Jan. 9, 1945.

S. I. CORY

2,366,834

PULSE REPEATING SYSTEM

Filed July 10, 1943

3 Sheets-Sheet 1

FIG. 1

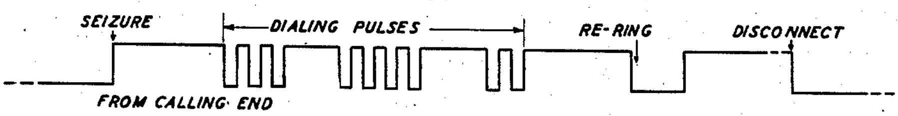


FIG. 2

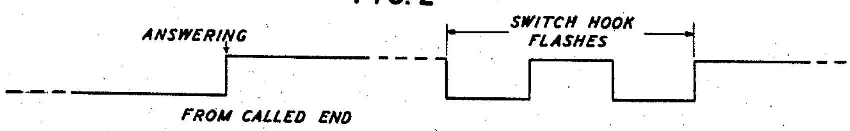


FIG. 3

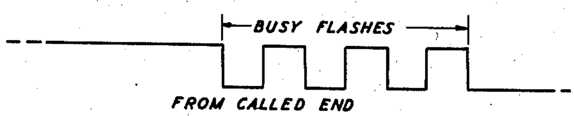
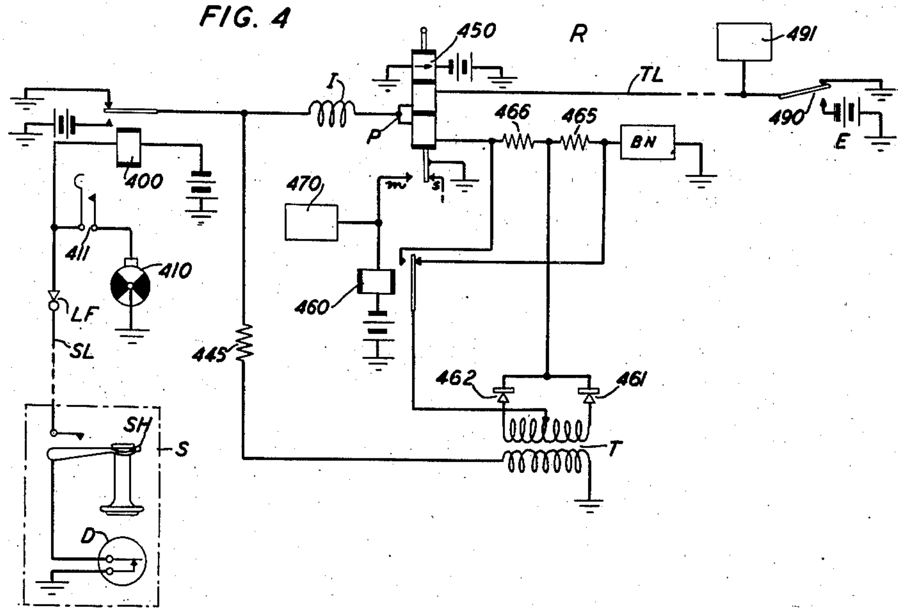


