F. NEWFORTH.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED DEC. 31, 1915. RENEWED FEB. 25, 1918.

1,287,079. Patented Dec. 10, 1918.

4 SHEETS—SHEET 1.

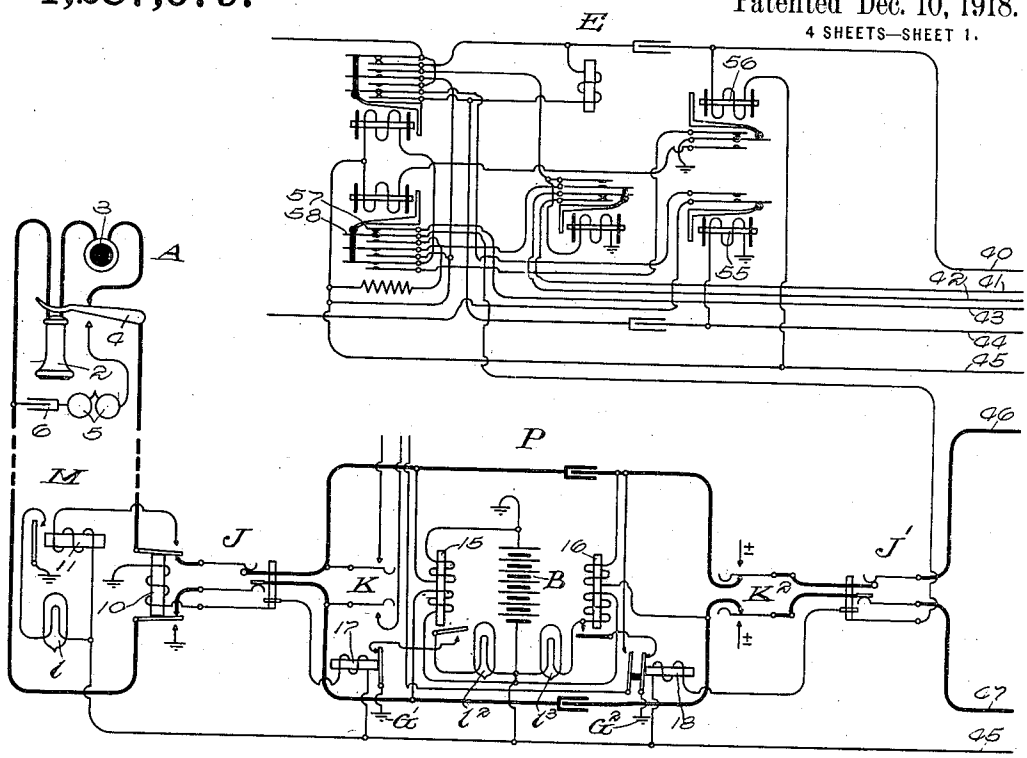
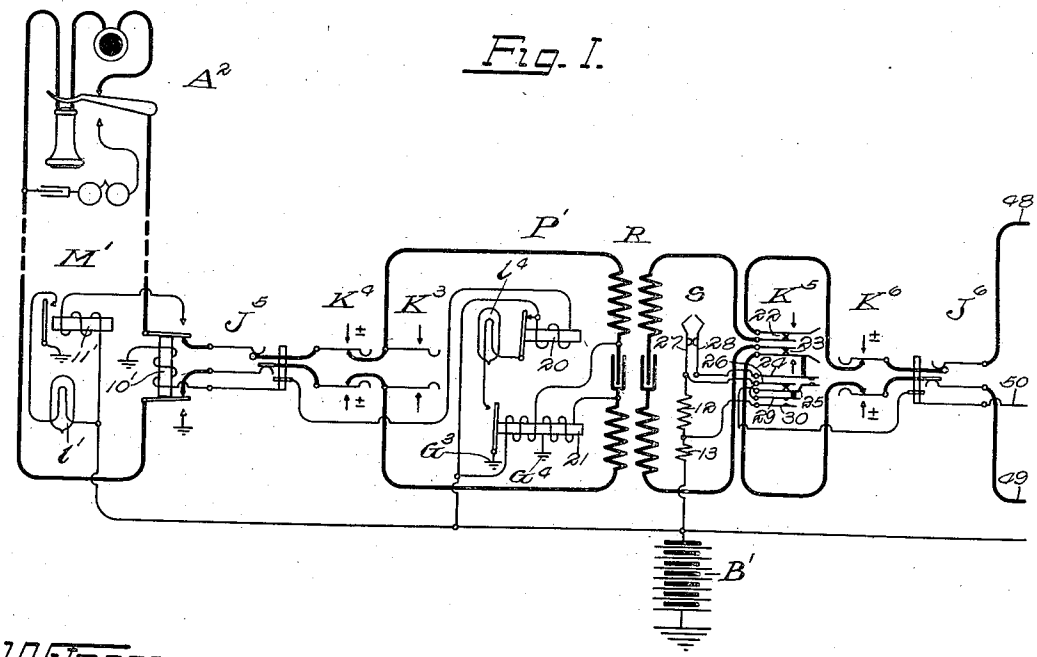


Fig. 1.



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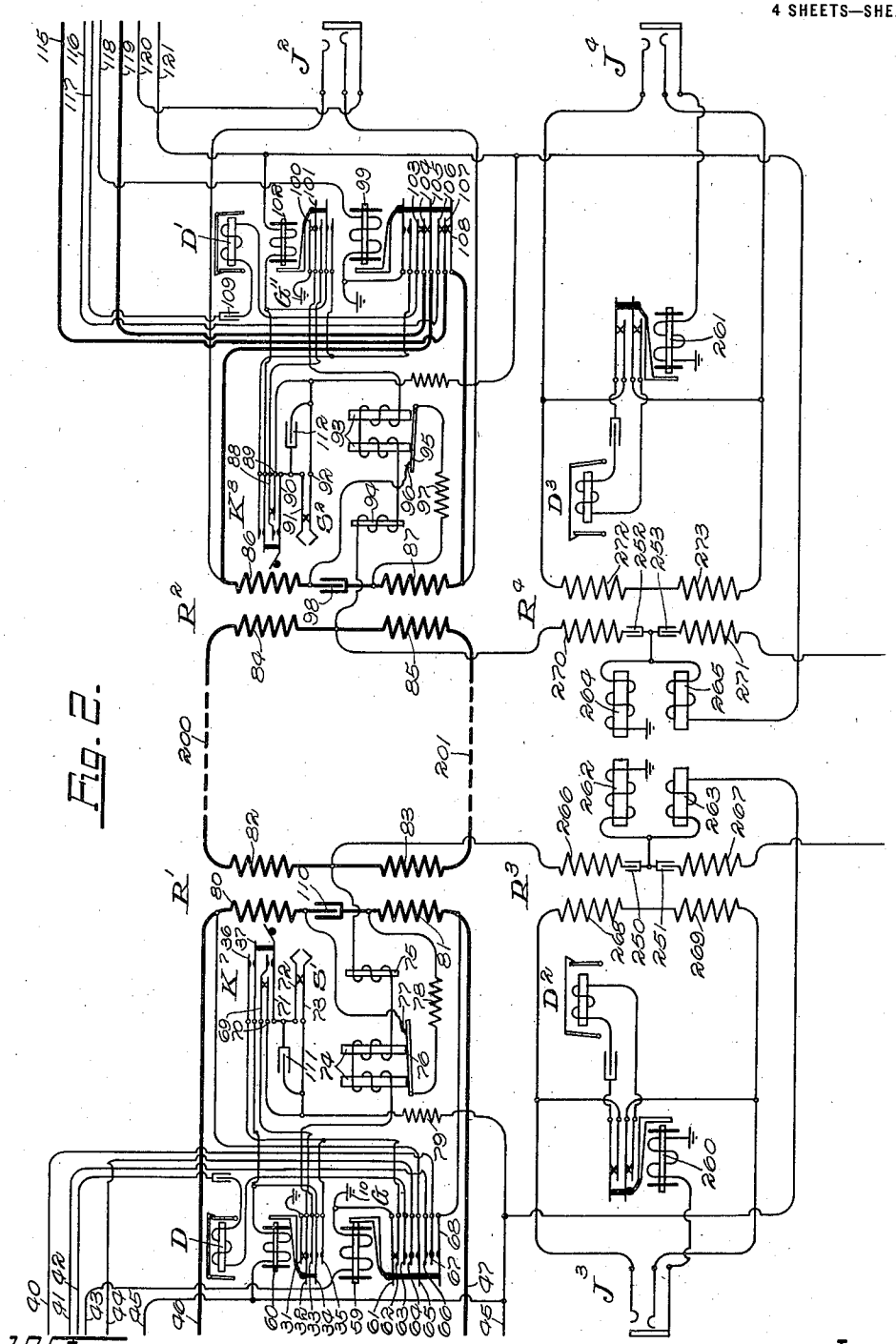

Fig. 2.

