L. A. MORTIMER.

TELEPHONE SYSTEM.

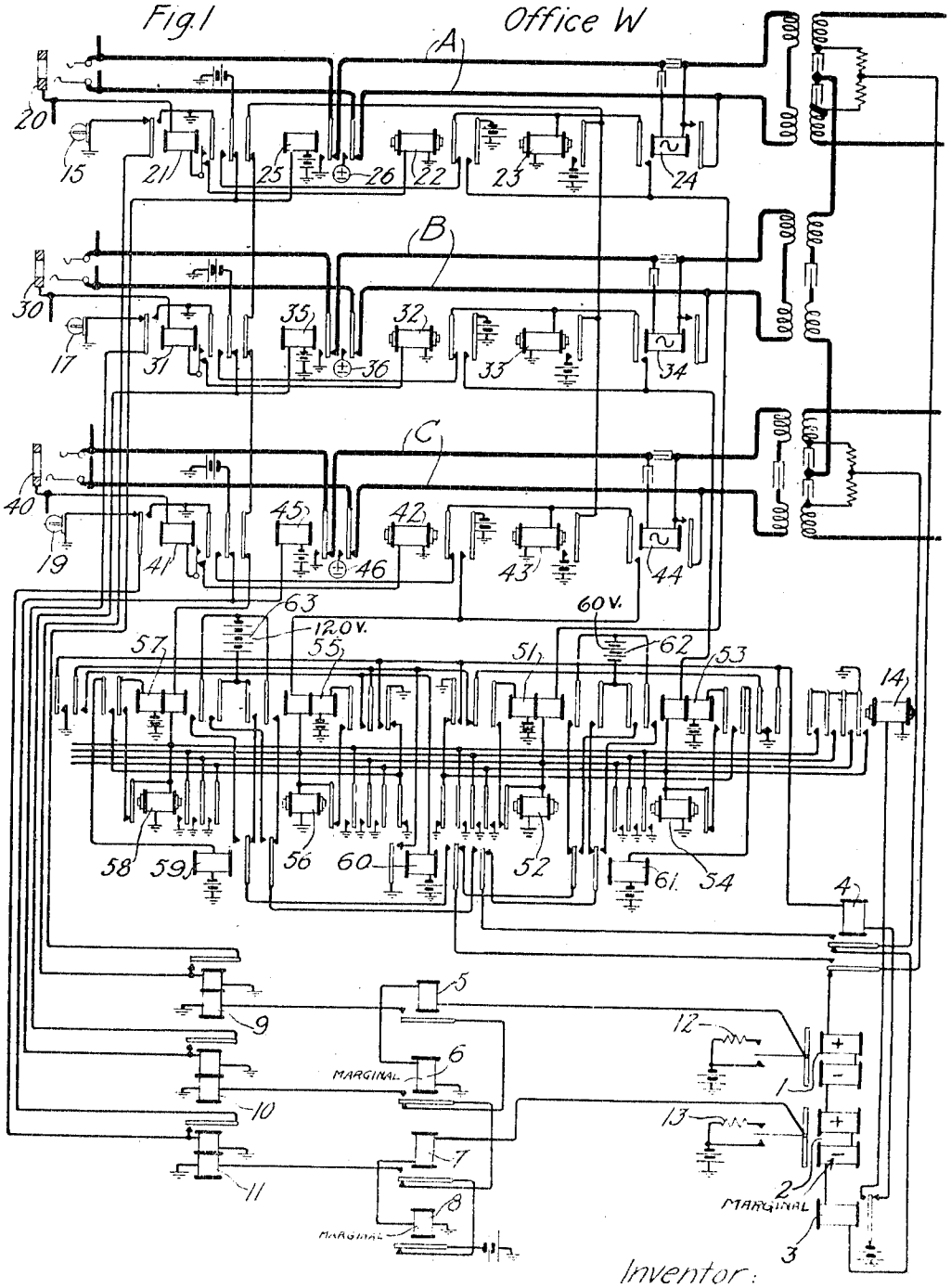
APPLICATION FILED MAR. 2, 1920.

1,406,678.

Patented Feb. 14, 1922.

5 SHEETS—SHEET 1.

Fig. 1



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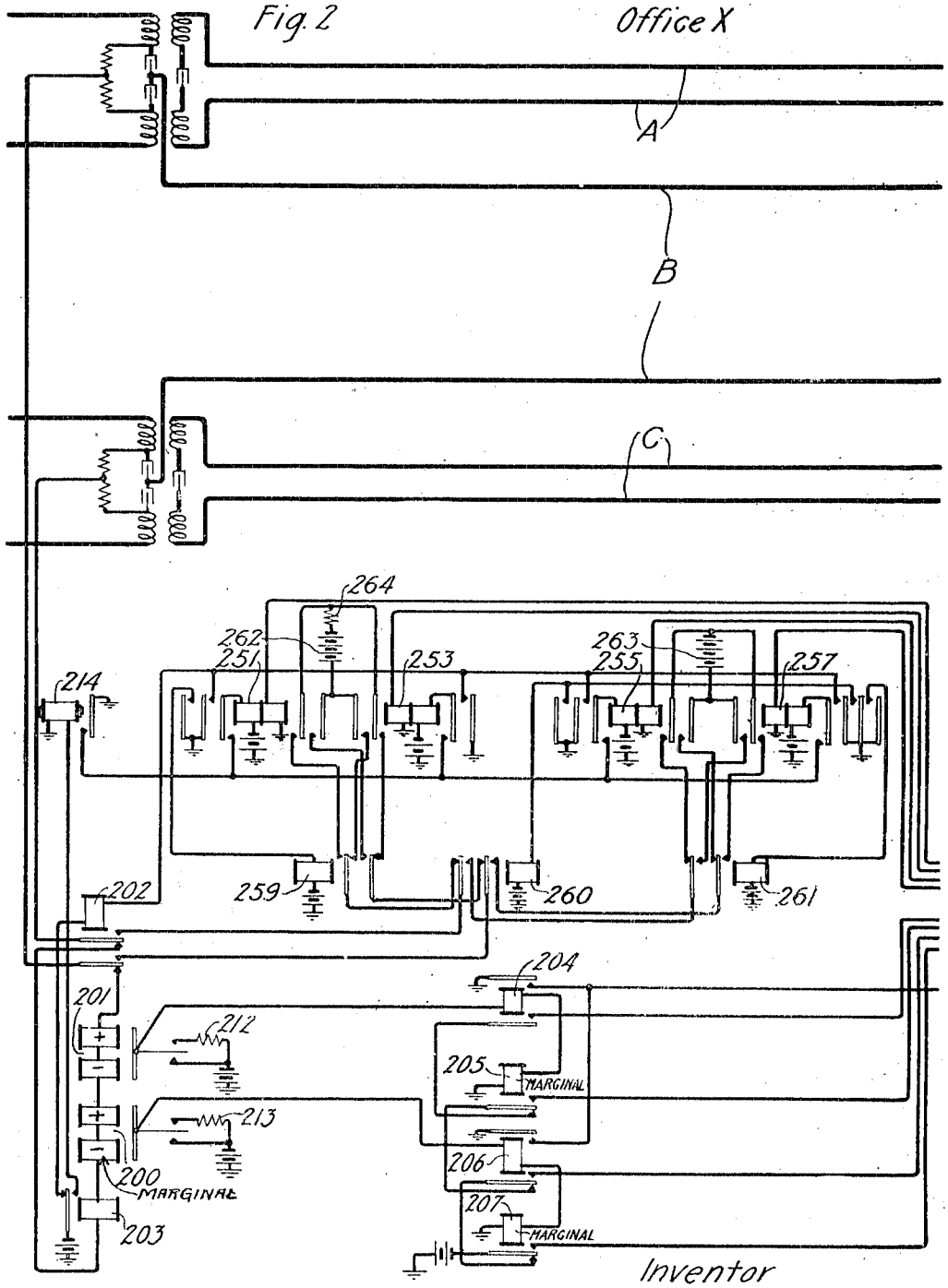
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5 SHEETS—SHEET 2.

Fig. 2



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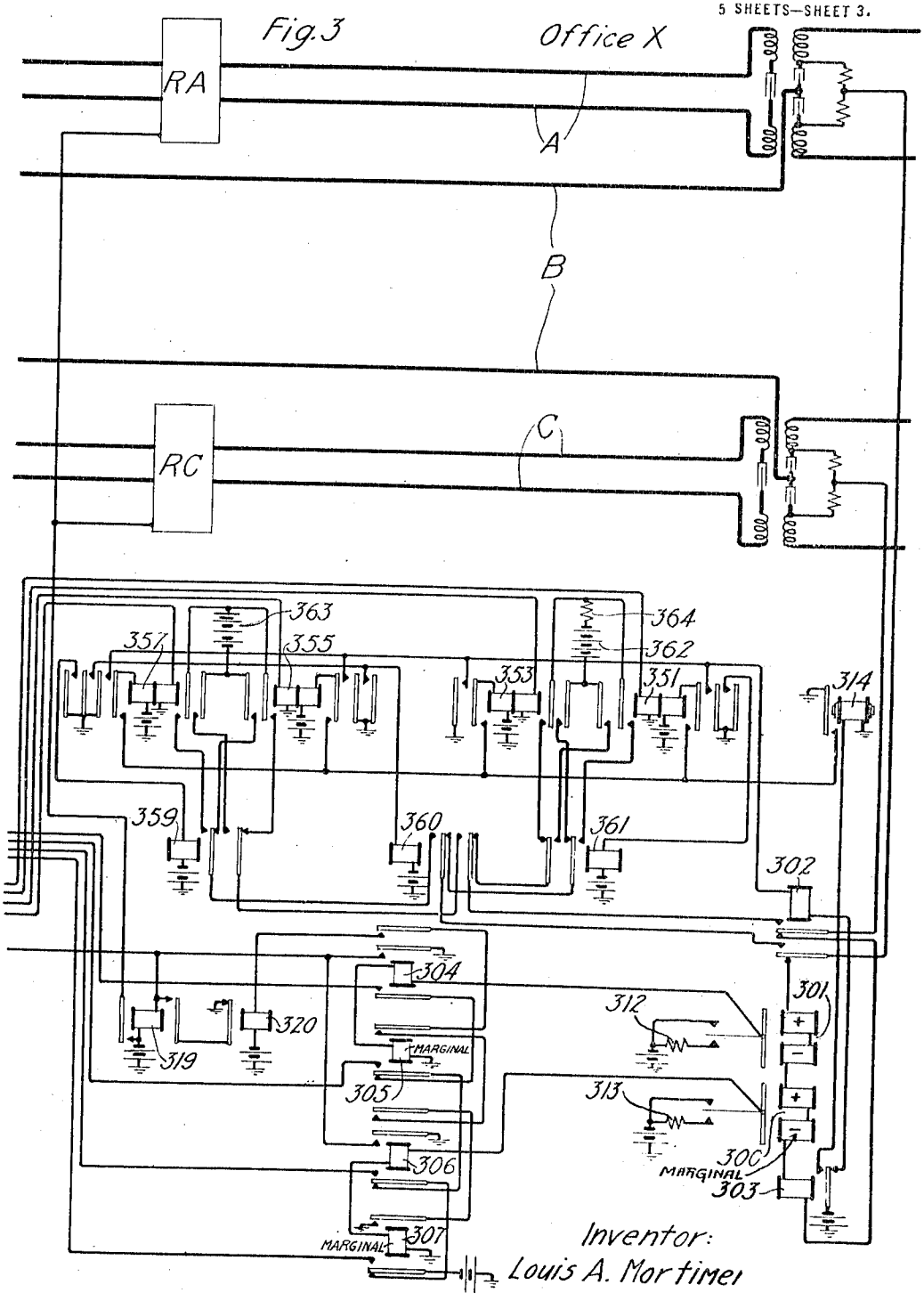
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5 SHEETS—SHEET 3.



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5 SHEETS—SHEET 4.