FIG. 4



INVENTOR
S. I. CORY
BY
O. E. Rasmussen
ATTORNEY

Jan. 9, 1945. S. I. CORY 2,366,834

PULSE REPEATING SYSTEM

Filed July 10, 1943 3 Sheets-Sheet 2

FIG. 5

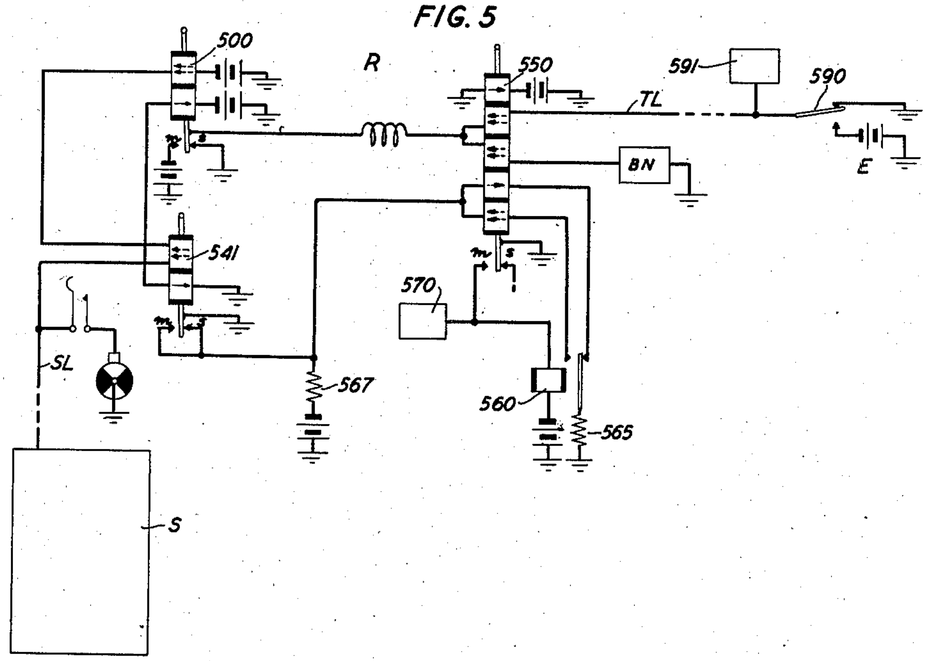
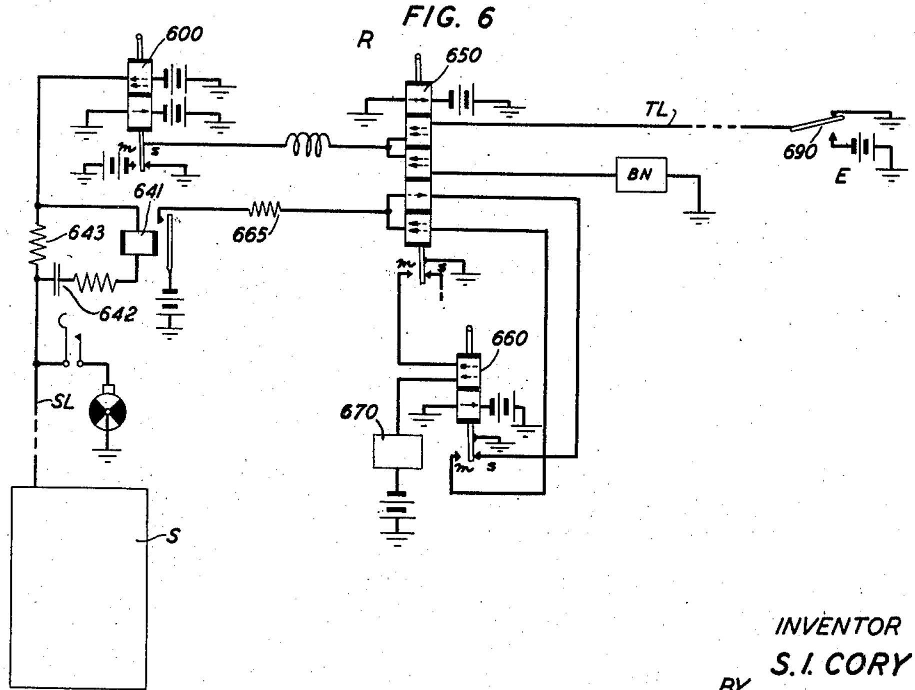


FIG. 6



INVENTOR
S. I. CORY
BY O. E. Rasmussen
ATTORNEY

Jan. 9, 1945.