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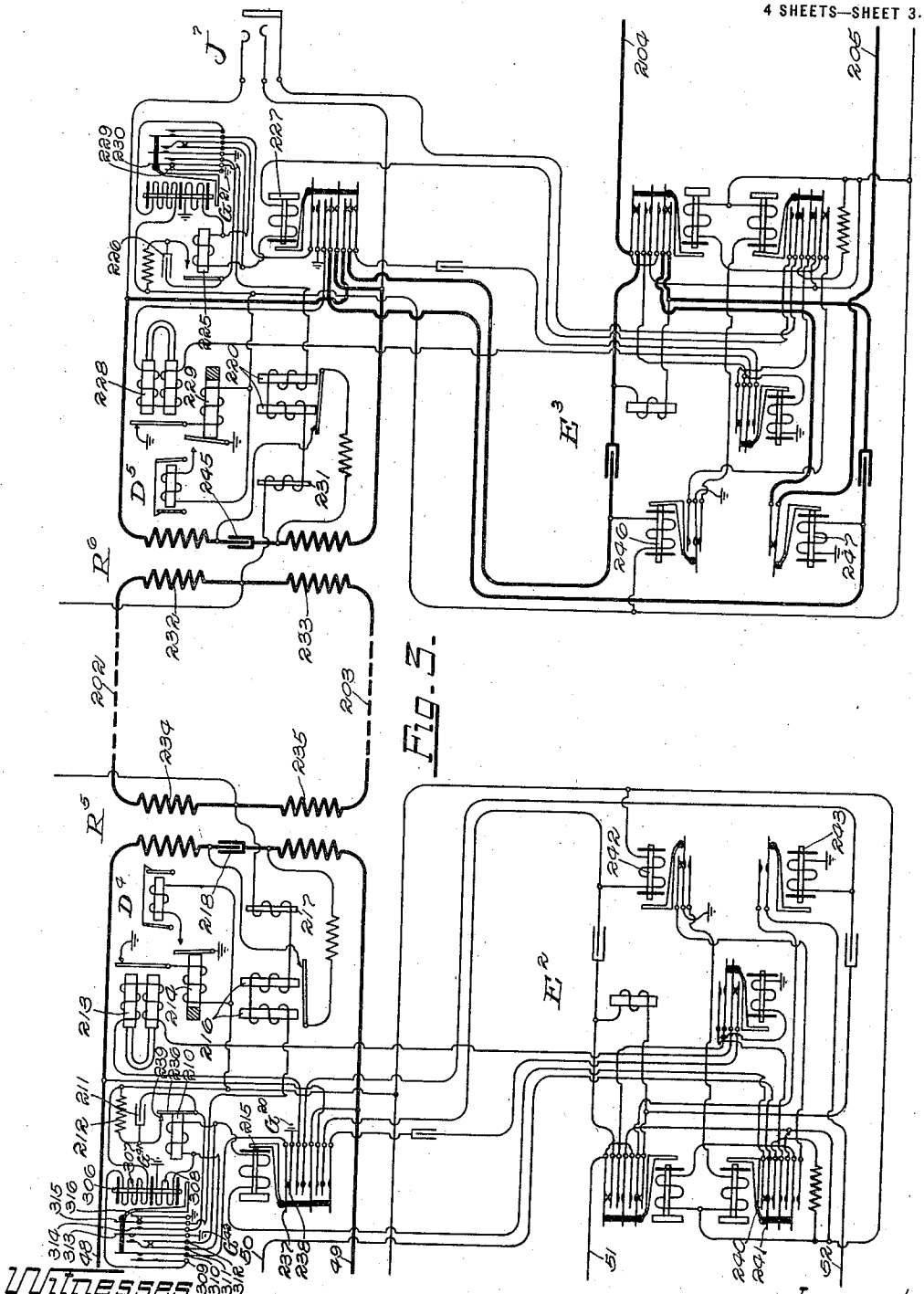

Fig. 3.

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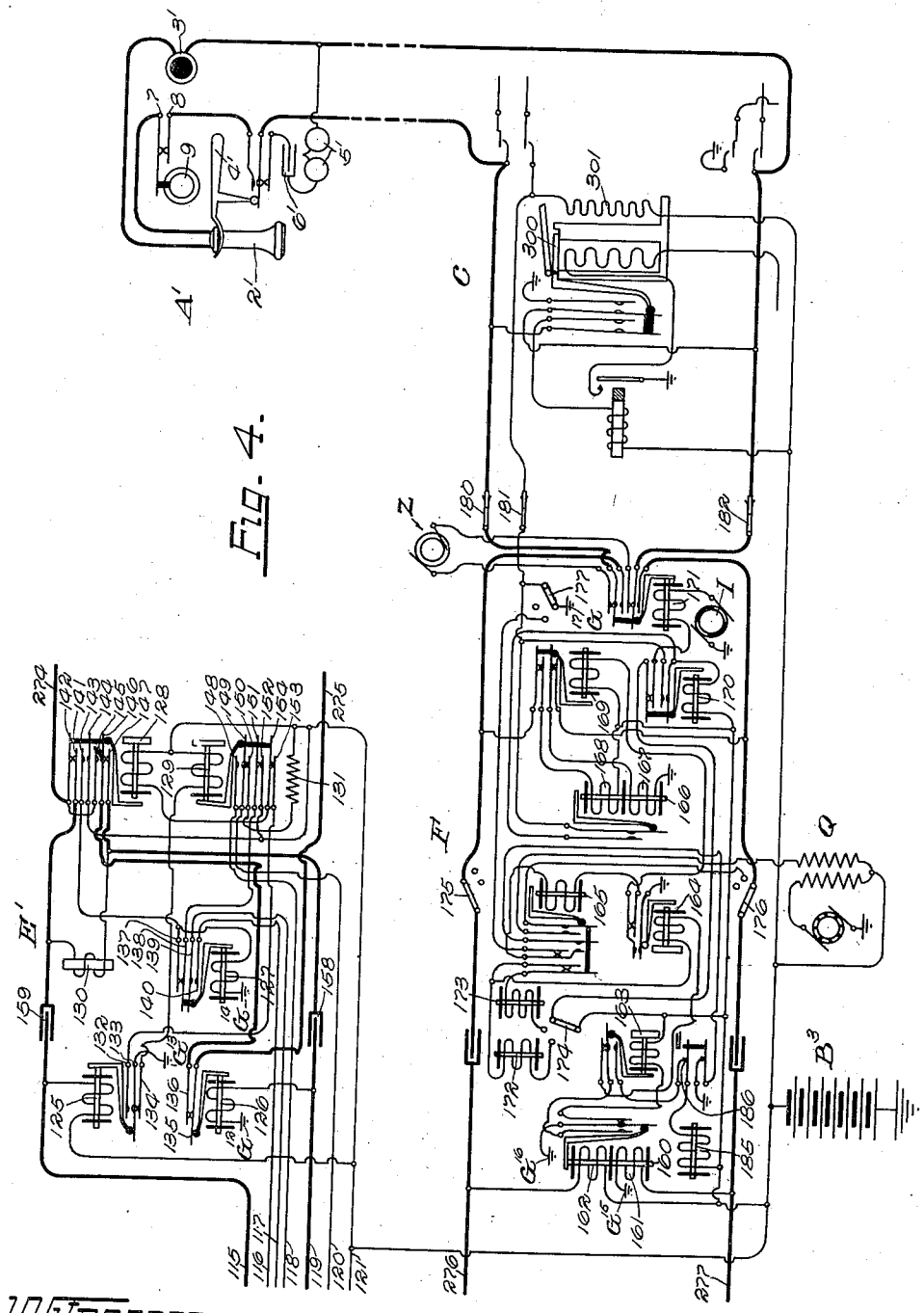

Fig. 4.

