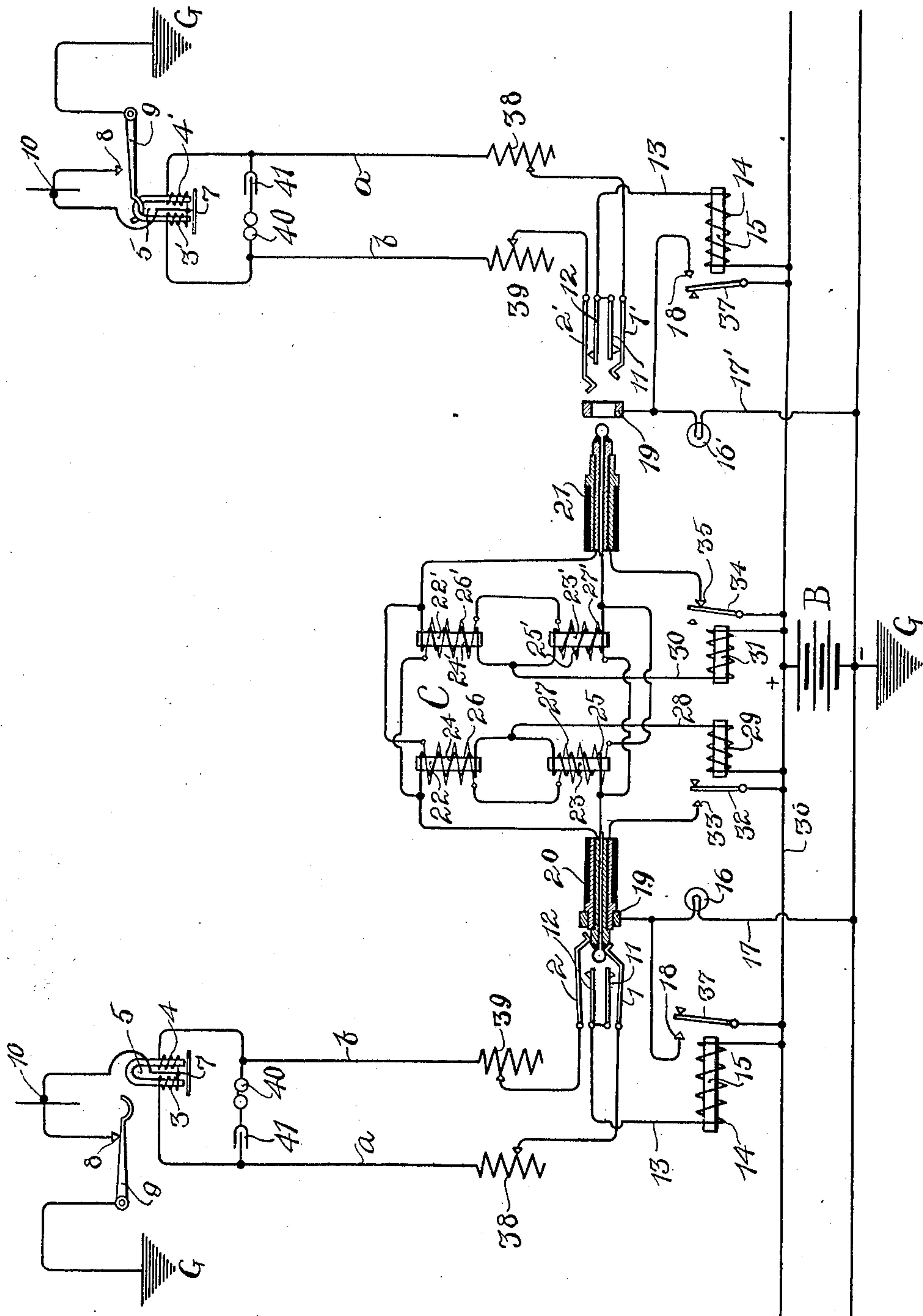


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TELEPHONE EXCHANGE SYSTEM.
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913,451.

Patented Feb. 23, 1909.



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TELEPHONE-EXCHANGE SYSTEM.

No. 913,451.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, GARRISON BABCOCK, citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented a certain new and useful Improvement in Telephone-Exchange 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 telephone exchange systems and has for its object a more simplified and a more efficient arrangement of the apparatus and circuits, particularly in central energy systems.

By means of my invention I am enabled to prevent the voice currents issuing from the transmitter at one substation from being audible in the receiver at that substation and only audible in the receiver at the other connected substation.

