F. M. SLOUGH.

TELEPHONE SYSTEM.

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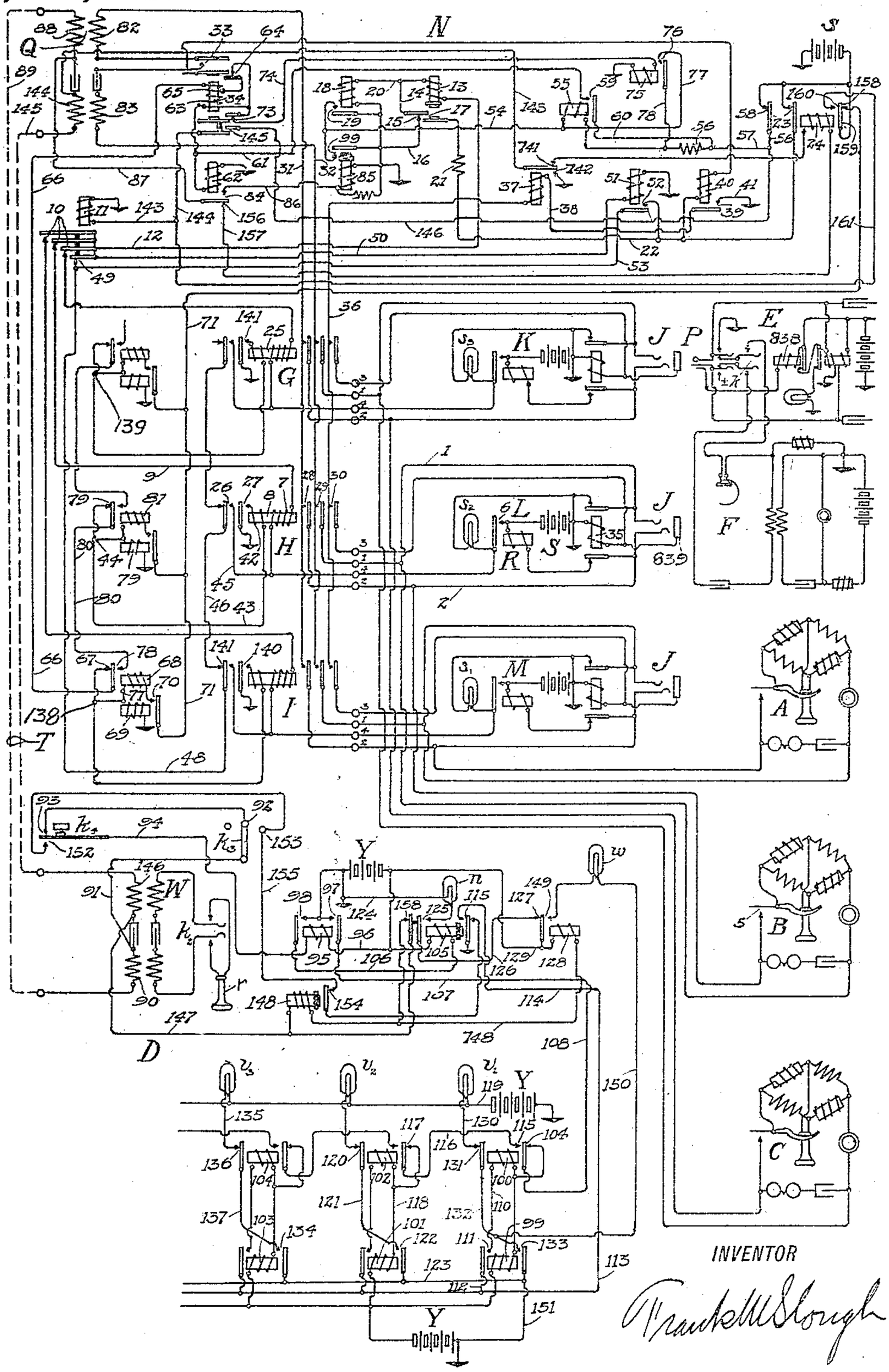

UNITED STATES PATENT OFFICE.

FRANK M. SLOUGH, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

1,294,841. Specification of Letters Patent. Patented Feb. 18, 1919.

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To all whom it may concern:

Be it known that I, FRANK M. SLOUGH, a citizen of the United States, residing at Rochester, in the county of Monroe, State of New York, have invented certain new and useful Improvements in Telephone Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone systems and more particularly to service observing systems for observing the character of service rendered on telephone lines by the operating force of telephone exchanges, and especially such systems in which the service upon any one of a plurality of telephone lines may be observed from a central point.

One of the objects of this invention is to provide improved signaling means for such a system, by means of which the number of the telephone line upon which the service is being observed, may be indicated to the observer.

Another object is to provide improved signaling means for such a system whereby the observer may be informed visually, as well as audibly, as to the various operating conditions of such an observed telephone line.

Other objects of the invention and the invention itself will be more fully understood by reference to the accompanying drawings illustrating an embodiment thereof.

As shown in the drawing, this invention comprises a service observing trunk T of two wires extending between a group of telephone lines, of which three are shown in the drawing at A, B and C, and a central observing switchboard comprising apparatus illustrated at D. The group of telephone lines may be composed of any number of lines, three only being shown in the drawing illustrating an embodiment of my invention.

