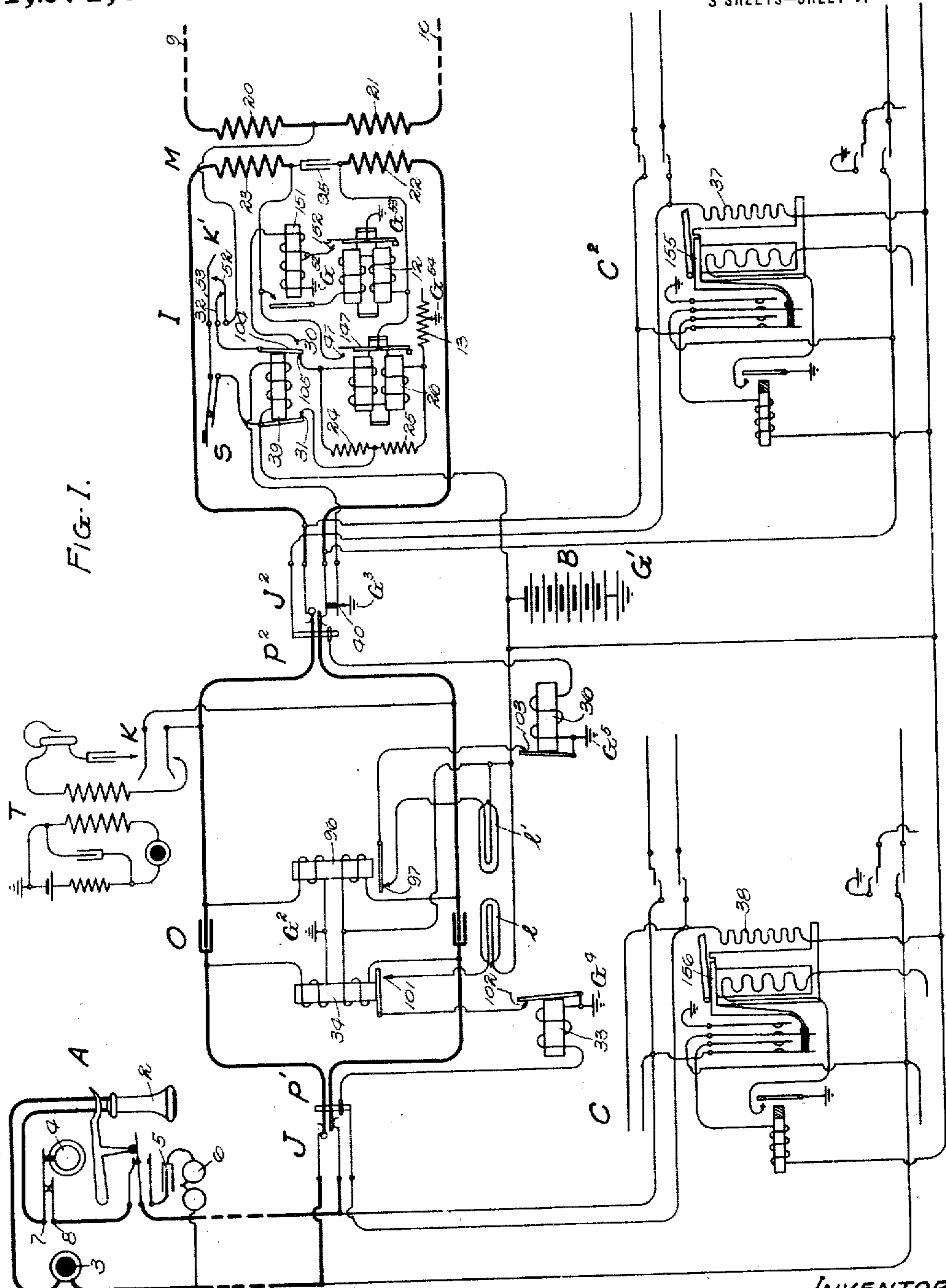


1,271,032.

B. C. GROH.
AUTOMATIC TELEPHONE SYSTEM.
APPLICATION FILED JULY 19, 1915.

Patented July 2, 1918.
3 SHEETS—SHEET 1.



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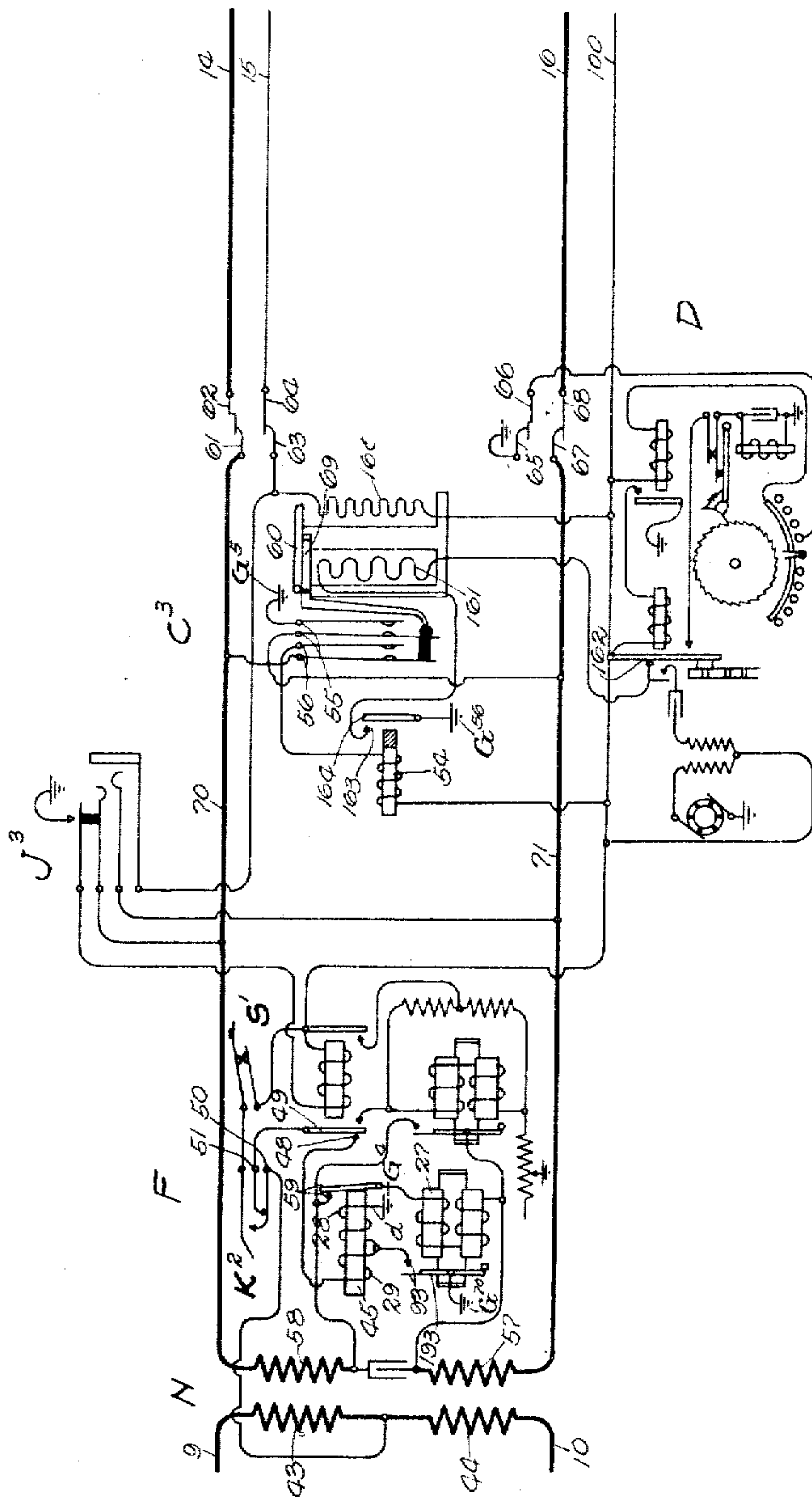
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3 SHEETS—SHEET 2.