S. I. CORY

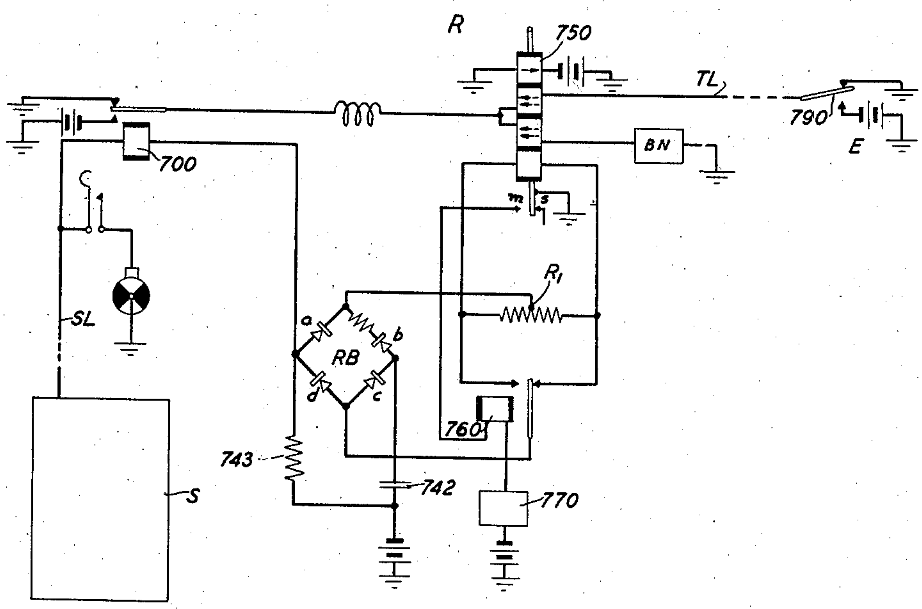
2,366,834

PULSE REPEATING SYSTEM

Filed July 10, 1943

3 Sheets-Sheet 3

FIG. 7



INVENTOR
S. I. CORY
BY O. E. Rasmussen
ATTORNEY

Patented Jan. 9, 1945 2,366,834

UNITED STATES PATENT OFFICE

2,366,834

PULSE REPEATING SYSTEM

Samuel I. Cory, Towaco, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application July 10, 1943, Serial No. 494,197

2 Claims. (Cl. 179—84)

The invention relates to pulse repeating systems and more particularly to systems of this type operating on a half-duplex basis.

It is an object of the invention to provide a pulse repeating system with a simplified duplex balance and capable of efficient operation under conditions of line variations and interference.

It is a more specific object of the invention to provide a system of this type which with standardized equipment is adapted for repeating selecting and supervising pulses for telephone switching systems over lines of greatly differing characteristics and lengths.

The selective supervisory operations of automatic telephone switching systems are frequently performed over extensive line circuits, such as toll lines, the lengths of which differ greatly and which are subjected to well-known disturbances and interferences. The selecting pulses, usually termed the dial pulses, are usually transmitted from one telephone exchange to another over half-duplex pulse repeating circuits, which hitherto have been carefully balanced to operate satisfactorily under the changing operating conditions in the line circuit. The reason for duplexing the pulse circuit is mainly to be found in the fact that the traffic requirements include the transmission in both directions over the line circuit of supervisory signals or pulses. The operations are further complicated by the requirement that, in the series of operations involved in the setting up of a connection, the line circuit is placed under two different conditions, which may be termed the idle and the busy conditions.

The pulse repeating system is adapted to receive dialing pulses from a calling station, which may be a remote telephone subscriber's station or a local operator's dialing circuit, and to repeat the pulses over an outgoing line circuit to a distant telephone exchange, equipped for automatic switching in response to the dial pulses for the selection of another exchange or another subscriber's station.

The repeating circuit includes a pole changing relay for applying two different transmitting potentials to the line circuit corresponding to the two conditions of the pulses, namely, marking and spacing or current and no current. The pulses from the pole changing relay are impressed upon a duplex circuit including the line circuit in one branch and the balancing circuit in the other branch.

A polar receiving relay is included in the duplex circuit for reception of signals incoming over the line circuit, this relay being unaffected by outgoing signals when the impedance balance is good. For this purpose the polar relay may be connected in any well-known manner, as by having its operating windings directly included in the two balanced circuits or connected in a bridge between the balanced circuits, in accordance with well-known practice in telegraph repeating systems. The system is also equipped for the transmission of busy signals comprising a series of pulses of a predetermined frequency, usually about 80 cycles per minute, which are impressed upon the duplex circuit by operation of the pole changer.

As is well known it has hitherto been necessary to establish a fair balance between the line circuit and the balancing network in duplex systems of either type referred to above, in order to prevent the receiving relay from responding to the outgoing pulses. When signals are impressed on an unbalanced system unbalance currents arise which may operate the receiving relay. Thus in the differential duplex circuit the currents in the two operating windings will be unequal or unbalanced and the stronger current may operate the relay. In the bridge duplex circuit the potentials applied to the relay winding are unequal and an equalizing or unbalance current will flow through the windings and may operate the relay.

In accordance with a feature of the invention, the balancing network is simplified and is standardized to supply a fair balance for a large variety of line circuits so that it may be manufactured at comparatively low cost. In accordance with the invention the system is furthermore arranged so that it will be unnecessary to adjust the balancing network to compensate for sporadic variations in the line circuits during ordinary operating conditions including temperature and leakage changes. This simplification of the balancing network is further effective in reducing the large amount of designing work involved in the provision of a large variety of differently dimensioned balancing networks for the corresponding varieties of line circuits to satisfy the present day severe demands for accuracy.

For the purposes just outlined the invention provides an arrangement for preventing false operations, which would be due to improper responses by the receiving relay during the transmission of outgoing pulses resulting from unbalanced conditions. By this provision a given design of balancing network may be based on certain average or predominant line conditions among the large variety of conditions met with in the plant. Such a network may thus provide an accurate balance for a large number of lines with average characteristics; it would however be less accurate in the balancing of line circuits having more diverging characteristics, without, however, establishing a circuit condition which would result in false operations due to unbalance conditions caused by line variations or interference.

