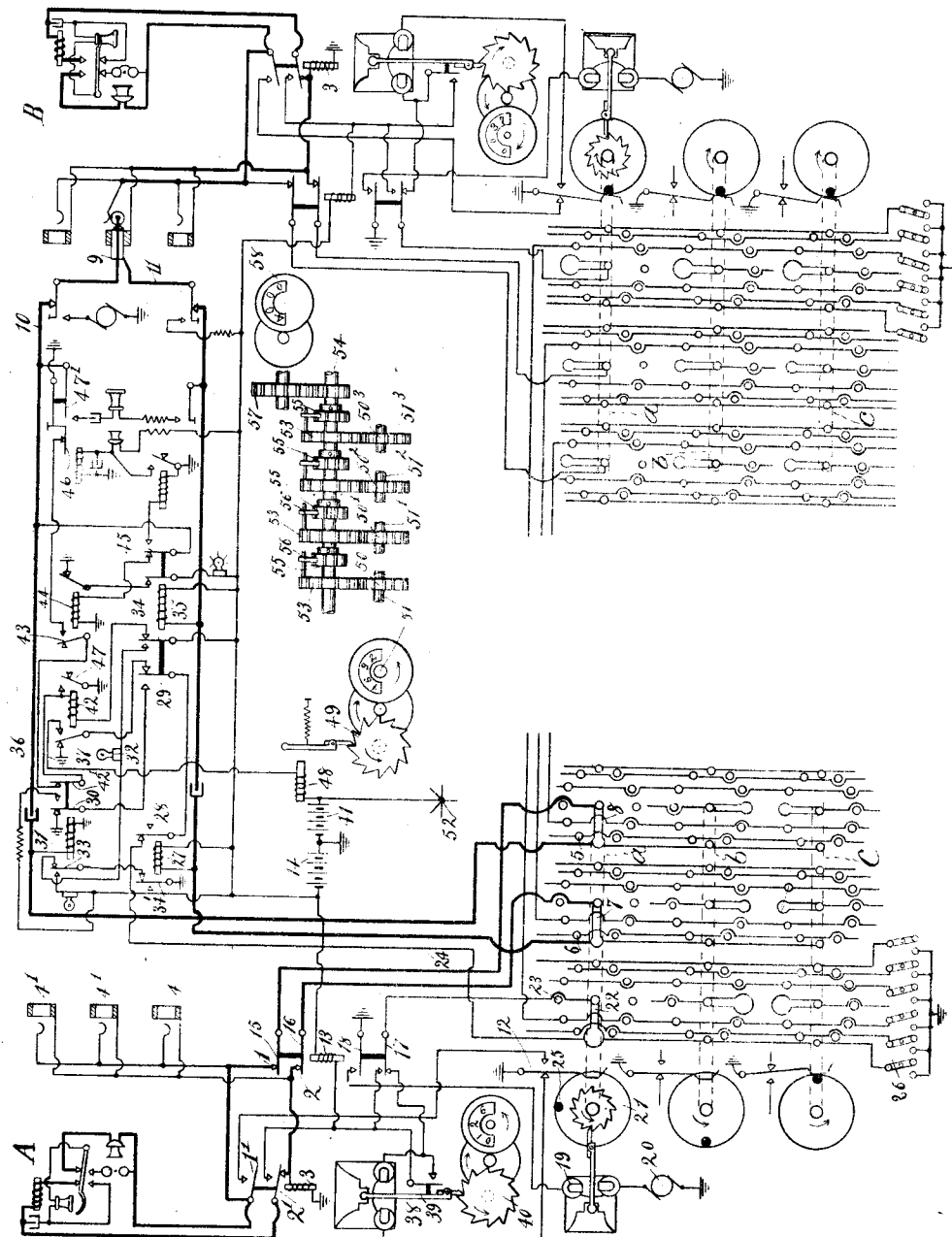


F. W. DUNBAR.
TELEPHONE SYSTEM.
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UNITED STATES PATENT OFFICE.

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KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

1,133,112.

Specification of Letters Patent.

Patented Mar. 23, 1915.

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To all whom it may concern:

Be it known that I, FRANCIS W. DUNBAR, citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Telephone Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to telephony, and has several objects.

One object of the invention is to provide a service meter that is adapted for operation in a system in which automatically operated selecting mechanism is employed to connect the answering ends of link circuits with calling lines, said link circuits being provided with manually controlled terminals, as, for example, those that reside in connecting plugs.

Another object of my invention is to provide a service meter that may be operated only once during each complete connection between calling and called subscribers and which will not be operated until after the called subscriber responds, this feature of the invention being adaptable to all systems of telephony wherein link circuits including connecting plugs are employed for connection with called lines.

Another object of my invention is to provide cord counters, one for each cord circuit, adapted to be operated only after the response of the called subscriber and only once during each connection between a calling and called subscriber, which feature of the invention is adapted to all systems of telephony employing connecting plugs for insertion within line jacks of called subscribers' lines.

A further feature of the invention resides in providing a common counter for each operator, to be actuated by the counters of her cord circuits, so that the total work of each operator may be recorded and her compensation arranged accordingly.

I will explain my invention more fully by reference to the accompanying drawing, illustrating the application thereof to one of the many telephone exchange systems to which the invention is adapted.

