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APPARATUS AND SYSTEM FOR MEASURING TELEPHONE SERVICE.

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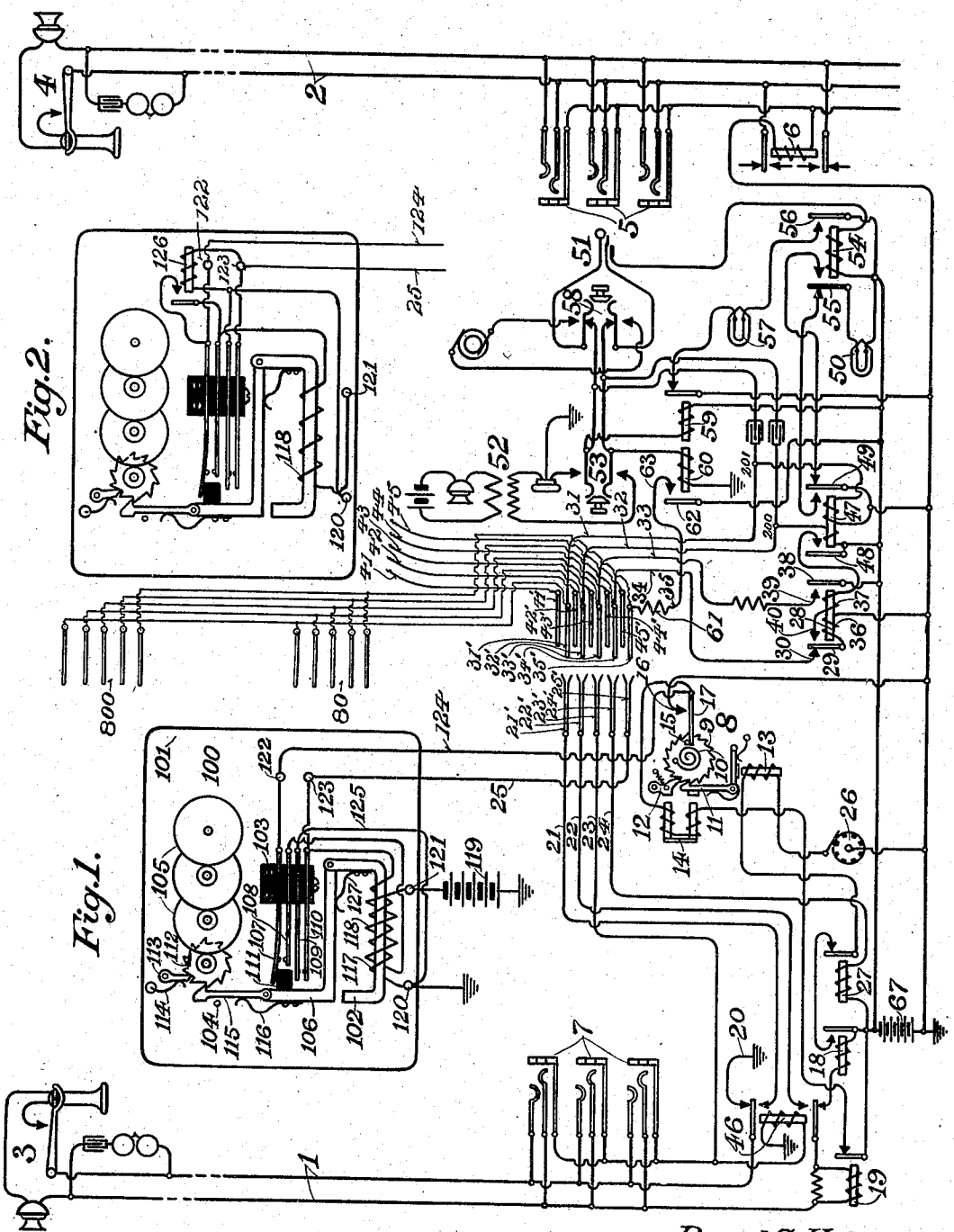

Fig. 2.

Fig. 1.

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APPARATUS AND SYSTEM FOR MEASURING TELEPHONE SERVICE.

No. 930,547. Specification of Letters Patent. Patented Aug. 10, 1909.