Fig. 2



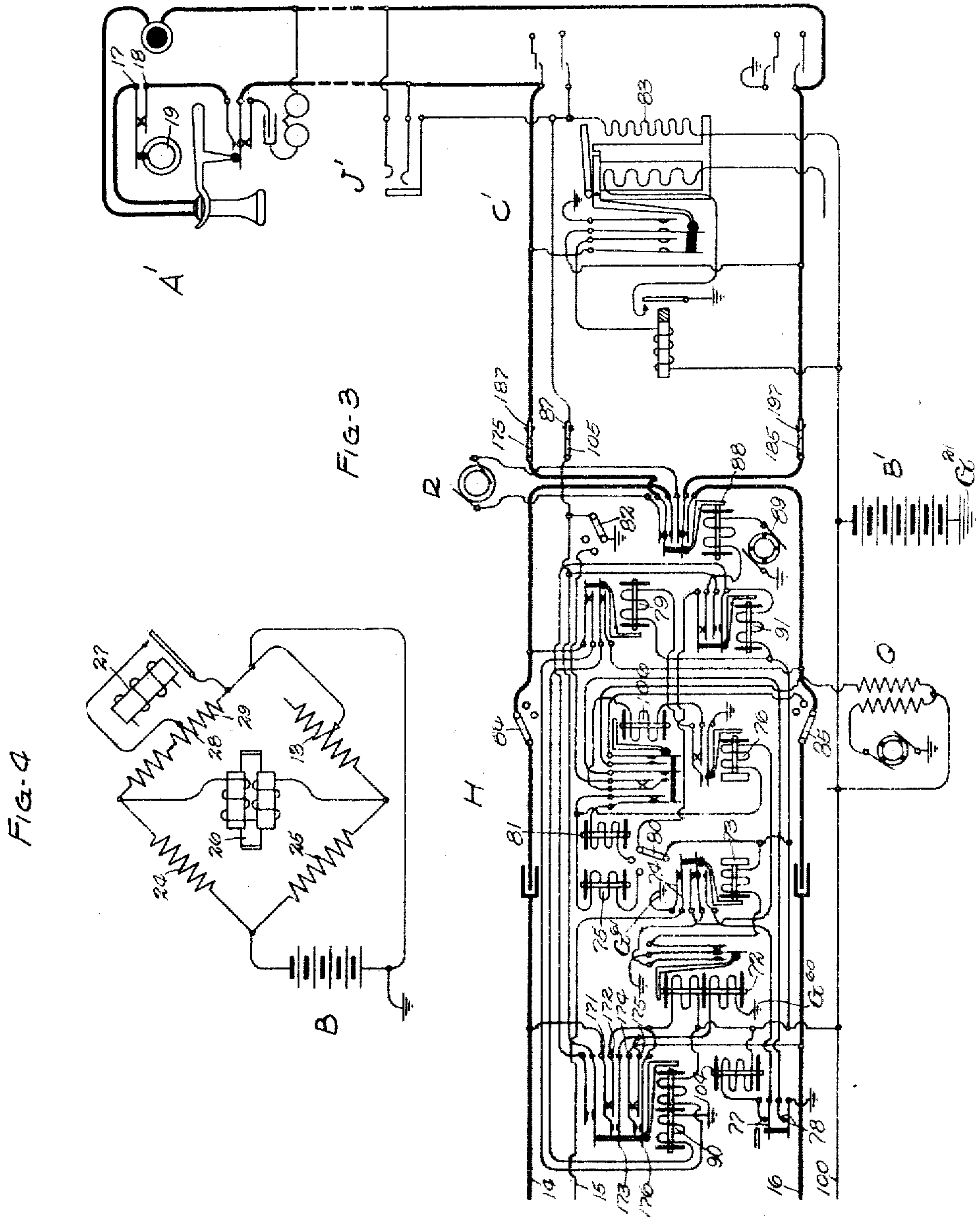
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 3 SHEETS--SHEET 3.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,271,032.

Specification of Letters Patent.

Patented July 2, 1918.

Application filed July 19, 1915. Serial No. 40,705.

To all whom it may concern:

Be it known that I, BERNARD C. GROH, a citizen of the United States, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems, but concerns itself more particularly with methods of toll supervision in systems containing one or more automatic exchanges.

In automatic exchanges, it has been customary to provide, in addition to the regular automatic apparatus, a multiple jack individual to each line in what is known as a toll switching section.

A subscriber who wants a long distance connection operates his dial for the proper number and connects by means of automatic apparatus with a recording operator who obtains the necessary data and passes it to a toll operator. If the party wanted is connected to an automatic exchange the toll operator will now plug into an idle toll line to the distant automatic exchange and, by means of her dial, connect automatically with the line of the wanted subscriber. The toll operator may now order up the number of the calling line at the toll switching section and complete the long distance connection by plugging into the trunk assigned by the toll switching operator.

I have briefly described above one method of handling long distance calls to an automatic exchange, but modifications will suggest themselves to those versed in the art. For example, the toll operator may connect automatically with the calling line thereby dispensing with the toll switching section. Or the originating exchange may be manual in which case connection will be established by methods common in manual practice and which are well known.

In any case, it is extremely desirable, or even necessary, that the toll operator be provided with lamp supervision controlled by the called subscriber in the distant automatic exchange.

The object of my invention is the provision of means whereby a subscriber with whom connection has been established auto-

matically by a distant toll operator over a toll line, may signal the calling toll operator by means of his receiver hook.

A further object of my invention is the provision of means whereby a toll line between two automatic exchanges may be used by an operator at either exchange to extend a connection to a subscriber in the other exchange, the calling toll operator having supervision controlled by the called subscriber.