Each of the subscribers' stations A—B is provided with customary common battery, subscriber's apparatus, a switchhook at each

station serving operatively metallically to unite the sides of the line when the receiver is removed. I do not deem a detailed description of the subscriber's apparatus to be essential, as the illustration is sufficient to make the same understood by those skilled in the art. Although I have illustrated one arrangement of subscriber's station apparatus, it will be obvious to those skilled in the art that other arrangements may be employed at the sub-stations, and I do not, therefore, wish to be limited to the arrangement and apparatus shown, nor do I wish to be limited in all embodiments of the invention to its application to a common battery system. In order that the wide adaptability of my invention may be appreciated, I have indicated an exchange system in which the telephone lines are divided into groups, subscriber A belonging to one group and subscriber B belonging to another. A link circuit is shown uniting the line of subscriber A of one group with the line of subscriber B of another group. I do not wish to be limited to division of the subscribers' lines into groups, as such is not necessary in all embodiments of the invention, and will, therefore, describe the invention in connection with the group containing subscriber A, which obviously might constitute the complete exchange equipment, the application of the invention to a system wherein the telephone lines are divided being well understood by those skilled in the art. The subscribers' lines are metallic lines (though the invention need not be limited to metallic circuits), said lines extending in two branches to the exchange, where they are provided with contacts 1—2 and are connected with the armatures 1¹—2¹ of a cut-off relay 3. Each of said telephone lines is provided with a line jack 4 and, as the system illustrated is a multiple switch-board system, there are also connected with said line multiple jacks 4¹—4¹, each of said jacks being located at a different section of the multiple board. In the system illustrated, the answering ends of the link circuits are automatically connected with calling lines, but I do not wish to be limited in all embodiments of the invention to such a system. In the precise system illustrated, the answering terminals 5—6 of the link circuits are stationary and the terminals 7—8 of the telephone lines are caused to travel, to seek the

said answering terminals of the link circuit. The particular form of link circuit illustrated has manually controlled terminals (complemental to the terminals 5—6) that
 5 are in the form of the tip and sleeve contacts forming parts of the connecting plug 9. I do not wish to be limited, however, to link circuits automatically connected at their
 10 answering ends with calling lines and provided with connecting plugs. The tip strand 10 of the link circuit illustrated is connected with a button 5 and the sleeve strand 11 is connected with a button 6.

I will now describe the apparatus for
 15 automatically connecting a calling line with a link circuit. A calling subscriber, subscriber A for example, upon lifting his telephone receiver from its switch-hook, establishes a circuit that may be traced from the
 20 grounded spring 12 and its normal contact, the contact of armature 1' and said armature, the line of the calling subscriber, the armature 2' and its normal contact, the line relay 13, to the grounded battery 14, being
 25 the left hand battery illustrated in the drawing. The armature-switches 15—16 are thereby removed from their contacts 1—2, the armature-switch 17 is removed from its normal contact to its alternate contact, and the armature-switch 18 is engaged with its
 30 contact, said armature-switches 15—16—17—18 being all operable by the magnet 13. By opening the circuit of the calling line at the relay 13, the cut-off relay 3 is for the
 35 time being, prevented from operating. When the switch 18 is closed against its contact, as hitherto stated, a circuit is established that includes the winding of a polarized relay 19 and a source of current 20 that is
 40 preferably alternating. The relay 19 operates a ratchet wheel 21 upon whose shaft are provided the switches 7—8 and also an auxiliary switch 22 whose function will be hereinafter set forth. Each line desirably has
 45 an instrumentality including the elements 21—22—7—8, together with the magnet 19, the generator 20 and the circuit including said elements 19—20. The arm 22 passes
 50 over buttons 23, there being as many buttons 23 as there are buttons 5 and as there are buttons 6, each link circuit having three buttons 5—6—23, said link circuit in addition to the conductors 10—11, which are the
 55 speaking conductors, having an auxiliary conductor 24 connected with the button 23. While there are as many sets of switches 7—8—22 as there are telephone lines in a group, there are as many buttons 6, as many
 60 buttons 5, and as many buttons 23, belonging to said switches as there are link circuits, and each link circuit has one button 5, one button 6, and one button 23, for each group of elements 7—8—22 belonging to the telephone lines, the buttons 5 belonging to
 65 one link circuit being multiplied together, as

are the buttons 6 of each link circuit and the buttons 23. The apparatus of the link circuit, in the embodiment of the invention shown, causes ground to be placed upon the
 70 conductor 24 and, consequently, upon the buttons 23 connected therewith, when the link circuit corresponding to said conductor 24 is busy, the ground being removed from
 75 its conductor when said link circuit is free to be used. When the arm 22 encounters a button 23 from which the ground has been removed (the arms 7—8 then engaging the answering buttons or terminals 5—6 of the same cord circuit to which the button 23
 80 belongs), the motor 19 has its circuit opened and is, therefore, stopped to continue the connection between the elements 7—8 and the buttons 6—5, for the magnet 13, which
 85 must be energized in order that the circuit of the relay 19 may be maintained at 18, now depends for its circuit upon the arm 22 and an engaged grounded contact 23, its
 90 circuit being traced from the grounded battery 14, through the relay 13, to the switch 17 and its alternate contact, the arm 22 connected with the switch 17, to the grounded
 95 contact 23. This is so because the pin 25 normally engaging the spring 12, to hold the same against its normal contact to permit of the establishment of one circuit for the relay 13, is immediately disengaged from
 100 said spring 12 when the wheel 21 begins to rotate. Thus, if the arm 22 is in engagement with a grounded button 23, a ground in substitution for the ground upon the spring 12, is at once supplied, to maintain
 105 the winding of relay 13 in closed circuit. In this way the arm 22 is continued in motion until it is in full connection with the button 23, whose ground has been removed, which, as stated, is the case only when the link circuit corresponding to this latter button is
 110 idle. In order that the relay 13 may not be included in open circuit until the arms 7—8—22 have rested upon the terminals 5—6—23 of an idle cord circuit, the free end of the arm 22 is flared, so that it will make
 115 contact with one button 23 before leaving the preceding button. The link circuits are subdivided into groups and distributed among the operators, and, in order that no operator need be overtaxed, means are provided whereby the cord circuits of any operator
 120 are made to correspond to busy cord circuits, to which end switches 26 connected with the conductors 24 may be placed upon their grounded contacts when cord circuits corresponding to conductors 24 are to be made unserviceable.