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To all whom it may concern:

Be it known that I, DAVID S. HULFISH, a citizen of the United States of America, and resident of Chicago, county of Cook, and State of Illinois, have invented a new and useful Improvement in Apparatus and Systems for Measuring Telephone Service, of which the following is a specification.

My invention pertains to telephone lines and the central office equipment thereof, with particular reference to features in the central office equipment by which connections originating upon any given telephone line may be recorded, the record being made to indicate the number of successful calls originating upon that line; or in other words, the number of calls originating upon that line in which the call progresses so far as the answering of a station upon the line called for, those calls not being recorded in which the line called for may be busy, or the station upon that line may not answer, or any other circumstance or combination might result in the abandonment of the call before actual connection of the station calling with a station upon the line called.

My invention pertains particularly also to lines equipped with automatic or semi-automatic equipment at the central office, the equipment of each line consisting in part of an automatic switch individual to that line and which is moved at each call to connect selectively with one of many possible sets of conductors or contact points. For example, in one type of such semi-automatic equipment each telephone line has an automatic switch and multiple jacks, the jacks being used in the completion of calls to that telephone line, and the automatic switch being used in the completion of calls from that telephone line, it being the duty of said automatic switch to select an idle trunk whenever said line originates a telephone call, to hold said trunk during the ensuing connection, to disconnect automatically at the end of the connection, and at all other times to remain in its position of rest.

The particular telephone line equipment (comprising as a part thereof an automatic switch) shown in the accompanying drawing and described in this specification, is of the type last above referred to; my improved counting and recording means may of course be used in conjunction with other types of equipment.

In the drawings: Figure 1 shows the system of automatic switching referred to, with service meter added in accordance with my present invention; Fig. 2 shows an alternative form of meter.

The system of automatic switching shown in Fig. 1 may be described as follows: Telephone lines 1 and 2 are equipped with substation telephones 3 and 4 respectively; telephone line 2 has multiple jacks 5 and automatic switch equipment partly illustrated at 6; telephone line 1 has multiple jacks 7, and a complete automatic switch equipment and meter, shown diagrammatically in detail.

8 is an automatic switch consisting of a fixed part and a rotary part; the rotary part which carries moving contacts, terminals or wipers 21′, 22′, 23′, 24′, 25′ (shown connected with conductors 21, 22, 23, 24, 25 respectively) is attached rigidly to ratchet wheel 9. and is always under tension of spring 10 which returns it to its position of rest and holds it there at all times except when controlled by pawls 11 and 12; magnet 13 actuates pawl 11 to advance ratchet 9 one step for each such actuation; pawl 12 holds ratchet 9 in the position determined by the actuation of pawl 11; magnet 14 removes both pawls at 11 and 12 from control of ratchet 9, and spring 10 then returns the rotary part of the switch to its position of rest. Pin 15 is attached to ratchet 9 and when the rotary part of the switch is in its position of rest, said pin 15 holds contact spring 17 away from contact point 16; but at the first step of ratchet 9, pin 15 permits the contact pair 16—17 to close, said contact pair then remaining closed until the release and restoration of the rotary part of the switch. The fixed part of switch 8 carries a plurality of sets of waiting contacts or terminals, two of such sets being illustrated in contacts 31′, 32′, 33′, 34′, 35′ connected to conductors 31,

32, 33, 34, 35 respectively, and contacts 41′, 42′, 43′, 44′, 45′ connected to conductors 41, 42, 43, 44, 45; these sets of contacts are adapted to be successively engaged by the set of wipers heretofore mentioned. The sets of waiting contacts of switch 8 are connected by conductors with corresponding sets of waiting contacts in the automatic selective switches of other telephone lines; thus for example, sets of waiting contacts 31′, 32′, 33′, 34′, 35′ are connected to similar sets of waiting contacts in two automatic switches at 80 and 800, said switches belonging to two other telephone lines respectively. In this manner each trunk is represented at each of a plurality of switches by a set of waiting contacts. When the rotary part of said switch is at rest, the wipers 21′, 22′, 23′, 24′, 25′ are out of contact, as shown, but at the first step of ratchet 9 they are propelled into contact with waiting-contact-set 31′, 32′, 33′, 34′, 35′; at the next step of ratchet 9 they leave these contacts and take a position in contact with waiting-contact-set 41′, 42′, 43′, 44′, 45′, and so on through a number of waiting-contact-sets.