At E, I show a cord circuit for answering the calls of any of the substations of the group of lines associated with the service observing system of my invention. This cord circuit E, of which there might be many at exchanges, is shown only in part, the answering end of the cord circuit being illustrated for the purpose of explaining the operation of the circuits involved, the calling end being omitted from the drawing; it is understood that the cord circuits may be any of the well-known types provided with answering and calling connecting switches of any approved type.

An operator's telephone set is shown at F, and is capable of being connected to the cord circuit E by a listening key *k*. Line signal lamps s_1, s_2 and s_3 are shown in connection with the respective line circuits whereby the operator at the exchange who is attending the answering of calls may be apprised of a call originating from one of the subscribers' stations at A, B and C. The line jacks J for each of the line circuits are provided to coöperate in the well-known manner with any plug P of such a cord circuit as the operator may use to answer the call, for instance, such as at E.

Line observing circuits shown at G, H and I are arranged so that the conductors thereof may be connected to the conductors of the line circuits K, O and M at the points 1, 2, 3 and 4, which preferably would be at the intermediate distributing frame of the telephone exchange. Common switching and controlling apparatus is shown at N for the group of line observing circuits. From the common apparatus N, a trunk line T leads to the service observing desk D at which are placed line indicating lamps v_1, v_2 and v_3.

In the embodiment illustrated, I show line observing circuit G with the line circuit K, line observing circuit H associated with the line circuit L, and line observing circuit I associated with line circuit M, therefore with the circuit connections as shown and which will be later described, I provide means whereby the indicating lamp v_1 indicates a call extended to the service observing desk D, over the trunk line T from a line circuit M. Likewise v_2 indicates a call from a line circuit L, and v_3 a call from line circuit K. Common signal lamps *n* and *w* are shown at the service observing desk to indicate to the observing operator that a call has been initiated, and that the call has been answered by the attendant operator at E, these indications being performed—first, by the signal lamp *n* becoming lighted at the initiating of a call, and the second, by signal lamp *w* becoming lighted when the call is answered by the at-

tendant operator; when the connection is taken down by the attendant operator both the common lamps n and w are extinguished.

At k_2, I show a listening key for the attendant operator whereby she may connect her telephone receiver r to the trunk line T, and thereby to the calling line through the intermediate apparatus at N, and thereby the attendant operator is enabled to overhear the conversation between the subscriber and the operator, and any subsequent conversation by either the subscriber or the operator during the ensuing connection.

I will now describe the means whereby a call initiated on one of the lines, for instance, from the substation B of the line circuit L, can be observed from the observing switchboard D and whereby during the various operating conditions, visual and audible indications thereof are conveyed to the operator at the observing switchboard.

Assuming that the subscriber at B initiates a call, the switchhook contacts 5 are closed completely, a circuit including a source of battery supply S, the line relay R, the conductors of the line leading to the substation B—including the contacts 5 of the switchhook at the substation B. This causes battery current to flow over this circuit, through the winding of the relay R energizing this relay, causing it to attract its armature, and closing a contact 6. This contact being closed battery current will flow from the source S through the contacts 6, through the line lamp s_2, and back to the source S by way of the ground terminal of the battery. Thus the line lamp s_2 would be lighted and an indication given to the operator whose telephone set is shown at F that a call has been made which should be answered. In addition to battery current flowing through the battery S, a circuit for the flowing of battery is also closed from the source S, the contacts 6; the conductor 4, the winding 7 of the relay 8, the conductor 9, contacts 10 of the relay 11, conductor 12, the winding of the relay 13, the conductor 14, contacts 15 of the relay 13, and the conductor 16 leading to the ground terminal of battery. Therefore, the relay 8 will be energized attracting its armatures and switching circuit connection in a manner to be later described. The relay 13 is also at this time energized attracting its armature, and therefore operating the contacts 15 and the contacts 17 controlled thereby. The contacts 15 being operated will open a circuit thereby causing the current which has just been described as flowing through the relay 13, and through these contacts to find a circuit instead through the alternative circuit which includes the winding of the relay 18 which is now energized and attracting its armature, closing contacts 19.

At the time the relay 13 was operated, a shunt for this relay and also the winding 7 of the relay 8 was provided as follows:—From the point 20, circuit conductor 14, now closed contacts 17 of the relay 13, the shunting resistance 21, conductor 22, the normally closed contacts 23 of the relay 24 to the negative pole of source of battery, S. The contacts 17 will remain closed up until the time of the operation of the relay 11 as will later be described, and after the operation of this relay 11 the circuit of the relay 13 will therefore be opened and release its armature, thereby opening the contacts 17. This shunt will not be sufficient to cause the relays 13 and 8 to deënergize sufficiently to allow the armatures thereof to be retracted, but will perform the function of reducing the available current in this circuit whereby relays of other line circuits corresponding to the relay 8, for instance, the relay 25 of the line circuit G, will not receive sufficient current to cause its subsequent operation were a call to occur on the line circuit K associated with the line observing circuit G immediately following the call on the line circuit L being described. In this way means are provided to prevent more than one line circuit to be connected to the observing system at a time.

It will be understood in speaking of the source of battery, that although this is shown in a number of places in the drawing, that this may be taken to mean simply one source of battery illustrated at various points for the sake of clarity, but it is understood that if preferred sources of battery additional to the one single source may be used, for instance, the source of battery Y illustrated at several points in connection with the observing switchboard apparatus D may be separate from the source S at the telephone exchange proper.