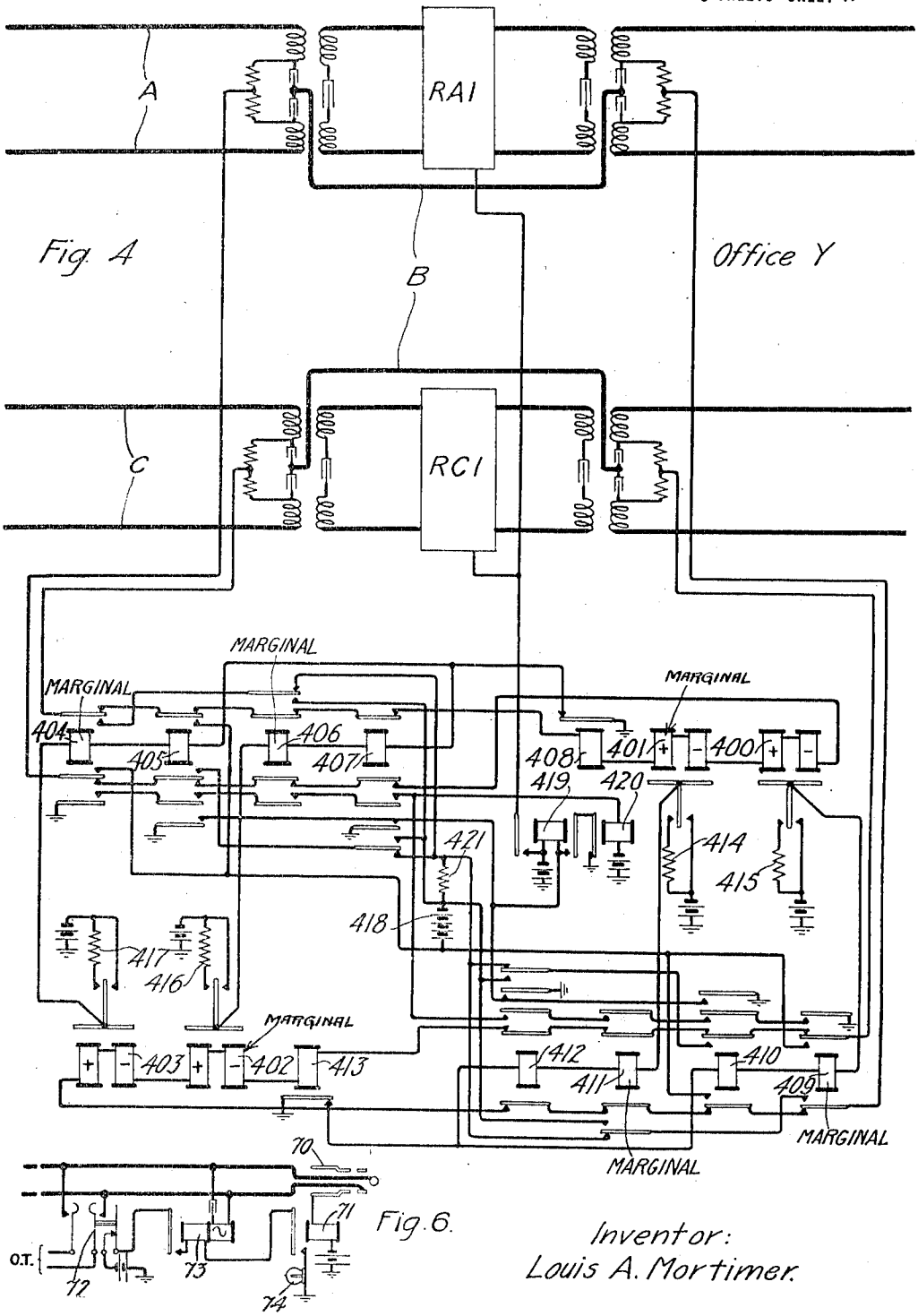


Fig. 4

Fig. 6.

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TELEPHONE SYSTEM.

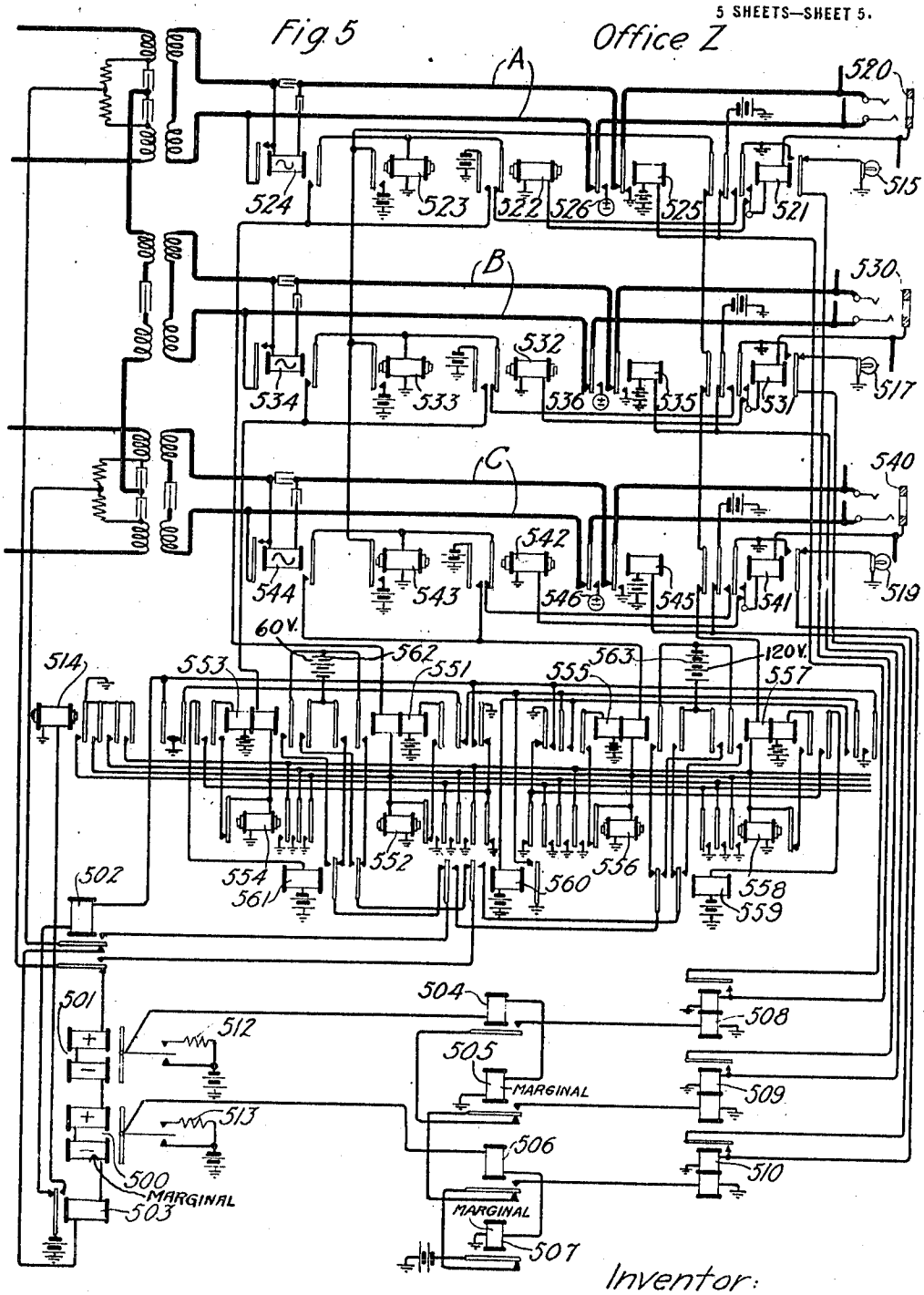
APPLICATION FILED MAR. 2, 1920.

1,406,678.

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5 SHEETS—SHEET 5.

Fig 5



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UNITED STATES PATENT OFFICE.

LOUIS A. MORTIMER, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

1,406,678. Specification of Letters Patent. Patented Feb. 14, 1922.

Application filed March 2, 1920. Serial No. 362,747.

To all whom it may concern:

Be it known that I, LOUIS A. MORTIMER, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Telephone Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to improvements in telephone systems and has particular reference to signaling means employed with transmission lines.

Heretofore, it has been customary to employ physical and phantom lines for interconnecting distant offices. Selective signals have been transmitted over these lines from one office to the other to control telephone repeaters at intermediate offices and to signal operators at the first named offices when connections are desired or when calls are terminated. It may sometimes occur, particularly when the jacks or other terminals at the distant offices are multipled, that signaling impulses are transmitted from the same or different offices simultaneously or contemporaneously with the result that impulses may be lost.

An object of the present invention is to overcome the mentioned difficulty by providing impulse storing means at various offices which will operate, when impulses are simultaneously transmitted, to store certain impulses for sufficient time to enable the others to be transmitted and then to release the stored impulses so that all of the impulses will successively perform their respective functions.

In the drawings, wherein the above and other objects are realized, Figs. 1 to 5 inclusive, taken together and arranged side by side in the manner indicated by the circuit lines extending to the margins of the drawings, illustrate what is now believed to be a preferred embodiment of the invention. Fig. 6 is a diagrammatic view of a cord circuit which may be used in connection with the invention.

Briefly, the invention is shown as consisting of two distant offices W and Z and intermediate offices X and Y with physical transmission lines A and C and a phantom line B interconnecting said offices. Telephone repeaters, shown conventionally at RA, RC, RA1 and RC1, are provided at offices X and Y, respectively. These repeaters may be of any well known type and since they form no part of the present invention it is deemed unnecessary to illustrate them in detail.

Each distant or terminating office is provided with an impulse mechanism containing relays which are individual to each line terminating at said office and upon the initiation of a call on one of the lines the relays associated therewith are operated to establish an impulse circuit which transmits an impulse to the nearest intermediate office where the same is repeated and again transmitted until it reaches the other distant office. The passage of the impulse through the intermediate offices is utilized to render effective the telephone repeaters thereat. At said other distant office the impulse actuates mechanism individual to the particular line over which the call is initiated to inform the operator that the line has been taken for use. Preferably, the physical lines A and C are employed for the transmission of the various impulses and normally included with these lines at the various offices are relays responsive to different polarities of current so as to identify the particular line over which a call is initiated. Upon the removal of all plugs from the jacks at the terminating offices, impulses of a different character from those utilized in establishing connections are transmitted from the distant offices to restore the telephone repeaters to normal.

The mechanism at the two distant offices is arranged so that, in the event of simultaneous or contemporaneous calls being initiated at the same office, the same will operate to immediately transmit the impulse for one of the calls and to store the other impulse until the first has been transmitted whereupon the mechanism again operates to send the second impulse. The mechanism will operate in a like manner should an incoming impulse reach a distant office at the same time that a call is initiated thereat. For simultaneous impulses transmitted from different offices and meeting therebetween, an impulse storing mechanism is provided at the intermediate office X which stores the first impulse received thereat until the second impulse has passed through whereupon said first impulse is transmitted from said office.

With this general description in mind, it is believed that the invention will now be fully understood from the following detailed description of the operation.

Operator at office W initiates a call to office Z over line A.

The operator at office W desiring to initiate a call over line A inserts the plug 70 of a link circuit (Fig. 6) of any well-known type into jack 20, and thereupon establishes a circuit extending from battery, through the winding of relay 71, the sleeve contacts of the plug 70 and jack 20, the winding and inner right-hand normal contact of relay 21 and the winding of slow-to-release relay 22 to ground. Relay 71 energizes but has no effect upon the link circuit at this time. Relays 21 and 22 energize and relay 21 locks in a circuit extending from ground through its middle alternate contact and winding, the sleeve contacts of jack 20 and the plug of the link circuit to grounded battery. Relay 21, upon energizing, immediately opens the circuit for relay 22, but this relay being slow to release maintains the alternate contact thereof closed for a sufficient length of time to transmit a signaling impulse. The energization of relay 22 establishes an impulse circuit extending from grounded battery through the alternate contact of relay 22, the right-hand winding of relay 51 and the winding of slow-to-release relay 52 to ground. The relays 51 and 52 energize in this circuit, relay 51 maintaining its alternate contacts closed during the energization of relay 22. Relay 52, being slow to release, will maintain its alternate contacts closed for a period of time after the release of relays 22 and 51. The closure of the alternate contacts of relay 52 establishes short circuits for slow-to-release relays 54, 56 and 58 to prevent energization of these relays during the transmission of the impulse from office W for line A. The energization of relay 51 establishes a circuit extending from grounded battery through the normal contact of relay 3, the winding of relay 4 and the outer left-hand alternate contact of relay 51 to ground. Relay 4 energizes in this circuit and disconnects the polar relays 1 and 2 and relay 3 from the simplex conductors included in the physical lines extending between offices W and X. The energization of relay 51 also establishes an impulse circuit extending from the negative pole of battery 62, preferably of 60 volts, through the outer right-hand alternate contact of relay 51, the right-hand normal contact of relay 61, the right-hand normal contact of relay 60, the upper alternate contact of relay 4, the simplex conductors included in the physical line C extending between office W and the mechanism of office X shown in Fig. 2, the upper normal contact of relay 202, the windings of relay 203 and the polar relays 200 and 201, the lower normal contact of relay 202, the simplex conductors included in the physical line A extending between the mechanism at office X shown in Fig. 2 and office W, the lower alternate contact of relay 4, the left-hand normal contact of relay 60, the left-hand normal contact of relay 61, and the inner right-hand alternate contact of relay 51 to the positive pole of battery 62. At the termination of the impulse extending over this circuit, relays 22 and 51 release and the release of the latter relay opens the previously described circuit for relay 4 which then restores to normal. The release of relay 22 establishes a circuit extending from grounded battery through the right-hand alternate contact of relay 21, the normal contact of relay 22 and the winding of slow-to-release relay 23 to ground. Relay 23 energizes and remains in this condition as long as a plug is inserted into jack 20, but the energization of relay 23 at this time has no effect upon the system. After the termination of the impulse, relay 52 remains energized for a definite interval and then releases to open the shunt circuits for relays 54, 56 and 58.