When the pulse repeating system is idle, the pole changing or sending relay will apply an idle condition to the toll line, which may be assumed to be a spacing or no current condition, the other end of the line circuit being assumed to apply a similar condition to the line. In response to the seizure of the repeater station by a calling station or an operator, the pole changer applies a busy or marking condition to the toll line. After the transmission of dialing pulses, the distant station also applies a marking or answering condition to the line circuit which consequently will operate the polar receiving relay at the repeating station.

After this condition has been reached, further pulses may be transmitted in either direction over the line circuit. For example, a rering pulse may be transmitted by the sending station in the form of a pulse which will cause the distant exchange to rearing the called line; busy flashes may be transmitted back to the calling line; and switchhook flashes may be transmitted in either direction.

The polar receiving relay at the repeater station will respond to incoming pulses from the line circuit and will respond to the answering condition imposed upon the line circuit from the distant end by operating to marking position. Thus, the receiving relay is arranged to control circuit equipment which, in well-known manner, may be arranged to respond in proper sequence to the traffic signals, such as "answering" and "busy," from the called line. It may furthermore be arranged to function in response to dial pulses from the distant station, when the call is in the opposite direction, for control of the selecting operation of telephone switches at the exchange with which the repeater is immediately associated.

It will, therefore, be seen that in a sense the repeater operates under full-duplex conditions, inasmuch as it will operate with either of two polarities applied to either or both ends of the line circuit. However, though the repeater is required to operate in both directions, it will operate only in one direction at a time, so that for any particular line condition the repeater will be operating on a half-duplex basis.

This particular condition permits of the introduction of a feature of the invention which basically resides in rendering the receiving relay ineffective during the transmission of outgoing signals and restoring the receiving relay circuit to effectiveness upon termination of the retransmission of outgoing signals.

In accordance with a more specific feature of the invention, holding impulses are caused to flow through the receiving relay during the transmission of outgoing pulses to prevent "kick-off" of the relay, and for this purpose a holding circuit is connected to one or more windings of the receiving relay for applying holding impulses to the relay only during the passing of outgoing transitions. By this provision any unbalance currents from the line and balancing circuits due to the outgoing pulses will be opposed.

In accordance with another specific feature of the invention, the holding impulse circuit includes inductive means for holding or locking the receiving relay in one or the other position in accordance with alternate line conditions.

The invention will now be described more in detail as to its organization and operation and as applied to specific embodiments. In the description reference will be made to the attached drawings, in which:

Figs. 1, 2, and 3 are diagrammatic representations of different typical pulses that may be transmitted in either direction over the line circuit;

Fig. 4 is a circuit diagram of a repeater circuit representing a specific application of the invention; and

Figs. 5, 6 and 7 are similar circuit diagrams of a repeater circuit representing other specific applications of the invention and including different modifications of the arrangement shown in Fig. 4.

Referring to the drawings, it will be assumed that a subscriber's station is connected to a telephone exchange and desires to make a call to a distant subscriber's station at another telephone exchange. The two exchanges are connected together over toll lines.

In accordance with established traffic conditions in the telephone plant, the subscriber first removes his receiver from the hook, thereby establishing a calling condition. Thereafter the subscriber operates his calling dial which transmits the usual groups of dialing pulses. The distant exchange then applies an answering condition to the line circuit and rings the called subscriber, who answers by lifting his receiver off the hook, thereby establishing a busy condition. If the called subscriber should be busy, a continuous series of busy pulses will be transmitted back to the calling station at the rate of 80 pulses per minute. Other busy conditions, as for local trunks or distant trunks, are indicated by similar impulses of different frequencies. Upon the distant subscriber disconnecting prematurely, a rering pulse may be transmitted from the calling end of the line circuit. Subscriber's switchhook flashes may be transmitted at any time in either direction.

The diagram in Fig. 1 shows the signaling current in the line circuit at the time of a call. Thus, when the line circuit is seized, the line current increases from a no current or spacing condition to a steady marking current condition. Thereafter the marking current is interruped by the dialing pulses, whereupon the line current remains steady. In the case of a subsequent rering the line current is momentarily interrupted.

Fig. 2 refers to the conditions at the called end of the toll line, which normally is applying a spacing condition to the line circuit. Upon answering, the called exchange transmits a steady line current which may subsequently be interrupted by switchhook flashes.

