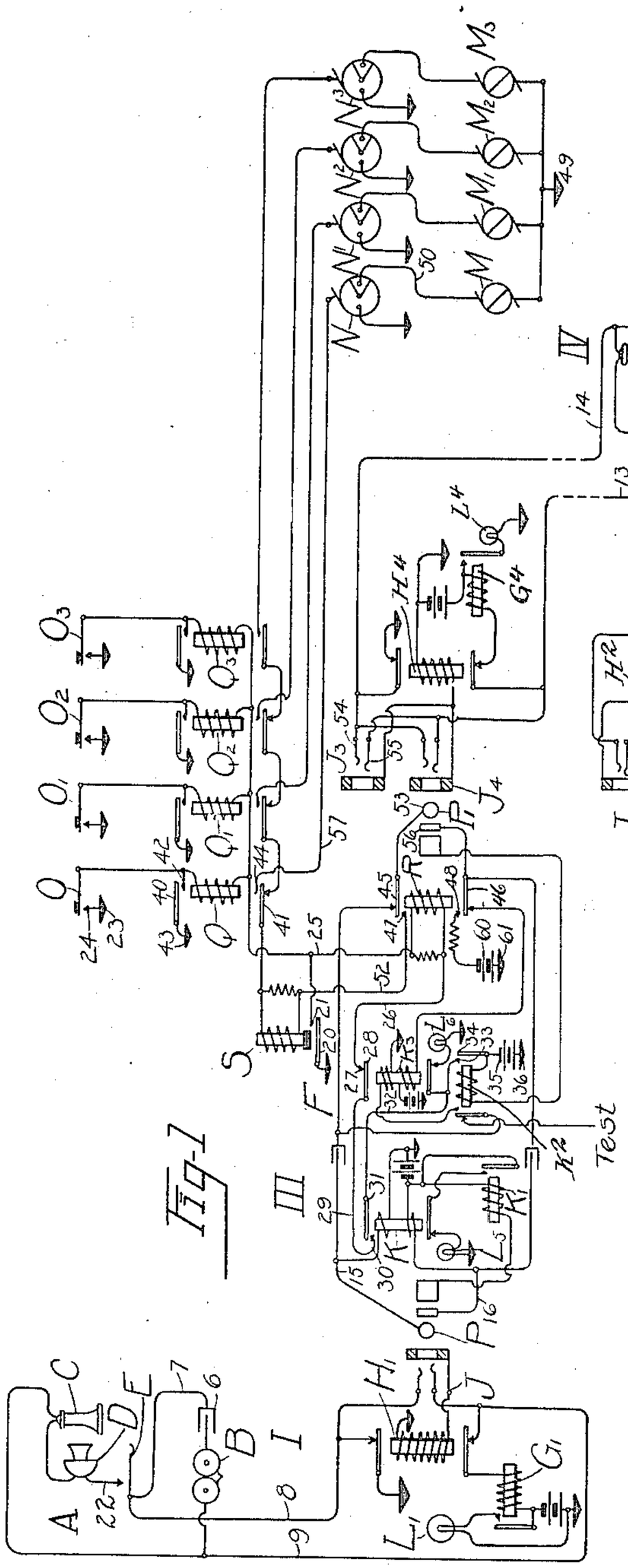

Fig-1

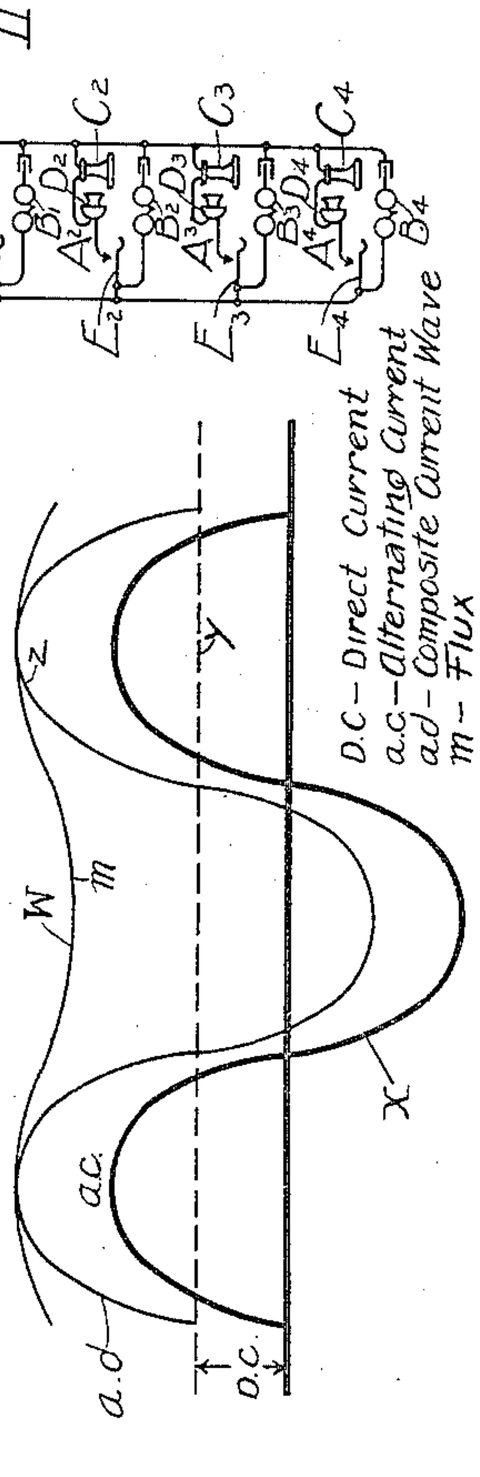

Fig-2

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,282,966. Specification of Letters Patent. Patented Oct. 29, 1918.

Original application filed November 12, 1914, Serial No. 871,666. Divided and this application filed January 31, 1916. Serial No. 75,222.

To all whom it may concern:

Be it known that I, FRANK M. SLOUGH, a citizen of the United States, residing at Elyria, in the county of Lorain and State of Ohio, have invented certain new and useful Improvements in Telephone Systems; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in telephone systems, and especially to improvements in what are known as automatic ringing systems, in which means are provided for continuing the ringing of the subscriber, after it has once been started by the operator, until the subscriber responds, when it is automatically disconnected through agencies under the control of the subscriber. In systems of this kind heretofore in use, so far as I am aware, the disconnect apparatus has been made such that it would respond to the substation signal operating current if the conditions happened to be right. For example, in the strength of current systems which are those almost universally in use, so far as I am aware, the disconnect apparatus has been operated by increasing the flow of current in the line, for example, by substituting a low resistance talking set for the high resistance bell bridge, and thereby increasing the strength of the current, so that the disconnect device would operate, whereas, it had refused to respond to the strength of current flowing before the low resistance bridge was placed upon the line. If, however, connection were made to a line upon which were a number of substations, the impedance offered to the flow of alternating current or signal operating current would be so reduced according to a well known law of electricity, that the flow of current would now be sufficient to operate the disconnect device just as effectively as if the subscriber had responded. Therefore, the first impulse of ringing current would disconnect the ringing current and the desired subscriber would never be rung.