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AUTOMATIC TELEPHONE SYSTEM.

1,287,079. Specification of Letters Patent. Patented Dec. 10, 1918.

Application filed December 31, 1915, Serial No. 69,633. Renewed February 25, 1918. Serial No. 219,167.

To all whom it may concern:

Be it known that I, FRANK NEWFORTH, a citizen of the United States, and a resident of Chicago, Cook county, 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 and more particularly to such systems as comprise two or more exchanges between which connections may be established automatically. It has been the common practice in the past to establish such connections by dialing over a so called simplex circuit formed with a repeating coil at each end of a metallic toll line connecting the two exchanges.

Attempts have been made to superimpose a phantom circuit on two toll lines which have been simplexed as above mentioned, the phantom circuit being used for manual and in some cases for automatic connections. Considerable difficulty has been experienced, however, in preventing interference between the two physical circuits and between the physical circuits and the phantom.

The object of my invention is to provide, in a system of the above character, improved means whereby two toll lines having a phantom circuit superimposed thereon may both be used to establish automatic connections or for conversation without perceptible interference with each other or with the phantom circuit.

A further object of my invention is to provide means whereby signals may be sent and a conversation held over the phantom circuit without interfering with the operation of either physical circuit.

A further object of my invention is the provision of improved circuits and an improved arrangement of apparatus thereby tending to make a system of the above character more efficient and reliable in operation. To accomplish these and other useful ends my invention comprises the means hereinafter set forth and claimed.

In the drawings, Figures 1, 2 and 4, taken in order with correspondingly numbered connecting lines in alinement, represent a complete circuit connection between a calling substation A and a called substation A′, these two substations being located in separate exchanges in a system embodying the principles of my invention. The said connection extends by way of jack J, cord circuit P, jack J′, toll line 200—201, repeater E′, and connector F to substation A′. In a similar manner but using somewhat different equipment, I have shown in Figs. 1, 3 and 4 a complete circuit connection between a calling substation A^2 and a called substation A′, these two substations being located in the above mentioned separate exchanges. The latter connection extends by way of jack J^5, cord circuit P′, jack J^6, toll line 202—203, repeater E^3, and a connector similar to connector F to substation A′.

In Figs. 2 and 3, taken with the lines at the bottom and top thereof in alinement, I have shown a phantom circuit extending from jack J^3 in one of the exchanges to jack J^4 in the other exchange, the said phantom circuit being superimposed upon the two toll lines above mentioned.

Referring now to Fig. 1, I have shown at A a substation having the receiver 2, transmitter 3, hook switch 4, ringer 5, and condenser 6. Associated with the substation A at the exchange is the jack J and the individual line apparatus M comprising the usual line relay 11, cut off relay 10 and line lamp *l*.

At P I have shown a cord circuit which may be of any approved type. The one shown comprises among other details the listening key K, the ringing key K^2, and the supervisory lamps l^2 and l^3 controlled respectively, by the relays 15 and 16.

The jack J′ may be one of a number of multiple jacks which are connected with the toll line shown at 200—201 (Fig. 2) through the medium of the repeating coil R′. At D is shown a drop for receiving manually projected signals. At K^7 is shown a key which is individual to the toll line with which it is associated; and at S′ is indicated a calling device which may be common to a number of toll lines.

The toll line 200—201 is connected, by means of the repeating coil R^2, with the repeater E′ (Fig. 4) which may be of the type disclosed in U. S. Letters Patent #1,136,912, granted April 20, 1915, to T. G. Martin.

The lines from repeater E′ may be extended to connector F by means of conductors 274 and 275 which would then be joined to conductors 276 and 277, respectively, for this purpose. The connector F is of the gen-

eral type disclosed in U. S. Letters Patent #815,176, granted March 13, 1906, to Keith, Erickson and Erickson; being however, of the particular type shown in French Patent #466,794, published May 23, 1914, although any approved type of connector might equally well have been used.

The substation A′ may be of any suitable or approved type and comprises the receiver 2′, transmitter 3′, hook switch 4′, ringer 5′, and condenser 6′. Being an automatic substation it is also provided with a pair of impulse springs 7 and 8 which may be separated momentarily a number of times by the impulse wheel 9 controlled through the medium of a finger hole dial (not shown).

The line switch C is individual to the substation A′ and may be of the type disclosed in U. S. Letters Patent #1,078,690, granted Nov. 18, 1913, to Frank Newforth. A line switch of this type, as is well known, may be used by its associated automatic substation for selecting an idle trunk line preliminary to establishing an automatic connection.

To provide for establishing connections in the reverse direction, I have shown the above equipment in duplicate whenever necessary. Referring to Fig. 2, the jack J^2 is accessible to an operator having cord circuits similar to cord circuit P by means of which she is enabled to connect substations in her exchange with the toll line 200—201. The drop D′, key K^8, and calling device S^2 may be similar in all respects to drop D, key K^7, and calling device S′. At E (Fig. 1) I have shown a repeater which may be similar to repeater E′ and by means of which the line is extended on to a connector such as connector F (Fig. 4).

Considering now the toll line 202—203 and associated equipment, I have shown at A^2 (Fig. 1) a substation which may be similar to substation A. At P′ I have shown a cord circuit comprising, among other elements, the repeating coil R, the listening key K^3, the calling device key K^5, and ringing keys K^4 and K^6. The calling device S may be common to a number of cord circuits, to any one of which it can be connected by throwing the proper calling device key.

The jack J^6 may be one of a number of multiple jacks which are connected to the toll line 202—203 by means of the repeating coil R^5. An impulsing relay 210 performs the same function here that the calling device S′ does in the case of the other toll line. Relay 213 is an alternating current relay for actuating the drop D^4.

Through the medium of the repeating coil R^6 the toll line 202, 203 is connected at the other end with the repeater E^3 which is similar in all respects to the repeater E′. The repeater E^3 may be connected directly with a connector such as connector F. In order to economize in the drawing I have shown but one of these connectors, it being understood that the conductors 204 and 205 may lead to another connector similar to connector F. The toll line 202—203 is also a two way toll line and accordingly is equipped with duplicate apparatus at either end, in the same way as toll line 200—201 is equipped, this duplication of apparatus being readily apparent from the drawing.

At each end of each toll line, I have shown an open core impulsing relay, indicated by reference characters 74, 93, 216, and 220. These relays are preferably of high resistance and have an open magnetic circuit, the cores being joined at the end opposite the armature by a brass heel piece. This is done to counteract the effect of the shunted condensers in the phantom which otherwise would tend to make these impulsing relays sluggish.