I will now describe the manner in which
 125 the ground is placed upon the conductor 24 of the busy link circuit shown. The arm 22, resting upon a button 23 from which the ground has been removed, because the link circuit shown is idle, effects an interruption
 130

of the circuit including the magnet 13, as hitherto stated, whereby the armature-switches 15—16—17—18 are released, permitting the establishment of a circuit for the cut-off relay 3, which may be traced from the grounded terminal of said cut-off relay or magnet, the armature-switch 16 and its contact 2, the arm 7, the button 6 engaged thereby, a part of the sleeve strand 11, the magnet or relay 27, to the grounded battery 14. The magnet 27 attracts its armature 28, which, when the cord circuit is idle, is unattracted, to remove the ground from the button 23, but which establishes this ground when attracted, through one path before the connection is established with the called line and through a second path after this connection with a called line has been established. The first path includes the normal contact of an armature-switch 29 and the alternate contact of an armature-switch 30, for circuit through magnet 3 is established that may be traced from the grounded terminal of magnet 31, the tip strand 10, a button 5, the arm 8 engaging said button, the armature-switch 15 and its contact 1, the calling subscriber's line, the arm 7, the button 6 engaged thereby, the relay 27, to the grounded battery 14. This relay 31 in addition to establishing the ground upon the conductor 24, also acts as a calling relay to effect a signal at 32, the element 32 being preferably a small incandescent lamp and included in circuit by the armature-switch 33 belonging to the relay 31, which circuit may be traced from the ground established by the armature-switch 34' moved by the relay 27 against its contact, to the armature 33, the signal device 32, the armature-switch 34, when in engagement with its normal contact, to the grounded battery 14. The operator having ascertained the connection desired, in the usual way, inserts the connecting plug 9 into the jack of the called subscriber's line, whereby a circuit is established that may be traced from the grounded terminal of the cut-off relay 3 of the called subscriber (as B), the sleeve contact of the jack engaging the plug, the sleeve of said plug, the sleeve strand 11, the relay or magnet 35, to the grounded battery 14. The armature-switches 29—34 are thereupon moved away from their normal contacts into engagement with their alternate contacts, whereby the ground 36 is placed upon the conductor 24. It will be thus seen that the conductor 24 has a ground established thereupon as soon as connection is automatically effected with the link circuit and after the connecting plug has been inserted within the jack of the called subscriber, so that the switches 7—8—22 of any other calling subscriber will not be arrested at the terminals 5—6 of this now occupied link circuit. The alternate ground 36 thus placed upon the conductor 24 may be traced from said ground 36, to the normal contact of the armature-switch 27, the alternate contact of the armature-switch 29, the contact of the armature-switch 28, which latter contact is a permanent terminal of the conductor 24. By the operation of the relay 35 the signal occasioned by the device 32 is effaced, because the circuit including said device is opened by the separation of the armature-switch 34 from its normal contact, which switch and contact are required to complete the circuit through said signal device. If the calling subscriber should change his mind and not desire connection with another subscriber, or upon the withdrawal of the connecting plug from the called subscriber's line jack and the replacement of the calling subscriber's receiver upon its switch-hook, the actuated wheel 21 is restored to its normal position, because the motor 19 again has its circuit closed to effect the rotation of the wheel 21 until the pin 25 engages the spring 12 to move it from its alternate contact into engagement with its normal contact. These results will be understood from the following description: Circuit is initially established from the ground upon the switch-arm 12, the alternate contact of said switch-arm, the winding of a service meter 38, whose operation will more fully hereinafter be set forth, the normal contact of armature-switch 17, the switch-arm 22, the conductor 21, the armature-switch 28 and its contact, the now released armature-switch 29 and its normal contact, the now released armature-switch 30 and its normal contact, to the grounded battery 14. The armature of relay 33 is thereupon operated to establish a circuit that may be traced from the grounded switch 12, to the armature-switch 39 operated by the relay 33, together with the contact of said armature-switch, the line relay 13, to the grounded battery 14. The line relay 13 is thus energized to establish circuit for the relay 19 at 18, whereby the wheel 21 is continued in its original direction of rotation, but which wheel stops when the pin 25 removes the armature-switch from its alternate to its normal contact, for upon the separation of the switch 12 from its alternate contact, the circuit through the magnet 13 is broken, whereupon the circuit including the motor 19 is opened at 18, causing said motor to cease its operation. It will be understood that the shafts *a*, *b*, *c* carry the wipers or rotating contact arms that are mounted thereon.

Referring now to the service meter, when the battery 14 is included in circuit with the polarized relay 38, for the purpose of applying the armature-switch 39 to its contact, the armature of the relay 38, while being provided with a pawl for operating the ratchet

wheel 40 of a counting train belonging to the service meter, does not move far enough to the right to cause the said pawl to engage a new tooth of said ratchet wheel. It is desired to have the service meter operated only when the called subscriber has responded, to which end the armature of relay 38 is moved to the left each time a call is to be registered. The special battery 41 is provided for the purpose of operating the relay 38, this battery directing current through said relay in a direction opposite to that furnished by the battery 14. Circuit including the battery 41 and the relay 38 is established as follows: The called subscriber having removed his telephone receiver from its switch-hook, metalically connects the two sides of his line, whereby circuit is established that may be traced from the grounded battery 41, the alternate contact of armature-switch 37 (the relay or magnet 42 being now energized by reason of the establishment of a circuit that may be traced from the grounded battery 14, to the armature-switch 34 and its alternate contact, the winding of relay 42, the armature 42¹ operated by relay 31 and its contact, the armature-switch 43 and its contact—the relay or magnet 44 being now energized because of the establishment of a circuit including the armature-switch 45 and its alternate contact, the tip strand 10, the subscriber's line, the sleeve strand 11, to the grounded battery 14—to the normally closed grounded switch 46 and its contact), said armature-switch, the alternate contact of armature-switch 29, the armature-switch 28 and its contact, conductor 24, armature-switch 17 and its normal contact, to the relay 38. It will be seen that the current passing from the battery 41 through the polarized relay 38 is opposite to the current furnished by the battery 14. It will also be seen that this battery 14 is at this time out of operative relation with the relay 38, as circuit containing this battery 14 and said relay is now open at 29 and 30. It will thus be seen that the service meter is not operated until the called subscriber removes his telephone from its switch-hook. When the battery 41 has been included in circuit with the relay 38, to effect one movement of the register of the service meter, further operation of this service meter is prevented during the same connection between the calling and called subscribers, which result will be apparent from the following explanation: When the circuit has been established through the magnet or relay 42, as hitherto specified, the armature-switch 47 is moved against its contact to establish a local circuit that includes the winding of said magnet 42, the armature-switch 34 and its alternate contact, and the grounded battery 14, the relay 35 having its circuit closed to move the armature-switch 34, the circuit of