Frequently, also, the conditions of a line are such that less current will flow over the same when the receiver is off the hook than will flow over a short line when the receiver is on the hook. If the disconnect apparatus is adjusted so that it will respond when the subscriber on the long or high resistance line connects the low resistance bridge in circuit with the line, then such disconnect apparatus will respond on a low resistance line with no low resistance bridge thereon, the resistance of the low resistance line and a bell bridge being less than the resistance of the high resistance line with a low resistance talking bridge. Owing to this and other objections to the present systems of automatic ringing in vogue, considerable limitation has been placed upon the use of the same, and the operating companies employing the same have been handicapped, especially where long country lines and short city lines center in the same exchange. This trouble has also been keenly felt where multi-party lines have been employed, and as these conditions of long and short lines, some of which are multi-party lines, are employed in practically all exchanges, the automatic ringing hitherto used has had its limitations.

Efforts have also been made, so I am informed, to cure these defects, one of which has been the employment of a specially constructed relay in the ringing circuit. One of the forms which has been employed for this purpose was constructed with a copper band around a portion of the core, the copper band being provided as a sort of closed secondary transformer winding for the purpose of dissipating the alternating current pulsations, the idea being to cause the relay to be insensitive to alternating current flow, at the same time being sensitive to direct current flow. Such expedients have failed largely because of the fact that such a relay is composed in part of a normally open magnetic circuit, and is, therefore, inefficient as a transformer, particularly to alternating currents of commercial frequencies used for the purpose of ringing telephone bells. Therefor, only a portion of the alternating current pulsations would be subdued by the copper band, the balance being sometimes sufficient to cause the operation of the relay. Such systems have been subject to the same defects heretofore described, in that