Referring now to Figs. 2 and 3, I have shown a phantom circuit superimposed upon the two toll lines in the well known manner and terminating in the jacks J^3 and J^4. Normally bridged across the tip and ring springs of the jacks are drops D^2 and D^3 which may be disconnected by cut off relays 260 and 261, respectively. In carrying out my invention, I find it advisable to connect the junction of the windings 266 and 267 of the phantom repeating coil R^3 with the junction of two coils 262 and 263, the other terminals of these coils being connected to ground and battery respectively. Between the junction and either winding I insert a condenser as indicated by reference characters 250 and 251. The repeating coil R^4 is similarly equipped with a pair of coils 264 and 265 and a pair of condensers 252 and 253.

I also preferably connect a condenser in shunt of the impulse springs at each operator's calling device and at each impulsing relay such as relays 210 and 225, although this is not absolutely necessary. Condensers so connected are indicated by reference characters 111, 112, 211, and 226.

In the drawings and in the above explanation I have shown the repeaters as being directly connected to connectors but it will be apparent to those versed in the art that selector switches may be inserted between repeaters and connector switches for the purpose of increasing the capacity of the system. Selector switches which may be used for the above-mentioned purpose are of the type disclosed in British Patent to T. G. Martin, #1419 of 1910.

Throughout the drawings I have shown a plurality of batteries such as B, B′, etc., but it is to be understood that there may be but one battery, or preferably, one battery for each exchange, each battery having its positive terminal grounded. The reference

character Z indicates a generator for supplying ringing current and at Q is represented a busy signaling machine.

Having given a general description of the apparatus, I will now proceed to a more detailed description of the operation of the same. Inasmuch as a great deal of the automatic apparatus referred to above is well known and has been described in the publications referred to, the operation of such apparatus will be described in a general way, the details being given only where they have reference in some respect to the application of the principles of my invention.

I will first describe the method by which a connection is established between a calling substation A and a called substation A′ over the toll line 200—201; after which a similar connection over the toll line 202—203 will be briefly described. Following this, a brief mention will be made of means for establishing these connections in the reverse direction; and, finally, the operation of completing a connection over the phantom will be described, particular attention being paid to the means by which interference is prevented between the above circuits and connections.

When the subscriber at A wishes to make a call he removes his receiver thereby lighting the line lamp l and attracting the attention of an operator. Upon hearing the operator answer the subscriber gives her the necessary information concerning the connection he wants and this information is turned over to a toll operator, who may at once connect with the calling subscriber by plugging into his multiple jack J. It is understood that the local connection may be made in any approved manner either manually or automatically.

The toll operator will now insert the other plug of the cord circuit she is using, cord circuit P, for example, in the multiple jack J′ of an idle toll line extending to the desired exchange, the idle or busy condition of the toll line being determined by testing with the tip of the plug in the well known manner. By plugging into jack J′ an energizing circuit is completed for cut off relay 59 (Fig. 2) as follows: ground at G^{10}, winding of relay 59, wire 43, contact springs 57 and 58, sleeve of jack J′, sleeve of plug, sleeve relay 18 to battery B. Relay 59 attracts its armature and by means of contact springs 63 to 68 inclusive, disconnects the tip and ring of jack J′ from the drop D and from the line relays 55 and 56 of the repeater E. Also, by means of contact springs 61 and 62 an energizing circuit is prepared for relay 60.

Since the connection is to be established automatically, the operator now throws the key K^7 associated with toll line 200—201, thereby inserting the calling device S′ in a circuit which will be described and also closing an initial energizing circuit for relay 60 as follows: ground at G^{10}, contact springs 61 and 62, contact springs 36 and 37, and winding of relay 60 to battery B. Relay 60, upon energizing, closes the contact springs 34 and 35, thereby rendering the above circuit independent of key K^7; and also, by shifting the contact spring 32 from its normal connection with ground spring 31 into engagement with contact spring 33, completes an energizing circuit for the open core relays 74 and 93 as follows: ground at G^{11}, contact springs 100 and 101, winding of open core relay 93, winding of retardation coil 94, windings 84 and 85 of repeating coil R^2 in parallel, lines 200 and 201 in parallel, windings 82 and 83 of repeating coil R′ in parallel, retardation coil 75, winding of open core relay 74, contact springs 32 and 33, contact springs 69 and 71, impulse springs 72 and 73, and resistance 79 to battery. By attracting its armature 76, relay 74 closes a shunt around the condenser 110 which operation is of no consequence at this time.

At the far end of the toll line the open core relay 93 has attracted its armature 95 and closed a shunt around the condenser 98 in an obvious manner, resulting in the energization of line relays 125 and 126 of the repeater E′ over the following path: ground at G^{12}, winding of relay 126, wire 119, contact springs 104 and 105, winding 86 of repeating coil R^2, contact 96, armature 95, resistance 97, winding 87 of repeating coil R^2, contact springs 108 and 107, wire 115, and winding of relay 125 to battery. Relay 125, upon energizing, closes a circuit for slow acting relay 129 as follows: ground at G^{13}, contact springs 133 and 134, winding of relay 129 to battery. Relay 129 attracts its armature and by means of contact springs 148, 149, and 150 shifts the sleeve of jack J^2 from the winding of relay 99 to battery by way of resistance 131. In this manner a guarding potential is placed on the sleeve of jack J^2; and, furthermore, should the operator disregard her busy test and plug into jack J^2 accidentally she will not release a connection already established from the other exchange, for the relay 99 has its circuit opened as explained. Relay 129 also prepares an energizing circuit for relay 128 and a locking circuit for relay 127. Relay 126, upon energizing, closes a circuit for the line relay 160 of connector F as follows: ground at G^{15}, winding 161 of relay 160, wire 277, wire 275, contact springs 135 and 136, contact springs 146 and 147, retardation coil 130, contact springs 141 and 142, wire 274, wire 276, winding 162 of relay 160 to battery. The line relay 160 energizes over this circuit and completes a circuit from ground at G^{16} to the slow acting relay

163 which in turn prepares a circuit for the vertical magnet in the well-known manner. It should be mentioned here that in case selector switches are used the relay 163 will be provided with an extra pair of springs for supplying a holding ground for the selector or selectors.

The foregoing operations have all taken place in response to the insertion of the plug in jack J′ and the operation of key K⁷. The operator at the originating exchange may now proceed to dial the number of the called substation. The operation of the dial, as is well known, results in momentary separations of the impulse springs 72 and 73 corresponding in number to the digits of the number called. Accordingly, upon dialing the first digit the relays 74 and 93 have their circuit broken a number of times corresponding to the first digit of the called substation. The resulting deënergizations of relay 74 have no effect at this time. As relay 93 deënergizes, however, it breaks the previously described circuit of relays 125 and 126 whereupon these relays also vibrate their armatures in response to the impulses. At the first deënergization of relay 125 a circuit is completed for slow acting relay 128 as follows: ground at G¹³, contact springs 133 and 132, contact springs 153 and 154, and winding of relay 128 to battery. Relays 129 and 128, being slow acting, retain their armatures in an operated position during impulses after which relay 128 retracts its armature. In its energized condition relay 128 disconnects the conductors 274 and 275 from the condensers 159 and 158, respectively, and from the normally bridged coil 130; substitutes for the latter a direct path by way of contact springs 145 and 146, and contact springs 136 and 135; and completes an energizing circuit for relay 127 as follows: ground at G¹⁴, winding of relay 127, contact springs 143 and 144, to battery. Relay 127 locks itself by closing contact springs 137 and 138, and by separating contact springs 139 and 140 opens the circuit of the drop D′.