the relay 35 being traceable from the grounded battery 14, to the winding of said relay, the sleeve strand 11, to the cut-off relay 3, whereby the relay 42 is locked, so that it cannot be deenergized until circuit through the relay 35 is opened, upon the withdrawal of the connecting plug from connection with the called subscriber's line. Thus, the battery 41 is constantly maintained in circuit with the relay 38 after the called subscriber has removed his telephone receiver from its switch-hook and until the connecting plug 9 is withdrawn, for it is the connecting plug 9 that controls the circuit of the relay 35. That this battery 41 is constantly maintained in circuit with the relay 38 as specified, is apparent when it is noted that the armature-switch 37 of relay 42 is locked in connection with its alternate contact until the relay 35 is deenergized.

As in some systems of telephony the tip and sleeve of the connecting plugs are liable to be directly connected by the thimbles of the jacks into which they are inserted and from which they are being withdrawn, which in the system here shown would cause a premature and faulty operation of the magnet 44 (which magnet should only be operated by the called subscriber's switch-hook), I make the ground upon the contact of the armature-switch 43 separable from said contact. This result may readily be accomplished, particularly in multiple switch-board practice, by mechanically associating the switch 46 and its contact with the operator's telephone key 47¹, so that, while the operator is testing and inserting a plug, she will have the key 46 depressed, because of its mechanical association with her listening and testing key 47¹, to remove the ground from the contact of armature-switch 43, thus making it immaterial whether or not the sleeve and tip of the connecting plug are directly connected momentarily as the plug is being inserted, the switch 46 being released after the connecting plug has been sufficiently inserted and prior to the completion of the conversation. It will be thus seen that the relay 42 cannot be operated to lock itself until the called for party responds, and if the called for subscriber does not respond, the connection may be taken down and the calling subscriber will not be wrongfully charged therefor. To insure that no false charge will be made on withdrawing a plug when the called for subscriber has not responded, I preferably provide the armature 42¹ and its contact associated with the relay 31, which will remove the ground at 46 to prevent the operation of relay 42 by an accidental cross between the strands 10—11—the calling subscriber's telephone then being upon its hook. It will be apparent that this feature of my invention is useful in connection with systems of teleph-

only now in use, and I do not, therefore, wish to be limited in all embodiments of the invention to systems wherein the answering ends of the link circuits are automatically connected with calling telephone lines.

Another feature of my invention adaptable for use in connection with systems of the kind illustrated and also with systems of telephony now in use, relates to the means employed for keeping track of the work performed by the operator. It is the object of this feature of my invention to provide cord counting mechanism that will be operated only upon the response of a called subscriber and which cannot thereafter be operated during the same connection, mechanism being provided whereby a reoperation of the called subscriber's switch-hook during such connection, will prevent the operation of the cord counting mechanism. I also provide totalizing mechanism, operated by the cord counters, one such totalizing mechanism being provided for each operator, so that the work she performs may be measured and her compensation arranged accordingly. This totalizing mechanism will furnish a guide to determine the capacity of the operator and the adjustment of the switches 26, so that the cord circuits available for her use may be properly regulated in number. I find that the results desired may be gained by including a magnet 48 in circuit with the battery 41 between the said battery and the alternate contact of armature-switch 37, whereby said relay 48 will have the same government as that which is had of the relay 38 by the elements 37-42-43-44-45-46-47, so that said relay 48 has circuit closed therethrough through the agency of the called subscriber's switch-hook when relieved of the receiver it supports, such circuit being maintained closed and only being opened when a connection between the calling and called subscribers is taken down, for the relay 42 maintains the closure of this circuit in the manner hitherto described in connection with the relay 38, and a description of such operation need not, therefore, be repeated. The relay 48 operates the counting mechanism 49 (diagrammatically indicated), which counting mechanism includes in its train a gear wheel 50 provided upon a shaft 51. There is one such counting mechanism 49, one such gear wheel or pinion 50, and one such shaft 51, for each link circuit, there being three other such wheels and shafts indicated and designated 50¹-50²-50³-51¹-51²-51³. Taps 52 indicate the connection of other relays 48 and the immediate conductor portions including the same with the battery 41. In order that the movements of the wheels 50-50¹-50²-50³ belonging to one operator may be totalized,

I preferably employ the totalizing mechanism illustrated, which comprises a number of wheels 53, one for each link circuit, meshing with the wheels 50-50¹, etc., a shaft 54 upon which the wheels 53 are loosely mounted to rotate with respect thereto, a wheel 55 for each wheel 53 and fixed upon said shaft, a pawl 56 for each wheel 53 and in engagement with the associate wheel 55, and a wheel 57 mounted upon the shaft that operates the totalizing mechanism 58. By this construction when any shaft 51-51¹, etc., is operated, the totalizing mechanism 58 is operated. The shaft 51 and the shaft of the wheel 57 are shown disconnected from their respective counters, but the mechanical connection is understood.

The magnet or relay 48 is desirably of low resistance as compared with the winding of the relay 13, so that the current flowing through the relays 38 associated with said link circuits connected with the lines of called subscribers who have removed their telephones from their switch-hooks, will not be momentarily reversed in direction, whereby the said relays 38 belonging to said link circuits whose contacts 5-6-23 are thus being ridden over by the switches of a calling subscriber, will not effect a false operation of the service meter.

The operators' switches 46 and 42¹ serve to prevent premature or false operation of the link cord counter and its magnet 48 in the same way that it prevents premature operation of the relay 38.