Fig. 3 shows conditions at the called exchange when a busy condition exists in which case the steady marking condition is interrupted by spacing conditions.

Referring now particularly to Fig. 4, the circuit is that of a repeater station R connected over a toll line circuit TL to a distant exchange station represented at E. The repeater station may be assumed to be located at an exchange to which a plurality of subscribers are connected, one of which is shown at S.

Subscriber station S may be a conventional station with a switchhook SH and a dial D. The station is connected over a subscriber's line SL to the repeater station. However, for the purposes of the invention the line circuit SL may be connected to a toll operator's circuit instead of to a subscriber's station, in which case the switchhook may be replaced by a key and the dial by an operator's pulse sending device.

The repeater station R comprises the pole changer or sending relay 400 connected in the line circuit SL to receive pulses and having contacts for alternately applying ground and battery to the line circuit TL in sending the pulses outgoing from the exchange. A source of busy signal 410 may be connected through busy key 411 or any automatic means for applying the busy signal to the line circuit SL for operation of relay 400.

The polar receiving relay 450 has a biasing winding normally holding the relay in its spacing position and two operating windings cooperating to operate the relay to marking. The contacts of relay 400 are connected through an inductance I, through the upper operating winding of relay 450, to the toll line TL and through the lower operating winding to the balancing network BN. Thus, the operation of relay 400 in sending outgoing pulses will not ordinarily affect relay 450, since proportionate currents pass through the two windings in opposing relation in accordance with the balance between the line circuit TL and the network BN.

The distant exchange E may include a suitable responsive switch control circuit 491. The station E may also include a repeater circuit similar to the circuit R with a receiving relay similar to relay 450 and with transmitting contacts 490 similar to those of relay 400.

When the circuit is in the condition shown in the drawing, ground is applied to both ends of the line TL and to the balancing network BN so that no current will be flowing. When relay 400 operates, battery is connected to the bridge point P and current flows through one winding over the line circuit to ground at E and through the other winding through the balancing network to ground. The windings being opposed under this condition, relay 450 would not respond provided the balance is good. With relay 400 applying ground to the duplex circuit and contacts 490 at the distant end of the line operated to apply battery, the incoming line current will pass through the upper operating winding to ground at relay 400 and in a direction to overcome the biasing winding and operate relay 450 to marking. If now relay 400 be operated to also apply battery to the duplex circuit, practically no current will flow in the line and through the upper operating winding; the battery at relay 400 will, however, send current through the lower operating winding on relay 450 in a direction to keep relay 450 operated to marking. Thus in receiving incoming, marking, and spacing pulses, the two operating windings of relay 450 will be in cooperative relation to operate the relay to marking or spacing respectively.

Although the receiving relay 450 is shown in the drawings and is described herein as being connected in a differential duplex circuit, it should be understood that in accordance with the invention, this relay may be connected in a duplex bridge circuit with similar advantages.

Relay 450 in marking condition applies ground to relay 460 and at the same time to a circuit equipment 470 which is part of the exchange equipment and serves in part to selectively control switches for setting up a connection in response to pulses incoming from a distant exchange to the repeater R.

The contacts of relay 400 are also connected through resistance 445 and the primary winding of transformer T to ground. The secondary winding is divided into two parts and is connected over rectifiers 461 and 462 and over contacts of relay 460 to resistances 465 and 466, which in turn are connected in series in the balancing branch of the duplex circuit. The arrangement is such that impulses induced in either half of the secondary winding in response to operations of relay 400 will normally be applied in the same direction to the balancing circuit through resistance 465. However, when relay 460 is operated the induced impulses will be applied in the reverse direction through resistance 466. The impulses from the transformer T applied to the balancing branch will be superimposed upon the signal pulses from relay 400 during the transmission and thus will counteract any unbalance currents between the line circuit TL and the balancing network BN during the sending of a transition, thereby preventing "kick-off" by relay 450.

The operation of the circuit will now be described. It will be assumed that the circuit is in the rest condition, as shown in the drawings.

When the subscriber moves the receiver from the hook SH, ground is extended over the subscriber's line SL, through the winding of relay 400 which quickly operates. Relay 400 applies battery to the duplex circuit and over the line to the distant exchange E for operation of the switch control circuit 491.

Relay 400 also applies battery to the transformer T causing an induced impulse to flow through resistance 465. This impulse will establish a potential difference across the resistance which will be poled in the proper direction to oppose any fortuitous potential established in the duplex circuit due to an unbalance condition and so directed as to tend to cause an unbalanced current to flow which would operate relay 450 out of its spacing position. The impulse produced by the transformer is of short duration to be effective in preventing this operation during the sending of the space-to-mark transition.