To accomplish these and other useful ends my invention comprises the means hereinafter set forth and claimed.

In the drawings Figures 1, 2 and 3 show a complete connection between a calling substation A in one exchange and a called substation A' in a second exchange in a system embodying the principles of my invention. Fig. 4 is a theoretical diagram illustrating these principles more clearly.

Referring to Fig. 1, there is shown at A an automatic substation having at the exchange the individual line switch C and the multiple jack J. At O is shown a toll operator's cord circuit which may be of any approved type. The one shown, however, is very simple comprising, among minor elements, the supervisory lamps *l* and *l'* controlled by relays 34 and 96, respectively, and an operator's head set T which may be connected to the two strands of the cord by the key K. For convenience I have shown the answering plug P' of the cord circuit O as being inserted directly in the multiple jack of the calling substation A, although it is understood that in practice the toll operator may complete a connection to a calling substation A in any approved manner, as has been explained.

The calling plug P² of the cord circuit O is shown as being inserted in the multiple jack J² of a toll line 9 and 10 extending to the distant office. Associated with the toll line at the originating office is a line switch C², a repeating coil M, a group of relays I, and a key K'. The calling device S may be common to a number of toll lines. Relays 12 and 26 are polarized relays, i. e., they will not operatively attract their armatures unless current flows through their windings in the right direction.

The toll line (9—10) has individual apparatus at the distant exchange similar to

the apparatus at the originating exchange. Referring to Fig. 2, there is shown at N a repeating coil, at F a group of relays, at K² at key, at J³ a multiple jack, and at C³ a line switch. At D is shown a master switch for controlling a group of line switches such as C³, and it is assumed that all other line switches shown are controlled in the same manner by master switches similar to D.

All the line switches shown herein are of the general type of line switch shown in British patent to R. W. James No. 26,301 of 1906, being, however, more nearly of the particular type disclosed in U. S. Letters Patent No. 1,078,690, granted Jan. 17, 1912, to F. Newforth.

The master switch D is of the same general type as that disclosed in the above mentioned British Patent No. 26,301 of 1906, being, however, more nearly of the particular type disclosed in British patent to T. G. Martin, No. 1419 of 1910.

Accessible to the line switch C³ is a connector switch H (Fig. 3) which is of the same general type as that disclosed in U. S. Letters Patent No. 815,176 granted March 13th, 1906, to Keith, Erickson and Erickson, being, however, more nearly of the particular type disclosed in French Patent No. 466,794 issued March 13th, 1914.

While I have shown the line switch C³ as having direct access to the connector switch H, it may be readily seen that selector switches of any approved type may be inserted between the said line switch and the connector switch in order to increase the capacity of the system. Selector switches which may be used for the above purpose are of the type shown in British patent to T. G. Martin No. 1419 of 1910.

At A' is shown an automatic substation having at the distant exchange an individual line switch C' similar to the switch C, and a multiple jack J'.

For the purpose of supplying battery current for talking and for operating the automatic switches I have shown at the originating exchange the battery B and at the distant exchange the battery B', the two batteries being grounded at G' and G², respectively. At R is shown a generator and at Q is shown a busy signaling machine.

Inasmuch as the automatic apparatus illustrated herein is well known in the art and is described in the publications above referred to, it is thought to be unnecessary to give more than a general description of the apparatus and operation thereof.

In the following description it will be explained briefly how a connection may be established between the calling substation A in one exchange and a called substation A' in a distant exchange after which there will be shown in detail the method by which

the subscriber at the called substation may signal the toll operator at the originating office.

It will furthermore be shown how the above connection may be established in the reverse direction, the subscriber at A, in this case, being able to signal a toll operator in the distant office.

To obtain a long distance connection the subscriber at A must first get in communication with a recording or toll operator and this may be accomplished by raising the receiver and operating the impulse wheel 4, controlling the impulse springs 7 and 8, in accordance with the proper digit or digits. The line switch C and a switch or switches accessible to it respond to these operations in the well known manner and thereby connection is established between the substation A and a recording operator. Upon making known his wants the subscriber at substation A is told to hang up for a moment, which he does and thereby disconnects his automatic apparatus.

The recording operator makes out a ticket containing the required information and passes it to a toll operator who will now insert the plug P² in the multiple jack J² of an idle toll line extending to the desired exchange, the idle or busy condition of such toll lines being determined by testing with the tip of the plug in the well known manner. The engagement of the sleeve of plug P² with the sleeve of jack J² closes a circuit including the sleeve relay 36 and the holding winding 37 of the line switch C². The sleeve relay 36 completes a circuit for the supervisory lamp Z at contact 103; and the winding 37, by attracting the armature 155, disconnects the tip and ring springs of jack J² from ground and battery, respectively, at line switch C².

The insertion of plug P² also closes contact 40 of jack J² thereby completing a circuit for relay 39 as follows: ground at G³, contact 40, winding of relay 39 to battery. Relay 39, by attracting its armatures, completes two parallel circuits which may be traced as follows: negative pole of battery B, contact 31, junction of resistance coils 24 and 25, where the circuit divides, one branch extending by way of resistance coil 24, contact 105, armature 104, contact springs 32 and 52, windings 20 and 21 of repeating coil M in parallel, lines 9 and 10 in parallel, windings 43 and 44 of repeating coil N (Fig. 2) in parallel, contact springs 50 and 51, armature 49, contact 48, windings 29 and 28 of relay 45 in series to ground at G⁴, while the other branch extends by way of resistance coil 25, through adjustable resistance 13 to ground at G⁵. The polarized relay 26 is bridged across the two parallel circuits described above, one terminal being connected to the junction of resistance 24 with con-

tact 105 and the other terminal being connected to the junction of the resistance coil 25 with the adjustable resistance 13, the whole forming a Wheatstone bridge arrangement as shown diagrammatically in Fig. 4. The bridge may be balanced by adjusting the resistance 13 so that no current will ordinarily flow in the winding of the polarized relay 26.

It will be seen that one leg of the Wheatstone bridge circuit traced above includes a simplex circuit which in this particular disclosure includes the two sides of a talking circuit in parallel. This simplex circuit may be traced from the spring 52 of key K' in Fig. 1 to the middle point of windings 20 and 21 of repeating coil M, through said windings in parallel, conductors 9 and 10 in parallel, windings 43 and 44 of repeating coil N Fig. 2, in parallel to spring 50 of key K².

At the distant office the energization of relay 45 completes a circuit for the line relay 54 of line switch C³ as follows: ground at G⁵, contact springs 55, line 71, winding 57 of repeating coil N, winding of polarized relay 27, armature and contact 59, winding 58 of repeating coil N, line 70, contact springs 56, winding of line relay 54 to battery.