I do not wish to be limited to all of the features herein illustrated, nor in all embodiments of the invention to the precise form of telephone system herein shown, as modifications and various applications of my invention may be made without departing from its spirit, but,

Having thus described my invention, I claim as new and desire to secure by Letters-Patent the following:—

1. A telephone exchange system including a plurality of telephone lines extending from subscribers' stations to an exchange, service meters for subscribers' lines, link-circuits for uniting subscribers in conversation including connecting plugs adapted for connection with called subscribers' lines, apparatus and circuit connections governing the operation of each service meter and including a called subscriber's switch-hook and the connecting plug effecting association of said called subscriber with the calling subscriber's line and service meter; the circuit for the said service meter being controlled by the switch-hook of the called subscriber's line, a relay for the link-circuit uniting the calling and called subscribers' lines having an armature-switch adapted to close circuit through the relay when ener-

gized to maintain the service meter in closed circuit during an established connection, a second relay governing the circuit of the aforesaid relay and serving to effect de-energization of said relay when connection
5 between lines is broken, link-circuit apparatus for governing said second relay, the circuit for the second relay including contacts of the called subscriber's jack and engaging
10 plug.

2. A telephone exchange system including a plurality of telephone lines extending from subscribers' stations to an exchange, service meters for subscribers' lines, link-
15 circuits for uniting subscribers in conversation including connecting plugs adapted for connection with called subscribers' lines, apparatus and circuit connections governing the operation of each service meter and including
20 a called subscriber's switch-hook and the connecting plug effecting association of said called subscriber with the calling subscriber's line and service meter, the circuit for the said service meter being controlled by the switch-hook of the called subscriber's line, a relay for the link-circuit
25 uniting the calling and called subscribers' lines having an armature-switch adapted to close circuit through the relay when energized, to maintain the service meter in closed
30 circuit during an established connection, a second relay governing the circuit of the aforesaid relay and serving to effect de-energization of the first aforesaid relay when connection between lines is broken,
35 and link-circuit apparatus for governing said second relay.

3. A telephone exchange system including a plurality of telephone lines extending
40 from subscribers' stations to an exchange, service meters for subscribers' lines, link-circuits for uniting subscribers in conversation including connecting plugs adapted for connection with called subscribers' lines, apparatus and circuit connections governing
45 the operation of each service meter and including a called subscriber's switch-hook and the connecting plug effecting association of said called subscriber with the calling
50 subscriber's line and service meter, the circuit for the said service meter being controlled by the switch-hook of the called subscriber's line, a relay for the link-circuit uniting the calling and called subscribers'
55 lines for maintaining the service meter in closed circuit during an established connection, a relay governing the circuit of the aforesaid relay and serving to prevent the reoperation of the aforesaid relay during a
60 connection between lines and serving to effect a release of the aforesaid relay, to open the circuit of the service meter when connection between lines is broken, and link-circuit apparatus for governing said second
65 relay.

4. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters for subscribers' lines, apparatus and circuit connections governing the operation of each service meter and including the switch-hook of the line connected with a line having the service meter, the circuit for the said service meter being controlled by the switch-hook of the called subscriber's line, a relay for the link-circuit uniting the calling and called subscribers' lines, for maintaining the service meter in closed circuit during an established connection, a relay governing the circuit of the aforesaid relay and serving to prevent the reoperation of the aforesaid relay during a connection between lines and serving to effect a release of the aforesaid relay, to open the circuit of the service meter
70 when connection between lines is broken, and link-circuit apparatus for governing said second relay.

5. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters for subscribers' lines, apparatus and circuit connections effecting the operation of each service meter and including the switch-hook of the
75 called line connected with a line having a service meter, a relay for preventing reoperation of the service meter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the service meter upon dis-connection between the subscribers, a relay controlling said switching mechanism, and a circuit governing the relay and including a contact of the jack of the called subscriber and an engaging contact of the plug of the link-circuit.

6. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters for subscribers' lines, apparatus and circuit connections effecting the operation of each service meter and including the switch-hook of the called line connected with a line having
110 a service meter, mechanism for preventing reoperation of the service meter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the service meter upon dis-connection between the subscribers, a relay controlling said switching mechanism, and a circuit governing the relay and including a contact of the jack of the called subscriber and an engaging contact of the plug of the
115 link-circuit.

7. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters for sub-
120

scribers' lines, apparatus and circuit connections effecting the operation of each service meter and including the switch-hook of the called line connected with a line having a service meter, a relay for preventing reoperation of the service meter during an established connection, said relay being provided with an armature switch serving, when the relay is energized, to maintain circuit through the relay closed, to prevent the reoperation of the service meter, the link-circuit uniting the lines including switching mechanism serving to release the service meter upon disconnection between the subscribers, and a relay controlling said switching mechanism, the relay for controlling the switching mechanism being governed by a circuit including a contact of the jack of the called subscriber and an engaging contact of the plug of the link-circuit.

8. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters for subscribers' lines, apparatus and circuit connections effecting the operation of each service meter and initially actuated only by the switch-hook of the called line connected with a line having a service meter, a relay for preventing reoperation of the service meter during an established connection, said relay being provided with an armature-switch serving, when the relay is energized, to maintain circuit through the relay closed, to prevent the reoperation of the service meter, the link-circuit uniting the lines including switching mechanism serving to release the service meter upon disconnection between the subscribers, and a relay controlling said switching mechanism.

9. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters for subscribers' lines, apparatus and circuit connections effecting the operation of each service meter and initially actuated only by the switch-hook of the called line connected with a line having a service meter, a relay for preventing reoperation of the service meter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the service meter upon disconnection between the subscribers, and a relay controlling said switching mechanism.

10. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters at the exchange for subscribers' lines, apparatus and circuit connections effecting the operation of each service meter and initially actuated only by the switch-hook of the called line connected with a line having a

service meter, mechanism for preventing reoperation of the service meter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the service meter upon disconnection between the subscribers, and a relay controlling said switching mechanism.

11. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters at the exchange for subscribers' lines, apparatus and circuit connections effecting the operation of each service meter and initially actuated only by the switch-hook of the called line connected with a line having a service meter, and mechanism for preventing reoperation of the service meter during an established connection, the link-circuit uniting the lines including electromagnetic switching mechanism serving to release the service meter upon disconnection between the subscribers.

12. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters at the exchange for the subscribers' lines, circuit connections including contacts of the called subscriber's jack and the engaging plug governing the operation of the service meter of the calling line, means for applying calling current to a called subscriber's line, and an operator's switching device for changing the relation of the circuit connections, to prevent untimely operation of the service meter.

13. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters for the subscribers' lines, circuit connections including contacts of the called subscriber's jack, an engaging plug governing the operation of the service meter, and the switch-hook of the called subscriber, means for applying calling current to a called subscriber's line, and an operator's switching device for changing the relation of the circuit connections, to prevent untimely operation of the service meter.

14. A telephone exchange system including a plurality of telephone lines extending from subscribers' stations to an exchange, link circuits for uniting subscribers in conversation including connecting plugs adapted for connection with called subscribers' lines, link-circuit counters for measuring the operations of the link circuits, apparatus and circuit connections governing the operation of each link-circuit counter and including a called subscriber's switch-hook and the connecting plug effecting association of said called subscriber with the calling subscriber's line and the link-circuit counter, the circuit for the said link-circuit counter

being controlled by the switch-hook of the called subscriber's line, a relay for the link-circuit uniting the calling and called subscribers' lines having an armature-switch adapted to close circuit through the relay, when energized, to maintain the link-circuit counter in closed circuit during an established connection, a second relay governing the circuit of the aforesaid relay and serving to effect an opening of the circuit including the first aforesaid relay when connection between lines is broken, the circuit for the second relay including contacts of the called subscriber's jack and engaging plug, and link-circuit apparatus for governing said second relay.

15. A telephone exchange system including a plurality of telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting subscribers in conversation including connecting plugs adapted for connection with called subscribers' lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections governing the operation of each link-circuit counter and including a called subscriber's switch-hook and the connecting plug effecting association of said called subscriber with the calling subscriber's line and the link-circuit counter, the circuit for the said link-circuit counter being controlled by the switch-hook of the called subscriber's line, a relay for the link-circuit uniting the calling and called subscribers' lines having an armature-switch adapted to close circuit through the relay when energized, to maintain the link-circuit counter in closed circuit during an established connection, a second relay governing the circuit of the aforesaid relay and serving to effect an opening of the circuit including the first aforesaid relay when connection between lines is broken, and link-circuit apparatus for governing said second relay.

16. A telephone exchange system including a plurality of telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting subscribers in conversation including connecting plugs adapted for connection with called subscribers' lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections governing the operation of each link-circuit counter and including a called subscriber's switch-hook and the connecting plug effecting association of said called subscriber with the calling subscriber's line and the link-circuit counter, the circuit for the said link-circuit counter being controlled by the switch-hook of the called subscriber's line, a relay for the link-circuit uniting the calling and called subscribers' lines for maintaining the link-circuit counter in closed circuit during

an established connection, and a relay governing the circuit of the aforesaid relay and serving to prevent the reoperation of the aforesaid relay during a connection between lines and serving to effect a release of the aforesaid relay, to open the circuit of the link-circuit counter when connection between lines is broken, and link-circuit apparatus for governing said second relay.

17. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, a relay for preventing reoperation of the link-circuit counter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the link-circuit counter upon disconnection between the subscribers, a relay controlling said switching mechanism, and a circuit governing the relay and including a contact of the jack of the called subscriber and an engaging contact of the plug of the link-circuit.

18. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, mechanism for preventing reoperation of the link-circuit counter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the link-circuit counter upon disconnection between the subscribers, a relay controlling said switching mechanism, and a circuit governing the relay and including a contact of the jack of the called subscriber and an engaging contact of the plug of the link-circuit.

19. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, and a relay for preventing reoperation of the link-circuit counter during an established connection, said relay being provided with an armature-switch serving, when the relay is energized, to maintain circuit through the relay closed, to prevent the reoperation of the link-circuit counter, the link-circuit uniting the lines including electromagnetic mechanism

serving to release the link-circuit counter upon disconnection between the subscribers.

20. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, and a relay for preventing reoperation of the link-circuit counter during an established connection, said relay being provided with an armature-switch serving, when the relay is energized, to maintain circuit through the relay closed, to prevent the reoperation of the link-circuit counter, the link-circuit uniting the lines including electromagnetic switching mechanism serving to release the link-circuit counter upon disconnection between the subscribers.

21. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, a relay for preventing reoperation of the link-circuit counter during an established connection, said relay being provided with an armature-switch serving, when the relay is energized, to maintain circuit through the relay closed, to prevent the reoperation of the link-circuit counter, the link-circuit uniting the lines including switching mechanism serving to release the link-circuit counter upon disconnection between the subscribers, and a relay controlling said switching mechanism, the relay for controlling the switching mechanism being governed by a circuit including a contact of the jack of the called subscriber and an engaging contact of the plug of the link-circuit.

22. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, a relay for preventing reoperation of the link-circuit counter during an established connection, said relay being provided with an armature-switch serving, when the relay is energized, to maintain circuit through the relay closed, to prevent the reoperation of the link-circuit counter, the link-circuit uniting the lines including switching mechanism serving to release the link-circuit counter upon

disconnection between the subscribers, and a relay controlling said switching mechanism.

23. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, a relay for preventing reoperation of the link-circuit counter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the link-circuit counter upon disconnection between the subscribers, and a relay controlling said switching mechanism.

24. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, mechanism for preventing reoperation of the link-circuit counter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the link-circuit counter upon disconnection between the subscribers, and a relay controlling said switching mechanism.

25. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, and a relay for preventing reoperation of the link-circuit counter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the link-circuit counter upon disconnection between the subscribers.

26. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, and mechanism for preventing reoperation of the link-circuit counter during an established connection, the link-circuit uniting the lines including switching mechanism serving to release the link-circuit counter upon disconnection between the subscribers.

27. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, and a relay for preventing reoperation of the link-circuit counter during an established connection, the link-circuit uniting the lines including mechanism serving to release the link-circuit counter upon disconnection between the subscribers.
28. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections effecting the operation of each link-circuit counter and including the switch-hook of the called line, and mechanism for preventing reoperation of the link-circuit counter during an established connection, the link-circuit uniting the lines including mechanism serving to release the link-circuit counter upon disconnection between the subscribers.
29. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, circuit connections including contacts of the subscriber's jack and the engaging plug and the subscriber's switch-hook governing the operation of the link-circuit counter, and an operator's switching device for changing the relation of the circuit connections, to prevent the operation of the link-circuit counter prior to the operation of the switch-hook.
30. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, circuit connections including contacts of the called subscriber's jack and engaging plug and the switch-hook of the called subscriber governing the operation of the link-circuit counter, and an operator's switching device for changing the relation of the circuit connections, to prevent untimely operation of the link-circuit counter.
31. A telephone system including telephone lines extending from subscribers' stations to the exchange, link circuits having manually controlled terminals for connection with called lines, service meters for subscribers' lines, electromagnets for operating said meters, circuit connections for said meter magnets whose association with said magnets is governed by apparatus of the link circuits, automatically operated selecting mechanism for connecting calling subscribers' lines with the answering ends of the link circuits and effecting association of said circuit connections with the service meter magnets, and means to prevent the closure of said magnet circuits until after such connection is effected.
32. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits having manually controlled terminals for connection with called lines, service meters for subscribers' lines, circuit connections for the service meters, a pair of supervisory relays associated with the link-circuits and jointly governing the association of said circuit connections with the service meters, and automatically operated selecting mechanism for connecting calling subscribers' lines with the answering ends of the link-circuits.
33. A telephone system including a pair of telephone lines, a cord-circuit connecting said lines, an electromagnet at the exchange, an indicating device actuated by said magnet, supervisory relays one connected to each line, and a circuit for said magnet jointly controlled by said relays.
34. A telephone system including a calling line, a link-circuit connected therewith, a call register for the calling line, a called line, a connection terminal for said link-circuit for use in connecting the calling line to the called line, an electromagnet for said link-circuit controlling said register, a pair of relays in bridge of the talking conductors of said link-circuit controlling jointly said magnet, and a switch at the called substation for controlling one of said relays.
35. A telephone system including a calling telephone line, a call register therefor, a link-circuit connected therewith, a register relay for said link-circuit controlling said register, a circuit pertaining to said relay having two normally open contacts, a called line, a relay associated with said link-circuit controlling one of said contacts adapted for operation over a connection including a portion only of the talking circuit of the called line on connection of said link-circuit thereto, an additional relay associated with said link-circuit controlling the other of said contacts adapted for operation over a circuit including the entire talking circuit of the called line, and a switch at the called substation for controlling said relay.
36. A telephone system including a calling line and a called line, a call register for the calling line, a link-circuit interconnecting said lines, supervisory relays for said link-circuit having their respective operative conditions controlled by the substation switches of said lines, a circuit including

switch contacts of both said relays, a magnet included in said circuit operatively related with said register, and a locking circuit therefor to prevent reoperation of said register.

37. A telephone system including a calling subscriber's line and a called subscriber's line, a call register for the calling line, an operator's link-circuit connecting said lines, a pair of relays for said circuit responsive to currents over said lines respectively jointly controlling the operation of said register, an operator's listening device, and a circuit for controlling said register including a switch contact of said device.

38. A telephone system including a calling telephone line, a call register at the central office for said line, an electromagnet for operating said register, a called line, a selective switch for use in establishing the connection between said lines, a circuit for controlling said register including the switch-hook of the called station, and means effected in the operation of said control circuit to prevent more than a single operation of said electromagnet after the connection is established.

39. A telephone system including subscribers' lines, call registers at the central office for said lines, selective switches for use in establishing connections from calling to called lines, circuits for said registers controlled in part through said selective switches, said circuits being also controlled by the switch-hooks at the called substations and automatically operated means for removing the called substation control of said circuits.

40. The combination with a calling subscriber's telephone line, of a selective switch adapted for operation when the line is a calling line to extend the circuit thereof, a call register at the central office for said line, a circuit for said register controlled at the called substation and automatically operated means for removing the called substation control of said circuit.

41. The combination with a calling telephone line, of a call register therefor at the central office, an electromagnet adapted for operating said register, a called line connected with said first-mentioned line, a selective switch included in the circuit between said lines, the operation of said register magnet being controlled over a circuit established in part by said selective switch and in part responsive to the switch-hook at the called substation and means to prevent but a single operation of said magnet responsive to said switch hook at the called substation.

42. A telephone system including subscribers' lines, link-circuits at the exchange for extending connections from calling lines to called lines, selective switches at the ex-

change for use in automatically connecting said link-circuits interchangeably with different calling lines, switches at the substations of said lines for initiating travel of said selective switches, service meters for said lines at the exchange, circuits for said meters partially established by said selective switches in their operations, means controlled by currents over the called lines for completing the circuits of said meters to register calls and means to prevent but a single closure of said circuits for each connection to a called line.

43. A telephone system including a calling subscriber's line, a link-circuit at the exchange, a selective switch for connecting said link-circuit and line, a hook-switch at the calling substation controlling a circuit for initiating travel of said selective switch, independent means for controlling the travel of said switch when started, to complete the connection of said circuit and line, a service meter at the exchange, a circuit therefor completed in part by operation of said switch in completing said connection, a switch device included in said link-circuit further controlling said meter circuit to render the same effective to record a call against said line and means for removing the switch device control of the meter circuit after a call is recorded.

44. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, link-circuit counters for measuring the operations of the link-circuits, apparatus and circuit connections governing the operation of each link-circuit counter and including the switch-hook of the called line, mechanism for preventing reoperation of the link-circuit counter during an established connection operated by the switch-hook of the called subscriber, and apparatus for releasing the said mechanism associated with the link-circuits.