The strength and direction of flow of the current in the impulse circuit passing through relays 200, 201 and 203 is such as to cause the energization of polar relay 201 which in this instance closes its upper contact. Relay 203 is also energized in this circuit and establishes an obvious energizing circuit for slow-to-release relay 214 but the energization of this relay at this time has no effect upon the system. The closure of the upper contact of polar relay 201 establishes a circuit extending from grounded battery, through the resistance 212, the upper contact of relay 201 and the windings of relays 204 and 205 to ground. Relay 205 is marginal and does not energize in this circuit due to the inclusion of the resistance 212, but relay 204 energizes to establish an obvious circuit for filament control relay 319. This relay energizes and locks in a circuit extending from grounded battery through its winding and contact and the contact of relay 320 to ground. The energization of relay 319 connects battery through its left-hand alternate contact to the filaments of telephone repeaters conventionally illustrated at RA and RC associated with lines A and C respectively to render said repeaters effective. Relay 319 remains energized as long as a plug is inserted into any one of the jacks at the terminating offices W and Z, but when all of these plugs are removed relay 320 is energized in a manner to appear in the course of the description to open the locking circuit for relay 319 and thus remove the battery supply from the filaments of the telephone repeaters.

The energization of relay 204 also establishes a circuit extending from grounded battery through the normal contacts of relays 207, 206, and 205 in series, the lower

alternate contact of relay 204 and the left-hand winding of relay 351 to ground. Relay 351 energizes and remains in this condition throughout the duration of the impulse. The energization of relay 351 establishes a circuit extending from grounded battery through the winding of relay 361 and the outer right-hand contact of relay 351 to ground. The energization of relay 351 also establishes a circuit for relay 302 extending from grounded battery through the normal contact of relay 303, the winding of relay 302 and the middle right-hand contact of relay 351 to ground. Relay 302 energizes and disconnects the polar relays 300 and 301 and relay 303 from the simplex conductors included in the lines A and C at office X. The energization of relays 302, 351 and 361 establishes an impulse circuit extending from the positive pole of battery 362, through the outer left-hand contact of relay 351, the left-hand alternate contact of relay 361, the right-hand normal contact of relay 360, the upper alternate contact of relay 302, the simplex conductors included in the physical line C extending between office X and office Y, the upper normal contact of relays 404 and 405, the middle normal contact of relay 406, the upper normal contact of relay 407, the winding of relay 408, the windings of polar relays 401 and 400, the middle normal contact of relay 407, the lower normal contacts of relays 406, 405 and 404, the simplex conductors included in line A extending between offices Y and X, the lower alternate contact of relay 302, the left-hand normal contact of relay 360, the right-hand alternate contact of relay 361, the inner left-hand contact of relay 351 and the resistance 364 to the negative pole of battery 362. At the termination of the impulse relays 302, 351 and 361 release. The direction and strength of flow of current in the circuit just described does not affect polar relay 401, but causes the polar relay 400 to close its left-hand contact whereupon a circuit will be established from grounded battery through the resistance 415, left-hand contact of polar relay 400 and the windings of relays 409 and 410 to ground at the contact of relay 413. Relay 409, being marginal, does not respond to the current flowing through this circuit but relay 410 energizes and closes its alternate contacts. A circuit will then be established from ground through the outer upper alternate contact of relay 410 and the winding of relay 419 to grounded battery. Relay 419 energizes and establishes a locking circuit for itself extending from grounded battery through the winding and right-hand contact of said relay and the contact of relay 420 to ground. In energizing, relay 419 connects battery to its left-hand contact and this battery is extended to the filaments of the telephone repeaters RA1 and RC1 associated with the lines A and C respectively, to render said repeaters effective. The locking circuit for relay 419 will be maintained until relay 420 is energized in a manner to appear in the course of the description, which occurs when all of the plugs are removed from the jacks at the two distant offices.

The current previously referred to, which flows through polar relays 400 and 401, also energizes relay 408 and removes ground from the contact thereof to prevent the operation of any of the relays 404, 405, 406 and 407 during the transmission of the impulse to office Z so that an impulse tranmitted from the latter office during this interval will have no effect upon said relays.

The energization of relay 410, under the control of polar relay 400, establishes a circuit extending from the positive pole of battery 418 through the lower alternate contact of relay 410, the lower normal contact of relay 409, the simplex conductors included in the physical line A extending between office Y and office Z, the lower normal contact of relay 502, the windings of polar relays 501 and 500, the winding of relay 503, the upper normal contact of relay 502, the simplex conductors included in the physical line C extending between office Z and office Y, the upper normal contact of relay 409, the inner upper alternate contact of relay 410, the upper normal contact of relay 412 and the resistance 421 to the negative pole of battery 418. The strength and direction of flow of current in this circuit has no effect upon polar relay 500 but causes polar relay 501 to close its upper contact. Relay 503 also energizes in this circuit and establishes an obvious energizing circuit for relay 514 but the operation of this latter relay has no effect upon the system at this time. The closure of the upper contact of polar relay 501 establishes a circuit extending from grounded battery through resistance 512, the upper contact of relay 501 and the windings of relays 504 and 505 to ground. Relay 505, being marginal, does not respond to the current flowing in this circuit but relay 504 energizes. A circuit is thereupon established extending from grounded battery through the normal contacts of relays 507, 506 and 505 in series, the alternate contact of relay 504 and the lower winding of relay 508 to ground. Relay 508 energizes and locks in a circuit extending from ground through the upper winding and the contact of said relay, and the middle left-hand normal contact of relay 521 to grounded battery. By closing its contact, relay 508 also establishes a circuit from ground through lamp 515, the right-hand normal contact of relay 521, the contact of relay 508, and the middle left-hand normal contact of relay 521 to

grounded battery. Lamp 515 is lighted in this circuit and the operator at office Z observing the condition of this lamp inserts the plug 70 of another link circuit into jack 520. This operation establishes a circuit extending from grounded battery at the link circuit through the winding of relay 71, the sleeve contacts of the plug of said circuit and the jack 520, the winding and inner left-hand normal contact of relay 521 and the winding of slow-to-release relay 522 to ground. Relay 71 energizes but has no effect upon the link circuit. Relays 521 and 522 energize and the energization of the former opens the previously described circuit for lamp 515 which lamp is thereupon extinguished. Relay 521 locks through its winding and middle alternate contact to ground and in energizing opens the circuit for relay 522. This relay being slow to release, however, does not open its alternate contact until after a definite period of time has elapsed and during this time an impulse is transmitted from office Z. Upon the release of said relay, relay 523 is energized through the normal contact of relay 522 and the outer left-hand alternate contact of relay 521. The circuit for this impulse extends from grounded battery, through the alternate contact of relay 522, the left-hand winding of relay 551 and the winding of slow-to-release relay 552 to ground. Relays 551 and 552 energize and the energization of the latter relay in closing its alternate contacts establishes shunt circuits for slow-to-release relays 554, 556, and 558 to prevent the energization thereof during the transmission of the impulse. The energization of relay 551 establishes a circuit extending from grounded battery through the normal contact of relay 503, the winding of relay 502 and the outer right-hand alternate contact of relay 551 to ground. Relay 502 energizes and disconnects polar relays 500 and 501 and the relay 503 from the simplex conductors included in the physical lines at office Z. The energization of relay 551 establishes an impulse circuit extending from the negative pole of battery 562, through the outer left-hand contact of relay 551, the left-hand normal contacts of relays 561 and 560, the upper alternate contact of relay 502, the simplex conductors included in the physical line C extending between office Z and office Y, the upper normal contacts of relays 409, 410, 411 and the middle normal contact of relay 412, the winding of relay 413, the windings of polar relays 402 and 403, the lower normal contact of relay 412, the middle normal contact of relay 411, the lower normal contacts of relays 410 and 409, the simplex conductors included in the physical line A extending between office Y and office Z, the lower alternate contact of relay 502, the right-hand normal contacts of relays 560 and 561 and the inner left-hand contact of relay 551 to the positive pole of battery 562. Relay 413 energizes in this circuit and by removing ground from its contact prevents the energization of any one of the relays 409, 410, 411 and 412 during the transmission of the impulse from office Z through office Y.

The direction of flow and strength of the current in this impulse circuit has no effect upon polar relay 402 but polar relay 403 operates to close its left-hand contact. A circuit is thereupon established extending from grounded battery through the resistance 417, left-hand contact of relay 403, the windings of relays 404 and 405 and the contact of relay 408 to ground. Relay 404, being marginal, does not respond to the current flowing through this circuit, but relay 405 operates to close its alternate contacts. The closure of the lowermost alternate contact of relay 405 establishes an energizing circuit for relay 419, but as this relay is already energized and locked to supply battery to the filaments of the telephone repeaters at office Y the closure of the circuit for relay 419 by the energization of relay 405 has no effect upon the former relay.

The energization of relay 405 under the control of polar relay 403 establishes an impulse circuit extending from the positive pole of battery 418, through the uppermost alternate contact of relay 405, the upper normal contact of relay 404, the simplex conductors included in line C extending between office Y and office X, the upper normal contact of relay 302, the winding of relay 303, the windings of polar relays 300 and 301, the lower normal contact of relay 302, the simplex conductors included in line A extending between office X and office Y, the lower normal contact of relay 404, the inner lower alternate contact of relay 405, the lower normal contact of relay 407 and the resistance 421 to the negative pole of battery 418. The relay 303 energizes in this circuit and establishes an obvious energizing circuit for slow-to-release relay 314, but the energization of this relay has no effect upon the system at this time. The strength and direction of flow of the current in the circuit extending through polar relays 300 and 301 causes the latter relay to close its lower contact, whereupon a circuit is established from grounded battery through the resistance 312, lower contact of relay 301 and the windings of relays 304 and 305 to ground. Relay 305, being marginal, does not respond to the current flowing in this circuit due to the resistance 312, but relay 304 energizes and establishes an obvious energizing circuit for relay 319. This relay is already energized and locked, and therefore the establishment of the new energizing circuit for the

same, has no effect. The energization of relay 304 also establishes a circuit extending from grounded battery through the normal contacts of relays 307, 306, and 305 in series, the lower alternate contact of relay 304, and the right-hand winding of relay 251 to ground. Relay 251 energizes in this circuit and establishes an energizing circuit for relay 202 extending from grounded battery, through the normal contact of relay 203, winding of relay 202 and the middle left-hand contact of relay 251 to ground. The energization of relay 251 also establishes a circuit extending from grounded battery through the winding of relay 259 and the outer left-hand contact of relay 251 to ground. Relays 202 and 259 are energized and the energization of the former relay disconnects the polar relays 200 and 201 from the conductors included in the physical lines A and C at office X. Therefore, upon the energization of relays 202, 251 and 259, an impulse circuit is established from the positive pole of battery 262, through the outer right-hand contact of relay 251, right-hand alternate contact of relay 259, the right-hand normal contact of relay 260, lower alternate contact of relay 202, the simplex conductors included in the line A extending between Fig. 2 and Fig. 1, the lower normal contact of relay 4, windings of polar relays 1 and 2, winding of relay 3, upper normal contact of relay 4, the simplex conductors included in line C extending between Fig. 1 and Fig. 2, upper alternate contact of relay 202, left-hand normal contact of relay 260, left-hand alternate contact of relay 259, inner right-hand contact of relay 251, and resistance 264 to the negative pole of battery 262. Relay 3 is energized in this circuit to establish an obvious energizing circuit for slow-to-release relay 14, but the operation of this latter relay has no effect upon the circuit at this time.