A plurality of waiting-contact-sets is provided as above stated, each such waiting-contact-set being fully equipped as shown in connection with waiting-contact-set 31′, 32′, 33′, 34′, 35′. All other parts of Fig. 1, excepting the meter 100, are represented by symbols readily recognizable.

Disregarding for the present the meter 100, the operation of the system is as follows: To make a call, substation 3 removes the receiver from its hook, closing circuit of the substation telephone, giving path for current from battery 67 through relays 18 and 19, line and substation telephone to ground 20; energization of relay 18 gives path for current through magnet 13 and interrupter 26; the closure of this circuit at 26 results in the energization of magnet 13; contact of wipers 21′, 22′, 23′, 24′, 25 with waiting contacts 31′, 32′, 33′, 34′, 35′ immediately follows, giving path for current from battery 67 through relays 27 and 28, as follows:—battery 67, relay 27, conductor 24, contacts 24′, 34′, conductor 34, contact point 30, armature 29 and winding 36 of relay 28 to the other pole of the battery. This current energizes relay 27 to interrupt the circuit of magnet 13 to prevent the wipers from stepping farther, and also energizes relay 28 to close its contacts 38—39 and open 29—30, but contact 29—30 is mechanically such that its break is delayed; the attraction of armature 38 of relay 28 gives path for current from the non-grounded pole of battery 67 to armature 38, contact 39, conductor 33, contacts 33′, 23′, conductor 23 to relay 46 and ground, thereby energizing relay 46, which by attracting its armature breaks the circuit of relay 18 and places the two limbs of the line 1 upon conductors 21 and 22, giving path for current from battery 67 through relay 47, elements 200, 32, 32′, 22′, 22, 1, 3, 1, 21, 21′, 31′, 31, 201 and relay 47 back to battery 67; relay 47 thus energized, attracts its armature 48 and thus gives path for current through winding 37, contact 40, armature 29, winding 36, effecting the break of contact 29—30 and release of armature of relay 27; prior to the release of relay 27, relay 18 has been released by operation of relay 46. The attraction of armature 49 sends current through lamp 50, located near plug 51, by the passage of current over the following path: from battery 67, to armature 49, armature 55, lamp 50, to the other pole of the battery. The telephone operator at telephone set 52 answers the call by means of key 53, takes the order of the calling subscriber, tests a jack, as 5, of the line called for, and inserts plug 51 in the jack, giving path for current from battery 67 through relays 54 and 6; armature 55 is attracted and opens circuit of lamp 50 and armature 56 closes circuit of lamp 57, causing lamp 57 to glow as a signal to the operator that the called party is not at his telephone. The circuit through lamp 57 is as follows: from one pole of battery 67 to armature 56, lamp 57, armature of relay 59 back to the other pole of the battery. The operator now rings the called station by means of the ringing key 58, and the answering of the called station and consequent closure of the circuit through the substation telephone gives path for current from battery 67 through relay 59, elements 2, 4, 2, and relay 60 to ground; energization of relay 59 opens the circuit of lamp 57, indicating to the operator that the called station has answered. The two subscribers are now connected for conversation over a metallic circuit between the sides of which battery 67 is bridged; this circuit extends from telephone at substation 3, by left-hand conductor of line 1 to conductor 22, contacts 22′, 32′, conductor 32 including a condenser, sleeve contacts of plug 51 and jack 5, left-hand conductor of line 2, telephone at substation 4, right-hand conductor of line 2, tip contacts of jack 5 and plug 51, conductor 31 including a condenser, contacts 31′, 21′, conductor 21 to right-hand conductor of line 1, to the telephone at substation 3. Battery 67 is bridged between the sides of this circuit by connections leading from point 200 through the left-hand winding of relay 47 to one pole of the battery, and from point 201 through the right-hand winding of relay 47 to the other pole of the battery. Both relay 59 and relay 60 will remain energized so long as the telephone at substation 4 is off the hook.