if a sufficient number of substations were upon the line, or if for other reasons the resistance or impedance of the line to the ringing current was sufficiently reduced, the specially constructed relay would intermittently respond. Others have sought to remedy the defect by excluding the bulk of the ringing current from that portion of the ringing circuit which controlled the cut-off controlling device, but these systems have likewise failed, because it is next to impossible to exclude all of the ringing current and at the same time enable the subscriber at all times to control the cut-off device, and if the system was so constructed that little or none of the ringing current passed through the cut-off control arrangement, the conditions would be such that for certain lines insufficient current could pass through to cause its operation. In fact, all of the automatic ringing systems hitherto in use, so far as I am aware, have been quite marginal in one respect or another, and conditions have been such that for certain lines they would operate improperly, and as such lines are always met with in practice, sooner or later, these systems have been defective.

Needless to say, numerous other efforts have been made to improve the system so as to make it meet all the conditions of practice, but so far as I am aware, this has not been done.

The object of my invention is to overcome these obstacles and to produce a cut-off device which will under no circumstances respond to the ringing current at all until the subscriber has responded. In accomplishing these, I wipe out all of the delicate adjustments, strength of current, marginal schemes, mechanisms for preventing the cut-off controlling apparatus from responding to fluctuating currents and other such delicate mechanisms, and provide a cut-off controlling mechanism which responds to the alternating current or not. My success lies in providing a cut-off mechanism which will not respond, even though its controlling mechanism is responsive to fluctuating currents. I further provide means controlled by the subscriber for causing the operation of the cut-off mechanism and a cut-off mechanism which will not respond until the subscriber starts the same into operation.

Other objects of my invention and the invention itself will probably be better understood from a description of particular embodiments.

This application is a division of my application #871,666, filed November 12, 1914.

Figure 1 is an illustration of the preferred embodiment of my invention.

Fig. 2 is a diagrammatic illustration of electric current and magnetic flux waves.

Referring now to the embodiment illustrated in Fig. 1, at I is shown a telephone line which may be here spoken of properly as the calling line, and which I have for convenience shown as a single party-line. At II is shown a second telephone line, shown for convenience as a multi-party line, and which may be properly called a called line. At III is shown a main station. Each telephone line is provided with substation apparatus, shown on the line I at A and which includes a signal bell B, a receiver C, a transmitter D and a switch-hook E. A condenser 6 may be included in the bell bridge 7. The line I is connected by line conductors 8 and 9 to the main station. The line II is provided with a plurality of substations, A_1, A_2, A_3, A_4. Each is provided with bells B_1, B_2, B_3, B_4, which are included in the telephone apparatus. This apparatus also includes receivers C_1, C_2, C_3, C_4, transmitters D_1, D_2, D_3, D_4 and switch hooks E_1, E_2, E_3, E_4. Condensers may likewise be connected in the bell bridges.

I have illustrated a third telephone line, shown at IV, which may also be called a called line. This line is provided with substation apparatus A_5 which includes a bell B_5, a receiver C_5, a transmitter D_5 and a switch-hook E_5. The line II leads by its line limbs or conductors 10 and 11 to the main station and the line IV leads by its line limbs or conductors 13 and 14 to the main station. At the main station means are provided for connecting the telephone lines together, here shown as a cord circuit, which consists of a plurality of strands including talking strands 15 and 16. Switching apparatus is provided for connecting the cord circuit to the telephone lines, here shown as plugs and jacks, the line I being provided with a jack J, the line II with jacks J_1 and J_2 and the line IV with jacks J_3 and J_4. The cord is provided with an answering plug P and a calling plug P_1. Of course the lines may be provided with any suitable number of jacks. Each line is also provided with line signals, the line I with the line signal L_1, the line II with the line signal L_2 and the line IV with the line signal L_4. Each line is also provided with line relays, the line I with the line relay G_1, the line II with the line relay G_2 and the line IV with the line relay G_4. Each line is also provided with cut-off relays, the lines I, II and IV being provided with the cut-off relays H_1, H_2 and H_4, respectively. The cord circuit is provided with suitable supervisory signaling apparatus, the answering end of the cord being provided with a supervisory lamp L_5 and the calling end of the cord being provided with a supervisory lamp L_6. These lamps are controlled by supervisory relays K, K_1 for the lamp L_5 and K_2 and K_3 for the lamp L_6.