The strength and direction of flow of current in the impulse circuit just described has no effect upon polar relay 2, but cause the polar relay 1 to close its upper contact. A circuit is then established extending from grounded battery, through the resistance 12, the upper contact of polar relay 1 and the windings of relays 5 and 6 to ground. Relay 6, being marginal, does not respond to current flowing in this circuit, but relay 5 operates to close its contact. A circuit is now established extending from grounded battery, through the normal contacts of relays 8, 7 and 6 in series, the contact of relay 5 and the lower winding of relay 9 to ground. Relay 21, being energized, the upper winding of relay 9 is short circuited by the ground at the left-hand alternate contact of relay 21. Relay 9 is energized by the circuit just described for it, but due to the short circuit, this relay will not lock through its winding and contact and therefore will remain energized only throughout the duration of the impulse. Energization of relay 9 establishes a circuit for relay 25, which is normally short circuited through the middle right-hand normal contact of relay 21, extending from grounded battery through the winding of relay 25, the contact of relay 9 and the left-hand alternate contact of relay 21 to ground. Relay 25 energizes and in so doing connects a source of signaling current 26 to the line and link circuit which will give a momentary audible signal to the operator at office W whose listening key 72 is actuated at this time to indicate that the operator at office Z has responded by inserting a plug into jack 520.

At the termination of the conversation on line A the operator at office W may transmit a disconnect signal to the operator at office Z, or during the use of line A may re-ring the operator at the latter office by actuating the ringing key (not shown) of the link circuit connected to jack 20 whereupon a circuit will be established for relay 24 extending from a source of signaling current (not shown) through the tip contacts of the plug 70, jack 20 and the left-hand normal contact of relay 25, the winding of relay 24, the left-hand winding of the repeating coil adjacent the latter relay, the right-hand normal contact of relay 25 and the ring contacts of jack 20 and plug 70 to ground at said ringing key. Relay 24 energizes and establishes an impulse circuit extending from grounded battery through the right-hand alternate contact of relay 21, the normal contact of relay 22 and the left-hand contact of relay 24 where it joins the circuit previously traced for relays 51 and 52. The closure of the right-hand contact of relay 24 short circuits line A and prevents the transmission of the signaling current thereover to office X. Relays 51 and 52 operate to cause the transmission of an impulse from office W through the various offices as previously described, resulting in the energization of relay 508 at office Z. Due to the energization of relay 521 at this time, the upper winding of relay 508 is shunted by the ground at the right-hand alternate contact of relay 521 and therefore relay 508 will not lock through its upper winding and contact, but will remain energized only throughout the duration of the impulse. Operation of relay 508 establishes a circuit for relay 525 extending from grounded battery, through the winding of said relay, the contact of relay 508, and the right-hand alternate contact of relay 521 to ground. Relay 525 energizes and connects a source of signaling current 526 to the link circuit engaged with jack 520 and through the right-hand winding of the bridged relay 73 which thereupon energizes to establish a locking circuit extending from battery

through the right-hand contact of key 72, the contact and left-hand winding of relay 73, the contact of relay 71 and the lamp 74 to ground. Lamp 74 is lighted in this circuit and the operator observing the same, actuates her listening key to ascertain the nature of the call and by so doing opens said locking circuit and extinguishes the lamp 74. If the signal be for disconnect, the plug is then withdrawn from jack 520 and relays 521 and 523 release. Release of relay 523 will have no effect upon the system at this time if it be assumed that lines B and C are in use and relays 531 and 541 are energized.

In the same manner, the operator at office Z may transmit a disconnect signal to the operator at office W by operating the ringing key of the link circuit connected to jack 520 whereupon relay 524 will be operated over an obvious circuit by a source of signaling current associated with said link circuit. The closure of the left-hand contact of relay 524 short circuits the line A and prevents the passage of the signaling current over said line to office Y. The closure of the right-hand contact of relay 524 establishes an impulse circuit extending from grounded battery through the left-hand alternate contact of relay 521, the normal contact of relay 522 and the right-hand contact of relay 524 where it joins the previously traced circuit for relays 551 and 552. These relays operate in the same manner as before to transmit an impulse from office Z through the various other offices to operate relay 9. This relay also has its upper winding short circuited by the ground at the left-hand alternate contact of relay 21, and therefore only remains energized throughout the duration of the impulse. Operation of relay 9 establishes a circuit for relay 25 extending from grounded battery through the winding of said relay, the contact of relay 9 and the left-hand alternate contact of relay 21 to ground. In energizing relay 25 connects the source of signaling current 26 to the link circuit to light the lamp 74 associated therewith in the same manner as previously described. Receiving this signal, the operator may then remove the plug 70 of the link circuit from jack 20 whereupon relays 21 and 23 release. The release of relays 21 and 23 will have no effect upon the system if it be assumed that either of lines B and C or both are in use and relays 31 and 41 kept energized by the plugs engaged with jacks 30 and 40.

Operator at office W initiates a call to office Z over line B.

The operator at office W desiring a connection to office Z over line B inserts a plug 70 of another link circuit into jack 30 and thereby establishes a circuit extending from grounded battery through the winding of relay 71, the sleeve contacts of the plug of said circuit and jack 30, the winding and inner right-hand normal contact of relay 31, the winding of slow-to-release relay 32 to ground. Relay 31 energizes and locks through its winding and middle alternate contact to ground and by energizing opens a circuit for relay 32 which, being slow-to-release, does not open its alternate contact until after a period of time has elapsed sufficient to transmit an impulse from office W. The energization of relay 32 establishes an impulse circuit extending from grounded battery, through the alternate contact of relay 32, the left-hand winding of relay 53 and the winding of slow-to-release relay 54 to ground. Relays 53 and 54 energize and the latter relay in closing its alternate contacts short circuits relays 52, 56 and 58 during the transmission of the impulse from office W. The energization of relay 53 establishes a circuit for relay 4 extending from grounded battery, through the normal contact of relay 3, winding of relay 4 and the outer right-hand alternate contact of relay 53 to ground. The energization of relay 53 also establishes a circuit for relay 61 extending from grounded battery through the winding of said relay, the middle right-hand alternate contact of relay 53 and the left-hand normal contact of relay 52 to ground. The energization of relays 4, 53 and 61 establishes a circuit extending from the negative pole of battery 62, through the outer left-hand alternate contact of relay 53, the left-hand alternate contact of relay 61, the left-hand normal contact of relay 60, the lower alternate contact of relay 4, the simplex conductors included in the physical line A extending between office W and the mechanism of office X shown in Fig. 2, the lower normal contact of relay 202, windings of polar relays 201 and 200, the winding of relay 203, upper normal contact of relay 202, the simplex conductors included in the physical line C extending between Fig. 2 and Fig. 1, the upper alternate contact of relay 4, the right-hand normal contact of relay 60, the right-hand alternate contact of relay 61, and the inner left-hand alternate contact of relay 53 to the positive pole of battery 62. At the termination of the impulse at office W relay 32 releases and establishes an energizing circuit for slow-to-release relay 33 extending from ground, through the winding of relay 33, the normal contact of relay 32, and the right-hand alternate contact of relay 31 to grounded battery. The energization of relay 33 at this time has no effect upon the system since relays 21 and 31 are both energized. Relay 203 is energized in the impulse circuit to establish an obvious energizing circuit for relay 214 but the operation of the relay at this time has no effect upon the system. The strength

and direction of flow of the current through polar relays 201 and 200 is such as to cause the former relay to close its lower contact. A circuit is then established extending from grounded battery, through the lower contact of relay 201 and the windings of relays 204 and 205 to ground. Since the resistance 212 is not included in this circuit, relays 204 and 205 will both energize and the operation of the former relay again establishes the original energizing circuit for relay 319, but inasmuch as this relay is already in a locked condition to supply battery to the filaments of telephone repeaters RA and RC, the establishment of the last energizing circuit for said relay has no effect thereupon. The energization of relay 205 establishes a circuit extending from grounded battery, through the normal contacts of relays 207 and 206, the alternate contact of relay 205, and the right-hand winding of relay 353 to ground. Relay 353 energizes to establish an energizing circuit for relay 302 extending from ground through the outer left-hand contact of relay 353, the winding of relay 302, and normal contact of relay 303 to grounded battery. The energization of relay 353 also establishes an impulse circuit extending from the positive pole of battery 362 through the outer right-hand contact of relay 353, the right-hand normal contact of relay 361, the left-hand normal contact of relay 360, the lower alternate contact of relay 302, the simplex conductors included in line A extending between office X and office Y, the lower normal contacts of relays 404, 405 and 406, the middle normal contact of relay 407, the windings of polar relays 400 and 401, the winding of relay 408, the upper normal contact of relay 407, the middle normal contact of relay 406, the upper normal contacts of relays 405 and 404, the simplex conductors included in the line C extending between office Y and office X, the upper alternate contact of relay 302, the right-hand normal contact of relay 360, the left-hand normal contact of relay 361, the inner right-hand contact of relay 353 and the resistance 364 to the negative pole of battery 362. The strength and direction of flow of current in this circuit again energizes relay 408 to remove ground from its contact to prevent the operation of any of the relays 404, 405, 406 and 407 during the transmission of the impulse. The polar relay 401 does not respond to the current flowing in this circuit but relay 400 operates to close its right-hand contact. A circuit is thereupon established from grounded battery through the right-hand contact of relay 400 and the windings of relays 409 and 410 to ground at the contact of relay 413. Since the resistance 415 is not included in this circuit, both relays 409 and 410 will energize and in the closing of the outer upper alternate contact of relay 410, ground will again be connected to the winding of relay 419, but this relay being already energized and locked the circuit therefor will have no effect upon the relay and the battery supply to the filaments of the telephone repeaters RA1 and RC1 will not be affected.

The energization of relays 409 and 410 establishes a circuit extending from the positive pole of battery 418 through the middle alternate contact of relay 409, the simplex conductors included in physical line C extending between office Y and office Z, the upper normal contact of relay 502, the winding of relay 503, the windings of polar relays 500 and 501, the lower normal contact of relay 502, the simplex conductors included in physical line A extending between office Z and office Y, the lower alternate contact of relay 409, the lower normal contact of relay 411 and the resistance 421 to the negative pole of battery 418. Relay 503 responds to current flowing through this circuit and establishes the previously mentioned circuit for relay 514, but the energization of this relay, at this time, has no effect upon the system. The strength and direction of flow of the current from battery 418, in this instance, has no effect upon polar relay 500 but causes polar relay 501 to energize and close its lower contact whereupon a circuit is established from grounded battery through the lower contact of polar relay 501 and the windings of relays 504 and 505 to ground. Inasmuch as the resistance 512 is not included in this circuit, both of the relays 504 and 505 will energize. A circuit will thereupon be established from grounded battery through the normal contacts of relays 507 and 506, the alternate contact of relay 505 and the lower winding of relay 509 to ground. Relay 509 energizes and locks in a circuit extending from ground through the winding and contact of said relay and the middle left-hand normal contact of relay 531 to grounded battery. The energization of relay 508 establishes a circuit extending from ground through the lamp 517 individual to line B, the right-hand normal contact of relay 531, the contact of relay 509 to grounded battery at the middle left-hand normal contact of relay 531. The circuit extending through the lamp 517 lights the same and the operator at office Z observing the lighted condition of the lamp inserts the plug 70 of another link circuit into the jack 530.

The engagement of the plug with jack 530 establishes a circuit through the sleeve contacts of the plug of said circuit and jack 530, the winding and inner left-hand normal contact of relay 531 and the winding of slow-to-release relay 532 to ground. Relays 531 and 532 energize and the energization of the former opens the previously described

circuit for the lamp 517 which is thereupon extinguished. Relay 531 locks through its winding and middle alternate contact to ground and in energizing opens the circuit for relay 532. This relay being slow to release, however, does not open its alternate contact until after a definite period of time has elapsed which is sufficient to transmit an impulse from office Z. Upon the release of relay 532 at the end of the impulse, relay 533 energizes through the normal contact of relay 532 and the outer left-hand alternate contact of relay 531. This impulse is produced by a circuit extending from grounded battery through the alternate contact of relay 532, the right-hand winding of relay 553 and the winding of slow-to-release relay 554 to ground. Relays 553 and 554 energize and the energization of the latter relay establishes shunt circuits through its alternate contacts for the other slow-to-release relays 552, 556 and 558 so that these latter relays will not be energized during the transmission of the impulse from office Z. The energization of relay 553 establishes a circuit extending from grounded battery through the normal contact of relay 503, the winding of relay 502 and the outer left-hand alternate contact of relay 553 to ground. Relay 502 energizes and disconnects the polar relays 500 and 501 and relay 503 from the conductors connected to the physical lines at office Z. The energization of relay 553 also establishes a circuit for relay 561 extending from grounded battery, through the winding of said relay, the middle left-hand alternate contact of relay 553 and the right-hand normal contact of relay 552 to ground. Relays 553 and 561 being now energized throughout the duration of the impulse a circuit is established extending from the negative pole of battery 562 through the outer right-hand alternate contact of relay 553, the right-hand alternate contact of relay 561, the right-hand normal contact of relay 560, the lower alternate contact of relay 502, the simplex conductors included in line A extending between offices Z and Y, the lower normal contacts of relays 409 and 410, the middle normal contact of relay 411, the lower normal contact of relay 412, the windings of polar relays 403 and 402, the winding of relay 413, the middle normal contact of relay 412, the upper normal contacts of relays 411, 410 and 409, the simplex conductors included in line C extending between offices Y and Z, the upper alternate contact of relay 502, the left-hand normal contact of relay 560, the left-hand alternate contact of relay 561 and the inner left-hand alternate contact of relay 553 to the positive pole of battery 562. Relay 413 energizes in this circuit and thereby prevents the energization of either of the relays 409, 410, 411 and 412 during the transmission of this impulse from office Y.