Another feature of my invention lies in the absence of all inductive or transformer means at the substations and in the provision of common transformation means at the central exchange. I also provide improved indicating and supervisory signaling means, the indicating lamp or other signal serving also as the supervisory signal.

In my system the direct current for supplying the transmitters at the substations passes parallelly over the line limbs while the telephonic voice currents pass serially through the line limbs. The resistance to the direct current is therefore practically reduced to one-fourth the resistance encountered in systems of the prior art with the same size conductors, or in other words, to produce as efficient results as in prior systems practically only one-fourth the cross section of conductor would be necessary. At the substations the receiver coils are included serially in the line limbs and from a point between the coils the transmitter circuit leads to ground. Normally the central battery is connected between ground and through an indicating relay with both line limbs, and upon closure of the transmitter circuit at the substation current flows from the battery parallelly through the line limbs, differentially through the receiver coils and through the transmitter circuit. The cord circuit at the central exchange is divided into two inductively separated parts provided with repeating coils which inductively

repeat the voice currents from one line to the other connected line, and these repeating coils are so arranged that when conversation is going on between two substations, the voice currents from either substation will pass differentially and parallelly through the receiver coils through the corresponding repeating coils at the central exchange, where they are rearranged to flow serially through the line limbs of the other substation and serially through the receiver coils thereat. Thus the receiver at a substation is not responsive to the voice currents from that substation but is responsive only to the voice currents coming from the other substation.

My invention will be best understood by reference to the accompanying drawing which diagrammatically shows one form of system in which the several features of my invention may be utilized.

The line limbs *a-b* lead from the jack springs 1 and 2 and at the substation include serially the coils 3 and 4 of the receiver 5. The transmitter circuit thus leads from a point 7 between the receiver coils to the contact 8 of the switch hook 9 and includes the transmitter 10, the switch hook being connected with ground G. The alternate jack springs 11 and 12 are normally in engagement with the main springs 1 and 2 and both connect with the conductor 13 containing the winding 14 of the indicating relay 15 and connect with the positive side of the common battery B. A lamp or other signal 16 is included in the conductor 17 leading from the negative side of the battery B to the front contact 18 of the indicating relay and to the jack thimble 19.

At the central exchange are cord circuits C each provided with the plugs 20 and 21. Each plug is associated with two sets of repeating coils, one set including the repeating coils 22 and 23 and the other set including the repeating coils 22' and 23'. The sleeve and tip members of the plug 20 are connected together through two parallel paths, one path including the primary windings 24 and 25 of the coils 22 and 23 respectively, and the other path including the secondary windings 26' and 27' of the coils 22' and 23'. The sleeve and tip members of the plug 21 are also connected together through parallel paths, one including the primary windings 24' and 25' of the coils 22' and 23' respectively, and the secondary windings 26 and

27 of the coils 22 and 23. The conductor 28 leads from the positive side of the battery to a point between the primary windings 22 and 23 and includes the winding of the supervisory relay 29. The conductor 30 leads from the positive side of the battery and to a point between the primary windings 22' and 23' and includes the winding of the supervisory relay 31. The armature 32 of the relay 29 is connected with the positive pole of the battery, and the normal contact 33 therefor is connected with the sleeve member of the plug 20. The armature 34 of the relay 31 connects with the positive pole of the battery, and the normal contact 35 therefor connects with the sleeve member of the plug 21.

The operation of a system of this kind is now apparent. Upon removal of the receiver from the hook the transmitter circuit at the substation is connected with ground and current will flow as follows: from the positive pole of the battery at the central exchange through the trunk conductor 36 to the conductor 13, through winding 14 of the indicating relay and to the normal spring contacts 11 and 12, the current then passing parallelly through the main jack springs 1 and 2 and through the line limbs *a* and *b* parallelly through the receiver coils 3 and 4 and through the transmitter circuit at the substation to ground, the negative side of the central battery being also grounded. The indicating relay becomes energized to attract its armature 37 against its contact 18 whereupon circuit will be closed through the lamp 16 from the battery through the conductor 17, through contact 18 and attracted armature 37, the lamp 16 being illuminated to notify the operator who inserts the plug 20 into the corresponding springjack. Insertion of the plug, however, lifts the main springs 1 and 2 from the normal contact springs 11 and 12 thus opening the circuit through the indicating relay and the circuit controlled thereby through the lamp. The primary windings 24 and 25 of the repeating coils 22 and 23, however, are connected parallelly in circuit and positive battery is fed to the line and substation through the relay 29 and conductor 28. Consequent energization of the relay 29 causes attraction of its armature 32 to prevent closure of a circuit through the lamp 16 upon insertion of a plug in the jack, which circuit through the lamp would otherwise be closed through the circuit including the conductor 17, the jack thimble 19, the sleeve member of the plug 20, the contact 33 and the armature 32, the circuit controlling the relay 29 being in turn controlled by the condition of the substation apparatus. I have not shown operator's telephonic apparatus or ringing apparatus, as the principles of my invention can be illustrated without such