Means are provided for operating the signal bells B, B_1, B_2, B_3, B_4, B_5. In the form shown these means are located at the main station and are illustrated as alternating current generators M, M_1, M_2, M_3. I have illustrated in the diagrams the apparatus which is employed in the well known harmonic selective signaling systems, in which four parties are generally employed, it being understood that I am not limited to a four party-line, but contemplate lines on which any number of subscribers may be connected. Of course, where but one subscriber is connected, but one generator is necessary. In this well known harmonic system each generator is adapted to produce an alternating current of a certain definite frequency and the bells at the substations respond one to each of these frequencies. This arrangement, however, may be employed without departing from the spirit of my invention. Means are provided for connecting one of the generators to the bell of the desired subscriber, in order that the bell may be operated by the current supplied by the generator. In the form shown, this connection is effected through conductors, switches, a portion of the cord circuit, the apparatus for connecting the cord to the lines and the telephone line. In the form shown I provide means for breaking up the ringing current into intervals, so that the subscriber's bell may be rung at intervals, avoiding an incessant ringing of the bell. These means are shown as commutators N, N_1, N_2, N_3 which rotate constantly alternately making and breaking the circuit of the ringing circuit. At O, O_1, O_2, O_3 are shown switches, here illustrated as manual switches controlling the connection of the generating means to the signal bell, one key being provided for each generator.

At Q, Q_1, Q_2 and Q_3 I show relays which are controlled by the keys O, O_1, O_2, O_3, which in turn control the connection of the generators to the lines. At R is shown a relay which controls the talking strands of the cord circuit and the connection of the ringing current to the telephone line. At S is shown a relay which controls the disconnection of the ringing current from the telephone line. This relay also controls the circuits of the relays Q, Q_1, Q_2 and Q_3. While the ringing is in progress, ringing current flows through the relay S, but the current produced by the generating means is of such a character that the armature of the relay S fluctuates without closing the switch 20—21 for any appreciable length of time, so that the connection between the ringing generator and the bell will not be interrupted. When, however, the character of the current flowing through the relay S is so changed that the magnet flux is constant or substantially unidirectional, the switch 20—21 is closed and whichever one of the relays Q, Q_1, Q_2 or Q_3 has been operated, will be deënergized and the connection between the ringing generator and the bell interrupted. The character of the current which flows through the relay S may be changed in a number of ways and the character of the flux in the relay S may be changed in a number of ways to effect the functions which it is to perform. In the form shown I have accomplished this change by superposing upon the alternating current produced by the generator a direct current, which, upon the response of the called subscriber, will cause a resultant current of a different character. In the embodiment illustrated in Fig. 1 the wave form will be changed with respect to the line of zero polarity. While the unmodified alternating current was flowing, the flux in the circuit of the relay S would be of alternating polarity, following the alternating current. However, when the current is shifted, its flux will be substantially constant, or of substantially uni-directional polarity, and the magnet will be operated for a sufficient length of time to cause the disconnection. However, when the alternating current alone is applied, the switch 20—21 will be closed for such brief intervals of time that the magnet Q will never let go its contacts.

The operation of the system illustrated in Fig. 1 is as follows: Assuming that the subscriber at A desires to communicate with the subscriber at A_5, the receiver C is removed from the switch-hook E, closing the switch E—22 and completing a circuit through the line relay G_1, causing the illumination of the line lamp L_1. This lamp is located so that it will attract the attention of the operator, who will insert the plug P into the jack J and in the well known manner learn that it is the subscriber at A_5 that is wanted. She then inserts the plug P_1 into one of the jacks J_4 and depresses one of the ringing keys, according to what character of current is desired. Assuming that the generator M produces the character of current desired, the key O would be depressed, completing a circuit as follows: ground at 23—contact 24—O—relay Q—conductor 25—relay R—conductor 26—27—28—29—30—31—32—33—34—battery 35—to ground at 36, energizing the relays Q and R, the relay K having previously been energized in the well known way when the plug P was inserted into the jack H through a circuit including the answering end of the cord and the calling line. The relay Q will attract its armatures 40 and 41, completing a locking circuit for the relay Q through 40—42 to ground at 43. The attraction of the armature 41 closes a switch 41—44 in the ringing circuit. The relay R attracts its armatures 45 and 46, interrupting the talking strands of the cord

circuit and closing the switches 45—47 and 46—48 in the ringing circuit. The ringing circuit will now be traced as follows: from ground 49—through M—conductor 50—commutator N—conductor 57—44—41—relay S —52—47—45—tip 53—tip spring 54—conductor 14—the bell B conductor 13—leaf spring 55—sleeve 56—46—48—battery 60—to ground 61. Thus current flowing through the relay S will rapidly energize and deënergize the same in such a manner that the switch 20—21 will be closed, if at all, only for short intervals of time. The periods for which this switch will be closed, if at all, will be functional to the frequency of and in harmony with the ringing current employed. The intervals of closure of this switch during the ringing period will be so slight that the shunting effect of the magnet Q will be ineffective to deënergize the relay Q, owing to the fact that the magnetism in a short-circuited relay decays very slowly. All during the ringing period, the condenser 62 at substation A_5 prevents the flow of direct current from the battery 60.