Upon the completion of the conversation,

hanging up of receiver, and breaking of circuit through substation 4 will release relay 59, reëstablishing the previously traced lighting circuit of lamp 57, thereby causing the latter to glow as a disconnect signal to the operator; hanging up of the telephone and breaking of the circuit through substation 3, will release relay 47, which, with relay 54 remaining energized, will cause lamp 50 to glow also as a disconnect signal to the operator. The circuit which thus causes lamp 50 to glow extends from one pole of battery 67 through armature 49, back contact of said armature to front contact of armature 55, armature 55, lamp 50 to the other pole of the battery. Upon disconnection of the plug 51, the release of relay 54 will extinguish both lamps 50 and 57. Hanging up of receiver and breaking of circuit through substation 3 also releases relay 19, which thus gives path for current from battery 67 through magnet 14 and contact 17—16 back to battery; energization of magnet 14 releases the rotary part of the switch 8, by the return of which contact 17—16 is opened and all parts are at rest, awaiting another call from a line. If, prior to another call originated by the line 1, a call be completed for the line 1, the insertion of a plug in one of the jacks 7 will energize relay 46 and remove all the automatic equipment from the line without having operated any part of it other than the relay 46. If when the line 1 had called as above assumed, the trunk equipment associated with conductors 31, 32, 33, 34, 35 had been in use by some other subscriber, no circuit would have existed from conductor 34 to ground, since 30 and 29 would have been out of contact, and relay 27 thus would not have been energized; interrupter 26 then would have alternately opened and closed the circuit of magnet 13, stepping the rotary part of the automatic switch forward until an idle trunk was encountered, whereupon circuit to ground from conductor 24 would have resulted in action as above outlined.

In connection with equipment required in the normal operation of the circuit as described, I add the wiper 25′ connected with conductor 25, the waiting contact 35′ connected with conductor 35, and also connected to other corresponding waiting contacts at other automatic switches (such as 80 and 800) as heretofore explained, the conductor 35 including resistance 61, and the armature contacts 62, 63 of relay 60 (mentioned above but not forming a necessary part of such a switching system if the meter is omitted), and the meter 100.

In the meter 100: Upon a base plate 101 are mounted core 102, insulating block 103, fixed pin 104 and counting train 105; armature 106 is mounted upon core 102 by pivot connection and is held away from the free end of said core by a spring 127; in insulating block 103 are supported electrical contact springs 107, 108, 109 and 110; upon armature 106 there is an insulating projection 111 adapted to engage electrical contact springs 107 and 109 alternatively; ratchet 112 forms a part of counting train 105 and has holding pawl 113 pressed by spring 114 and driving pawl 115 pivotally sustained upon armature 106 and pressed by spring 116; pin 104 locks pawl 115 against ratchet 112 when armature 106 is attracted, to limit the motion of ratchet 112 to one step; contact spring 107 has a tendency to close with 108, but normally is held out of contact by insulating projection 111; terminals 120, 121, 122, 123 are provided for the connection of external conductors; core 102 has two insulated windings, 117 and 118.

The operation of the meter 100 is as follows: Until the answering of the called party, the meter is not operated, but by the closing of the circuit of the substation telephone 4, the relay 60 is energized, as heretofore explained, giving path for current from battery 67 through elements 62, 63, 35, 61, 35′, 25′, 25, 123, 117, 120 to ground; this energizes core 102 attracts armature 106 and registers the successful connection upon the registering train; in the motion of armature 106, insulating projection 111 has released spring 107, and permitted contact 107—108 to close, giving path for current from battery 119 through elements 121, 118, 108, 107, 122, 124, 17, 16, to ground at battery 67; later the insulating projection 111 presses spring 109 and closes the contact 109—110, so that current from terminal 123 passes through 110, 109, 125 to ground at terminal 120 without passing through winding 117, but core 102 remains energized by reason of current flowing in winding 118; it is seen now that as current from armature 62 does not flow through the winding 117 of core 102, meter 100 is independent of breaks or makes at that armature, and therefore can register only once for this connection, regardless of subsequent motion of the hook at substation telephone 4. It will be noticed also that the waiting contact or terminal 35′, connected with conductor 35 and contacted with by wiping contact or terminal 25′, is now connected directly to ground through elements 25, 123, 110, 109, 125, 120 without intervening apparatus or resistance, and that therefore the difference in electrical potential existing between said waiting contact and the earth by reason of current flowing from battery 67 through armature 62, is practically *nil;* therefore, as other wipers corresponding to 25, in other automatic switches (such as 80 and 800) corresponding to 8, of other lines corresponding to 1, make contact, by reason