When the relay 8 was operated circuits were closed at its contacts at 26, 27, 28, 29 and 30, effecting circuit changes as follows:—The contacts 28 and 29 being closed extend the line conductors 1 and 2 of the calling telephone line, by means of conductors 31 and 32 to the terminals of the repeating coil Q, and thence when the contacts 33 of the relay 34 are closed to the trunk line circuit T which leads to the observing switchboard. The operator at the observing switchboard is thus placed in electrical telephonic connection with the subscriber in substation B, and will be able to overhear the operator at F whenever the said operator answers the call.

Also when the relay 8 is operated contacts 27 of the relay 8 will be closed forming a circuit path as follows:—from ground to the armature of the relay, the now closed contacts 27 thereof, the low resistance winding 42, circuit conductor 43 lead-

ing to a point 44. Thus ground potential of battery through a coil of very low resistance is placed on the point 44 of the circuit conductor 43 for a purpose later to be described.

The make contacts 26 also being closed when the relay 8 is energized, battery will flow over a circuit traced as follows:—from the negative pole of battery, through the contacts 6 of the relay R, circuit conductor 4, circuit conductor 45, contacts 26 of the relay 8, circuit conductor 46, normal contacts 141 of the relay I, circuit conductor 48, contacts 49 of the relay 11, circuit conductor 50, the winding of the relay 51 to the ground pole of battery. This will cause the energization of the relay 51 closing its contacts 52. The closing of the contact 52 furnishes a path for a locking circuit for the relay 8, maintaining relay 8 energized until what I will call the impulse sending interval is over. This locking circuit is traced as follows:—from the negative pole of battery, the normal contacts 23 of the relay 24, the circuit conductor 22, the contacts 52 of the relay 51, circuit conductor 53, the conductor 48, the normal contacts 141 of the relay I, the now made contacts of the relay H, the winding 7 of the relay 8, the conductor 9, the contacts 10 of the relay 11, conductor 12, the winding of the relay 13, the winding of the relay 18 to the ground pole of battery. Thus should the line relay contacts 6 be made intermittently or irregular by any reason, and thus fail to supply battery continuously to the winding 7 of the relay 8 as well as the windings of the relays 13 and 18, battery will be supplied continuously nevertheless over the locking circuit just described until the end of what I have called the impulse sending interval.

The relay 18 being operated as has been described, closes its contacts 19 and maintains them closed in view of what has just been said until after the impulse sending interval has lapsed.

The closing of the contacts 19 closes a circuit from the ground pole of battery, through the contacts 19, the conductor 54, the winding of the relay 55, the resistance coil 56, the circuit conductor 57, the normally made contacts 58 of the relay 24 to the negative pole of battery. The relay 55 is thus operated, its contacts 59 closing a path for current as follows: from the negative pole of battery, the contacts 58 of the relay 24, the conductor 57, conductor 60, contacts 59 of the relay 55, conductor 61 and thence through three branches of the circuit, each in parallel one with the other to ground battery; the first branch including the winding of the relay 62 which relay is energized and attracts its armature making certain circuit changes as will be later described. The second branch leads to ground through a shunted winding 63 of the relay 34, which is shunted by the contacts 64 of this relay and the unshunted winding 65, also of the relay 34, and thence through the circuit conductor 66, the normally made contacts 67 of the relay 68, and thence to ground through the winding of the relay 69. The relay 69 is operated closing the contact 70 which conditions the winding of the relay 68 for operation, but this relay will not at present be operated as long as contact 59 is closed, since the contact 59 causes battery to be connected through the unshunted winding 65 of the relay 34, which winding 65 is of extremely low resistance, and therefore negative battery potential will be for the time being exist from the end of the winding which is connected to the contact 67, and negative battery will also exist connected to the other side of the winding by means of the contact 70, circuit conductor 71, and the normally made contacts 158 of the relay 24, which are connected to the negative pole of battery. Negative pole of battery existing at both ends of the relay 68, this winding will not energize the relay until the condition is changed which will occur as will be later described by the opening of the contact 59 of the relay 55. Having thus described the two branches of the divided circuit, the third branch leads from the negative pole of battery as has been described through the contacts 59 of the relay 55, through the normal contacts 73 of the relay 34, circuit conductor 74 and the winding of the relay 75. The relay 75 will therefore be energized by current flowing through it over the circuit just described and will close its contacts 76, which contacts by means of the circuit conductors 77 and 78 form a shunt about the relay 55. A relay shunted in this manner will have the well-known property of releasing its attracted armature slowly which the relay 55 now does, and in an interval of time which may be about $\frac{1}{20}$ of a second opens its contacts 59 breaking the energized circuit of the divided circuit just described and provides results now to be related. First—the opening of the contacts 59 removes the battery potential from that side of the winding of the relay 68 which is connected to the contact 67, a ground potential being present through the winding of the relay 69, the relay 68 will now be operated over a circuit from ground through the winding of the relay 69, the circuit conductor 77, the winding of the relay 68, the contact 70 of the relay 69, circuit conductor 71, contact 158 of the relay 24 to the negative pole of battery.

The relay 68 being thus operated, its armature is attracted and opens the contact 67 previously closed, and closes the contacts 78, thus switching the circuit conductor 66 from

connection with the relay 69, connecting it for the time being to the relay 79 which corresponds to relay 69; being a similar one of a similar set of two relays, the unit sets being arranged as will appear in sequence one after the other, each set being operated by a current impulse over the conductor 66 as has been described, for the set including the relays 68 and 69, the operation of each set occurring in sequence until the current impulses cease. The winding 65 of the relay 34 through which the current impulses are sent is as above stated of very low resistance and consists of a very few turns of wire compared to the winding 63 which contains a great many turns of wire, and which winding is of higher resistance.