Line relay 54 energizes over this circuit and attracting its armature completes a circuit for the pull-in winding 161 as follows: ground at G⁵⁶, armature 164, contact 163, pull-in winding 161, contact 162 to battery. The energization of the pull-in winding attracts the plunger arm 60 and the cut-off armature 69, the former by means of its plunger (not shown) forcing the springs 61, 63, 65 and 67 into engagement with the contacts 62, 64, 66 and 68, respectively, and the latter separating the pair of contact springs 56 and the pair of contact springs 55, thereby breaking the circuit of the line relay 54.

The engagement of springs 61 and 67 with contacts 62 and 68, respectively, completes a circuit for the line relay 72 of the connector H as follows: ground at G⁶⁰, lower winding of line relay 72, contact springs 174 and 175, line 16, contact 68, spring 67, line 71, winding 57 of repeating coil N, winding of polarized relay 27, armature and contact 59, winding 58 of repeating coil N, line 70, spring 61, contact 62, line 14, contact springs 171 and 172, upper winding of line relay 72 to battery. Upon energizing, the line relay 72 completes a circuit for the slow acting relay 73, which in turn completes a holding circuit for the line switch C³ over the following path: ground at G⁶¹, contact springs 74, wire 15, contact 64, spring 63, holding winding 160 to battery. The line relay 54 is slow acting and retains its armature until after the

above described holding circuit has been established. A branch of the holding circuit extends from the junction of winding 160 and spring 63 to the multiple jack J³ where a guarding potential is placed on the sleeve.

Two circuits have been described already, that of the line relay 54 now broken, and the present circuit of the line relay 72, which include the polarized relay 27. The direction of the current in relay 27 is such, however, that the lower end of armature 193 is attracted thereby holding contact 93 open.

The foregoing operations of relays at I and F and the operation of line switch C³ and relays of connector H have taken place in response to the insertion of plug P² in jack J². The toll operator at the originating office is now ready to dial the number wanted but first she must actuate the key K' thereby substituting the impulse springs of the calling device S for the resistance coil 24 in the circuit of the relay 45 (relay group F). Relay 45 remains energized but the balance of the Wheatstone bridge is destroyed and current flows through the winding of polarized relay 26 as follows: ground at G⁵⁴, adjustable resistance 13, winding of relay 26, winding of resistance coil 24, contact 31 to battery. The effect upon relay 26 produced by current flowing as described above is such, however, that the lower end of armature 147 is attracted, thereby holding contact 47 open.

The operator may now operate her dial for the first digit of the desired number thereby separating a number of times the impulse springs of the calling device S and causing corresponding deenergizations of the relay 45. At each deenergization of the relay 45 the line relay 72 of the connector H retracts its armature and sends an impulse to the slow acting relay 76 and the vertical magnet 75 in series, the slow acting relay 73 keeping its armature attracted meanwhile. The vertical magnet raises the shaft carrying the wipers 175, 105 and 185 until the wipers stand opposite the horizontal level of contacts in which are located the contacts of the desired line. The slow acting relay 76, in series with the vertical magnet, holds its armature attracted during the series of impulses and in its energized position closes a circuit of the private magnet 79. At the end of the series of impulses the relay 76 retracts its armature whereupon the circuit of the private magnet 79 is broken and it deenergizes thereby allowing the side switch wipers to move to their second position in the well known manner.

The operator may now operate her dial for the last digit of the desired number resulting as before in deenergizations of the line relay 72 which now (the side switch wipers being in second position) sends im-

pulses to the slow acting relay 76 in series with the rotary magnet 81. The rotary magnet rotates the shaft until the wipers 175, 105 and 185 rest upon the bank contacts 187, 87 and 197 of the line extending to substation A'. The slow acting relay 76, by actuating the private magnet as before serves to move the side switch wipers to their third position. Side switch wiper 82 in its third position places ground potential through the private wiper 105 upon the contact 87 and its multiple contacts in other connector banks thereby making the line of substation A' busy to the other connectors. A circuit may be traced from contact 87 through holding winding 83 of line switch C'. Winding 83 is energized over this circuit and, by attracting the cut-off armature, disconnects the lines of substation A' from battery and ground at line switch C'. The wires 14 and 16 are connected by the side switch wipers 84 and 85 in their third position with the line wipers 175 and 185. The side switch wiper 80 in its third position completes the circuit of the ringing relay 88 in series with the interrupter 89 whereupon the ringing relay is actuated intermittently to ring the bell at substation A'.

The operator may now restore her key K' thereby cutting out the calling device S and restoring the normal balance of the bridge. She may also, at this time insert the plug P' in the multiple jack J of the calling subscriber at substation A, and if the subscriber has not already removed his receiver she may ring his bell by actuating a ringing key (not shown) which may be included in her cord circuit. The engagement of the sleeve of plug P' with the jack J completes a circuit including the sleeve relay 33 and the holding winding 38 of line switch C. The sleeve relay 33 closes at its contact 102 the circuit of the supervisory lamp L; and the holding winding 38, by attracting the cut-off armature 156, disconnects the calling line from battery and ground at the line switch C.

We are now ready to consider the supervisory lamps L and L' whose circuits have been completed by sleeve relays 33 and 36 respectively. The supervisory lamp L is controlled by the subscriber at substation A through the medium of the double wound relay 34 in a manner made evident from the drawing.

The supervisory lamp L' is controlled by the subscriber at substation A' through the medium of means provided by my invention and in a manner which may be described as follows: Upon the removal of the receiver at substation A' a circuit is completed for the double wound back bridge relay 90 of the connector H, which relay is provided for feeding talking battery to the called subscriber.

Relay 90 upon attracting its armature, completes a circuit of the ring cut off relay 91 thereby stopping the ringing, and also reverses the battery connections to wires 14 and 16 thereby reversing the direction of current flow in the polarized relay 27. The effect of the current is now such that the upper end of armature 193 is attracted whereupon contact 93 will be closed.

The closure of contact 93 short circuits winding 28 of relay 45 thereby considerably decreasing the resistance of that leg of the bridge which includes the toll line and relay 45. As a result the bridge is again unbalanced and current flows in the winding of polarized relay 26 over the following path: ground at G⁷⁰, contact 93, winding 29 of relay 45, contact 48, armature 49, contact springs 51 and 50, windings 43 and 44 of repeating coil N in parallel, lines 9 and 10 in parallel, windings 20 and 21 of repeating coil M in parallel, contact springs 52 and 32, armature 104, contact 105, winding of polarized relay 26, resistance coil 25, contact 31 to battery. Current flowing in the direction described above in relay 26 is such that the armature 147 is brought into engagement with contact 47 thereby short circuiting the condenser 95.