connections. But supposing connection is desired with the substation shown at the right of the diagram. The operator inserts the plug 21 into the corresponding springjack which then immediately closes a circuit through the lamp 16', through the armature 34, contact 35, sleeve member of the plug 21, jack thimble 19 and conductor 17', the lamp becoming illuminated. Upon removing the receiver from the hook in response to a calling signal, however, circuit will be closed through the supervisory relay 31 to open the circuit through the lamp 16', the circuit through the relay being traced as follows: from the positive pole of the battery through relay 31 parallelly through the primary windings 24' and 25', parallelly through the plug members and jack springs 1' and 2' and through the line limbs *a* and *b*, parallelly through the coils 3' and 4' of the receiver at the called station, and through the transmitter circuit to ground, and the two substations are now telephonically connected. The current for supplying the transmitter thus passes parallelly through the line limbs and through the receiver coils, and these coils being differentially wound, voice currents from the corresponding transmitter will not be audible in the receiver. In other words, the user of the telephone can not hear his own voice. His voice currents pass to the central exchange and through the corresponding primary and secondary coils of the repeating mechanism, being there redirected to flow serially into the connected line and through the line limbs, and consequently to flow serially through the receiver connected therewith and to be audible to the user of this receiver, whose voice currents pass parallelly through the receiver coils and are inaudible to him. The secondary windings 26 and 27, for instance, are so associated with the primary windings 24 and 25 that the parallel direction of the voice currents from the corresponding substation through these primary coils will be given a serial direction through the secondary coils and consequently through the line limbs of the other line. In the same manner the secondary windings 26' and 27' of the relays 22' and 23' are arranged to cause serial current flow in the other line of the induced voice currents flowing parallelly through the primary windings 24' and 25'. This parallel arrangement, as is evident, greatly reduces the required cross section of conductor. The annoyance due to extraneous noises in the transmitter is also entirely obviated. The primary windings of the repeating coils are preferably of sufficient impedance to prevent leakage of voice currents, cross-talk and so on, while the corresponding primary and secondary windings are preferably in opposition to render the repeating coil non-inductive to allow free passage of telephonic cur-

rents between the connected substations. After the subscribers have finished conversation, the receivers are replaced on the hooks, thus breaking the circuit through the respective supervisory relays, and the armatures of these relays falling back to their normal contacts close circuit through the respective signal lamps to notify the operator that conversation is ended. The same lamp or other signal, therefore, serves both as an indicating signal and as a supervisory signal.

In a system of this kind there will be considerably less trouble, both line limbs being at the same potential and in parallel, and should one line limb become broken, for instance, or in any other way defective, the subscriber can still call the central exchange over the other conductor, and, although it may be difficult to converse, sufficient signals can be given to notify the central exchange that the line is out of order. To further balance the line, adjustable resistances 38 and 39 may be included in the line limbs, and this resistance is preferably in the form of heat coils which then serve the combined purposes of protecting the line against overflow of current and also to balance the line limbs.

The calling circuit at the substations may be connected with the line limbs in various ways, being here shown in bridge across the limbs and including the signal bell 40 and the condenser 41. The ringing arrangement at the central exchange will then be connected with the cord circuit to properly send signaling current for the substation signal circuit.

I thus provide a very simple, economical and efficient telephone system, but do not wish to be limited to this particular adaptation thereof shown, as the features thereof may be utilized with equal efficiency in local battery and other system arrangements.

Having described the principle of my invention, however, I claim as new and desire to secure by Letters Patent:

1. In a telephone system, the combination with a substation, of line limbs leading therefrom, means at the substation for transmitting telephonic currents, means at the substation for receiving telephonic currents, means for causing the transmitted currents to pass parallelly over the line limbs, and means for causing the received telephone currents to pass serially through the line limbs.