The subscriber now operates the dial, the contacts of which produce spacing pulses, as shown in Fig. 1, by short interruptions of the ground connection to the line SL. On the arrival of the first pulse, relay 400 releases and applies ground to the line circuit and also deenergizes the primary winding of transformer T, thereby inducing an impulse in the secondary winding in the opposite direction of the previous impulse and, therefore, passing through the rectifier 462 from the left-hand portion of the secondary winding to the resistance 465 in the same direction as before; the potential difference across resistance 465 thus again will oppose any potentials in the duplex circuit tending to cause relay 450 to operate out of spacing.

At the end of the first dial pulse, relay 400 operates to apply battery to the duplex circuit and to transformer T, thereby again inducing an impulse through rectifier 461 and resistance 465 for holding relay 450 in spacing. During each pulse series relay 400 will repeat each marking and spacing transition and will cause a locking impulse to be produced by transformer T through resistance 465. During an interval between pulse series relay 400 remains attracted and during the succeeding series of pulses the operations are repeated.

Thereafter steady battery will be applied to the duplex circuit by relay 400 in marking position.

When the answering condition is established at the distant end of the line TL, as by the contacts 490 operating to battery, relay 450 will operate to marking, thereby applying ground to the circuit equipment 470 for the proper reception of the answering signal. Relay 450 also operates relay 460 to switch the impulse circuit from transformer T from resistance 465 to resistance 466. Since the rectifiers 461 and 462 remain connected to the same point in the balancing branch and the mid-point of the transformer is switched from the right-hand side to the left-hand side of the resistances relative to the rectifier connection, the impulses produced by the transformer will traverse the resistance 466 in the opposite direction relative to the impulses previously produced in resistance 465. The potential drop across resistance 466 will thus be in a direction to oppose stray potentials in the duplex circuit poled so as to tend to produce unbalance currents which would cause relay 450 to operate out of its marking position.

The desired connection may now be assumed to have been established and the called subscriber will be rung by the ringing equipment at the exchange E. When the called subscriber answers, the conversation may be carried on over a talking circuit, not shown in the drawings, but which would be closely associated with the toll line TL, as by being included in the same cable quad or by some composite arrangement.

It will now be assumed that some special circumstance arises, as for example, that the distant subscriber hangs up prematurely, necessitating the sending of further pulses from the calling end, for example, a rering pulse, as indicated in Fig. 1. The relay 400 would momentarily interrupt the battery connection and an impulse would be produced through rectifier 462, resistance 466 and over make contact of relay 460 which, as already explained, will prevent "kick-off" of relay 450 under the changed line condition. At the end of the rering pulse relay 400 returns to apply battery to the line circuit, thereby again causing a holding impulse to flow through resistance 466 in the same direction as before, the impulse in this case passing through rectifier 461.

In the case of a busy condition existing at the distant end after all dial pulses were transmitted, a series of marking pulses would be transmitted by the contacts 490 over the line TL, through the windings of relay 450 and network BN to ground, causing relay 450 to operate in unison with the busy pulses, and apply corresponding busy pulses to the circuit 470 for suitable response. The consequent operation of relay 460 will have no effect.

In the case of a call incoming to repeater station R, relay 450 would be operated to marking in response to the application of battery at the distant exchange E to the line. Subsequent interruptions, as by dial pulses, would cause relay 450 to oscillate and apply corresponding pulses to the circuit 470 for selective operation of switches. In response to this selective operation a switch may ultimately connect the subscriber station S to the repeater station R. This switch is diagrammatically represented by contacts LF; contacts LF may also represent the line finder switch for connecting the subscriber station to the repeater in response to a call by the subscriber. With the subscriber connected in this manner, switchhook flashes may be transmitted back to station E in the manner already described.

In case the subscriber S is busy, the connection at switch LF will remain open and the circuit 470 may be arranged to automatically operate the key 411 for application of busy signal from interrupter 410. This will cause relay 400 to operate in unison with the busy pulses and produce holding impulses through resistance 466, as already described.

On observing the busy signal, the distant calling station at E will hang up and thus will send a disconnect signal by applying steady ground over contacts 490, through the windings of relay 450, thereby operating the relay back to spacing. The circuit 470 responding to this operation may be arranged to automatically disconnect the interrupter 410 by means of contacts 411, whereupon the whole system will be restored to idle condition.

The inductance I is inserted between the contacts of relay 400 and the apex P for the purpose of shaping the outgoing pulses in any desired manner.