of the temporary connection of a moving switch in passing a busy trunk, with other waiting contacts multiplied to contact 35, as heretofore explained, there will be no tendency for current to flow from said other waiting contacts through meters connected to said other automatic switches. In other words, the connection of waiting contact 35′ directly to ground by the operation of the meter, as stated above, removes from all other waiting contacts (corresponding to contact 35′ and located in other switches, such as 80 and 800) of the selected trunk, the predetermined electrical condition or potential, the presence of which is essential to the operation of other meters which may be passingly or temporarily connected to said trunk by the searching wiping contacts of other switches in hunting a disengaged trunk; this condition is maintained during the continuance of the connection to the selected trunk. Furthermore, until the called party upon a busy trunk has answered, there will be no contact at armature 62, therefore no battery connection upon the waiting contact 35′ and corresponding contacts at other switches, and hence no tendency (the predetermined electrical condition or potential being absent) to operate the meter of another line at whose switch passing engagement is made with waiting contacts of the engaged trunk. It is seen thus that the meter of a line is not operated before an idle trunk is selected and, after such idle trunk has been selected, is operated only when the called station responds, and not at any other time and not more than once. Resistance 61 is included in conductor 35 to control the flow of current from battery 67 after conductor 25 has been grounded by contact 109—110.

In present common battery telephone practice, it is customary to work the switch-hook to attract the attention of the operator for another call, and such operation of the switch-hook will deënergize magnet 19 in the same manner as when the receiver is hung upon its hook; magnet 19 thereupon releases its armature which closes circuit through magnet 14, releasing switch 8 and disconnecting the trunk, as already explained. The return of switch 8 to its normal position opens contact 16—17, thus releasing the meter and restoring conditions for the recording of the succeeding call. In a connection in which the telephone line 1 is the called line, the meter is entirely disconnected by action of the relay 46.

In Fig. 2 an alternative type of meter is shown, the relay 126 being introduced in lieu of the winding 117; in the operation of this form of meter mechanism, current from conductor 25 to terminal 120 upon the answering of the called station energizes relay 126, which by closing its armature contact, gives path for current from battery 119 and terminal 121 through winding 118 to terminal 122 which registers, connects terminal 123 to terminal 120, and leaves the core 102 energized by winding 118, all as described with reference to the type of meter shown in Fig. 1.

I understand that in the general plan and within the scope of my invention, many types of electrical counting or registering devices may be united with many possible forms of relay and circuit combinations; therefore, I do not wish to limit myself to the particular form of registering equipment herein shown and described, nor solely to an equipment in combination with the form of telephone switching circuits and apparatus shown and described herein.

What I claim is:

1. In a telephone system, the combination of a telephone line; a selective switch for said line; trunk lines terminating in said selective switch; means for causing said switch to automatically select a trunk and connect said telephone line therewith; a meter connected to said selective switch the operation thereof being dependent upon current received over a circuit including said selected trunk; means associated with said selected trunk adapted to supply current by way of said circuit; and means associated with the meter whereby said meter by operating removes itself from the influence of said circuit including the selected trunk, and, during the continuance of the connection with the said trunk, subjects itself to control of current supplied by a different circuit.

2. In a telephone system, the combination of a telephone line; a selective switch for said line; trunk lines terminating in said selective switch; means for causing said switch to automatically select a trunk and connect said telephone line therewith; a meter connected to said selective switch and adapted to be actuated by current received over a meter-actuating circuit including said selected trunk; means associated with said selected trunk adapted to supply meter-actuating current by way of said circuit; and means associated with the meter whereby said meter by its actuation removes itself from control of said meter-actuating circuit, and, during the continuance of the connection with the selected trunk, subjects itself to control of current supplied by a different circuit.