The strength and direction of flow of current through the circuit above described is such as to cause polar relay 403 to close its right-hand contact. A circuit is thereupon established extending from grounded battery through the right-hand contact of polar relay 403 and windings of relays 404 and 405 to ground at the contact of relay 408. Inasmuch as the resistance 417 is not included in this circuit, both relays 404 and 405 will energize and relay 405 in closing its lowermost alternate contact establishes an obvious energizing circuit for relay 419, but this latter relay having been already energized and locked, the establishment of the above mentioned circuit has no effect upon the relay. The energization of relays 404 and 405 establishes an impulse circuit extending from positive pole of battery 418 through the middle alternate contact of relay 404, the simplex conductors included in line A extending between offices Y and X, the lower normal contact of relay 302, the windings of polar relays 301 and 300, the winding of relay 303, the upper normal contact of relay 302, the simplex conductors included in line C extending between offices X and Y, the upper alternate contact of relay 404, the upper normal contact of relay 406 and the resistance 421 to the negative pole of battery 418. Relay 303 energizes in this circuit and establishes an obvious energizing circuit for relay 314 but the operation of this relay has no effect upon the system at this time.

The strength and direction of flow of current in the impulse circuit above described is such as to cause polar relay 301 to close its upper contact. A circuit is then established extending from grounded battery through the lower contact of polar relay 301 and the windings of relays 304 and 305 to ground. Since the resistance 312 is not included in this circuit relays 304 and 305 both respond to the current flowing in this circuit and relay 304 again closes an obvious circuit for relay 319 which is already energized and locked to supply battery to the filaments of repeaters RA and RC. The energization of relay 305 establishes a circuit extending from grounded battery through the normal contacts of relays 307 and 306, the lower alternate contact of relay 305 and the left-hand winding of relay 253 to ground. Relay 253 energizes in this circuit and establishes a circuit for relay 202 extending from ground through the outer right-hand alternate contact of relay 253, the winding of relay 202, and the normal contact of relay 203 to grounded battery. Relay 202 energizes and disconnects polar relays 200 and 201 and relay 203 from the conductors included in the physical lines at office X. The energization

of relay 253 also establishes an impulse circuit extending from the positive pole of battery 262 through the outer left-hand alternate contact of relay 253, the left-hand normal contacts of relays 259 and 260, the upper alternate contact of relay 202, the simplex conductors included in line C extending between Figs. 2 and 1, the upper normal contact of relay 4, the winding of relay 3, the windings of polar relays 2 and 1, the lower normal contact of relay 4, the simplex conductors included in the line A extending between Figs. 1 and 2, the lower alternate contact of relay 202, the right-hand normal contacts of relays 260 and 259, the inner left-hand alternate contact of relay 253 and the resistance 264 to the negative pole of battery 262. Relay 3 energizes in this circuit and establishes an obvious circuit for relay 14 but the operation of this relay has no effect upon the system at this time.

The strength and direction of flow of the current in the impulse circuit just described is such as to cause polar relay 1 to close its lower contact whereupon a circuit will be established from grounded battery through the lower contact of polar relay 1 and the windings of relays 5 and 6 to ground. Relays 5 and 6 energize owing to the fact that resistance 12 is not included in the circuit and the energization of relay 6 establishes a circuit for relay 10 extending from grounded battery, through the normal contacts of relays 8 and 7, the alternate contact of relay 6 and the lower winding of relay 10 to ground. Relay 10 energizes, but inasmuch as the relay 31 is now energized the upper winding of relay 10 is short circuited by the ground at the left-hand alternate contact of relay 31 and consequently relay 10 will only remain energized throughout the duration of the impulse and will not lock through its upper winding and contact. The energization of relay 10 establishes a circuit for relay 35 extending from grounded battery, through the winding of said relay, contact of relay 10 and the left-hand alternate contact of relay 31 to ground. Relay 35 energizes and throughout the duration of the impulse connects a source of signaling current 36 to the line and link circuit connected to jack 30. The operator at office W, having her listening key actuated at this time, will receive a momentary audible signal which will indicate that the operator at office Z has responded by inserting a plug into jack 530 and conversation may now proceed between the operators over the phantom line B.

At the termination of the conversation over line B the operator at office W may transmit a disconnect signal to the operator at office Z, or during conversation over line B, may re-ring the latter operator by actuating the ringing key of the link circuit connected to jack 30 which will establish a circuit extending from a source of signaling current through the tip contacts of the plug of the link circuit and jack 30, the left-hand normal contact of relay 35, the winding of relay 34, the left-hand winding of the repeating coil adjacent to relay 34, the right-hand normal contact of relay 35, and the ring contacts of jack 30 and plug 70 to ground at said ringing key. Relay 34 energizes and in closing its right-hand contact short circuits the line B and therefore prevents the transmission of the signaling current through the repeating coil associated with said line. The energization of relay 34 establishes an impulse circuit extending from grounded battery, through the right-hand alternate contact of relay 31, the normal contact of relay 32 and the left-hand contact of relay 34, where the circuit joins the previously described impulse circuit for relays 53 and 54. The impulse sending mechanisms at the various offices now operate in the same manner as described in connection with the initiation of a call on line B at office W with the following exception: When relay 509 energizes in response to the operation of marginal relay 505, relay 531 being now energized, the upper winding of relay 509 is short circuited by the ground at the right-hand alternate contact of relay 531 and relay 509 therefore only remains energized throughout the duration of the impulse. The energization of relay 509 establishes a circuit extending from grounded battery, through the winding of relay 535, the contact of relay 509 and the right-hand alternate contact of relay 531 to ground. Relay 535 responds to the current flowing through this circuit and connects the source of signaling current 536 to the line B and the link circuit engaged by jack 530 and this signaling current will operate relay 73 to light lamp 74. The operator responds by actuating the listening key 72 which extinguishes lamp 74 and upon ascertaining that disconnection is desired, withdraws the plug from jack 530 and relays 531 and 533 release. Release relay 533 has no effect upon the system at this time assuming that relay 541 is still energized.

Likewise, the operator at office Z may transmit a disconnect signal to or re-ring the operator at office X by the operation of the ringing key of the link circuit engaged in jack 530. This will cause the energization of relay 534 which in closing its left-hand contact short circuits the line B and prevents the transmission of this signaling current over said line. The energization of relay 534 closes an impulse circuit extending from grounded battery through the left-hand alternate contact of relay 531, normal contact of relay 532 and the right-hand contact of relay 534 where it joins the impulse circuit previously described which extends

through the windings of relays 553 and 554. These relays operate as before to transmit the signal from office Z to office Y where the same is repeated through to offices X and W. Relay 10 is again energized to cause the operation of relay 35 in the same manner as previously described and the source of signaling current 36 is again connected to the link circuit engaged with jack 30. In the same manner as previously set forth, lamp 74 is lighted and extinguished and the operator withdraws the plug from the jack.

Operator at office W initiates a call to office Z over line C.

The operator at office W desiring a connection to office Z over line C inserts a plug 70 of another link circuit into jack 40 whereupon a circuit is established extending from battery at the link circuit, through the winding of relay 71, the sleeve contacts of the plug 70 and jack 40, the winding and inner right-hand normal contact of relay 41 and the winding of slow-to-release relay 42 to ground. Relay 71 energizes in this circuit but its operation has no effect. Relays 41 and 42 energize in said circuit and relay 41 locks through its winding and middle alternate contact to ground. The energization of relay 41 opens the energizing circuit for relay 42, but this relay being slow to release does not open its alternate contact until a sufficient time has elapsed for the transmission of the impulse from office W. The energization of relay 42 establishes a circuit extending from grounded battery through the alternate contact of relay 42, the left-hand winding of relay 55 and the winding of slow-to-release relay 56 to ground. Relays 55 and 56 energize and the latter relay in closing its alternate contacts short circuits relays 52, 54 and 58 so as to prevent the operation of these relays during the transmission of the impulse from office W. The energization of relay 55 establishes a circuit extending from grounded battery through the normal contact of relay 3, winding of relay 4, the outer right-hand alternate contact of relay 55 to ground. Relay 4 energizes to disconnect the polar relays 1 and 2 from the simplex conductors connected to the physical lines extending from office W. The energization of relay 55 also establishes an energizing circuit for relay 60 extending from grounded battery, through the winding of relay 60, the middle right-hand alternate contact of relay 55, the right-hand normal contact of relay 51 and the normal contact of relay 53 to ground. Relay 60 is energized and relay 55 also being energized, an impulse circuit is established extending from the positive pole of 120-volt battery 63 through the outer left-hand alternate contact of relay 55, the left-hand normal contact of relay 59, the middle alternate contact of relay 60, lower alternate contact of relay 4, the simplex conductors included in line A extending between Fig. 1 and Fig. 2, the lower normal contact of relay 202, the windings of polar relays 201 and 200, the winding of relay 203, the upper normal contact of relay 202, the simplex conductors included in line C extending between Fig. 2 and Fig. 1, the upper alternate contact of relay 4, the right-hand alternate contact of relay 60, the right-hand normal contact of relay 59 and the inner left-hand alternate contact of relay 55 to the negative pole of battery 63. This impulse circuit is maintained throughout the energization of relay 42 and upon the release of this relay, relays 55 and 56 deenergize. The release of relay 42 establishes an energizing circuit for relay 43 extending from grounded battery through the right-hand alternate contact of relay 41, the normal contact of relay 42, and the winding of relay 43 to ground. The energization of relay 43 at this time has no effect upon the system assuming that relays 21, 31 and 41 are now all energized.

The current flowing through the impulse circuit just described energizes relay 203 to establish an obvious energizing circuit for relay 214, but the operation of this relay has no effect upon the system at this time. The strength and direction of flow of current through polar relays 201 and 202 is such as to cause both of the polar relays to close their upper contacts. A circuit is then established extending from grounded battery, through the resistance 212, the upper contact of relay 201, the windings of relays 204 and 205. Resistance 212 being in the circuit, relay 205 does not respond to the current flowing therein. Another circuit is established from grounded battery, through the resistance 213, the upper contact of polar relay 200 and the windings of relays 206 and 207. The relay 207, being marginal, does not respond to the current flowing in this circuit due to the resistance 213. Therefore, relays 204 and 206 are now energized. A circuit is now established extending from grounded battery, through the normal contact of relay 207, the lower alternate contact of relay 206 and the left-hand winding of relay 355 to ground. Relay 355 energizes to establish a circuit for relay 302 extending from ground through the middle right-hand alternate contact of relay 355, winding of relay 302 and the normal contact of relay 303 to ground. Relay 302 energizes to disconnect polar relays 300 and 301 from the simplex conductors included in the physical lines at office X. The energization of relay 355 also establishes a circuit for relay 360 extending from grounded battery, through the winding of relay 360 and the outer right-hand alternate contact of

relay 355 to ground. Relays 302, 355 and 360 now being energized, an impulse circuit is established extending from the negative pole of battery 363, through the outer left-hand alternate contact of relay 355, the left-hand normal contact of relay 359, the left-hand alternate contact of relay 360, the lower alternate contact of relay 302, the simplex conductors included in line A extending between office X and office Y, the lower normal contacts of relays 404, 405 and 406, the middle normal contact of relay 407, the windings of polar relays 400 and 401, the winding of relay 408, the upper normal contact of relay 407, the middle normal contact of relay 406, the upper normal contacts of relays 405 and 404, the simplex conductors included in line C extending between office Y and office X, the upper alternate contact of relay 302, the right-hand alternate contact of relay 360, the right-hand normal contact of relay 359, and the inner left-hand alternate contact of relay 355 to the positive pole of battery 363.