Relay 126, at each deënergization, breaks the circuit of the line relay 160 of the connector F, which responds by sending impulses to the vertical magnet 172 in the well-known manner, side switch wiper 174 being in its first position. The vertical magnet operates thereupon to raise the shaft carrying the wipers 180, 181, and 182 until they stand opposite the level or bank contacts in which are located the contacts of the desired number. The slow acting relay 164 is energized in series with the vertical magnet and retains its armature during a series of impulses thereby closing an energizing circuit for the private magnet 169. At the end of the series of impulses the relay 164 retracts its armature whereupon the private magnet deënergizes and allows the side switch wipers to move to their second position in the well-known manner.

The operator may now operate her dial in accordance with the final digit of the desired number, resulting in a repetition of the operations caused by the dialing of the first digit, except that now (side switch wiper 174 being in its second position) the line relay 160 sends impulses to the rotary magnet 173 which operates in response thereto to rotate the wipers 180, 181, and 182 until they rest upon the contacts of the desired line.

During this last series of impulses the relay 164 controls the private magnet in the previously described manner thereby moving the side switch wipers to their third position.

The conductors 276 and 277 are now connected by means of side switch wipers 175 and 176, in their third position, with wipers 180 and 182, these wipers being now in contact with the terminals of the line extending to substation A′. This line is disconnected from ground and battery at the line switch C by the attraction of the cut off armature 300, brought about by the completion of a circuit from ground at G¹⁷, by way of side switch wiper 177 in its third position, and private wiper 181 to the holding winding 301 of said line switch. Side switch wiper 174 in its third position completes a circuit for the ringing relay 171 in series with the interrupter I. The ringing relay 171 is energized intermittently and operates to project ringing current out over the line to the substation A′ where the called subscriber is signaled by the ringing of his bell.

Having completed the dialing of the required number, the operator may now restore the key K⁷ to its normal position, thereby cutting out the calling device S′ and making it available for use in other connections. When the called subscriber removes his receiver from the hook his transmitter is provided with talking current from the double wound back bridge relay 166 which attracts its armature and closes an energizing circuit for the ringing cut off relay 170. The ringing cut off relay locks itself and opens the circuit of the ringing relay. The transmitter at the calling substation is supplied with talking current through windings of the relay 15 of cord circuit P. The complete talking connection which has now been established is shown by the heavy lines and needs no further explanation.

At the conclusion of the conversation both subscribers will replace their receivers. The hanging up of the receiver at substation A results in the deënergization of relay 15 in cord circuit P, whereupon the circuit of su-

pervisory lamp l^2 will be closed. The lighting of this lamp indicates to the operator that the conversation is finished and she accordingly removes the plugs from the jacks. The removal of the plug from jack J′ breaks the circuit of relay 59; and the consequent deënergization of this relay breaks the locking circuit of relay 60, which relay, upon deënergizing, breaks the circuit of relays 74 and 93. Relay 93, upon deënergizing, breaks the circuit of line relays 125 and 126. The deënergization of relay 126 opens the circuit of line relay 160 of the connector F which, upon retracting its armature, breaks the circuit of slow acting relay 163. Relay 163, upon deënergizing, closes a circuit for the release magnet 185 which operates to restore the shaft and side switch wipers to their normal position, after which its own circuit is broken at contact 186. The apparatus has now all been returned to normal position and is ready to handle another call.

If the line of substation A′ had been busy the connector F would have operated at the end of the final series of impulses, to connect the busy machine Q with the conductor 277, the side switch wipers being held in the second position for this purpose. In this way a distinctive tone is transmitted to the subscriber at substation A, who upon perceiving it hangs up his receiver. The operator then removes her plugs from the jacks and the connection is released as hereinbefore described.

We may now turn our attention to the other toll line and consider how a connection may be established between a calling substation A^2 and the called substation A′. The apparatus used in connection with toll line 202, 203, might just as well have been an exact duplicate of that already described but I have preferred to modify the arrangement somewhat by associating the calling device with the cord circuit rather than with the toll line itself. We will assume that the subscriber at substation A^2 has communicated with the toll operator in the prescribed manner for the purpose of obtaining a connection with the subscriber at substation A′. The toll operator may now insert the answering plug of the cord circuit P′ in the multiple jack J^5 of substation A^2 and the calling plug in the multiple jack J^6 of the toll line 202, 203. The engagement of the sleeve of the plug with the sleeve of jack J^6 results in the closing of a circuit for relays 215 and 306 over the following path: ground at G^{41}, winding 308 of relay 306, contact springs 311 and 312, winding of relay 215, contact springs 240 and 241 (E^2), conductor 50, sleeve of jack J^6, sleeve of plug, contact springs 25 and 26, resistance 12, and resistance 13 to battery B′. Relay 306 has a marginal adjustment so that its winding 308 is inoperative when the resistance 12 is included in its circuit. Relay 215, however, attracts its armature, thereby preparing a circuit for winding 307 of relay 306, and at the same time disconnecting the line conductors 48 and 49 from the line relays 242 and 243 of the repeater E^2, and from the alternating current relay 213, all in an obvious manner.

The operator may now throw the key K^5, thereby inserting the calling device S in the previously described circuit of relays 215 and 306, and at the same time short circuiting the resistance 12. As a result of the increased current flow in winding 308, relay 306 attracts its armature and closes a circuit for its upper winding as follows: ground at G^{20}, contact springs 238 and 237, contact springs 310 and 309, and winding 307 of relay 306 to battery B′. By closing contact springs 311 and 313 and separating contact springs 311 and 312 the winding of relay 210 is substituted for winding 308 of relay 306, this relay remaining energized by means of its winding 307. Also, by shifting contact spring 315 from its normal position against ground spring 316 to its working position in engagement with contact spring 314, the normally grounded terminal of relay 216 is connected to armature 236 of relay 210. Relay 210, upon energizing, completes a circuit for relays 216 and 220 over the following path: ground at G^{21}, contact springs 229 and 230, winding of relay 220, winding of retardation coil 231, windings 232 and 233 of repeating coil R^5 in parallel, lines 202 and 203 in parallel, windings 234 and 235 of repeating coil R^5 in parallel, winding of retardation coil 217, winding of relay 216, contact springs 315 and 314, armature 236, contact 239, and resistance 212 to battery B′. Relay 216, upon energizing, produces no effect other than the closing of a shunt around condenser 218, which is not material to the operation. The shunting of condenser 245, however, which follows the energization of relay 220, closes the circuit of line relays 246 and 247 of repeater E^3. The operation of repeater E^3 is similar to the operation of repeater E′ already described. As previously stated, conductors 204 and 205 lead to a connector similar to connector F, but for the purpose of description the connector F will be used in extending the connection to substation A′.

The apparatus is now in the proper position for the operator to proceed with the manipulation of the calling device S. Operations of the dial in accordance with digits of the desired number will result in momentary separations of the impulse springs 27 and 28, in response to which the relay 210 will deënergize a corresponding number of times. The relay 215, however, being slow acting, retains its armature in operated posi-

tion. At each deënergization of relay 210 the circuit of relays 216 and 220 is broken. It follows then that relay 220 will repeat the impulses to the line relays 246 and 247 of the repeater E^3, whence they are repeated to the line relay 160 of the connector F. The remainder of the operation will be sufficiently clear from the previous explanation.

Considering now the method by which the above connections or similar connections may be established in the reverse direction, it will be seen that the two toll lines are equipped substantially in duplicate at both ends. The tool operator at the exchange to which substation A′ is connected may be provided with cord circuits similar to cord circuits P and P′, by means of which she may connect a calling substation with jack J^2 or jack J^7. If the tool line represented by jack J^2 is to be used the connection will be established by means of calling device S^2 which will control the relay 74 and cause it to repeat impulses to the repeater E which in turn will repeat the impulses to a connector, such as connector F, with which it is connected. In case the toll line represented by jack J^7 is to be used it will be necessary to use a cord circuit such as P′ which has a calling device by means of which the relay 225 may be controlled to transmit impulses to the relay 216. Relay 216 will repeat these impulses to repeater E^2 which in turn will repeat them to a connector, such as connector F, with which it is connected.