When the subscriber responds, the switch E_5—63 will be closed, owing to the removal of the receiver C_5 from the hook E_5, which may be spring pressed upward. This will shunt the condenser 62 and admit the flow of direct current from the source 60. As a result, a different kind of current will flow in the circuit, including a relay S, and as a result thereof the relay S will operate. In the form shown the current flowing in the circuit of the relay S, after the receiver is removed from the hook, will be an alternating current, which is shifted with respect to the zero abscissa, or it may be a pulsating current, according to the relative strength of the alternating and direct currents. This current will cause a substantially constant, or substantially unidirectional, flux to flow in the magnet S. The magnet of the relay S will now be energized for a sufficient length of time to hold steadily closed the switch 20—21 long enough to effectively shunt the magnet Q which will be deënergized, whereupon the armature 41 drops back, opening the ringing circuit at 41—44 and disconnecting the generator from the signal bell. At the same time, the circuit of the relay R will be broken, still further interrupting the ringing circuit and restoring the cord circuit. The subscribers will then be in connection and at the termination of the conversation, the operator will be apprised of the desire for the disconnect, and the plugs will be withdrawn, restoring the system to normal.

In Fig. 2 I have shown diagrammatically one theory upon which my apparatus may be operated. The curve X represents the flow of alternating current during the ringing period. The curve Y represents the direct current introduced into the circuit when the receiver is taken from the hook. The curve Z represents the polarized alternating current in the ringing circuit when both the ringing machine and the source 60 are connected to the ringing current. The curve W represents the flux in the relay S when both the ringing machine and the direct current are connected in the circuit.

I have shown the theoretical diagram illustrated in Fig. 2 as being a mere theory as to what might take place under a given set of conditions, but I do not wish to be limited either to the embodiment illustrated in Fig. 1 or to the theory of operation which I have illustrated in Fig. 2. In fact, I have illustrated this embodiment and this theoretical diagram in order to better explain my invention, and not that I may be limited thereto, as it will be apparent that many departures may be made from the modifications and the theory illustrated, especially when the claims are consulted.

I claim:—

1. In a telephone system, a main station, a telephone line leading to the main station, substation apparatus including a signal bell on the telephone line, a source of signaling current at the main station, a ringing circuit including said source, said line and said bell, a relay controlling said circuit, a circuit for the relay, contacts in the circuit, a second relay in the ringing circuit controlling said contacts and adapted to vibrate said contacts during the ringing period, said first named relay being unaffected when its contacts are thus vibrated, and means controlled by the substation apparatus to cause said second relay to close the contacts in the circuit of the first named relay for an appreciable length of time, whereby said relay is operated to interrupt the ringing circuit.

2. In a telephone system, the combination of a signal device, a source of current, a ringing circuit including said source and said signal device, a relay controlling said ringing circuit, a circuit for said relay, a shunt of said relay and a second relay in the ringing circuit controlling said shunt, a shunt of the second relay and a non-inductive resistance in said shunt and substation apparatus associated with the signal device controlling said second relay.

3. In a telephone system, the combination of a main station, a telephone line leading to the main station, substation apparatus on the line including a signal bell and a switch, means at the main station for generating current to operate the bell, a ringing circuit including said bell and said generating means, a relay for the ringing circuit controlling the same, a second relay in the ringing circuit governing said first-named relay, a shunt of the second relay

and a non-inductive resistance in said shunt and means including the switch at the substation controlling the slow acting relay.

4. In a telephone system, the combination of a signal device, a source of alternating ringing current, a ringing circuit including said source and signal device, a relay controlling said ringing circuit, a circuit for said relay, a shunt of said relay, a second relay responsive to a flow of polarized current to control said shunt to shunt said first-named relay, said second relay being irresponsive to alternating currents to cause the operation of the first relay, a shunt of the second relay and a non-inductive resistance in said shunt and substation apparatus associated with the signal device adapted to cause a flow of polarized current through said second relay to operate the second relay.

In witness whereof I have signed my name hereunto this 22nd day of January, 1916.

FRANK M. SLOUGH.