The current impulses prior to the last current impulse passing through the winding 65 are not of sufficient strength to cause the relay 34 to attract its armatures, the relay 34 being placed in the circuit mainly to cause a discontinuance of the said current impulse after a current impulse of sufficient strength passes through it, this necessarily being the last current impulse of a train of current impulses.

I have now described the circuit connections whereby the relay 55 is operated and whereby subsequent to this operation the relay 75 causes the deënergization of the relay 55 interrupting the current path momentarily provided by the contacts 59 of the relay 55. This being done the relay 75 will be deënergized as it is one operated through the said contacts 59, and the two relays continue to thus energize and deënergize one after the other until a current impulse of sufficient strength passes through the winding 65 of the relay 34 to cause a cessation of this action as will be now described. With the line circuit L calling, on the second current impulse passing through the contacts 59, the circuit conductor 61, the non-shunted low resistance winding 65 of the relay 34, the conductor 66, the now made contacts 78, the circuit conductor 80, the normally closed contacts 79 of the relay 81, and thence to ground over two paths, the first being of very low resistance and the second of higher resistance. The first being over conductor 43, the very low resistance winding 42 of the relay 8, the now closed contacts 27 to the ground pole of battery. This will provide a substitute locking circuit including the winding 42 of the relay 8 for the locking circuit which has previously been described and which contained the winding 7 of the relay 8.

The relay 79 in the other branch of the circuit will not be operated because of the shunting of its winding by the low resistance winding 42 of the relay 8. The circuit just described is of very low resistance, and therefore a large amount of current will flow over this circuit through the low winding 65 of the relay 34 causing a sudden and quick operation of the relay 34, which relay 34 will attract its armatures interrupting certain circuits and closing other circuits as will be described.

One of the circuits closed is the circuit for the winding of the relay 11 which is operated by current over a circuit as follows:— from the ground pole of battery, the winding of the relay 11, circuit conductor 143, the circuit conductor 144, now closed contacts 145 of the relay 34, circuit conductor 146, the normally closed contacts 58 of the relay 24, and thence to the negative pole of battery. The relay 11 being operated attracts all of its armatures interrupting contacts in each of the like line observing circuits, such as 10, and also contacts 49 common to all of the line observing circuits. The opening of the contacts 49 interrupts the circuit of the relay 51 which has been described, releasing its armature and opens the contacts 52, which as has been described, have been during the impulse sending interval maintaining current through the high resistance winding of the individualizing relay, such as 8 of the calling line observing circuit H. The opening of this locking circuit for the winding 7 of the relay 8 will not deënergize the relay, because prior to this time the additional locking circuit for the relay including the winding 42, contacts 27, and the winding of the relay 34 has been completed thereby maintaining this relay in operation. The contacts, such as 10, which are opened for all of the line observing circuits render any effort to affect the line observing circuits of any of the other lines futile during the operation of the relay 11. Thus I provide the means for enabling a single line circuit upon which a call has been initiated to operatively dis-associate all of the other of the group from the common apparatus. The relay 11 is maintained energized until the end of the observing period when it may be released in a manner to be later described.

The contacts 64 of the relay 34 will be interrupted thus inserting in series with the conductor 66 the high resistance winding 63 of the relay 34 which will maintain the relay 34 in its operated position, but the resistance of this winding will reduce the very large amount of current which momentarily was caused to flow over the circuit. At this time the relay 40 will be operated through the now made contacts of the relay 34, being thereby, connected with the high resistance winding 63 of the relay 34. The relay 40 being thus operated will close its contacts 39 for a proposition later to be described. The circuit of the relay 75 is interrupted at the contact 73, and therefore the relay 75 will no longer be operated to deënergize the relay 55 so that the relay 55 will remain ener-

gized, and the current impulse circuit will remain closed. Thus the cessation of impulses by continuation of the last impulse the contacts 33 of the relay 34 will now be closed, closing the conversational circuit from talking conductors 1 and 2 of the line circuit, through the trunk line repeating coil terminals 82 and 83. Thus the talking conductors of the line circuit are extended in conversational circuit to the trunk line T, and thereby to the distant switchboard D and to the attendant operator's telephone r, when the key k_2 is thrown.

I have described how the relay 62 would be operated over one branch of the divided circuit on current impulses through the contacts 59 of the relay 55, and therefore the armatures of the relay 62 will be operated in unison with these impulses making circuit changes. One of the circuit changes each time the relay 62 was operated is to close the contacts 84, which causes a current impulse to flow over a strand of the trunk line, the circuit being described as follows:—from the ground pole of battery, the shunted relay 85 which relay is of the slow releasing type, circuit conductor 86, the contacts 84 of the relay 62, circuit conductor 87, the winding 88 of the repeating coil Q, conductor 89 of the trunk line T, the winding 90 of the repeating coil W, the conductor 91, the normally made contacts 92 of the key k_3, the normally made contacts 93 of the key k_4, the circuit conductor 94, and the winding of the relay 95 through circuit conductor 96 to the negative pole of battery. Thus the relay 95 will be energized attracting its armatures and closing its contacts 97 and 98, making circuit connections as will be later described, and the relay 85 will be operated closing its contacts 99 for a purpose to be described.