Having explained separately the operation of the two physical circuits, I will now explain the operation of their superimposed phantom circuit. This circuit as shown is intended for manually established connections only and accordingly is equipped with a jack, drop, and cut off relay at each end. The operator at the exchange to which the substation A is connected may partially complete a connection between substation A and substation A′ by means of a cord circuit such as P, inserting the answering and calling plugs in jacks J and J^3, respectively. She may now operate her ringing key K^2 thereby sending ringing current through the windings 268 and 269 of repeating coil R^3 in series. An alternating current is then induced in windings 266 and 267 of repeating coil R^3 which takes the following path: upper terminal of winding 266, winding 266, condenser 250, condenser 251, winding 267, windings 234 and 235 of repeating coil R^5 in parallel, lines 202 and 203 in parallel, windings 232 and 233 of repeating coil R^6 in parallel, winding 271 of repeating coil R^4, condenser 253, condenser 252, winding 270 of repeating coil R^4, windings 84 and 85 of repeating coil R^2 in parallel, lines 200 and 201 in parallel, windings 82 and 83 of repeating coil R′ in parallel, to upper terminal of winding 266, the starting point. A branch of the above circuit may be traced from the junction of windings 234 and 235 of repeating coil R^5, by way of retardation coil 217, open core relay 216, one side of battery, same or opposite side of battery, open core relay 74, retardation coil 75, to junction of windings 82 and 83 of repeating coil R′. Each of the windings 266 and 267 also has a separate shunt around it formed by half of the above described circuit taken in connection with one of the coils 262 and 263. All the above branch circuits are duplicated at the other exchange. The frequency of the ringing current used on the phantom, however, is as high as practicable, the high frequency enabling the retardation coils inserted in the above branch circuits to effectually prevent the shunting of a serious amount of current, thereby preventing ringing current on the phantom from interfering with the open core impulsing relays such as relays 74.

It follows then that most of the current induced in windings 266 and 267 of repeating coil R^3 will flow through windings 270 and 271 of repeating coil R^4, thereby inducing a current in windings 272 and 273, which actuates the drop D^3. The operator at the exchange to which A′ is connected will respond by plugging into the jack J^4 after which she may complete the desired connection by inserting the other plug in the multiple jack of the substation wanted and operate her ringing key. The phantom circuit may of course, be used to establish a connection in the reverse direction in the same manner.

We may consider now the action of the coils 262—265 inclusive, and the condensers 250—253 inclusive. At least one condenser is necessary in series with the phantom windings of repeating coils R^3 and R^4 in order to prevent the flow of direct current from one physical circuit to the other. If special means were not provided to prevent it, these condensers would charge and discharge in series with the open core impulsing relays of one physical circuit while impulses were being sent over the other physical circuit. The special means consists of the coils 262—265 inclusive, connected as shown, one of which is evidently at all times in shunt of a given open core impulsing relay. The coils 262—265 inclusive, are preferably very much lower in resistance than the impulsing relays, therefore most of the charging and discharging current of condensers 250—253 inclusive, passes through these coils in preference to the impulsing relays, thereby preventing interference between the two physical circuits. It would seem that these charging currents could be heard on the phantom circuit, since each condenser charges and discharges through a winding of a phantom repeating coil. They

are scarcely perceptible, however, owing to the extremely high resistance of the impulsing relays such as relay 74: and also on account of the condensers 111, 112, 211, and 226 which are shunted around the impulse springs, these condensers serving to smooth out the sharp breaks in the circuit.

It will be seen from the foregoing, that my invention provides a simple and efficient means whereby two physical circuits may be phantomed and yet may be used for setting up automatic connections without interference; while the phantom circuit may be used at the same time without interfering with either of the physical circuits. While I have shown one form in which my invention may be practised, it is evidently susceptible to modifications by those skilled in the art. I do not, therefore, wish to be held strictly to the exact embodiment shown herein, but desire rather 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 line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits, and a shunt for said controlling relays.

2. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits, and a shunt for said relays extending from the junction of said condensers.

3. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, automatic switches accessible to said lines, and controlling relays for said switches in said second and third circuits.

4. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, and a shunt for said controlling relays.

5. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, and a shunt for said relays extending from the junction of said condensers.

6. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, and impulse sending devices in said second and third circuits at the other end.

7. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said controlling relays, and a condenser in shunt of each of said devices.

8. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said relays

extending from the junction of said condensers, and a condenser in shunt of each of said devices.

9. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, and a condenser in shunt of each of said devices.

10. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits, said controlling relays provided with a pair of magnetically distinct cores, and a shunt for said controlling relays.

11. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said second and third circuits at one end, said controlling relays provided with a pair of magnetically distinct cores, impulse sending devices in said second and third circuits at the other end, and a shunt for said relays extending from the junction of said condensers.

12. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, said controlling relays provided with a pair of magnetically distinct cores, impulse sending devices in said second and third circuits at the other end, and a condenser in shunt of each of said devices.

13. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, and a shunt for said controlling relays.

14. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, and a shunt for said relays extending from the junction of said condensers.

15. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, and controlling relays for said switches in said second and third circuits.

16. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits at one end, impulse sending devices

in said second and third circuits at the other end, and a shunt for said controlling relays.

17. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, and a shunt for said relays extending from the junction of said condensers.

18. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits at one end, and impulse sending devices in said second and third circuits at the other end.

19. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said controlling relays, and a condenser in shunt of each of said devices.

20. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said relays extending from the junction of said condensers, and a condenser in shunt of each of said devices.

21. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, and a condenser in shunt of each of said devices.

22. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, said controlling relays provided with a pair of magnetically distinct cores, and a shunt for said controlling relays.

23. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said second and third circuits at one end, said controlling relays provided with a pair of magnetically distinct cores, impulse sending devices in said second and third circuits at the other end,

and a shunt for said relays extending from the junction of said condensers.

24. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits at one end, said controlling relays provided with a pair of magnetically distinct cores, impulse sending devices in said second and third circuits at the other end, and a condenser in shunt of each of said devices.

25. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits, a shunt for said controlling relays, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

26. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits, a shunt for said relays extending from the junction of said condensers, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

27. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

28. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said controlling relays, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

29. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said relays extending from the junction of said condensers, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

30. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third conductor including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

31. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, impulse sending

devices in said second and third circuits at the other end, a shunt for said controlling relays, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

32. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said relays extending from the junction of said condensers, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

33. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

34. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits, said controlling relays provided with a pair of magnetically distinct cores, a shunt for said controlling relays, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

35. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said second and third circuits at one end, said controlling relays provided with a pair of magnetically distinct cores, impulse sending devices in said second and third circuits at the other end, a shunt for said relays extending from the junction of said condensers, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

36. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits at one end, said controlling relays provided with a pair of magnetically distinct cores, impulse sending devices in said second and third circuits at the other end, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

37. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, a shunt for said controlling relays, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

38. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, a shunt for said relays extending from the junction of said conden-

sers, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

39. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

40. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said switches, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said controlling relays, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

41. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said relays extending from the junction of said condensers, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

42. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

43. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said controlling relays, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

44. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a shunt for said relays extending from the junction of said condensers, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

45. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current,

a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

46. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, said controlling relays provided with a pair of magnetically distinct cores, a shunt for said controlling relays, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

47. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said second and third circuits at one end, said controlling relays provided with a pair of magnetically distinct cores, impulse sending devices in said second and third circuits at the other end, a shunt for said relays extending from the junction of said condensers, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

48. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits at one end, said controlling relays provided with a pair of magnetically distinct cores, impulse sending devices in said second and third circuits at the other end, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

49. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said battery, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines at both ends, controlling relays for said switches in said second and third circuits, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit.

50. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said battery, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines at both ends, controlling relays for said switches in said second and third circuits, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, an inductive shunt for each of said controlling relays, and a condenser in shunt of each of said devices.

51. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said

battery, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accesible to said lines at both ends, controlling relays for said switches in said second and third circuits, said controlling relays each having a pair of magnetically distinct cores, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, an inductive shunt for each of said controlling relays, and a condenser in shunt of each of said devices.

52. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said battery, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines at both ends, controlling relays for said switches in said second and third circuits, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

53. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said battery, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines at both ends, controlling relays for said switches in said second and third circuits, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, an inductive shunt for each of said controlling relays, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

54. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said battery, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines at both ends, controlling relays for said switches in said second and third circuits, said controlling relays each having a pair of magnetically distinct cores, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, an inductive shunt for each of said controlling relays, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

55. In a telephone system, a line, a second line, manually controlled means for signaling over said lines, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits, and a shunt for said controlling relays.

56. In a telephone system, a line, a second line, manually controlled means for signaling over said lines, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said second and third circuits at one end, impulse sending devices in said second and third circuits at the other end, and a shunt for said relays extending from the junction of said condensers.

57. In a telephone system, a line, a second line, manually controlled means for signaling over said lines, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a pair of coils for each of said condenser pairs, said coils being in series with said battery and having their junction connected to the junction of said condensers, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, and controlling relays for said switches in said second and third circuits.

58. In a telephone system, a line, a second line, manually controlled means for signal-

ing over said lines, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines, controlling relays for said switches in said second and third circuits, a shunt for said controlling relays, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

59. In a telephone system, a line, a second line, manually controlled means for signaling over said lines, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said battery, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines at both ends, controlling relays for said switches in said second and third circuits, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit.

60. In a telephone system, a line, a second line, manually controlled means for signaling over said lines, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said battery, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines at both ends, controlling relays for said switches in said second and third circuits, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

61. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said battery, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting a subscriber's station with either of said lines at either end thereof, automatic switches accessible to said lines at either end for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, impulse sending devices, means for separately switching either of said second or third circuits to the other pole of said battery and for including at the same time one of said devices in the circuit.

62. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of battery, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting a subscriber's station with either of said lines at either end thereof, automatic switches accessible to said lines at either end for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, said control relays each having a pair of magnetically distinct cores, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, an inductive shunt for each of said controlling relays, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, and a retardation coil in series with each of said controlling relays.

63. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, a pair of condensers in the phantom circuit at each end for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting one of said stations with either of said lines, automatic switches accessible to said lines for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, a shunt for said relays extending from the junction of said condensers, means for signaling over said phantom circuit, a retardation coil in series with each of said controlling relays, and means for manually completing a connection between two of said stations over said phantom circuit.

64. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being

normally connected to the same pole of battery, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting a subscriber's station with either of said lines at either end thereof, automatic switches accessible to said lines at either end for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, said control relays each having a pair of magnetically distinct cores, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, an inductive shunt for each of said controlling relays, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, a retardation coil in series with each of said controlling relays, and means for manually completing a connection between two of said stations over said phantom circuit.

65. In a telephone system, a line, a second line, manually controlled means for signaling over said lines, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of said battery, condensers in the phantom circuit for preventing direct current flow between said lines, automatic switches accessible to said lines at both ends, controlling relays for said switches in said second and third circuits, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, and means for manually completing a connection between two of said stations over either of said lines.

66. In a telephone system, a line, a second line, a phantom circuit superimposed thereon, a second circuit including said first line, a third circuit including said second line, a battery for supplying current, both terminals of said second and third circuits being normally connected to the same pole of battery, condensers in the phantom circuit for preventing direct current flow between said lines, a plurality of subscribers' stations, means for connecting a subscriber's station with either of said lines at either end thereof, automatic switches accessible to said lines at either end for extending a connection to another of said stations, controlling relays for said switches in said second and third circuits, said controlling relays each having a pair of magnetically distinct cores, impulse sending devices, means for separately switching either terminal of said second or third circuit to the other pole of said battery and for including at the same time one of said devices in the circuit, an inductive shunt for each of said controlling relays, a condenser in shunt of each of said devices, means for signaling over said phantom circuit, a retardation coil in series with each of said controlling relays, means for manually completing a connection between two of said stations over said phantom circuit, and means for manually completing a connection between two of said stations over either of said lines.

67. In a telephone system, a trunk line, means including a manual connective terminal at one end and a second manual connective terminal and a call signal at the other end for completing connections over said trunk line in one direction, means including said first manual connective terminal and an automatic switch at the other end controllable over said trunk line for completing connections over said trunk line in the same direction, and means including said second manual connective terminal and a second automatic switch at the other end controllable over said trunk line for completing connections over said trunk line in the opposite direction.

68. In a telephone system, a trunk line, means including a manual connective terminal at one end and a second manual connective terminal and a call signal at the other end for completing connections over said trunk line in one direction, means including said first manual connective terminal and an automatic switch at the other end controllable over said trunk line for completing connections over said trunk line in the same direction, means including said second manual connective terminal and a second automatic switch at the other end controllable over said trunk line for completing connections over said trunk line in the opposite direction, and means for rendering the manual connective terminal at either end busy to an operator when the automatic switch at the same end is operated.

69. In a telephone system, a trunk line, means including a manual connective terminal at one end and a second manual connective terminal and a call signal at the other end for completing connections over said trunk line in one direction, means including said first manual connective terminal and an automatic switch at the other end controllable over said trunk line for completing connections over said trunk line in the same direction, means including said second manual connective terminal and a second automatic switch at the other end controllable over said trunk line for completing connections over said trunk line in the op-

posite direction, and means for disconnecting said call signal when the automatic switch at the same end is operated.

70. In a telephone system, a trunk line, means including a manual connective terminal at one end and a second manual connective terminal and a call signal at the other end for completing connections over said trunk line in one direction, means including said first manual connective terminal and an automatic switch at the other end controllable over said trunk line for completing connections over said trunk line in the same direction, means including said second manual connective terminal and a second automatic switch at the other end controllable over said trunk line for completing connections over said trunk line in the opposite direction, and means for disconnecting the automatic switch at either end whenever the trunk line is taken for use by an operator at the same end.

71. In a telephone system, a trunk line connecting two exchanges, means including a manual connective terminal in one exchange and an automatic switch in the second exchange controllable over said trunk line for completing connections over said trunk line in one direction, means including a manual connective terminal in the second exchange and an automatic switch in the first exchange controllable over said trunk line for completing connections over said trunk line in the opposite direction, a call signal associated with one of said manual connective terminals, and operators equipment for completing connections over said trunk line manually by way of said connective terminals.

72. In a telephone system, a trunk line connecting two exchanges, means including a manual connective terminal in one exchange and an automatic switch in the second exchange controllable over said trunk line for completing connections over said trunk line in one direction, means including a manual connective terminal in the second exchange and an automatic switch in the first exchange controllable over said trunk line for completing connections over said trunk line in the opposite direction, a call signal associated with one of said manual connective terminals, operator's equipment for completing connections over said trunk line manually by way of said connective terminals, and means for disconnecting said call signal when the automatic switch at the same end is operated.

73. In a telephone system, a trunk line connecting two exchanges, means including a manual connective terminal in one exchange and an automatic switch in the second exchange controllable over said trunk line for completing connections over said trunk line in one direction, means including a manual connective terminal in the second exchange and an automatic switch in the first exchange controllable over said trunk line for completing connections over said trunk line in the opposite direction, a call signal associated with one of said manual connective terminals, operator's equipment for completing connections over said trunk line manually by way of said connective terminals, and means for rendering the manual connective terminal at either end busy to an operator when the automatic switch at the same end is operated.