2. In a telephone system, the combination with a telephone line, of substations connected therewith, transmitting and receiving apparatus at each substation associated with the line, a common source of current for supplying the line and apparatus, means for causing telephonic currents from the transmitting apparatus at one substation to flow in such a manner through the receiving

apparatus at said substation as to render said receiving apparatus irresponsive to such current flow, and means for causing said current flow to pass in such manner through the receiving apparatus at a connected substation as to cause said other receiving apparatus to be responsive.

3. In a telephone system, the combination with substations, of a line connecting said substations, a source of current for supplying the line and substations, a transmitter and a receiver at each substation associated with the line limbs thereat, and means associated with the line for causing telephonic currents transmitted from one substation to flow parallelly through the receiver thereat and through the line limbs of said substation and to flow serially through the line limbs and through the receiver of a connected substation, whereby the receiver at the connected substation only is responsive to said currents.

4. In a telephone system, the combination with substations connected by a telephone line, of a source of current for supplying said line and substations, a transmitter and a receiver at each substation associated with the line limbs thereat, and means associated with the line for causing telephonic currents transmitted from a substation to flow parallelly through the receiver coils and the line limbs and for causing telephonic currents received at the substation to pass serially through the receiver coils.

5. In a telephone system, the combination with substations connected by a telephone line, of a source of current for supplying the line at substations, a receiver and a transmitter at each substation connected with the line thereat, and means for causing telephonic currents transmitted from a substation to pass differentially through the coils of the receiver at said substation and parallelly through the line limbs leading therefrom and for causing telephonic currents received at the substation to flow serially through the line limbs and receiver coils, whereby said receiver is irresponsive to transmitted currents and responsive only to received currents.

6. In a telephone system, the combination with two substations, of line limbs leading therefrom, a source of current for supplying said line limbs and substations, a transmitter and a receiver at each substation, means adapted upon actuation of the transmitter at one substation for causing the generated telephonic currents to flow from the substation parallelly through the line limbs and through the receiver coils, whereby the receiver is irresponsive; means associated with the line limbs leading from each substation for rearranging the parallel currents from a substation to cause them to flow serially through the line limbs of the other sub-

station and the receiver coils thereat, whereby the receiver at the other substation is responsive to the currents transmitted from the first substation.

5 7. In a telephone system, the combination with two substations, of line limbs leading from each substation, receiving and transmitting apparatus at each substation, means adapted upon actuation of the transmitting
10 apparatus at a substation for causing the generated telephonic currents to flow parallelly through the line limbs, means for causing the receiving apparatus to be irres-
15 ponsive upon such parallel current flow, inductive means associated with the line limbs from each substation for rearranging the parallel current flow received thereby and causing the current to flow serially through the line limbs of the other substation and the
20 receiving apparatus thereat, and means for causing the receiving apparatus to be responsive to such serial current flow.

8. In a telephone system, the combination with two substations, of line limbs leading
25 from each substation, transmitting and receiving apparatus at each substation, a source of current for supplying the line limbs and substation apparatus, means oper-
30 able upon actuation of the transmitting apparatus at one of the substations for causing telephonic currents to flow parallelly over the line limbs from the substation, means
35 for causing the transmitting apparatus at the substation to be irresponsive to such parallel current flow, inductive means connected with the line limbs for receiving the telephonic currents from the line limbs of the first substation and inducing these cur-
40 rents to the line limbs of the other substation, said inducing means being arranged to cause the induced currents to flow serially through the line limbs of the other substa-
45 tions and the receiving apparatus thereat, and means for causing the receiving apparatus to be responsive to such serial current flow.

9. In a telephone system, the combination with two substations, of line limbs leading from each substation, a transmitter and a
50 receiver at each substation, a common source of current for supplying the line limbs and telephonic apparatus at the substations, means operable upon actuation of the trans-
55 mitter at either of the substations for causing the generated telephonic currents to flow parallelly through the receiver coils and through the line limbs whereby the receiver is rendered irresponsive to the transmitted telephonic currents, inductive mechanism as-
60 sociated with the line limbs from each substation for receiving the telephonic currents transmitted from one substation and for inducing said currents to the line limbs of the other substation, said inductive means being
65 arranged to cause the induced currents to

flow serially through the line limbs of the other substation whereby the receiver coils at the other substation are included serially in circuit and the receiver rendered respon-
70 sive to received currents.

10. In a telephone system, the combina-
tion with a central exchange, of telephone lines leading therefrom and terminating in substations, a source of current at the ex-
75 change for supplying the lines, transmitting and receiving apparatus at each substation, and means for causing telephonic currents transmitted from one substation to flow paral-
80 lellly through the line limbs to the central exchange and serially through the line limbs of a connected substation from the central exchange, the receiving apparatus being irresponsive to telephonic currents transmit-
85 ted from the substation but responsive to currents received at the substation.