The circuit just described for the transmission of impulses over the trunk line in unison with the impulses operating the sequence relays at the exchange will operate the relay 95 at the observing switchboard intermittently, and in unison with these impulses. The circuits are so arranged that sets of sequence relays at the observing switchboard D will be operated in synchronism with the sequence relays at the exchange. At the observing switchboard these relays consist of relays 99 and 100 of the first set, 101 and 102 of the second set and 103 and 104 of the third set. Each of these sets control indicating lamps v_1, v_2 and v_3 in a manner to be described. The relay 95 being operated by the train of impulses will operate the relay 105 which is a slow releasing relay, and it will be maintained in operation continuously by the intermittent current through its winding over the circuit as follows:—from the ground pole of battery, the contacts 98 which contacts are intermittently operated through the impulse sending interval, the conductor 106, and the winding of the relay 105 to the negative pole of battery. This relay 105 being operated will attract its armatures, causing circuit changes to be described.

The contact 97 of the relay 95 will also be operated intermittently, causing intermittent connection with the ground pole of battery to be made to the circuit conductor 107 leading to circuit conductor 108, and thence to the sequence relays. This circuit is as follows, for the first impulse of current:—from the ground pole of battery to contacts 97 of the relay 95, circuit conductor 107, circuit conductor 108, the normally closed contacts 109 of the relay 100, the winding of the relay 99 and from thence to the negative pole of battery. The relay 99 will operate its armature throwing the winding of the relay 100 into a condition to be operated when the current impulse is removed. While the current impulse is maintained, the winding of the relay 100 will not operate the relay due to the fact that ground pole of battery will be placed on both sides of the winding thus effectively shutting it out, but after the current impulse is removed the relay 100 and the relay 99 will be operated in series over a circuit as follows:—from the negative pole of battery, the winding of the relay 99, the winding of the relay 100, the circuit conductor 110, the make contacts 111 of the relay 99, the circuit conductor 112, the circuit conductor 113, the circuit conductor 114, the now closed contact 115 of the relay 105 which as has been stated is maintained in operation during this time, and thence to the ground pole of battery.

The operation of the relay 100 provides a like energizing circuit for the second set of relays comprising the relays 101 and 102, which relays will be operated in the same way as the relays 99 and 100 on the second current impulse, and will prepare a circuit for the next set of relays 103 and 104 on the next succeeding current impulse, if there be such an impulse, it being the aim to so arrange these sets of relays that as many sets will be operated as there are current impulses sent over the line. When the line circuit H causes the current impulses to be produced as previously described, it is seen there are two current impulses; the first of short duration and the second being a continuous impulse. This second continuous impulse will at the central observing switchboard cause a circuit for the relay 101 to be completed as follows:—from the ground pole of battery, the contacts 97 of the relay 95, the conductor 107, the conductor 108, the now made contacts 115, the conductor 116, the normally made contact 117, circuit conductor 118, the winding of the relay 101, and thence to the negative pole of battery. This

second impulse when the line circuit H is the calling line circuit being the last impulse and which is continuous, the relay 102 of this second set of relays will not be energized; and a circuit will thereupon be completed for the signal lamp v_2 as follows:—from the negative pole of battery, the conductor 119, the signal v_2, the normally closed contacts 120, the circuit conductor 121, the now made contacts 122, and the circuit conductor 123 leading to the ground pole of battery. This will operate the signal lamp v_2 which signal lamp is a line designation lamp, and designates in the system as herein set forth the line circuit H which is connected to the calling line, having a substation B connected thereto as has been described. The observing operator thereupon knows that it is the substation B which is calling, or another substation which may be placed on the same line.

At the same time that the first impulse was received at the central observing switchboard, the relay 105 being operated, operates the signal lamp n which will also be operated over a circuit as follows:—from the ground pole of battery, the conductor 124, the signal lamp n, the now made contacts 125 of the relay 105, the circuit conductor 126, the normal contacts 127 of the relay 128, and thence by means of the conductor 129 to the negative pole of battery. The lamp n is the call indicating signal and is so arranged in the circuit to operate substantially simultaneous with the line lamp of the calling circuit, such as the lamp s_2 of the line circuit L, which is in the present system shown connected to the line observing circuit H. Thus the operator at the indication of a call has a lamp to indicate the particular line calling, and an additional lamp to indicate the condition of operation of the line lamp at the exchange. When the call is answered at the exchange, this calling lamp n will be extinguished at the observing desk by the operation of the relay 128 in a manner to be described, and as will be described the connection lamp w, will be lighted during the connection period. The line indicating lamp, such as v_2, will remain lighted during the calling and connection periods.

I have now described how upon the initiation of a call over one of the lines, as for instance, that one connected to the line circuit L, the indication of such a call is conveyed to the observing switchboard, and the information is also conveyed by means of signals at the observing switchboard as to the particular line calling. Had the calling substation been A instead of B, then the line observing circuit I would have been operated instead of the line observing circuit H, and only a single impulse would have been sent over the sets of sequence relays at the exchange and at the observing switchboard, instead of two impulses as had been described for a call originating from the substation B. With the single impulse, only the relay 99 of the sequence relays at the observing switchboard would have been operated, and the line indicating lamp v_1 would have been operated over a circuit as follows:—from the negative pole of battery, the indicating lamp v_1, the circuit conductor 130, the normally closed contacts 131 of the relay 100, the circuit conductor 132, the now closed contacts 133 of the relay 99 and from thence to the ground pole of battery, thus operating the lamp and apprising the operator that it is a substation such as A, on the line circuit M at the exchange which is calling.