The current flowing in this circuit again energizes relay 408 to remove ground from its contact to prevent the energization of any of the relays 404, 405, 406 and 407 during the transmission of this impulse. The strength and direction of flow of current in this circuit is such as to cause polar relays 400 and 401 to close their left-hand contacts. A circuit is then established from grounded battery through the resistance 414 and the windings of relays 411 and 412 to ground at the relay 413. Relay 411, being marginal, does not energize but relay 412 operates to close its alternate contacts. Another circuit is established from grounded battery through the resistance 415 and the windings of relays 409 and 410 to ground at the relay 413. Relay 409 being marginal, does not respond to the current flowing in this circuit, but relay 410 energizes. A condition then exists wherein relays 410 and 412 are energized and ground at the uppermost alternate contact of relay 410 and at the middle upper alternate contact of relay 412 is connected to relay 419, but, as before explained, this relay is energized and locked and the new circuit therefore has no effect thereupon. The energization of relays 410 and 412 establishes a circuit extending from the positive pole of battery 418, the lower alternate contact of relay 410, the lower normal contact of relay 409, the simplex conductors included in line A extending between office Y and office Z, the lower normal contact of relay 502, the windings of polar relays 501 and 500, the winding of relay 503, the upper normal contact of relay 502, the simplex conductors included in line C extending between office Z and office Y, the upper normal contact of relay 409, the inner upper alternate contact of relay 410 and the outer upper alternate contact of relay 412 to the negative pole of battery 418. Relay 503 is energized in this circuit to again establish an energizing circuit for relay 511, but the energization of the latter relay has no effect upon the system at this time. Polar relays 500 and 501 both respond to the current flowing in this circuit from battery 418 and operate to close their upper contacts. A circuit is then established from grounded battery through resistance 512, the upper contact of polar relay 501 and the windings of relays 504 and 505 to ground. Relay 505 does not energize in this circuit but relay 504 operates to close its contact. Another circuit is established from grounded battery through resistance 513, the upper contact of polar relay 500 and the windings of relays 506 and 507 to ground. Relay 507, being marginal, does not energize in this circuit but relay 506 operates to close its alternate contact whereupon a circuit is established from grounded battery through the contact of relay 507, the alternate contact of relay 506 and the lower winding of relay 510 to ground. It will be obvious that the energization of relay 504 has no effect upon relay 508 since the energizing circuit previously traced for this relay is opened at the normal contact of relay 506. Relay 510 energizes in the circuit traced therefor and locks from ground through the winding and contact of said relay and the middle left-hand normal contact of relay 541 to grounded battery. The energization of relay 510 establishes a circuit extending from ground through the lamp 519, the right-hand normal contact of relay 541 and the contact of relay 510 to grounded battery at the inner left-hand normal contact of relay 541. Lamp 519 is lighted in this circuit and the operator at office Z observing the lighted condition of the lamp inserts the plug of another link circuit into the jack 540.

The engagement of a plug with jack 540 establishes an energizing circuit for relays 541 and 542 extending from grounded battery at the link circuit, through the winding of relay 71, the sleeve contacts of the plug 70 and jack 540, the winding and inner left-hand normal contact of relay 541 and the winding of relay 542 to ground. The energization of relay 541 opens the circuit for lamp 519 and also breaks the energizing circuit for relay 542. The latter relay being slow to release does not open its alternate contact until a sufficient time has elapsed to transmit a signaling impulse from office Z. The circuit for this impulse now extends from grounded battery, through the alternate contact of relay 542, the right-hand winding of relay 555 and the winding of slow-to-release relay 556 to ground. The energization of the latter relay establishes, through its alternate contacts, short circuits

for the other slow-to-release relays 552, 554 and 558 to prevent these relays from energizing during the transmission of the impulse from office Z. In energizing, relay 555, establishes a circuit for relay 502 extending from grounded battery through the normal contact of relay 503, the winding of relay 502 and the outer left-hand alternate contact of relay 555 to ground. Relay 502 energizes and as before disconnects polar relays 500 and 501 from the conductors included in the physical lines at office Z. The energization of relay 555 also establishes a circuit for relay 560 extending from grounded battery through the winding of said relay, the middle left-hand alternate contact of relay 555, the left-hand normal contact of relay 551 and the normal contact of relay 553 to ground. Relays 555 and 560 now being energized, an impulse circuit is established extending from the positive pole of battery 563, through the outer right-hand alternate contact of relay 555, the right-hand normal contact of relay 559, the middle alternate contact of relay 560, the lower alternate contact of relay 502, the simplex conductors included in line A extending between offices Z and Y, the lower normal contacts of relays 409 and 410, the middle normal contact of relay 411, the lower normal contact of relay 412, the windings of polar relays 403 and 402, the winding of relay 413, the middle normal contact of relay 412, the upper normal contacts of relays 411, 410 and 409, the simplex conductors included in line C extending between offices Y and Z, the upper alternate contact of relay 502, the left-hand alternate contact of relay 560, the left-hand normal contact of relay 559, and the inner right-hand alternate contact of relay 555 to the negative pole of battery 563. Relay 413 is energized in this circuit and removes ground from its contact to prevent the energization of any of the relays 409, 410, 411 and 412 during the transmission of the impulse through office Y. At the termination of the impulse at office Z, relay 542 releases and establishes an energizing circuit for relay 543 extending through the normal contact of relay 542 and the left-hand alternate contact of relay 541.

The strength and direction of flow of current in the impulse circuit just described is such as to cause the polar relays 402 and 403 to close their left-hand contacts. A circuit is then established from grounded battery, through the resistance 417, the left-hand contact of polar relay 403, the windings of relays 404 and 405 and the contact of relay 408 to ground. Relay 404, being marginal, does not respond to the current flowing through this circuit, but relay 405 operates. Another circuit is established extending from grounded battery, through the resistance 416, the left-hand contact of polar relay 402 and the windings of relays 406 and 407 to ground at the contact of relay 408. Relay 406, being marginal, does not energize in this circuit, but relay 407 operates. A condition now exists in which relays 405 and 407 are operated, hence an impulse circuit is established extending from the positive pole of battery 418, through the upper alternate contact of relay 405, the upper normal contact of relay 404, the simplex conductors included in line C extending between offices Y and X, the upper normal contact of relay 302, the winding of relay 303, the windings of polar relays 300 and 301, the lower normal contact of relay 302, the simplex conductors included in line A extending between offices X and Y, the lower normal contact of relay 404, the inner lower alternate contact of relay 405 and the lowermost alternate contact of relay 407 to the negative pole of battery 418.

Relay 303 responds to the current flowing through the above described impulse circuit and in operating establishes an energizing circuit for relay 314, but the operation of this relay has no effect upon the system at this time. The strength and direction of the flow of current through said impulse circuit is such as to cause polar relays 300 and 301 to close their lower contacts. Obvious circuits are now established for relays 304, 305, 306 and 307 through resistances 312 and 313. Relays 305 and 307, being marginal, do not operate in said circuits due to the inclusion of said resistance therein. The operation of relay 306 establishes a circuit extending from grounded battery, through the normal contact of relay 307, the lower alternate contact of relay 306 and the right-hand winding of relay 255 to ground. Relay 255 energizes and establishes an obvious circuit through its middle left-hand alternate contact for relay 202 which operates and disconnects polar relays 200 and 201 from the conductors included in the physical lines at office X. The operation of relay 255 also establishes an energizing circuit for relay 260 extending from grounded battery, through the winding of said relay and the outer left-hand alternate contact of relay 255 to ground. Relays 255 and 260 now being energized, an impulse circuit is established extending from the positive pole of battery 263, through the outer right-hand alternate contact of relay 255, the right-hand normal contact of relay 261, the right-hand alternate contact of relay 260, the lower alternate contact of relay 202, the simplex conductors included in line A extending between Figs. 2 and 1, the lower normal contact of relay 4, the windings of polar relays 1 and 2 and relay 3, the upper normal contact of relay 4, the simplex conductors included in line C extending between Figs. 1 and 2, the upper alternate contact of relay 202, the left-

hand alternate contact of relay 260, the left-hand normal contact of relay 261 and the inner right-hand alternate contact of relay 255 to the negative pole of battery 263.

Relay 3 energizes in the circuit just described and again establishes the energizing circuit for relay 14, the operation of which has no effect upon the system at this time. The strength and direction of flow of the current in the impulse circuit just described causes polar relays 1 and 2 to close their upper contacts. Obvious circuits are thereby closed through resistances 12 and 13 for relays 5, 6, 7 and 8, but relays 6 and 8, being marginal, do not respond to the current flowing therethrough. The operation of relay 7 establishes a circuit extending from grounded battery through the normal contact of relay 8, the alternate contact of relay 7 and the lower winding of relay 11 to ground. Relay 11 energizes, but does not lock through its upper winding and contact since relay 41 is now operated and ground is connected to the left-hand alternate contact thereof to shunt said upper winding. The energization of relay 11, however, closes a circuit extending from grounded battery through the winding of relay 45, the contact of relay 11 and the left-hand alternate contact of relay 41 to ground. The energization of relay 45 connects a source of signaling current 46 to the link circuit engaged with jack 40 and the operator at office W receives an audible signal which lasts throughout the energization of relays 11 and 45.

At the termination of the conversation over line C, the operator at office W may transmit a disconnect signal to the operator at office Z or she may re-ring the latter operator during conversation by operating the ringing key of the link circuit connected with jack 40 and thereby cause the energization of relay 44 through an obvious circuit. Relay 44 in closing its right-hand contact short circuits the line C and prevents the transmission of the signaling impulse thereover to office Y. The closure of the left-hand contact of relay 44 establishes an impulse circuit extending from grounded battery through the right-hand alternate contact of relay 41, the normal contact of relay 42, and the left-hand contact of relay 44 where it joins the circuit previously described for relays 55 and 56. These latter relays operate as previously set forth to cause the transmission of an impulse through the various offices to operate relay 510. The operation of relay 510 results in the connection of the source of signaling current 546 to the link circuit engaged with jack 540 to light the lamp 74 in the same manner as described in connection with the application of signaling current to lines A and B. The operator at office Z answering the signal, then listens in on the line and if disconnection is desired, withdraws the plug from jack 540. Withdrawal of the plug causes the release of relays 541 and 543 with a result that will presently be described.

The operator at office Z may also transmit a disconnect or re-ring signal to operator at office X by the operation of the ringing key of the link circuit connected with jack 540 which causes the energization of relay 544. Line C is again short-circuited by the energization of relay 544 and an impulse circuit is established extending from grounded battery, through the left-hand alternate contact of relay 541, the normal contact of relay 542 and the right-hand contact of relay 544 where it joins the previously described energizing circuit for relays 551 and 552. An impulse is consequently transmitted from office Z through the other offices to again energize relay 11, which results in the application of signaling current from the source 46 to the link circuit connected with jack 40 in the same manner as previously described to light the lamp 74. The operator at office W then removes the plug from jack 40 causing relays 41 and 43 to release.

Restoration of repeaters when all lines are idle.

At the termination of the call on line C in the instance where the operator at office W transmits a disconnect signal to office Z and then removes the plug from jack 40 to release relays 41 and 43, assuming that the other lines are idle, the following operation takes place to restore the telephone repeaters to normal.

Upon the release of relay 41, an impulse circuit is established extending from grounded battery through the contact of relay 43, this relay being slow to release, the outer right-hand normal contacts of relays 21, 31 and 41 in series, the right-hand winding of relay 57 and the winding of slow-to-release relay 58 to ground. Relays 57 and 58 energize and the latter relay in closing its alternate contacts short circuits the windings of the other slow-to-release relays 52, 54 and 56 and prevents operation of these relays should another impulse be started at office W simultaneously with the impulse utilized to restore the repeaters. The energization of relay 57 establishes a circuit extended from grounded battery through the normal contact of relay 3, the winding of relay 4, and the outermost left-hand alternate contact of relay 57, to ground. Relay 4 energizes and disconnects polar relays 1 and 2 and relay 3 from the conductors included in the physical lines at office W. The energization of relay 57 also establishes a circuit extending from grounded battery through the winding of relay 59, the next to the innermost left-hand alternate contact of relay 57, and the right-hand normal contact of relay 56, to ground. Another

circuit is established by the energization of relay 57, extending from grounded battery through the winding of relay 60, the next to the outermost left-hand alternate contact of relay 57, the right-hand normal contact of relay 51 and the normal contact of relay 53 to ground. Relays 59 and 60 energize in the respective circuits therefor and the energization of these relays establishes an impulse circuit extending from the positive pole of battery 63 through the outer right-hand alternate contact of relay 57, the right-hand alternate contacts of relays 59 and 60, the upper alternate contact of relay 4, the simplex conductors included in line C extending between Figs. 1 and 2, the upper normal contact of relay 202, the windings of relay 203 and polar relays 200 and 201, the lower normal contact of relay 202, the simplex conductors included in line A extending between Figs. 2 and 1, the lower alternate contact of relay 4, the middle alternate contact of relay 60, the left-hand alternate contact of relay 59 and the inner right-hand alternate contact of relay 57 to the negative pole of battery 63.