74. In a telephone system, a trunk line connecting two exchanges, means including a manual connective terminal in one exchange and an automatic switch in the second exchange controllable over said trunk line for completing connections over said trunk line in one direction, means including a manual connective terminal in the second exchange and an automatic switch in the first exchange controllable over said trunk line for completing connections over said trunk line in the opposite direction, a call signal associated with one of said manual connective terminals, operator's equipment for completing connections over said trunk line manually by way of said connective terminals, and means for disconnecting the automatic switch at either end whenever the trunk line is taken for use by an operator at the same end.

75. In a telephone system, a two way trunk line, means including a call signal and operator's equipment at each end of said trunk line for completing connections thereover manually in either direction, an automatic switch at each end of said trunk line controllable thereover, and means including said manual equipment and said switches for completing connections over said trunk line semi-automatically in either direction.

76. In a telephone system, a two way trunk line, means including a call signal and operator's equipment at each end of said trunk line for completing connections thereover manually in either direction, an automatic switch at each end of said trunk line controllable thereover, means including said manual equipment and said switches for completing connections over said trunk line semi-automatically in either direction, and means for disconnecting the call signal at either end when the automatic switch at the same end is operated.

77. In a telephone system, a two way trunk line, means including a call signal and operator's equipment at each end of said trunk line for completing connections thereover manually in either direction, an automatic switch at each end of said trunk line controllable thereover, means including said

manual 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 an operator at either end whenever the automatic switch at the same end is operated.

78. In a telephone system, a two way trunk line, means including a call signal and operator's equipment at each end of said trunk line for completing connections thereover manually in either direction, an automatic switch at each end of said trunk line controllable thereover, means including said manual equipment and said switches for completing connections over said trunk line semi-automatically in either direction, and means for disconnecting the automatic switch at either end of said trunk line whenever the trunk line is taken for use by an operator at the same end.

79. In a telephone system, a trunk line provided with manual connective terminals at each end thereof, means including one of said manual connective terminals and an automatic switch at the other end of said trunk line controllable thereover for completing a connection over said trunk line in one direction, means including the other of said manual connective 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, call signals associated with said manual connective terminals, and operator's equipment for completing connections over said trunk line manually in either direction.

80. In a telephone system, a trunk line provided with manual connective terminals at each end thereof, means including one of said manual connective terminals and an automatic switch at the other end of said trunk line controllable thereover for completing a connection over said trunk line in one direction, means including the other of said manual connective 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, call signals associated with said manual connective terminals, operator's equipment for completing connections over said trunk line manually in either direction, and means for disconnecting the call signal at either end when the automatic switch at the same end is operated.

81. In a telephone system, a trunk line provided with manual connective terminals at each end thereof, means including one of said manual connective terminals and an automatic switch at the other end of said trunk line controllable thereover for completing a connection over said trunk line in one direction, means including the other of said manual connective 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, call signals associated with said manual connective terminals, operator's equipment for completing connections over said trunk line manually in either direction, and means for rendering the manual connective terminal at either end busy to an operator when the automatic switch at the same end is operated.

82. In a telephone system, a trunk line provided with manual connective terminals at each end thereof, means including one of said manual connective terminals and an automatic switch at the other end of said trunk line controllable thereover for completing a connection over said trunk line in one direction, means including the other of said manual connective 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, call signals associated with said manual connective terminals, operator's equipment for completing connections over said trunk line manually in either direction, and means for disconnecting the automatic switch at either end whenever the trunk line is taken for use by an operator at the same end.

83. In a telephone system wherein there is a pair of lines upon which there is superimposed a phantom circuit and wherein there is an impulse mechanism for transmitting impulses over each line, a reactance in said phantom circuit for preventing the impulses over one of said lines from passing to the other said lines.

84. In a telephone system wherein there is a pair of lines upon which there is superimposed a phantom circuit and wherein there is an impulse mechanism for transmitting impulses over each of said lines, a pair of coils connected in series to a source of current and a reactance in said phantom circuit connected to the mid-point of said coils for preventing the impulses transmitted over one of said lines from passing to the other line.

85. In a telephone system wherein there is a pair of lines upon which there is superimposed a phantom circuit and wherein there is an operating circuit for each of said lines including an impulse mechanism at one end of one of said lines and a relay responsive thereto at the opposite end of said line and in which there is a generator for furnishing current for signaling purposes in said system, an impedance coil in series with said relay for preventing signaling current over one of said lines from operating the relay in the other of said lines.

86. In a telephone system wherein there is a pair of lines upon which there is super-

imposed a phantom circuit and wherein there is an impulse mechanism for transmitting impulses over each line, a reactance in shunt of said impulse mechanism for eliminating the noise on the phantom circuit during the transmission of impulses over either of said lines.

87. In a telephone system wherein there is a pair of lines upon which there is superimposed a phantom circuit; means including an impulse mechanism for transmitting impulses over each of said lines, a relay responsive thereto, and automatic switches controlled by said relay for automatically establishing a talking circuit over said lines; and means, including a signal and a source of current for operating the same over said lines, for the purpose of manually establishing a talking circuit.

88. In a telephone system, a trunk line, operators' equipment at each end of said trunk line for establishing connections thereover manually, and means including an automatic switch at each end of said trunk line one of which is controllable thereover for establishing a connection over said trunk line automatically.

89. In a telephone system, a trunk line, operators' equipment at each end of said trunk line and a call signal at one end thereof for handling calls over said trunk line manually in one direction, and means including an automatic switch at each end of said trunk line one of which is controllable thereover for establishing a connection over said trunk line automatically in the opposite direction.

90. In a telephone system, a trunk line, operators' equipment at each end of said trunk line for establishing connections thereover manually, means including an automatic switch at each end of said trunk line one of which is controllable thereover for establishing a connection over said trunk line automatically, and means including a test circuit whereby when the trunk line is in use on a manual connection it is made busy to automatic calls.

91. In a telephone system, a trunk line, operators' equipment at each end of said trunk line and a call signal at one end thereof for handling calls over said trunk line manually in one direction, means including an automatic switch at each end of said trunk line one of which is controllable thereover for establishing a connection over said trunk line automatically in the opposite direction, and means including a test circuit whereby when the trunk line is in use on a manual connection it is made busy to automatic calls.

92. In a telephone system, a trunk line, means including a manual connective terminal and operators' equipment at each end of said trunk line for establishing connections thereover manually in either direction, and means including an automatic switch at each end of said trunk line one of which is controllable thereover for establishing a connection over said trunk line automatically.

93. In a telephone system, a trunk line, means including a manual connective terminal and operators' equipment at each end of said trunk line for establishing connections thereover manually in either direction, means including an automatic switch at each end of said trunk line one of which is controllable thereover for establishing a connection over said trunk line automatically, and busy test circuits for preventing interference between manual and automatic connections.

94. In a telephone system, a plurality of subscribers' lines, means including a two-way trunk line and automatic switches for extending a connection in either direction between two of said subscribers' lines, means including a second two-way trunk line for extending a second connection in either direction between two of said subscribers' lines, and a phantom talking circuit superimposed on said trunk lines.

95. In a telephone system, a plurality of subscribers' lines, means including a two-way trunk line and automatic switches for extending a connection in either direction between two of said subscribers' lines, means including a second two-way trunk line for extending a second connection in either direction between two of said subscribers' lines, a phantom talking circuit superimposed on said trunk lines, and means for preventing interference between the said trunk lines and the said phantom circuit when in use.

96. In a telephone system, a pair of physical trunk circuits, means for controlling automatic switches over each of said physical circuits to extend a connection in either direction, and a phantom signaling circuit superimposed on said physical circuits.

Signed by me at New Richmond, Clermont county, State of Ohio, this 10th day of December, 1915.

FRANK NEWFORTH.