45. A telephone system including a calling line, a link-circuit connected therewith, a call register for the calling line, a called line, a connection terminal for said link-circuit for use in connecting the calling line to the called line, an electromagnet for said link-circuit controlling said register, a pair of relays in bridge of the talking conductors of said link-circuit controlling jointly said magnet, a switch at the called substation for controlling one of said relays, a locking circuit for said magnet, a switch contact controlled by the other relay included in said locking circuit, and an operator's switch solely controlling said other relay.

46. A telephone system including a calling telephone line, a call register therefor, a link-circuit connected therewith, a register relay for said link-circuit controlling said

register, a circuit pertaining to said relay having two normally open contacts, a called line, a relay associated with said link-circuit controlling one of said contacts adapted for operation over a connection including a portion only of the talking circuit of the called line on connection of said link-circuit thereto, an additional relay associated with said link-circuit controlling the other of said contacts adapted for operation over a circuit including the entire talking circuit of the called line, a switch at the called substation for controlling said relay, and a third normally open contact for said register relay, and an electromagnet controlling said contact controlled over a circuit including the substation switch of the calling line.

47. A telephone system including a calling line and a called line, a register for the calling line, a link-circuit interconnecting said lines, two relays at the exchange belonging to said link-circuit and sensitive to currents controlled by switches at the substations of the respective lines and a circuit for causing operation of said register including said register and switch contacts of both said relays.

48. A telephone system including a calling line and a called line, a call register for the calling line, a link-circuit interconnecting said lines, supervisory relays for said link-circuit having their respective operative conditions controlled by the substation switches of said lines, and a circuit for causing operation of said register including said register and switch contacts of both supervisory relays.

49. A telephone system including a pair of telephone lines, a cord-circuit connecting them, supervisory relays therefor one connected to each line, a call register for the calling line, and an electromagnet controlled by said relays jointly for directly operating said register.

50. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of interconnecting link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, manually operated means for connecting the other end of said link-circuit to a called telephone line, a service meter associated with the calling line, a control circuit for said meter controlled at the called substation for rendering the control circuit effective upon the response of the called party, and means for thereafter removing the substation control of said circuit.

51. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of interconnecting link-circuits, automatic switch mechanism for establishing connection between a calling

line and an idle link-circuit, manually operated means for connecting the other end of said link-circuit to a called telephone line, a counter associated with the connected link-circuit, and means for causing its operation only upon the response of the called party.

52. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of interconnecting link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, manually operated means for connecting the other end of said link-circuit to a called telephone line, a service meter associated with the calling line, a counter associated with the connected link-circuit, and means for causing their operation only upon the response of the called party.

53. A telephone system comprising a plurality of subscribers' telephone lines, selecting switch contacts in which said lines terminate, interconnecting link-circuits, means for automatically establishing connection between said selecting contacts of a calling line and an idle link-circuit, manually governed means for connecting the selected link-circuit to a called line, service meters for said line, and means solely dependent upon the response of the called party for operating the service meter of the calling line.

54. A telephone exchange system comprising a plurality of subscribers' telephone lines, selecting switch contacts in which said lines terminate, interconnecting link-circuits, means for automatically establishing connection between said switch contacts of a calling line and an idle link-circuit, operator controlled switching means for extending the circuit of the selected link-circuit to a called line, means adapted to be operated upon response of a called subscriber for recording a call against the calling party and switching means controlled by the operator to render ineffective said recording means.

55. In a telephone system including step-by-step switches, means for operating said switches in completing connections between substations, register devices at the central office equal in number to said switches, and mechanism mechanically independent of the switch mechanism but controlled over a connected substation for operating said registers to record the calls.

56. In a telephone system, the combination with an automatic selector, of a call register individual thereto and mechanically independent of said selector, and electrical connections between said register and said selector for governing the operations of said register.

57. A telephone system including an automatic selector, a telephone line, means for operating said selector by current over said

line, a call register individual to said selector and mechanically independent thereof, and electrical connections for operating said register governed by said selector.

5 58. A telephone exchange system including telephone lines extending from subscribers' stations to an exchange, link-circuits for uniting the lines, service meters at the exchange for the subscribers' lines, circuit connections including contacts of the called subscriber's jack and the engaging plug and the called subscriber's switch-hook for governing the operation of the service meters, switch contacts for applying calling current to the called line, and operators' switching devices for changing the relation of the circuit connections to prevent the operation of the service meters before the response of the called subscriber.

20 59. A telephone exchange system comprising substation telephone lines, link circuits for extending the circuits of calling to called lines, automatic switches for interchangeably connecting said lines and link circuits, service meters at the central office for said lines, circuit connections for said meters controllable at a called substation for recording a call against a calling substation, and means for removing the called substation control of said circuits.

30 60. A telephone exchange system comprising a calling telephone line, a plurality of link circuits, an automatic switch operated upon initiation of a call over said line for connecting said line with an idle one of said circuits, a service meter for said line, a control circuit for said service meter including wiper contacts of said switch, and means for disconnecting said control circuit from the

wiper contacts, while said switch is operating to connect said line to an idle circuit. 40

61. A telephone system including a substation telephone line, link circuits, an automatic switch connected with said line and having access to said link circuits, adapted 45 upon initiation of a call over said line to select an idle one of said circuits, a service meter for said line, a control circuit for said meter including a wiper contact of said switch, adapted to be energized by current 50 from said link circuits, and means to interrupt and thereby prevent energization of said circuit while said switch is operating to select an idle link circuit.

62. A telephone system including a telephone line, link circuits for extending the circuit connections of said line, an automatic switch adapted upon initiation of a call over said line for establishing connection between said line and link circuits, a 60 wiper for said switch having circuit connections for controlling the selection of an idle one of said link circuits, a service meter for said line, and a control circuit for said meter including said wiper. 65

63. A telephone system including an automatic selector, a call register at the exchange individual thereto, and electrical connections between said register and said selector, said connections being the sole means through 70 which the operations of said register are controlled.

In witness whereof, I hereunto subscribe my name this 13th day of March A. D., 1905.

FRANCIS W. DUNBAR.

Witnesses:

G. L. CRAGG,
LEON STROH.