3. In a telephone system, the combination of a telephone line; a selective switch for said line; trunk lines terminating in said switch; means for causing said selective switch to automatically select an idle trunk line; a relay associated with said selected trunk line; a meter connected with said selective switch and adapted to be actuated consequent upon the energization of said relay; and means whereby said meter when once actuated changes its circuit connections

and thereby renders itself unresponsive to further action of said relay during the continuance of the connection to the selected trunk.

4. In a telephone system, the combination of a telephone line; a selective switch for said line; trunk lines terminating in said selective switch; means for causing said selective switch to automatically select an idle trunk and connect said telephone line therewith; a relay associated with said selected trunk line; a meter connected with said selective switch; a meter-actuating circuit controlled by the operation of said relay; a second circuit for controlling the operation of the meter irrespective of the meter-actuating circuit; and means associated with said meter and controlled by registering-action thereof to subject the meter to the control of said second circuit; and means whereby the disconnection of said telephone line from said selected trunk by action of said selective switch removes the meter from control of said second circuit and permits restoration of the meter to condition to register subsequent connections effected through the selective switch.

5. In a telephone system, the combination of a telephone line; a selective switch for said line; trunks terminating in said selective switch; means for causing said selective switch to automatically connect said telephone line with a selected trunk line; a meter in connection with said selective switch; a relay associated with said selected trunk line; circuits by which the energization of said relay will cause the actuation of said meter; a second switch subsidiary to said selective switch and adapted to close an electric contact when said selective switch is out of its normal position of rest; a source of electric potential; and a meter controlling circuit including said second switch as a part thereof and adapted to be closed when said meter is actuated and to remain closed until opened by said second switch.

6. In a telephone system, the combination of a telephone line; a selective switch for said telephone line; trunks terminating in said selective switch; means for causing said selective switch to connect said telephone line with a selected idle one of said trunks; a meter in connection with said selective switch; an electromagnet forming a part of said meter; a winding on said electromagnet; a circuit by which said winding may be energized by current received from said selected trunk; a switch in connection with said electromagnet adapted to be actuated upon the energization of said winding; a second winding on said electromagnet; a second switch subsidiary to said selective switch and adapted to close together a pair of contact points when said selective switch is out of its normal position of rest; a source of potential; and a circuit including said source of potential, said switch in connection with said electromagnet, said second winding and said second switch.

7. In a telephone system, an electromagnetic connection-registering meter; a relay adapted to control the actuation of said meter by its electromagnet; an automatic switch adapted to connect the circuits of said meter with the circuits of said relay; an off-normal switch associated with said automatic switch; and a circuit for controlling the meter when it is once operated, said circuit including said off-normal switch as part thereof and adapted to be closed by the action of said meter and to remain closed until opened by said off-normal switch, substantially as described.

8. In a telephone system, the combination of a telephone line; an automatic selective switch for said telephone line; other lines terminating in said selective switch; means for causing said selective switch to connect said telephone line with a selected one of said other lines; a meter for said telephone line including as parts thereof an electromagnet, windings on said electromagnet, and an armature for said electromagnet adapted to actuate a counting train; circuit-controlling means forming a part of said automatic selective switch; and circuits by which upon the attraction of said meter armature by current flowing through one of said windings a circuit is closed through another of said windings and through said circuit-controlling means, substantially as described.

9. In a telephone system, a plurality of calling telephone lines; a plurality of trunks; an automatic switch corresponding to each calling telephone line, and having terminals of its said line and terminals of each of said trunk lines adapted to be brought into engagement when the switch automatically connects a calling line with one of said trunks; a connection-registering meter for each calling telephone line connected to one of the line-terminals of the corresponding automatic switch, and the trunk-terminals with which said line-meter-terminal is adapted to respectively engage being hereinafter designated "trunk-meter-terminals"; connections joining in multiple the trunk-meter-terminals of each trunk throughout the plurality of automatic switches; means associated with each trunk for imposing upon its trunk-meter-terminals a predetermined electrical condition essential to the operation of a meter; and means rendered effective by the operation of a meter, which is connected to a trunk through engaging automatic switch terminals, to remove from the multipled trunk-meter-terminals of said trunk said predetermined electrical condition during the continuance of the connection which produced said operation of the meter.