Relay 203 is energized in this circuit and establishes an obvious energizing circuit for the slow-to-release relay 214, but the operation of this relay at this time has no effect upon the system. The strength and direction of flow of current in the impulse circuit just described, is such as to cause polar relays 200 and 201 to close their lower contacts. One circuit is thereupon established from grounded battery through the lower contact of polar relay 201 and the windings of relays 204 and 205 to ground, and both of the latter relays energize in this circuit. Another circuit is established from grounded battery through the lower contact of polar relay 200 and the windings of relays 206 and 207 to ground, whereupon both of these relays energize. The energization of relay 207 establishes a circuit extending from grounded battery through the alternate contact of relay 207 and the right-hand winding of relay 557 to ground. Relay 357 is energized and closes a circuit for relay 302 extending from grounded battery through the normal contact of relay 303, the winding of relay 302 and the next to the innermost left-hand alternate contact of relay 357 to ground. Relay 302 energizes and disconnects the polar relays 300 and 301 from the conductors included in the physical lines A and C at office X. The energization of rela, 357 also establishes a circuit for relay 359 extending from grounded battery through the winding of said relay and the outermost left-hand alternate contact of relay 357 to ground. Relay 360 is also energized by the operation of relay 357 over a circuit extending from grounded battery through the winding of relay 360 and the next to the outermost left-hand alternate contact of relay 357 to ground. Relays 302, 357, 359 and 360 now being energized, an impulse circuit is established extending from the negative pole of battery 363 through the outer right-hand alternate contact of relay 357, the right-hand alternate contacts of relays 359 and 360, the upper alternate contact of relay 302, the simplex conductors included in line C extending between offices X and Y, the upper normal contacts of relays 404 and 405 and middle normal contact of relay 406, the upper normal contact of relay 407, the winding of relay 408, the windings of polar relays 401 and 400, the middle normal contact of relay 407, the lower normal contacts of relays 406, 405 and 404, the simplex conductors included in line A extending between offices Y and X, the lower alternate contact of relay 302, the left-hand alternate contacts of relays 360 and 359, and the inner right-hand alternate contact of relay 357 to the positive pole of battery 363.

Relay 408 energizes in the circuit just described and removes ground from its contact to prevent the energization of any of the relays 404, 405, 406 and 407 during the transmission of the impulse through office Y. The strength and direction of flow of the current through the impulse circuit just described is such as to cause polar relays 400 and 401 to close their right-hand contacts. One circuit is thereby established extending from grounded battery through the right-hand contact of polar relay 400, the windings of relays 409 and 410 and the contact of relay 413 to ground. Inasmuch as the resistance 415 is not included in this circuit, relays 409 and 410 will both energize. Another circuit is established extending from grounded battery through the right-hand contact of polar relay 401 and the windings of relays 411 and 412 to ground, at the contact of relay 413. Relays 411 and 412 both energize in this circuit to establish a circuit for relay 420 extending from grounded battery through the winding of said relay, the lower alternate contact of relay 412, the upper alternate contact of relay 411, the middle upper alternate contact of relay 410, and the upper alternate contact of relay 409 to ground. Relay 420 energizes in this circuit and in so doing opens the locking circuit for relay 419 which thereupon releases to disconnect the battery supply from the filaments of the telephone repeaters RA1 and RC1 associated with the lines A and C at office Y. The energization of relays 409, 410, 411 and 412 establishes an impulse circuit extending from the positive pole of battery 418 through the middle alternate contact of relay 409, simplex conductors included in line C extending between offices Y and Z, the upper normal contact of

relay 502, the winding of relay 503, the windings of polar relays 500 and 501, the lower normal contact of relay 502, the simplex conductors included in line A extending between offices Z and Y and the lower alternate contacts of relays 409 and 411 to negative pole of battery 418.

Relay 503 energizes in this circuit and establishes an obvious circuit for slow-to-release relay 514, but the operation of this relay at this time has no effect upon the system. The strength and direction of flow of the impulse circuit just described causes the energization of polar relays 500 and 501 and the closure of their lower contacts. One circuit is thereby established extending from grounded battery through the lower contact of polar relay 501 and the windings of relays 504 and 505. Another circuit is established from grounded battery through the lower contact of polar relay 500 and the windings of relays 506 and 507 to ground. Since the resistances 512 and 513 are not included in these circuits, the relays 504, 505, 506 and 507 are energized and the energization of the latter relay disconnects the battery from the normal contact thereof so that neither of the relays 508, 509 or 510 will be energized and consequently no signaling impulse will be transmitted to the operator at office Z.

Upon the removal of the plug from jack 540 at office Z in response to the disconnect signal transmitted by the operator at office W over line C, relays 541 and 543 are released. Relay 543 being slow to release establishes an impulse circuit upon the restoration of relay 541 which extends from grounded battery through the contact of relay 543, the outer left-hand normal contacts of relays 521, 531 and 541 in series, the left-hand winding of relay 557 and the winding of relay 558 to ground. Relays 557 and 558 energize and the latter relay in closing its alternate contacts shunts the windings of relays 552, 554 and 556 to prevent the operation of these relays during the transmission of the impulse from office Z. The energization of relay 557 establishes a circuit for relay 502 extending from grounded battery through the normal contact of relay 503, the winding of relay 502 and the outermost right-hand alternate contact of relay 557 to ground. Relay 502 energizes and disconnects the polar relays 500 and 501 from the conductors included in the physical lines at office Z. The energization of relay 557 also establishes a circuit for relay 559 extending from grounded battery through the winding of said relay, the next to the innermost right-hand alternate contact of relay 557 and the left-hand normal contact of relay 556 to ground. A circuit for relay 560 is also established by the operation of relay 557 extending from grounded battery through the winding of relay 560, the next to the outer-most right-hand alternate contact of relay 557, the left-hand normal contact of relay 551 and the normal contact of relay 553 to ground. Relays 502, 557, 559 and 560 being energized, an impulse circuit is established extending from the positive pole of battery 563 through the outer left-hand alternate contact of relay 557, the left-hand alternate contacts of relays 559 and 560, the upper alternate contact of relay 502, simplex conductors included in line C extending between offices Z and Y, the upper normal contacts of relays 409, 410 and 411, the middle normal contact of relay 412, the winding of relay 413, the windings of polar relays 402 and 403, the lower normal contact of relay 412, the middle normal contact of relay 411, the lower normal contacts of relays 410 and 409, simplex conductors included in line A extending between offices Y and Z, the lower alternate contact of relay 502, the middle alternate contact of relay 560, the right-hand alternate contact of relay 559 and the inner left-hand alternate contact of relay 557 to the negative pole of battery 563.

Relay 413 is energized in this impulse circuit to remove ground from its contact and consequently prevent the energization of any of the relays, 409, 410, 411 and 412, during the transmission of the impulse through office Y. The strength and direction of flow of the current in the impulse circuit is such as to cause the operation of polar relays 402 and 403 and the closure of their right-hand contacts. Circuits are thereby established from grounded battery through the right-hand contacts of polar relays 402 and 403 and the windings of relays 404, 405, 406 and 407 to ground at the contact of relay 408. Relays 404, 405, 406 and 407 energize in these circuits to again cause the operation of relay 420, but this operation of said relay has no effect upon the system, since relay 419 has already been released to disconnect the battery from the telephone repeaters at office Y. The energization of relays 404, 405, 406 and 407, however, establishes an impulse circuit extending from the positive pole of battery 418 through the middle alternate contact of relay 404, the simplex conductors included in line A extending between offices Y and X, the lower normal contact of relay 302, the windings of polar relays 301 and 300 and relay 303, the upper normal contact of relay 302, the simplex conductors included in line C extending between offices X and Y, and the upper alternate contacts of relays 404 and 406 to the negative pole of battery 418.

Relay 303 responds to the current flowing through this circuit and establishes an energizing circuit for slow-to-release relay

314, but the operation of this relay has no effect upon the system at this time. The strength and direction of flow of the current through the impulse circuit just described is such as to cause polar relays 300 and 301 to close their upper contacts, whereupon circuits are established extending from grounded battery through the lower contacts of polar relays 300 and 301 and the windings of relays 304, 305, 306 and 307 to ground. All of the latter relays energize in these circuits, and in so doing establish a circuit for relay 320 extending from grounded battery through the winding of said relays, and the upper alternate contacts of relays 304, 305, 306 and 307 to ground. Relay 320 energizes and opens the locking circuit for relay 319, which in releasing, disconnects the battery from the filaments of the telephone repeaters RA and RC associated with the lines A and C at office X, and thus causes the restoration of these repeaters to their normal condition. The energization of relay 307 establishes a circuit extending from grounded battery through the lower alternate contact of said relay and the left-hand winding of relay 257 to ground. Relay 257 is energized to establish a circuit extending from ground through the next to the innermost right-hand alternate contact of said relay, the winding of relay 202, and the normal contact of relay 203 to grounded battery. Other obvious circuits are established, by the energization of relay 257, for relays 260 and 261. Relays 202, 257, 260 and 261 being now energized, an impulse circuit is established which extends from the positive pole of battery 263, through the outer left-hand alternate contact of relay 257, the left-hand alternate contacts of relays 261 and 260, the upper alternate contact of relay 202, the simplex conductors included in line C extending between Figs. 2 and 1, the upper normal contact of relay 4, the winding of relay 3, the windings of polar relays 2 and 1, the lower normal contact of relay 4, the simplex conductors included in line A extending between Fig. 1 and 2, the lower alternate contact of relay 202, the right-hand alternate contacts of relays 260 and 261 and the inner left-hand alternate contact of relay 257 to the negative pole of battery 263.

Relay 3 responds to the current flowing through this circuit and establishes an obvious energizing circuit for relay 14, the operation of which has no effect upon the system at this time. The strength and direction of flow of the current in the impulse circuit including polar relays 1 and 2 causes these relays to close their lower contacts, whereupon circuits are established from grounded battery through the lower contacts of polar relays 1 and 2 and the windings of relays 5, 6, 7 and 8 to ground. All of the latter relays energize and relay 8, by removing battery from its normal contact, will prevent the operation of either of the relays 9, 10 or 11 and consequently the operation of either of the lamps 15, 17 or 19. The telephone repeaters associated with the physical lines at offices X and Y are now restored to their normal conditions and the apparatus at the various offices is also at normal.

Two calls initiated simultaneously at office W.

The jacks or other terminals at offices W and Z are preferably multipled in any well known manner and it will therefore be apparent that two or more calls may be initiated simultaneously on the several lines, or in other words, the time intervals required to transmit impulses from the offices may overlap in which event one or more of the impulses may be lost. In order to overcome this difficulty, it is proposed in the present invention to provide means for storing one of the impulses when two of them are initiated simultaneously so that the impulse will be transmitted from the initiated office successively.

For purposes of illustration, let it be assumed that calls are initiated simultaneously at office W on lines A and B. The insertion of a plug into jack 20 of the line A causes the energization of relays 51 and 52 in the same manner as previously described with the result that relays 54, 56 and 58 are shunted during the energization of relay 52. Assuming now that a plug is inserted into jack 30 before the impulse for line A is transmitted from office W, an impulse circuit will be established through relays 53 and 54, but relay 54 being shunted will not close its alternate contacts. Relay 53 is however energized in the impulse circuit and locks in a circuit extending from grounded battery through the right-hand winding of relay 53, the inner right-hand alternate contact of said relay, the normal contact of relay 54, and the right-hand alternate contact of relay 52 to ground. During this interval, battery 62 is connected to the right-hand alternate contacts of relay 51 to transmit the first impulse for a line A from office W to office X and at the termination of this impulse relay 51 immediately releases, but relay 52 remains energized for an interval. Upon the release of relay 51 at the termination of the first impulse, and relay 53 still being in locked condition by reason of the energization of relay 52, a circuit is established for relay 61 extending from grounded battery through the winding of this relay, the middle right-hand alternate contact of relay 53 and the left-hand normal contact of relay 51 to ground. Relays 53

and 61 being now energized, an impulse circuit for line B is closed through the left-hand alternate contacts of relay 53, the alternate contacts of relay 61 and the normal contacts of relay 60 in the same manner as previously described. It will therefore be obvious that upon the simultaneous initiation of two calls at office W, the first impulse will be transmitted therefrom in the ordinary manner, but the second impulse will be stored at said office until the termination of the first impulse whereupon said second impulse will be transmitted to office X. Inasmuch as the two impulses reach office X and the succeeding offices in successive order, it will be obvious that the mechanism at office Z will operate in the same manner as before described and the lamps 515 and 517 associated with lines A and B will be lighted to indicate to the operator at office Z that calls are being initiated upon said lines.