The purpose of the holding circuit for relay 450 is attained during the transmission of outgoing pulses. Thus, in accordance with the invention and as already explained above, the balancing network is of simple construction and is designed so that networks of this kind may be used universally with toll lines of different lengths and different characteristics. It is, of course, within the scope of the invention that a few standardized types of network may be provided, each type to be used with lines having characteristics within comparatively narrow limits and the different types of networks supplementing one another to satisfy the requirements of all types of lines. Thus, any one network will be connected to a particular line circuit and may establish only an approximate balance, and the unbalance may be so pronounced that the receiving relay would "kick-off" during transmission of outgoing pulses.

It is furthermore well known that long line circuits, as used in toll service, are subject to sporadic variations in their characteristics which are beyond control. Where a very close balance is necessary, it has been the practice to continuously observe the line conditions and correspondingly vary the balance by the network.

By the provision of the holding circuit for the receiving relay appreciable leeway is afforded in the balancing of this circuit, thereby permitting the use of universal networks for approximate balancing over wide ranges and also in special cases obviating the need for continual readjustment of the network. Thus, during sending of pulses any stray potentials tending to produce unbalance currents in or out of the line circuit or the network due to unbalance conditions would be opposed by the potentials established in the balancing circuit by the holding pulses through the transformer T.

By always applying the neutralizing potentials in a direction corresponding to the position of the receiving relay, it is insured that this relay will not "kick-off" under either of the steady-state conditions in the line circuit.

It should be understood that the invention may readily be adapted for application to a telegraph repeating system with similar advantages, where sending takes place against two different signaling conditions imposed by the remote station.

Referring now more particularly to the embodiment illustrated in Fig. 5 of the drawings, the system is somewhat similar to that shown in Fig. 4 and corresponding elements are correspondingly numbered in two figures.

In the circuit of Fig. 5 the receiving relay 550 has two separate holding windings and the holding current is switched through one or the other winding by relay 560, dependent upon the position of the receiving relay. Relays 500 and 541 are biased polar relays having their operating windings serially included in the subscriber's dial circuit SL. Relay 541 normally connects ground to the holding circuit to short-circuit the holding windings of relay 550. In response to each transition of the dial pulses, relay 541 momentarily opens the short-circuit, thereby causing a holding impulse to flow in one or the other winding of the receiving relay.

Under the normal conditions, as shown in Fig. 5, a holding circuit is closed through resistance 565, over the break contact of relay 560, through the upper holding winding of relay 550, resistance 567 to battery. When current flows in this circuit, the holding winding will aid the biasing winding in holding relay 550 in spacing. However, due to the short-circuiting ground at relay 541, no current normally flows in the holding circuit.

When relay 500 operates to place battery on the duplex circuit, relay 541 operates to marking and during the travel time the short-circuit is opened, thereby permitting a holding impulse to flow through the upper holding winding during the sending of the space-to-mark transition. When relay 500 operates back to spacing, relay 541 again momentarily opens the short-circuit for the upper holding winding and relay 550 will again be held against spacing during the mark-to-space transition.

With battery supplied to the line circuit at the distant end of line TL, relay 550 will be operated to marking and relay 560 will be energized, thereby connecting the lower holding winding into the holding circuit. During the sending of pulses by relay 500 relay 541 will follow the operations, during each travel time permitting a holding impulse to flow through the lower holding winding of relay 550 which will overcome the effect of any unbalance current in the operating windings of the relay and lock the relay in marking position during outgoing transitions of either polarity.

The circuit arrangement shown in Fig. 6 is similar to those shown in Figs. 4 and 5 and is particularly similar to that in Fig. 5 in that relay 650 has two additional holding windings. The arrangement differs from that in Fig. 5 mainly in the fact that the holding circuit is normally open. The relay 641 is connected through condenser 642 across resistance 643 in the subscriber's line circuit SL and thus will receive operating potential across the resistance when current flows in the circuit SL.

During a rise of current in resistance 643 condenser 642 will be charged and the charging impulse will operate the neutral relay 641. During a decline of current through resistance 643 condenser 642 will discharge and the discharge impulse will temporarily operate relay 641.

With the circuit in the condition shown in the drawings, relay 641 is released. When the subscriber calls, relay 600 operates to marking and applies battery to the line circuit TL. Relay 641 responds to the space-to-mark transition in the circuit SL and operates, momentarily closing the holding circuit through resistance 665 and the upper holding winding of relay 650 over the spacing contact of relay 660 to ground, thereby locking the relay 650 in spacing position during the space-to-mark transition.