10. In a telephone system, a plurality of calling telephone lines; one or more called telephone lines; a plurality of trunks for interconnecting said calling and called lines; an automatic switch corresponding to each calling line, and having terminals of its said line and terminals of each of said trunk lines adapted to be brought into engagement when the switch automatically connects a calling line with one of said trunks; a connection-registering meter for each calling telephone line connected to one of the line terminals of the corresponding automatic switch, and the trunk terminals with which said line-meter-terminal is adapted to respectively engage being hereinafter designated "trunk-meter-terminals"; connections joining in multiple the trunk-meter-terminals of each trunk throughout the plurality of automatic switches; means associated with each trunk, and under control of a called line to which said trunk is connected, for imposing upon its trunk-meter-terminals a predetermined electrical condition essential to the operation of a meter; and means rendered effective by the operation of a meter, which is connected to a trunk through engaging automatic switch terminals, to remove from the multipled trunk-meter-terminals of said trunk said predetermined electrical condition during the continuance of the connection which produced said operation of the meter.

11. In a telephone system, the combination of a plurality of telephone lines; a selective switch for each line; a plurality of trunks; trunk-terminals in each selective switch for each of said trunks; connections joining in multiple throughout the switches the trunk-terminals of the respective trunks; means for causing the selective switch of a calling telephone line to automatically connect said line with terminals of a selected idle trunk; a meter connected to said selective switch and adapted to be actuated by current received from a terminal of said selected trunk; means in connection with said selected trunk adapted to give meter-actuating potential to said trunk terminal and the multipled terminals thereof at other selective switches; and means in connection with the meter whereby the latter by its actuation removes said meter-actuating potential from said trunk terminals of the selected trunk.

12. In a telephone system, the combination of a telephone line; a selective switch for said line; trunks having terminals in said selective switch; a source of electric potential and circuits for causing said selective switch to pass busy trunks and to automatically connect said telephone line with a selected idle trunk; other telephone lines; other selective switches having terminals of said trunks; conductors connecting together in multiple trunk terminals in a plurality of said selective switches; an electromagnetically operated meter in connection with said first-named selective switch; a relay connected with said selected trunk; circuit connections joining the armature contacts of said relay, multipled terminals of said selected trunk, a source of electric potential and the meter-operating electromagnet, whereby the energization of said relay will complete a path to give meter-actuating current to the said electromagnet; a switch in connection with said meter and actuated by said electromagnet; and circuits whereby said switch by its actuation removes from the multipled terminals of said selected trunk the condition placed thereon by said relay which caused the energization of said electromagnet and actuation of said meter.

13. In a telephone system, the combination of a telephone line; a selective switch for said line having wiping contacts connected with conductors pertaining to said telephone line and adapted to make contact with any set of a series of sets of waiting contacts of said selective switch; trunks connected to said sets of waiting contacts respectively; means for causing the wiper contacts of said switch to pass busy trunks and automatically connect said telephone line with a selected idle trunk; a meter connected to a wiping contact of said selective switch; one or more other telephone lines having similarly constructed and connected selective switches and meters, the sets of waiting contacts of said switches being connected in multiple to the corresponding waiting contacts of the first recited selective switch; means associated with each trunk adapted to give meter-actuating potential to the waiting contacts of said trunk which are adapted to be engaged at the several switches respectively by the wiping contact which is connected to a corresponding meter; and means in connection with each meter whereby its actuation removes said potential from said waiting contacts of the engaged trunk.

14. In a telephone system, the combination of a telephone line; a selective switch for said line; trunks terminating in said selective switch; means for causing said selective switch to pass busy trunks and to automatically connect said telephone line with a selected idle trunk; trunk terminals in said selective switch; other telephone lines; other selective switches; trunk terminals in said other selective switches; conductors connecting together in multiple trunk terminals in a plurality of said selective switches; a meter connected to said first-named selective switch and adapted to be actuated by current received from said selected trunk; means connected with said selected trunk adapted to give meter-actuating current to the said multipled terminals of said selected

trunk in said selective switches; and means in connection with said meter whereby said meter by its actuation removes from the multipled terminals of said selected trunk the condition which caused the actuation of said meter, substantially as described.

Signed by me at Chicago, county of Cook and State of Illinois, in the presence of two witnesses.

DAVID S. HULFISH.

Witnesses:
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