The double wound relay 96 is now energized over the following path: ground at G², upper winding of relay 96, tip of plug P², tip spring of jack J², winding 23 of repeating coil M, contact 47, armature 147, winding 22 of repeating coil M, ring spring of jack J², ring of plug P², lower winding of relay 96 to battery. Upon attracting its armature, relay 96 breaks the circuit of the lamp L' at contact 97 thereby extinguishing the lamp and indicating to the operator that the subscriber at the distant exchange has answered. When the conversation is finished the subscribers at substations A and A' will hang up their receivers, whereupon the circuits described above for relays 34 and 96 will be broken and these relays will retract their armatures thereby again completing the circuit of the supervisory lamps L and L'. Upon observing the lights burning the operator knows that the conversation is finished and therefore she removes the plugs P' and P² from the jacks. Upon the removal of plug P² the contact 40 is opened breaking the circuit of relay 39. Upon the deenergization of relay 39 the circuit of relay 45 is broken. Relay 45, by retracting its armature breaks the circuit of line relay 72 of the connector H whereupon the automatic apparatus used in the distant exchange is restored to normal in the well known manner.

I have assumed in the foregoing description that the called substation A' was idle when called. If it had been busy the con-

necter H would have operated, after the last series of impulses, to connect the busy signaling machine I with one side of the calling line, the side switch wipers being held in the second position for this purpose.

The calling subscriber, on hearing the busy signal hangs up his receiver, thereby giving the operator a disconnect signal as before, whereupon she removes the plugs P¹ and P² and the apparatus is returned to normal.

It has been mentioned before that toll lines equipped in accordance with the principles of my invention are adapted to handle traffic in either direction. This being the case it is evident that the subscriber at substation A' will be able, through the medium of a toll operator, to obtain a connection with the subscriber at substation A in the distant exchange, whereupon the toll operator will have supervision controlled by the subscriber at substation A. I will describe briefly how this is done.

The toll operator at the exchange to which A' is connected is provided with cord circuits similar to the cord circuit shown at O (Fig. 1) by means of which she can connect the line of substation A' at the multiple jack J' (Fig. 3) with the jack J² (Fig. 2) of the toll line to the distant exchange. The operation from now on is exactly the same as previously described it being understood that the line switch C² in Fig. 1 has access to connector switches such as connector H shown in Fig. 3 except that said connector switches are adapted to connect with a group of lines of which the line of substation A is one.

The supervision is taken care of by a Wheatstone bridge arrangement similar to the one described, and inasmuch as the apparatus at the two ends of the toll line are in duplicate it is thought to be unnecessary to further amplify the explanation. It will be readily understood that my system of toll line supervision may be used on toll lines extending from a manual to an automatic exchange in which case the apparatus need not be in duplicate.

While I have described one form in which my invention may be practised I do not wish to be held strictly to the apparatus and method shown herein, but desire to include all modifications which may come within the scope of the appended claims.

What I claim as my invention is:

1. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit.

2. In a telephone system, a first circuit,

a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, and means in said second circuit for operating said relay.

3. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit.

4. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch.

5. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches.

6. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit.

7. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, and means in said second circuit for operating said relay.

8. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of

said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit.

9. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch.

10. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches.

11. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction.

12. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, and means in said second circuit for reversing the direction of the current flow.

13. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said second relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for reversing the direction of current flow in the second circuit for operating said second relay.

In a telephone system, a first circuit, a signal for said circuit, a Wheatstone

bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch.

15. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches.

16. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a telephone associated with the first circuit, a telephone associated with the second circuit, and a talking circuit connecting the two, said talking circuit included in one leg of said bridge.

17. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit included in one leg of said bridge, and means for operating said automatic switch over the two sides of the talking circuit in said leg in multiple.

18. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay

across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit included in one leg of said bridge, and means for operating said automatic switches over the two sides of the talking circuit in said leg in multiple.

19. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a talking circuit extending over one leg of said bridge, and an adjustable resistance in one leg of the bridge whereby the bridge may be adjusted in balance when the resistance of the talking circuit varies.

20. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a talking circuit extending over one leg of said bridge, means in said second circuit for operating said relay, and an adjustable resistance in one leg of the bridge whereby the bridge may be adjusted in balance when the resistance of the talking circuit varies.

21. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, a talking circuit extending over one leg of said bridge, and an adjustable resistance in one leg of the bridge whereby the bridge may be adjusted in balance when the resistance of the talking circuit varies.

22. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit,

means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a talking circuit extending over one leg of said bridge, and an adjustable resistance in one leg of the bridge whereby the bridge may be adjusted in balance when the resistance of the talking circuit varies.

23. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a talking circuit extending over one leg of said bridge, and an adjustable resistance in one leg of the bridge whereby the bridge may be adjusted in balance when the resistance of the talking circuit varies.

24. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a line relay in series with both sides of said talking circuit in multiple, said talking circuit and relay in one leg of said bridge, and means for operating said relay over said talking circuit for controlling said automatic switch.

25. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with said first circuit, a telephone associated with said

second circuit, a talking circuit connecting the two, a line relay in series with both sides of said talking circuit in multiple, said talking circuit and relay in one leg of said bridge, and means for operating said relay over said talking circuit for controlling said automatic switches.

26. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, said bridge under the control of said line for controlling said signal.

27. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a magnet in said line, said bridge under the control of said magnet for controlling said signal.

28. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a magnet in said line, said bridge under the control of said magnet, a source of current in circuit with said line and magnet for supplying a flow of current in the line in one direction, and means for reversing the direction of flow in the line for controlling said magnet, bridge and signal.

29. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a polarized magnet in said line, said bridge under the control of said magnet, a source of current in circuit with said line and magnet for supplying a flow of current in the line in one direction, and means for reversing the direction of flow in the line for controlling said magnet, bridge and signal.

30. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a second line for controlling said relay, said second line and relay included in one leg of the bridge, and means in said first line for controlling said leg to control said signal.

31. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, an automatic progressively movable switch in said line, a line relay for controlling said switch, a second line for controlling said relay, said second line and relay included in one leg of the bridge, and means in said first line for controlling said leg to control said signal.

32. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch for said line, a line relay for controlling said switch, a second line for controlling said relay, said second line and relay included in one leg of the bridge, and means in said first line for unbalancing said leg to control said signal.

33. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch for said line, a line relay for controlling said switch, a second line for controlling said relay, said second line and

relay included in one leg of the bridge, and means in said first line for varying the resistance of said relay to unbalance said leg to operate said signal.

34. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a talking circuit, a simplex circuit superimposed upon said talking circuit, said relay controlled over said simplex circuit, means for connecting said relay in one leg of said bridge, and means for varying the resistance of said relay to unbalance said bridge to affect said signal.

35. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a second line, means for connecting said two lines, said bridge under the control of said second line over said first line for controlling said signal.

36. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in the second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

37. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, and means in said second circuit for operating said relay, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

38. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

39. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated

over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

40. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

41. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

42. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, and means in said second circuit for operating said relay, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

43. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, a telephone associated with the first circuit, a telephone

associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

44. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

45. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

46. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

47. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, and means in said second circuit for reversing the direction of the current flow, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit

cuit connecting the two, a section of said talking circuit included in one leg of said bridge.

48. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said second relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for reversing the direction of current flow in the second circuit for operating said second relay, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

49. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

50. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, a section of said talking circuit included in one leg of said bridge.

51. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a telephone asso-

ciated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

52. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, and means in said second circuit for operating said relay, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

53. In a telephone system a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for controlling said second and third circuits and for controlling said relay from said third circuit, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

54. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

55. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from

said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

10 56. In a telephone system, a first circuit,
a signal for said circuit, a Wheatstone bridge,
said signal under the control of a relay
across the branches of said bridge, a second
circuit, a relay in said second circuit, the
15 balance of said bridge under the control of
said relay whereby said signal may be oper-
ated from said second circuit, a telephone
associated with the first circuit, a telephone
associated with the second circuit, a talking
20 circuit connecting the two, said talking cir-
cuit divided into sections, one section of said
talking circuit included in one leg of said
bridge, said signal associated with a second
section.

25 57. In a telephone system, a first circuit, a
signal for said circuit, a Wheatstone bridge,
said signal under the control of a relay
across the branches of said bridge, a second
circuit, a relay in said second circuit, the
30 balance of said bridge under the control of
said relay whereby said signal may be op-
erated from said second circuit, and means
in said second circuit for operating said re-
lay, a telephone associated with the first cir-
35 cuit, a telephone associated with the second
circuit, a talking circuit connecting the two,
said talking circuit divided into sections, one
section of said talking circuit included in one
leg of said bridge, said signal associated
40 with a second section.

58. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second
45 circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and
50 third circuits and for controlling said relay from said third circuit, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit
55 divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

59. In a telephone system, a first circuit, a
60 signal for said circuit, a Wheatstone bridge,
said signal under the control of a relay
across the branches of said bridge, a second
circuit, a relay in said second circuit, the
balance of said bridge under the control of
65 said relay whereby said signal may be oper-

ated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

60. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

61. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

62. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, and means in said second circuit for reversing the direction of the current flow, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

63. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said second relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for reversing the direction of current flow in the second circuit for operating said second relay, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

64. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

65. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section.

66. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in the second circuit,

said bridge under the control of said relay whereby said signal may be operated over said second circuit, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

67. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, and means in said second circuit for operating said relay, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

68. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, a telephone associated with the first circuit, a telephone associated with the first circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

69. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge, said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated over said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

70. In a telephone system, a first circuit, a signal in said circuit, a Wheatstone bridge,

said signal under the control of said bridge, a second circuit, a relay in said second circuit, said bridge under the control of said relay whereby said signal may be operated

over said second circuit, a third circuit, means for connecting said second and third circuits, and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

71. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

72. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, and means in said second circuit for operating said relay, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

73. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits, and for controlling said relay from said third circuit, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said

talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

74. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

75. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising a plurality of progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

76. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the reverse direction, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

77. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a

relay across the branches of said bridge, a second circuit, a relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal
 5 may be operated from said second circuit, and means in said second circuit for reversing the direction of the current flow, a telephone associated with the first circuit, a telephone associated with the second circuit, a
 10 talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated
 15 with a third section.

78. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge,
 20 a second circuit, a relay in said second circuit, the balance of said bridge under the control of said second relay whereby said signal may be operated from said second circuit, a third circuit, means for connecting
 25 said second and third circuits and for reversing the direction of current flow in the second circuit for operating said second relay, a telephone associated with the first circuit, a telephone associated with the second
 30 circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay asso-
 35 ciated with a third section.

79. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of a relay across the branches of said bridge, a
 40 second circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal may be operated from said second circuit with current in one direction but not in the
 45 reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said third circuit, said means comprising an automatic progressively movable switch, a tele-
 50 phone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section of said talking circuit included in one
 55 leg of said bridge, said signal associated with a second section, said relay associated with a third section.

80. In a telephone system, a first circuit, a signal for said circuit, a Wheatstone bridge, said signal under the control of the relay across the branches of said bridge, a second
 60 circuit, a polarized relay in said second circuit, the balance of said bridge under the control of said relay whereby said signal

may be operated from said second circuit 65 with current in one direction but not in the reverse direction, a third circuit, means for connecting said second and third circuits and for controlling said relay from said circuit, said means comprising a plurality of
 70 progressively movable trunking switches, a telephone associated with the first circuit, a telephone associated with the second circuit, a talking circuit connecting the two, said talking circuit divided into sections, one section
 75 of said talking circuit included in one leg of said bridge, said signal associated with a second section, said relay associated with a third section.

81. In a telephone system, a signal, a 80 Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a line in said bridge for controlling said relay, said bridge under the control of said first line for con- 85
 trolling said signal.

82. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a controlling
 90 circuit including the relay winding for controlling said relay, a section of said controlling circuit forming part of said bridge, and means in said line for varying the resistance of the controlling circuit for con- 95
 trolling said signal.

83. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a controlling
 100 circuit including the relay winding for controlling said relay, a section of said controlling circuit forming part of said bridge, and means in said line for varying the resistance of the controlling circuit for controlling said signal, said controlling circuit
 105 including a talking circuit.

84. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a controlling
 110 circuit including the relay winding for controlling said relay, a section of said controlling circuit forming part of said bridge, and means in said line for varying the resistance of the controlling circuit for controlling said signal, said controlling circuit
 115 including a talking circuit, both sides of which are connected in multiple.

85. In a telephone system, a signal, a 120 Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a controlling circuit including the relay winding for controlling said relay, a section of said control-
 125 ling circuit forming part of said bridge, means in said line for varying the resistance of the controlling circuit for controlling

said signal, an impulse sender and means for including the impulse sender in said controlling circuit.

86. In a telephone system, a signal, a
5 Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a controlling circuit including the relay winding for controlling said relay, a section of said controlling circuit forming part of said bridge,
10 means in said line for varying the resistance of the controlling circuit for controlling said signal, said controlling circuit including a talking circuit, an impulse sender and
15 means for including the impulse sender in said controlling circuit.

87. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay
20 for controlling said switch, a controlling circuit including the relay winding for controlling said relay, a section of said controlling circuit forming part of said bridge, means in said line for varying the resistance
25 of the controlling circuit for controlling said signal, said controlling circuit including a talking circuit, both sides of which are connected in multiple, an impulse sender and means for including the impulse sender
30 in said controlling circuit.

88. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a controlling
35 circuit including the relay winding for controlling said relay, a section of said controlling circuit forming part of said bridge, means in said line for varying the resistance of the controlling circuit for controlling said signal, said controlling circuit
40 including a talking circuit, an impulse sender and means for switching said controlling circuit into connection with said impulse sender, said talking circuit including an inductive coil, said line relay having
45 one side connected to the mid-point of said coil whereby impulses from said impulse sender for operating said relay do not affect the talking circuit or interfere with
50 the talking.