In like manner a call originating from the substation C of the line circuit K would cause apparatus of the line observing circuit G to be operated, and three impulses—the last continuous would be sent, and the third lamp v_3 would be lighted by the operation in sequence of the sets of relays 99—100, 101—102 and finally the relay 103 of the said set 103—104. The relay 103 being operated closes a circuit for the line indicating lamp v_3 at its contacts 134; the circuit for the indicating lamp v_3 being as follows:—from the negative pole of battery, circuit conductor 119, the lamp v_3, circuit conductor 135, the normally made contacts 136 of the relay 104, the circuit conductor 137, the now made contacts 134 of the relay 103, and thence to the ground pole of battery, thus causing current to flow over this circuit to the lamp to be operated.

The number of impulses sent in each case depends upon whether the ground pole of battery is connected to the point 44 in the case of the line observing circuit H, the like point 138 of the line observing circuit I, or the point 139 of the line observing circuit G by contacts as 27 of the line circuit H, contacts 140 in the case of line circuit I, and contacts 141 in the case of line circuit G. The particular contacts being closed depending upon which line circuit is the calling line circuit.

It is obvious that any number of line circuits can be connected to the system of my invention, it being only required to provide what I term, an individualizing relay such as the relay 8 at the exchange for each line circuit, a pair of sequence relays or their equivalent at the exchange for each line circuit, and a pair of sequence relays or the equivalent thereof, together with line indicating lamps associated therewith at the observing switchboard. These can be added without disturbing the existing connections for existing line circuits.

The call having been initiated as has been described, and signals having been given at the observing switchboard as has been described, the operator at the exchange by mak-

ing connection between the line circuit and a connective circuit, or call answering circuit, such as the circuit E, the connection being made, for instance by means of the plug and jack switch P—J. Such a connection will be made by means of the plug P of the call answering circuit E and the jack J of the line calling circuit such as the line circuit L.

The exchange operator making a connection thereby provides a circuit for the flow of battery for the relay 35, also for the observing supervisory relay 37 as follows:—From the negative pole of battery in the connecting circuit E, through the winding of the relay 838, the shank of the plug P, the thimble 839 of the jack J, and from thence on circuit is divided, one branch being the winding of the cut-off relay 35 to ground battery, the other leading to ground battery over the circuit conductor 36, the winding of the relay 37, the conductor 38, the contacts 39 of the relay 40, and thence to ground at 41. Thus the observing supervisory relay 37 and the line cut-off relay 35 is operated. The line cut-off relay being operated will remove the line relay from the circuit in the well-known manner. The line relay being deënergized will release its armature, thus disconnecting the negative pole of battery from circuit conductor 4. The relay 37 being operated will break its normally made contacts 741 and close contacts 742. The contacts 742 being closed a circuit will be completed as follows:—from the ground pole of battery, the contacts 742, circuit 143, the winding 144 of the repeating coil Q, the limb 145 of the trunk line T, the winding 146 of the repeating coil W at the observing switchboard, circuit conductor 147, the winding of the slow releasing relay 148, the circuit being completed to the negative pole of battery over the circuit conductor 748, the winding of the relay 128, the circuit conductor 129 leading to the negative pole of battery. Thus the relays 148 and 128 will be operated at the observing switchboard. The relay 128 being operated will open contacts 127 in the circuit of the line signal indicating lamp *n* which has not been described, thus deënergizing the line signal lamp. The contacts 149 of the relay 128 will now be closed operating the supervisory signal lamp *w* over a circuit as follows:—from the negative pole of battery, the circuit conductor 129, the contacts 149 of the relay 128, the signal lamp *w*, circuit conductor 150, the contacts 133 of the relay 99 which as has been described was operated on the first impulse of the current traversing the trunk line, and from thence over the circuit conductor 151 leading to the ground pole of battery.

The operation of the signal lamp *w* and the extinguishing of the line indicating lamp *n* will indicate to the observing operator that the call has been answered at the exchange switchboard. The interval between the lighting of the line indicating lamp and the supervisory lamp is known as the answering time interval, and the observing operator by timing this interval may discover the time it takes to answer the call at the main exchange switchboard which is being observed. During the connection period the lamp *w* will be lighted at the observing switchboard, as well as one of the line indicating lamps v_1, v_2 or v_3, and the operator at the observing switchboard by the continued operation of the key K^2 may have her telephone in continuous conversational circuit with the telephone line being observed, and may observe the service being given by the main exchange operator to the telephone subscriber.

In connection with my improved system I provide means whereby the observing operator may at any time after the answering of a call at the main exchange switchboard, discharge the calling line from its operative connection with the observing system. This is done by operating the key k_4 from its normal position in which it closes the normal contacts 93, and cause it to momentarily take an operated position in which contacts 152 are closed. The switch k_3 may be operated in the same manner as the key k_4, opening the contacts 92 and closing the contacts 153, if desired, thus making the same circuit changes as the key k_4 just described. The switch k_3 is so constructed that it locks in either position to which it is moved, and the operator therefore may operatively discharge all of the line circuits from their operative connection with the observing system for any predetermined length of time. The opening of the contacts 93 opens the circuit of the relays 95 and 105, thus releasing the circuits controlled by these relays at the observing switchboard.