During a mark-to-space transition relay 641 will respond to the decaying current in resistance 643 and again momentarily close the holding circuit through the upper holding winding of relay 650.

With battery supplied to the toll line TL from the distant exchange E, relay 650 will operate to marking and relay 660 will be operated to marking to transfer the holding circuit from the upper to the lower holding winding of relay 650. During each outgoing transition relay 641 will close the holding circuit through the lower holding winding, thereby locking relay 650 in marking position.

The circuit arrangement shown in Fig. 7 is similar to those described above with the principal modification that the receiving relay has a single separate holding winding.

In this arrangement the dialing circuit SL from the subscriber's station extends through relay 700, resistance 743 to battery. The holding circuit is connected across the resistance 743 to receive a charging impulse through condenser 742, full-wave rectifier bridge RB, and through the holding winding of relay 750 in one direction or the other, dependent upon the position of relays 750 and 760.

With the circuit in the condition shown in the drawings the condenser 742 is discharged over the branch *b* of the rectifier bridge, the right-hand portion of resistance R1, the break contact of relay 760, the branch *d* of the rectifier bridge and resistance 743.

When the repeater is seized by the subscriber S, relay 700 operates to apply battery to the line circuit TL and the rising current in the pulse circuit and through resistance 743 causes a charging impulse to pass from the upper positive side of resistance 743, branch *a* of the rectifier bridge, through the right-hand portion of resistance R1, break contact of relay 760, branch *c* of the rectifier bridge, and through the condenser 742 to the negative side of resistance 743. Due to the potential drop in resistance R1 current will also flow from the mid-point of the resistance, through the left-hand portion thereof, through the holding winding of relay 750, to the other side of resistance R1. The holding impulse under this condition is in a direction to aid the biasing winding of relay 750 in holding the relay against spacing during the outgoing space-to-mark transition.

For the sending of a mark-to-space transition the decaying current through resistance 743 will cause the condenser 742 to discharge over the branch *b*, resistance R1, branch *d* and resistance 743. The potential drop across resistance R1 due to the discharge impulse will be in the same direction as before, thereby causing a holding impulse to flow through relay 750 to lock the relay in spacing position.

In answering condition the distant exchange E applies battery to the line circuit, thereby operating relay 750 to marking which, in turn, operates relay 760. Relay 760 now transfers the condenser and rectifier circuit to the left-hand portion of resistance R1, thereby reversing the direction of the holding current through relay **750** to lock the relay in marking position against "kick-off" by unbalance currents arising during outgoing transitions of either polarity. Thus, a charging current in resistance **743** will set up a potential drop across the left-hand portion of resistance R1. In this case a shunt path may be traced from the mid-point of resistance R1 through its right-hand portion, through the holding winding to the other end of resistance R1.

What is claimed is:

1. A two-way signaling system comprising an approximately balanced line circuit normally maintained alternately in marking and spacing steady state conditions from the remote end, receiving relay means having contacts for control of a receiving circuit in response to incoming marking and spacing signal pulses superimposed on said steady state conditions, auxiliary circuit means connected to be responsive to outgoing marking and spacing signal pulses to prevent said control by said relay means contacts in response to unbalance currents due to said outgoing pulses, and switching means connected to be responsive to said steady state conditions for the conditioning of said auxiliary circuit means for the proper prevention of said control under both of said steady state conditions, said auxiliary circuit means comprising a locking circuit connected to produce pulses through said receiving relay means for locking said receiving relay means in alternate positions, said locking circuit including two oppositely poled electromagnetic winding means, and said switching means including relay means connected for switching one or the other of said winding means into said locking circuit for reversing the locking action in accordance with said alternate steady state conditions.

2. A two-way signaling system comprising an approximately balanced line circuit normally maintained alternately in marking and spacing steady state conditions from the remote end, receiving relay means having contacts for control of a receiving circuit in response to incoming marking and spacing signal pulses superimposed on said steady state conditions, auxiliary circuit means connected to be responsive to outgoing marking and spacing signal pulses to prevent said control by said relay means contacts in response to unbalance currents due to said outgoing pulses, and switching means connected to be responsive to said steady state conditions for conditioning said auxiliary circuit means for the proper prevention of said control under both of said steady state conditions, said auxiliary circuit means comprising an impulse circuit connected to a winding circuit for said receiving relay means for locking said receiving relay means in alternate positions in accordance with alternate steady state conditions, said impulse circuit including two oppositely poled inductance circuits for producing impulses for said locking, and said switching means comprising relay means connected for switching the impulses from one or the other of said inductance circuits to said winding circuit in accordance with said steady state conditions.

SAMUEL I. CORY.