11. In a telephone system, the combina-
tion with a central exchange, of telephone lines leading therefrom and terminating in a substation, a cord circuit at the exchange
90 for connecting said lines together, repeating coils connected with the cord circuit, a trans-
mitter and a receiver at each substation, and means adapted upon actuation of the trans-
95 mitter at either substation for causing the generated telephonic currents to flow paral-
lellly and differentially through the receiver coils and through the line limbs to the re-
peating coils, said repeating coils causing the transmitted current to be induced to the
100 line limbs of the other substation and to flow serially through said line limbs and through the coils of the receiver thereat, each receiver being responsive to currents flowing serially through the line limbs but
105 irresponsive to currents flowing parallelly through the line limbs.

12. In a telephone system, the combina-
tion with a central exchange, of telephone lines leading therefrom and terminating in a substation, a cord circuit at the central
110 exchange, inductive repeating mechanism connected with the cord circuit, transmit-
ting and receiving apparatus at each sub-
station, a source of current at the central
115 exchange, means for causing direct currents from said source to flow parallelly through the repeating apparatus and the line limbs, and means for causing telephonic currents to flow parallelly over the line limbs from
120 a substation to the repeating apparatus and serially over the line limbs from the repeat-
ing apparatus to the substation.

13. In a telephone system, the combina-
tion with a central exchange, of telephone lines leading therefrom to substations, trans-
125 mitting and receiving apparatus at each substation connected with the line limbs thereat, a source of current at the central exchange, means for causing direct currents to flow
130 parallelly through the line limbs, and means

for causing telephonic currents to flow parallelly over the line limbs toward the central exchange and serially over the line limbs from the central exchange.

5 14. In a telephone system, the combination with a central exchange, of telephone lines leading therefrom to substations, transmitting and receiving apparatus at each sub-
 10 station connected with the line limbs thereat, a source of current at the central exchange, means for causing direct currents to flow parallelly through the line limbs, means for
 15 causing telephonic currents to flow parallelly over the line limbs toward the central exchange and serially over the line limbs from the central exchange, means for caus-
 20 ing the receiving apparatus to be irresponsive to telephonic currents flowing from the corresponding substation, and means for causing the receiving apparatus to be re-
 sponsive to telephonic currents received at the corresponding substation.

15 15. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom to sub-
 25 stations, transmitting and receiving apparatus at each substation, means for causing transmitter currents to flow in parallel over the line limbs to the central exchange, a
 30 cord circuit in the central exchange for connecting telephone lines together, an induction coil serving to convert the transmitter currents received thereby into currents for
 35 actuating the receiving apparatus at the connected substation, said induction coil serving also to rearrange the current flow to cause the current to flow serially through
 40 the line limbs and through the receiving apparatus at the connected substation.

16. In a telephone exchange system, the combination with a central exchange, of sub-
 stations connected therewith to telephone lines, a receiver and a transmitter at each

substation, a source of current for supply-
 ing the line and apparatus at the substations, 45
 means for causing the transmitter currents to flow from a substation parallelly through the receiver coils and through the line limbs to the central exchange, and adjustable
 means included in the line limbs for adjust- 50
 ing the current flow therethrough.

17. In a telephone exchange system, the combination with a central exchange, of
 substations connected therewith to telephone lines, a receiver and a transmitter at each 55
 substation, a source of current for supplying the line and apparatus at the substations, means for causing the transmitter currents to flow from a substation parallelly through
 the receiver coils and through the line limbs 60
 to the central exchange, and heat coils included in the line limbs for protecting
 against excessive current flow and for bal-
 65 ancing the current flow through the line limbs.

18. In a telephone exchange system, the combination with a central exchange, of sub-
 stations connected therewith to telephone lines, a receiver and a transmitter at each
 substation, a source of current for supply- 70
 ing the line and apparatus at the substations, means for causing the transmitter currents to flow from a substation parallelly through
 the receiver coils and through the line limbs
 to the central exchange, and adjustable re- 75
 sistances in the form of heat coils included in the line limbs for balancing the current
 flow therethrough and for protecting against
 excessive current flow.

In witness whereof, I hereunto subscribe 80
 my name this first day of July A. D., 1905.

GARRISON BABCOCK.

Witnesses:

CHARLES J. SCHMIDT,
 LEONARD W. NOVANDER.