The opening of the circuit of the conductor 94 by either of the keys k_3 or k_4 will also cause the release of the relay 85 in the circuit of this conductor at the exchange end of the trunk line which will open its contacts 99. At this stage of the operation these contacts 99 maintain in operation many of the circuits at the main office, including the circuits of many of the relays. These circuits being deprived of battery supply by the opening of these contacts 99 will be reversed, and such of them as are not restored to normal will be restored to normal a moment later when the relay 148 at the observing switchboard reaches its ultimate point of deënergization by being short-circuited by contacts 158 of the released relay 105, and closes its contacts 154, thus putting ground pole of battery on the conductor 155 which leads through the now closed contacts 153 or 152 of the key k_3 or key k_4, and thence by means of the conductor

91 and through conductors and windings to be now related forms a circuit to the negative pole of battery at the observing switchboard, this circuit being as follows:— from the conductor 91, the winding 90 of the repeating coil W, the conductor 89 of the trunk line, the winding 88 of the repeating coil Q, the circuit conductor 87, the normally made contacts 156 of the relay 62, the relay 62 now having been restored to normal, the circuit conductor 157, the winding of the relay 24, the normally made contacts 741 of the relay 37, the relay 37 being at this point restored to normal, circuit conductor 143, the winding 144 of the repeating coil Q, the other limb 145 of the trunk line, the winding 146 of the repeating coil W, the circuit conductor 147, the now closed contacts 158 of the relay 105, the winding of the relay 128, and the circuit conductor 129 to the negative pole of battery. This circuit being formed the relay 24 will be energized breaking all of its normally made contacts, the contacts 58, 23 and 159, and depriving the circuit conductors 146, 22 and 71 of their connection to battery, and therefore, all of the apparatus connected to these conductors will be restored to normal. The contacts 160 of the relay 24 will now be closed making a path for current from the negative pole of battery, the contacts 160, the conductor 161, the conductor 143, the winding of the relay 11, and thence to the ground pole of battery, thus operating the relay 11, whose contacts being broken will maintain the disabling of the line observing apparatus so that the operator by merely operating the self-restoring key k_4 or locking key k_3 at the observing switchboard can disable the entire observing system. The observing system may be restored to its operative condition by the observing operator's self-restoring key k_4 or the substitute locking key k_3 at the observing switchboard.

I have described in connection with the above a line finder system, and in connection with the line finder system have described a means of transmitting impulses to an auxiliary step-by-step apparatus and thereby selecting auxiliary electro-responsive devices peculiar to the line controlling the line finder apparatus. It is my intention to claim the same broadly, and in connection with a service observing system.

It will be understood that my invention as above described is not limited to a Service Observing System, although in such an embodiment it is very applicable; but I am aware that numerous and extensive departures may be made from the embodiment set forth without departure from the spirit of the invention.

What I claim is:—

1. In a service observing system, the combination of a trunk circuit extending from a central office to a service observing desk, a plurality of telephone lines terminating at the central office, means associated with the trunk circuit for automatically connecting a calling telephone line with the trunk circuit, signaling devices at the service observing desk for each of the telephone lines, and apparatus comprising counting relays adapted to cause the operation of the signaling devices corresponding to the telephone line connected to the trunk circuit to indicate the number of the telephone line.

2. In a service observing system, the combination of a trunk circuit extending from a central office to a service observing desk, a plurality of telephone lines terminating at the central office, impulse transmitting means at the central office, means associated with the trunk circuit for connecting a calling telephone line with the trunk circuit, counting relays at the service observing desk, signaling devices at the service observing desk for each of the telephone lines, said signaling devices being controlled by said counting relays, and means including said impulse transmitting means to cause said counting relays to select a particular signaling device corresponding to the calling telephone line connected with the trunk circuit.

3. In a service observing system, the combination of a group of telephone lines terminating at the central office, a service observing desk, a trunk line leading from the service observing desk to the central office, means associated with the trunk circuit for connecting a calling telephone line with the limbs thereof, means associated with the trunk circuit for sending current impulses over one of said limbs, a plurality of signaling devices at the service observing desk for the telephone lines each of said devices corresponding to a particular telephone line, and means at the service observing end of the trunk line operated by said current impulses to cause the operation of the signaling devices corresponding to the telephone line connected to the trunk circuit to indicate the number of the connected telephone line.

4. In a service observing system, the combination of a plurality of telephone lines terminating at a central office, a service observing desk, a trunk line connecting said service observing desk to said central office, signaling devices at the service observing desk, impulse operated means at the service observing desk controlling said signal devices, apparatus at the central office adapted to send current impulses over the trunk line to operate said impulse operated means, and apparatus and circuit connections whereby said current impulse sending means is controlled by the subscriber of a calling telephone line.

5. In a telephone system, the combination of a plurality of telephone lines terminating in an exchange, a trunk line leading from said exchange to a distant telephone station, electro-responsive devices at the telephone station corresponding to the telephone lines at the exchange, impulse operated means to select said electro-responsive devices, and means at the exchange adapted to be variably operated by apparatus of different calling telephone lines to cause variable sets of current impulses to be transmitted over said trunk line to variably operate said selecting means.

6. In a service observing system, the combination of a trunk line extending from a central office to a service observing desk, a plurality of telephone lines terminating at the central office, means associated with the trunk circuit for automatically connecting a calling telephone line with the trunk circuit, signaling devices at the service observing desk for each of the telephone lines, apparatus comprising sequence relays adapted to cause the operation of the signaling devices corresponding to the telephone line connected to the trunk circuit to indicate the number of the telephone line, and impulse transmitting means for operating said sequence relays, said impulse transmitting means controlled by apparatus of the calling telephone line.