89. In a telephone system, a signal, a Wheatstone bridge for controlling said signal, a line, a switch in said line, a line relay for controlling said switch, a controlling
55 circuit including the relay winding for controlling said relay, a section of said controlling circuit forming part of said bridge, means in said line for varying the resistance of the controlling circuit for controlling said signal, said controlling circuit including a talking circuit, both sides of
60 which are connected in multiple, an impulse sender and means for switching said controlling circuit into connection with said

impulse sender, said talking circuit including an inductive coil, said line relay having one side connected to the mid-point of said coil whereby impulses from said impulse sender for operating said relay do not affect the talking circuit or interfere with
70 the talking.

90. In a telephone system, a signal, a pair of conductors connected in multiple across the terminals of a battery, a signal controlling relay bridged across said multiple
75 at points of like potential dividing the multiple into four sections, a line, a switch for said line, a line relay for controlling said switch, a second line for controlling said relay, said second line and relay included in one of said sections, and means
80 in said first line for varying the resistance of said section to raise the potential of one of said points over the other to operate said signal relay to control said signal.
85

91. In a telephone system, a first circuit, a signal in said circuit, a pair of conductors connected in multiple across the terminals of a battery, a signal relay bridged across said multiple at points of like potential, a
90 second circuit, a relay in said second circuit, the relative potential of said points under the control of said last relay whereby the potential of one of said points is raised above the other to control said signal from
95 said second circuit.

92. In a telephone system, the combination with a trunk line and an automatic switch for connecting calling and called lines, of an operating circuit for said switch
100 comprising the two sides of a portion of the talking conductors of said trunk line in parallel, a source of current for said circuit, and a signal controlled by the called line by increasing the current flow in said circuit.
105

93. In a telephone system, means for connecting calling and called lines including a trunk line and an automatic switch, an operating circuit for said switch comprising the two sides of a portion of the talking
110 conductors of said trunk line in parallel, a source of current for said circuit, and a signal controlled from the called line by altering the current flow in said circuit.

94. In a telephone system, means for connecting calling and called lines including a two-way trunk line having an automatic switch at each end, a common operating circuit for said switches superimposed upon talking conductors of said trunk line, a
120 source of current for said circuit, a signal at each end of said trunk line, and means controlled by a called line at one end of said trunk line for operating the signal at the other end by altering the current flow
125 in said circuit.

95. In a telephone system, two exchanges connected by a trunk line terminating at

each end in an automatic switch, a controlling circuit superimposed on said trunk line and having at each end a normally connected branch containing a relay for controlling
 5 the automatic switch at that end, a source of current for said controlling circuit, circuits at each exchange adapted for connection to said trunk line, supervisory signals associated with said circuits, a normally
 10 disconnected branch at each end of said controlling circuit containing a supervisory control relay, means for connecting one of said circuits at either exchange with said trunk line, automatic means for then sub-
 15 stituting the normally disconnected branch at that exchange for the normally connected branch, and means for suitably controlling the current flow in said controlling circuit at proper times to effect through the medium
 20 of the controlling relay at one end and the supervisory control relay at the other end the operation of the automatic switch at one exchange and the signal associated with the connected circuits at the other exchange.
 25 96. In a telephone system, two exchanges connected by a trunk line terminating at each end in an automatic switch, a controlling circuit superimposed on said trunk line and having at each end a normally connected
 30 branch containing a relay for controlling the automatic switch at that end, a source of current for said controlling circuit, circuits at each exchange adapted for connection to said trunk line, supervisory signals
 35 associated with said circuits, a normally disconnected branch at each end of said controlling circuit containing a supervisory control relay, means for connecting one of said circuits at either exchange with said
 40 trunk line, automatic means for then substituting the normally disconnected branch at that exchange for the normally connected branch, means associated with the connected circuit at the one exchange for interrupting
 45 the controlling circuit to operate the controlling relay at the other exchange, and means at the said other exchange for altering the current flow in said controlling circuit for operating the supervisory control
 50 relay at the said first exchange.

97. In a trunking system, a pair of conductors, a first bridge across said conductors, a second bridge across said conductors, a third bridge, means for closing said third
 55 bridge across said first and second bridges, a first relay associated with said third bridge, a line, an automatic progressively movable switch, means for controlling said first relay over said third bridge to operate
 60 said switch to find said line, a second relay associated with said third bridge, a signal associated with said second relay, and means controlled over said line for operating said second relay by way of the third bridge for
 65 operating said signal.

98. In a trunking system, a pair of conductors, a first bridge across said conductors, a second bridge across said conductors, a third bridge, means for closing said third
 70 bridge across said first and second bridges, a source of current in said third bridge, a first line, a second line, a first relay associated with said third bridge, means controlled over the first line for controlling said
 75 first relay over said third bridge to operate said switch to connect the two lines by way of said conductors, a second relay associated with said third bridge, a signal associated with said second relay, means controlled
 80 over said second line for operating said second relay by way of the third bridge for operating said signal.

99. In a trunking system, a pair of conductors, a first bridge across said conductors, a second bridge across said conductors, a third bridge, means for closing said third
 85 bridge across said first and second bridges, a source of current included in said third bridge, a first relay associated with said third bridge, a line, an automatic progressively movable switch, means for controlling
 90 said first relay over said third bridge to operate said switch to find said line, a second relay associated with said third bridge, a signal associated with said second relay,
 95 said second relay normally inoperative, and means controlled over said line for increasing the flow of current in said third bridge whereby said second relay may be operated to control said signal.
 100

100. In a trunking system, a pair of conductors, a first bridge across said conductors, a second bridge across said conductors, a third bridge, means for closing said third
 105 bridge across said first and second bridges, a source of current in said third bridge, a first line, a second line, a first relay associated with said third bridge, means controlled over the first line for controlling said
 110 first relay over said third bridge to operate said switch to connect the two lines by way of said conductors, a second relay associated with said third bridge, a signal associated with said second relay, said second relay
 115 normally inoperative, and means controlled over said second line for increasing the flow of current in said third bridge whereby said second relay may be operated to control said signal.

101. In a telephone system, a trunk line, operator's equipment including a manual
 120 connective terminal at each end of said trunk line, an automatic switch at each end of said trunk line and controllable thereover, and means including said equipment and
 125 said switches for completing connections over said trunk line semi-automatically in either direction.

102. In a telephone system, a two-way trunk line provided with a manual connec- 130

tive terminal at each end, means including one of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in one direction, and means including the other of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in the opposite direction.

103. In a telephone system, a trunk line, operator's equipment including a manual connective terminal at each end of said trunk line, an automatic switch at each end of said trunk line and controllable thereover, means including said equipment and said switches for completing connections over said trunk line semi-automatically in either direction, and means for rendering the said trunk line busy to operators at either end thereof whenever the automatic switch at the same end is operated.