Likewise should calls be initiated simultaneously at office W, on lines B and C, the impulse produced upon the initiation of a call on line B energizes relays 53 and 54 and the impulse produced by the initiation of a call on line C will then energize relay 55 but relay 56 will not energize due to the shunting of its windings by the ground at the middle alternate contact of relay 54. Relay 55 locks in a circuit extending from grounded battery through the right-hand winding and inner right-hand alternate contact of said relay and the left-hand normal contact of relay 56, and the middle alternate contact of relay 54. At the termination of the impulse for line B, relay 53 releases to permit of the energization of relay 60 over a circuit extending from grounded battery through the winding of said relay, the middle right-hand alternate contact of relay 55, the right-hand normal contact of relay 51, and the normal contact of relay 53 to ground. Relays 55 and 60 now being energized, an impulse circuit is established from the source of battery supply 63 through the left-hand alternate contacts of relay 55, the normal contacts of relay 59, and the middle and right-hand alternate contacts of relay 60 in the same manner as previously described.

In like manner, impulses transmitted from any other two lines at office W or on any one of the lines and for the disconnect signal, one of the impulses is stored or held at office W until the first impulse initiated is transmitted therefrom.

If at any time during the energization of relay 60, due to the operation of either of the relays 55 or 57, an impulse circuit for some other line should be initiated to energize relays 51 or 53 and thus open the original energizing circuit for relay 60, it will be obvious that said relay will be held energized during the operation of either of said relays 55 or 57 by the ground extending through the left-hand alternate contact of relay 60, the middle right-hand alternate contact of relay 55 or the next to the outermost left-hand contact of relay 57, and the winding of relay 60 to grounded battery. Relay 560 at office Z is held energized in the same manner.

Calls initiated simultaneously at offices W and Z.

It will now be assumed that the impulse transmitted from office W for line A reaches office Z at the same time that another call on line B is initiated thereat. The impulse for line A is extended through the various offices in the same manner as previously described to effect the energization of polar relays 500 and 501, and the relay 503 at office Z. Relay 503 is energized and remains so during the transmision of the impulse and by removing battery from its normal contact prevents the energization of relay 502 should any one of the relays 551, 553, 555 or 557 be energized by an impulse initiated at office Z. The energization of relay 503 establishes the obvious circuit for slow-to-release relay 514 which in closing its alternate contacts shunts the slow-to-release relays 552, 554, 556 and 558. Therefore, assuming that a plug is inserted into jack 530 at the same time that the impulse from office W reaches office Z, an impulse circuit previously described will be established through relays 553 and 554. Relay 553 will energize in this circuit, but relay 554 being shunted by relay 514 will not energize. Relay 553 locks in a circuit extending from grounded battery through the left-hand winding and inner right-hand alternate contact of said relay, the normal contact of relay 554 and the innermost contact of relay 514 to ground. The energization of relay 553 establishes a circuit for relay 561 extending from grounded battery through the winding of said relay, the middle alternate contact of relay 553 and the right-hand normal contact of relay 552 to ground. The energization of relays 553 and 561 prepares an impulse circuit extending through the right-hand alternate contacts of relay 553, the alternate contacts of relay 561 and the normal contacts of relay 560, but due to the fact that relay 502 is not energized at this time, the impulse which is eventually produced by the energization of relays 553 and 561 will not be transmitted from office Z until the impulse being received at said office is terminated. At this time relay 503 releases and establishes a circuit for relay 502 extending from grounded battery through the normal contact of relay 503, the winding of relay 502 and the outer left-handed alternate contact of relay 553

to ground. Relay 553 remains energized and relay 554 shunted for a period of time due to the slow release nature of relay 514. Therefore, immediately upon the termination of the impulse received at office Z, a like impulse for line B will be transmitted from said office to office W to light lamp 17 in a manner that will now be clearly understood.

In the same manner any other impulse initiated at office Z to energize either the relays 551, 555 or 557 will be stored at this office until the impulse being received thereat is terminated.

Let it now be assumed that a call is initiated at office W on line A and contemporaneously therewith another call is initiated at office Z on line B and that the impulses reach the storing mechanism at office X at the same time, and let it further be assumed that the call on line A is the first to be initiated. Relays 51 and 52 are again energized in the manner previously described to transmit an impulse from the source of battery supply 62 through the polar relays 200 and 201 at office X with the result that relay 204 is energized. Relay 203 is also energized to prevent operation of relay 202 during the transmission of this impulse and also to establish the circuit of relay 214 for a purpose which will presently appear. The energization of relay 204 establishes the circuit previously described for relay 351, but assuming that before the latter relay is energized the impulse transmitted from office Z for line B reaches office X, polar relay 301 and relay 303 will be energized. The energization of relay 303 disconnects battery from the winding of relay 302 and establishes the obvious circuit for slow-to-release relay 314 so that when relay 351 is energized by the impulse transmitted from office W, the circuit for relay 302 will not be closed but relay 351 will lock in a circuit extending from grounded battery through the right-hand winding and inner right-hand alternate contact of said relay and the contact of relay 314 to ground. The energization of polar relay 301 causes the operation of relays 304 and 305 as before with the result that the previously described circuit for relay 253 is established. A condition now exists wherein relays 351 and 253 are energized but, due to the fact that the circuit for relay 302 is opened by the energization of relay 303, an impulse will not be transmitted from the source of battery supply 362 through contacts of relay 351. Relay 253 is also locked throughout the duration of the impulse from office W, over a circuit extending from grounded battery through the winding and inner right-hand alternate contact of relay 253 and the contact of slow-to-release relay 214 to ground. At the termination of the impulse from office W, relay 203 releases and establishes the circuit for relay 202 which extends to ground at the outer right-hand contact of relay 253. The energization of relay 202 in this circuit immediately establishes an impulse circuit extending from the source of battery supply 262 through the left-hand alternate contacts 253, the normal contacts of relays 259 and 260, and the alternate contacts of relay 202. This impulse is transmitted to office W to operate the lamp 17 thereat in a manner which will now be readily understood.

At the termination of the impulse at office X, relay 303 releases to establish the circuit for relay 302 to ground, at the middle right-hand alternate contact of relay 351 and the circuit for relay 314 is opened, but this relay being slow to release will not open the locking circuit for relay 351 until sufficient time has elapsed to permit of the transmission of the impulse for line A from office X. Immediately upon the energization of relay 302, the impulse circuit for line A at office X is established from the source of battery supply 362 through the left-hand contacts of relay 351, the alternate contacts of relay 361, the latter relay having been energized over an obvious circuit by the energization of relay 351, the normal contacts of relay 360 and the alternate contacts of relay 302 to the mechanism at office Y. The impulse is here repeated and transmitted to office Z whereupon relay 508 is energized to cause the lighting of lamp 515 in the manner previously described. It will thus be apparent that the impulse transmitted from office W for line A will be stored at office X until the impulse transmitted from office Z for line B has passed through office X whereupon the initial impulse will be transmitted to offices Y and Z. It is believed that from the foregoing description the storing of impulses at office X will be readily understood when calls are simultaneously initiated on other lines at offices W and Z.

In the event that for any reason the operators at the terminating offices should fail to secure a connection when initiating a call, it will be obvious that initiating impulses may be repeated simply by the operation of the ringing key of the link circuit connected to any particular one of the jacks which will operate one of the relays 24, 34, etc., or the operators may withdraw the plug of the link circuit from the particular jack and reinsert the same whereupon an impulse will be transmitted in the ordinary manner.

What is claimed is:

1. In a telephone system, two distant offices, an intermediate office, a plurality of transmission lines interconnecting said offices, a signaling circuit included in certain of said lines, means for transmitting a signaling impulse for any one of said transmission lines over said signaling circuit and

the lines included therewith when a call is initiated on one of said transmission lines, and means at said intermediate office operable when simultaneous calls are initiated for storing one of the impulses until the other has been transmitted through said intermediate office.

2. In a telephone system, two distant offices, an intermediate office, physical and phantom transmission lines interconnecting said offices, a signaling circuit included in said physical lines, means for transmitting a signaling impulse for any one of said transmission lines over said signaling circuit and physical lines when a call is initiated on one of said lines, and means at said intermediate office operable when contemporaneous calls are initiated for storing one of the impulses until the other has been transmitted through said intermediate office.

3. In a telephone system, two distant offices, a plurality of transmisison lines interconnecting said offices, a signaling circuit included in certain of said lines, means for transmitting a signaling impulse for any one of said transmission lines over said signaling circuit and the lines included therewith when a call is initiated on one of said transmission lines, and means at each distant office operable when an impulse is being received thereat simultaneously with the initiation of a call at said office for storing one of the impulses until the other has been transmitted.

4. In a telephone system, two distant offices, physical and phantom lines interconnecting said offices, a signaling circuit included in said physical lines, means for transmitting a signaling impulse over said signaling circuit and said physical lines when a call is initiated on one of said lines, and means at each distant office operable when an impulse is being received thereat simultaneously with the initiation of a call at said office for storing one of the impulses until the other has been transmitted.

5. A telephone system, two distant offices, an intermediate office, a plurality of transmission lines interconnecting said offices, a signaling circuit included in certain of said lines, means at said distant offices for transmitting a signaling impulse over said signaling circuit and the lines included therewith when a call is initiated on one of said lines, means at said distant offices operable when simultaneous calls are initiated for storing one of the impulses until the other has been transmitted, and means at said intermediate office operable when two calls are initiated simultaneously at said distant offices for storing the impulse for one call until the impulse for the other call has been transmitted through said intermediate office.

6. In a telephone system, two distant offices, intermediate offices, telephone repeaters at said intermediate offices, a plurality of transmission lines interconnecting said distant and intermediate offices, a signaling circuit included in certain of said lines, means for transmitting a signaling impulse from either of said distant offices over said signaling circuit when a call is initiated on one of said lines, means operable when simultaneous calls are initiated for storing one of the impulses until the other has been transmitted, and means at said intermediate offices responsive to an impulse transmitted thereto for rendering effective the repeaters at said intermediate offices.

7. In a telephone system, two distant offices, intermediate offices, telephone repeaters at said intermediate offices, a plurality of transmission lines inter-connecting said distant and intermediate offices, a signaling circuit included in certain of said lines, means for transmitting a signaling impulse from either of said distant offices over said signaling circuit when a call is initiated on one of said lines, means at said intermediate offices responsive to an impulse received thereat for rendering effective said telephone repeaters, and means at one of said intermediate offices operable when impulses are transmitted simultaneously from said distant offices for storing one of the impulses until the other impulse has been transmitted through said intermediate office.

8. In a telephone system, distant offices, a plurality of transmission lines interconnecting said offices, an impulse circuit for each line at each of said offices closed when a call is initiated upon the line to which the impulse circuit is individual, a relay in each impulse circuit energized when the same is closed, a second relay operable in each circuit to prevent energization of corresponding relays when a call is initiated on any one of said lines and to maintain the first named relay of another impulse circuit energized, when two calls are initiated simultaneously, until the impulse for one call is transmitted, and means controlled by the operation of said first named relays for transmitting the impulses from the offices in succession.

9. In a telephone system, distant offices, physical and phantom lines interconnecting said offices, a signaling circuit included in the physical lines extended between said offices, an impulse circuit for each line at each of said offices closed when a call is initiated upon the line to which the impulse circuit is individual, a relay in each impulse circuit energized when the same is closed, a second relay operable in each circuit to prevent energization of corresponding relays when a call is initiated on any one of said lines and to maintain the first named relay of another impulse circuit energized, when two calls are initiated simultaneously, until the

impulse for one call is transmitted, and means controlled by the operation of said first named relays for transmitting the impulses from said offices over said signaling circuit and physical lines in succession.

10. In a telephone system, two distant offices, an intermediate office, a plurality of transmission lines interconnecting said offices, a signaling circuit included in certain of said lines, means for transmitting a signaling impulse from either of said distant offices over said signaling circuit when a call is initiated on any one of said lines, means at said distant offices operable when simultaneous calls are initiated thereat for storing one of the impulses until the other has been transmitted, means at said intermediate office operable when calls are initiated simultaneously at said distant offices for storing the impulse of one call until that of the other call has been transmitted through said intermediate office, and polar relays at said offices and included in said signaling circuit for repeating the impulses received at said offices.

11. In a telephone system, two distant offices, an intermediate office adjacent each of said two distant offices, telephone repeaters at said intermediate offices, means at each distant office for operating the telephone repeaters at said intermediate offices, means controlled from one distant office for disabling the repeaters at the intermediate office adjacent the other distant office, and means controlled from said other distant office for disabling the repeaters at the intermediate office adjacent the first named distant office.

In witness whereof, I hereunto subscribe my name this 27th day of February, A. D., 1920.

LOUIS. A. MORTIMER.