7. In a service observing system, the combination of a group of telephone lines terminating at a central office, a trunk line leading from the central office to a distant switchboard, means associated with the trunk line for sending a predetermined number of current impulses over one of the limbs of said trunk line, an electro-magnet at the central office for each of the telephone lines for determining the number of said current impulses transmitted, and electro-magnetic step-by-step mechanism at the distant switchboard adapted to be operated by said current impulses.

8. In a service observing system, the combination of a plurality of telephone lines terminating at a central office, a distant switchboard, a trunk line connecting said switchboard to said central office, electro-magnetic step-by-step mechanism at the distant switchboard, said step-by-step mechanism controlling electric circuits, apparatus at the central office adapted to send a predetermined number of current impulses over the trunk line to operate said step-by-step mechanism, and apparatus at the central office controlled by the substation apparatus of a calling telephone line controlling said current impulse sending means.

9. In a service observing system, the combination of a plurality of telephone lines extending by their limbs from substations to an exchange, line relays for said lines, step-by-step mechanism arranged in sequence for all of the lines, a unit of said step-by-step mechanism associated with each of the lines, means to cause the line relay of one of the lines to start said step-by-step mechanism to operate, impulse sending means under the control of said step-by-step mechanism, and a second step-by-step mechanism operated by said impulse sending means.

10. In a service observing system, the combination of a plurality of telephone lines extending by their limbs from substations to an exchange, line relays for said lines, step-by-step mechanism arranged in sequence for all of the lines, a unit of said step-by-step mechanism associated with each of the lines, means to cause the line relay of one of the lines to start said step-by-step mechanism to operate, impulse sending means under the control of said step-by-step mechanism, a second step-by-step mechanism operated by said impulse sending means, and a series of electro-responsive devices under the control of said sectond step-by-step mechanism.

11. In a line finder system, the combination of a plurality of lines extending by their limbs from substations to an exchange, controlling apparatus for said lines, common impulse sending mechanism for said lines, step-by-step mechanism successive units of which are associated one with each of the lines, means to cause said impulse sending mechanism to operate said step-by-step mechanism, and means associated with said line controlling apparatus of a calling line to cause said impulse sending mechanism to discontinue sending impulses when said step-by-step mechanism has located the calling line.

12. In a line finder system, the combination of a plurality of lines extending by their limbs from substations to an exchange, controlling apparatus for said lines, common impulse sending mechanism for said lines, step-by-step mechanism successive units of which are associated one with each of the lines, means to cause said impulse sending mechanism to operate said step-by-step mechanism, means associated with said line controlling apparatus of a calling line to cause said impulse sending mechanism to discontinue sending impulses when said step-by-step mechanism, has located the calling line, and a second step-by-step mechanism likewise operated by said impulse sending means simultaneous with aforesaid step-by-step mechanism to select an electro-responsive device corresponding to said calling line.

13. In a service observing system, the combination of a trunk circuit extending from a central office to a service observing desk, a plurality of telephone lines extended by their limbs from substations to a central

office, means associated with the trunk circuit for automatically connecting a telephone line with the trunk circuit, means associated with the trunk circuit for subsequently barring a telephone line from said trunk circuit, signaling devices at the service observing desk for each of the telephone lines, and apparatus comprising counting relays at the central office associated with the trunk circuit to cause the operation of one of said signaling devices corresponding to the telephone line at the time connected to the trunk circuit.

14. In a line finder system, the combination of a plurality of contacts on said finder for each of the telephone lines associated with said finder, a plurality of impulse operating means for said finder, a control circuit for said finder containing a controlling relay, impulse sending mechanism, means to connect said impulse sending mechanism to said controlling circuit through said controlling relay whereby said finder will cause a conductor of said controlling circuit to be extended from one line finder contact to another line finder contact, a pair of windings on said controlling relay, one of said windings being a low resistance winding and the other winding being a high resistance winding, said high resistance winding being normally short circuited, means under the control of said relay to remove the short circuit, means under the control of each of the lines to place battery potential on its associated contact of said line finder whereby said circuit conductor being extended by said impulse operated means to the said contact, the said low resistance winding of said relay will operate said relay, and means under the control of said relay to cause it when operated to dis-associate said impulse sending mechanism and said line finder.

15. In a telephone observing system, the combination of a plurality of lines leading by their limbs from substations to an exchange, operators' link circuits at the exchange for interconnecting said lines, a pair of wires extended from the exchange to the observing switchboard, line identification lamps for each of the lines at the observing switchboard, a telephone set at the observing switchboard adapted to be operatively connected to said pair of wires for listening purposes, and controlling apparatus at the exchange for the lines for selectively controlling over said pair of wires the line indicating lamps at the observing switchboard.

16. In a telephone observing system, the combination of a plurality of lines extended by their limbs from substations to an exchange, an observing switchboard, line indicating means at the observing switchboard for each of the lines, a trunk line consisting of a single pair of wires leading from the observing switchboard to the exchange, apparatus common to the lines at the exchange end of the pair of wires for operating said line indicating means over said pair of wires, and an observing operator's telephone at the observing switchboard adapted to be connected for listening purposes to said single pair of wires.

In witness whereof, I hereunto subscribe my name this 19th day of March, A. D. 1917.

FRANK M. SLOUGH.