104. In a telephone system, a two-way trunk line provided with a manual connective terminal at each end, means including one of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in one direction, means including the other of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in the opposite direction, and means for rendering the said trunk line busy to operators at either end thereof whenever the automatic switch at the same end is operated.

105. In a telephone system, a trunk line, operator's equipment including a manual connective terminal at each end of said trunk line, an automatic switch at each end of said trunk line and controllable thereover, means including said equipment and said switches for completing connections over said trunk line semi-automatically in either direction, and means for rendering the automatic switch at either end inoperative whenever the trunk line is taken for use by an operator at the same end.

106. In a telephone system, a two-way trunk line provided with a manual connective terminal at each end, means including one of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in one direction, means including the other of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in the opposite direction, and means for rendering the automatic switch at either end inoperative whenever

the trunk line is taken for use by an operator at the same end.

107. In a telephone system, a two-way trunk line provided with a manual connective terminal at each end, means including one of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in one direction, means including the other of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in the opposite direction, and operator's equipment for completing connections over said trunk line manually by way of the said terminals.

108. In a telephone system, a two-way trunk line provided with a manual connective terminal at each end, means including one of said terminals and an automatic switch at the other end of said trunk line controlled thereover for completing connections over said trunk line in one direction, means including the other of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in the opposite direction, operator's equipment for completing connections over said trunk line manually by way of the said terminals, and means for rendering the said trunk line busy to an operator at either end whenever the automatic switch at the same end is operated.

109. In a telephone system, a two-way trunk line provided with a manual connective terminal at each end, means including one of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in one direction, means including the other of said terminals and an automatic switch at the other end of said trunk line controllable thereover for completing connections over said trunk line in the opposite direction, operator's equipment for completing connections over said trunk line manually by way of the said terminals, and means for rendering the automatic switch at either end inoperative whenever the trunk line is taken for use by an operator at the same end.

110. In a telephone system, a two-way trunk line, an automatic switch at each end of said trunk line for extending connection therefrom, and means for controlling the switch at either end from the other end over the two sides of said trunk line in parallel.

111. In a telephone system, a two-way trunk line, operator's equipment and an automatic switch at each end of said trunk line, and means controlled by an operator at either end of said trunk line for operat-

ing the automatic switch at the other end of said trunk line over the two sides thereof in parallel to extend a connection.

112. In a telephone system, a two-way trunk line, an automatic switch at each end of said trunk line, a controlling circuit for said switches including the two sides of said trunk line in parallel, and means for transmitting current impulses over said circuit from either end of said trunk line to operate the automatic switch at the other end.

113. In a telephone system, means including an operator's cord circuit and a trunk line for connecting a calling and a called line, a supervisory signal in said cord circuit, and a circuit for controlling said signal including the two sides of said trunk line in parallel.

114. In a telephone system, means including an operator's cord circuit and a trunk line for connecting a calling and a called line, a supervisory signal in said cord circuit, a circuit for controlling said signal including the two sides of said trunk line in parallel, and means under control of the called subscriber for controlling said circuit.

115. In a telephone system, means including in serial relation, an operator's cord circuit, a trunk line, and an automatic switch, for connecting a calling and called line, a supervisory signal in said cord circuit, a circuit for controlling said signal including the two sides of said trunk line in parallel, and means in said switch under control of the called subscriber for controlling said circuit.

116. In a telephone system, a two-way trunk line, means including operator's cord circuits for connecting calling and called lines over said trunk line in either direction, supervisory signals in said cord circuits, a circuit including the two sides of said trunk line in parallel, and means whereby a connected called subscriber at either end of said trunk line can control a supervisory signal at the other end of said trunk line over the said circuit.

117. In a telephone system, two exchanges, a toll line for establishing connections between said exchanges, said toll line having two branches at each end, one branch at each end extending to manual equipment and the other to an automatic switch, a circuit including the two sides of said toll line in parallel, said circuit controlled from the manual equipment at either end to control the automatic switch at the other end.

118. In a telephone system, two exchanges, a toll line for establishing connections be-

tween said exchanges, said toll line having two branches at each end, one branch at each end extending to manual equipment and the other to an automatic switch, a circuit including the two sides of said toll line in parallel, and means controlled from the manual equipment at either end for disconnecting the other branch at the same end and for controlling the automatic switch at the other end through the medium of said circuit.

119. In a telephone system, two exchanges, a toll line for establishing connections between said exchanges, said toll line having two branches at each end, one branch at each end extending to manual equipment and the other to an automatic switch, a circuit including the two sides of said toll line in parallel, and means controlled from the manual equipment at either end of said toll line for disconnecting the branch leading to the automatic switch at the same end and for sending impulses of current over said circuit to operate the automatic switch at the other end thereof to establish a connection between said exchanges.

120. In a telephone system, two exchanges, a trunk line for establishing connections between said exchanges in either direction, a branch at each end of said trunk line leading to an automatic switch, another branch at each end thereof leading to an operator's position, means controlled by the operator at either end of said trunk line for disconnecting the branch leading to the automatic switch at the same end and for closing a control circuit for the automatic switch at the other end over a circuit including the two sides of said trunk line in parallel, and means controlled by the operation of the switch at the opposite end for rendering said trunk line busy to calls in the opposite direction.

121. In a telephone system, the combination with two exchanges and an interconnecting toll line, of means including automatic switches at both ends of said toll line for establishing talking connections thereover in either direction, and means at each end of said toll line for closing a control circuit for the automatic switches at the other end, said control circuit including the two conductors of said toll line in parallel.

Signed by me at St. Paul, Ramsey county, Minnesota, this 13th day of July, 1915.

BERNARD C. GROH.

Witnesses:

G. M. TRONSRUE,
A. J. SEYMOUR.

DISCLAIMER.

1,271,032.—*Bernard C. Groh*, Chicago, Ill. AUTOMATIC TELEPHONE SYSTEM. Patent dated July 2, 1918. Disclaimer filed September 10, 1919, by the patentee, the assignee, *Automatic Electric Company*, consenting.

Enters this disclaimer—

"To claims 113, 114, and 115 in said specification, which is in the following words, to wit:

"113. In a telephone system, means including an operator's cord circuit and a trunk line for connecting a calling and a called line, a supervisory signal in said cord circuit, and a circuit for controlling said signal including the two sides of said trunk line in parallel.

"114. In a telephone system, means including an operator's cord circuit and a trunk line for connecting a calling and a called line, a supervisory signal in said cord circuit, a circuit for controlling said signal including the two sides of said trunk line in parallel, and means under control of the called subscriber for controlling said circuit.

"115. In a telephone system, means including in serial relation, an operator's cord circuit, a trunk line, and an automatic switch, for connecting a calling and a called line, a supervisory signal in said cord circuit, a circuit for controlling said signal including the two sides of said trunk line in parallel, and means in said switch under control of the called subscriber for controlling said circuit."

[*Official Gazette September 30, 1919.*]