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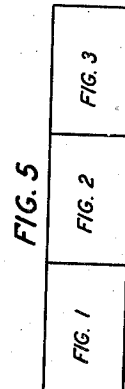
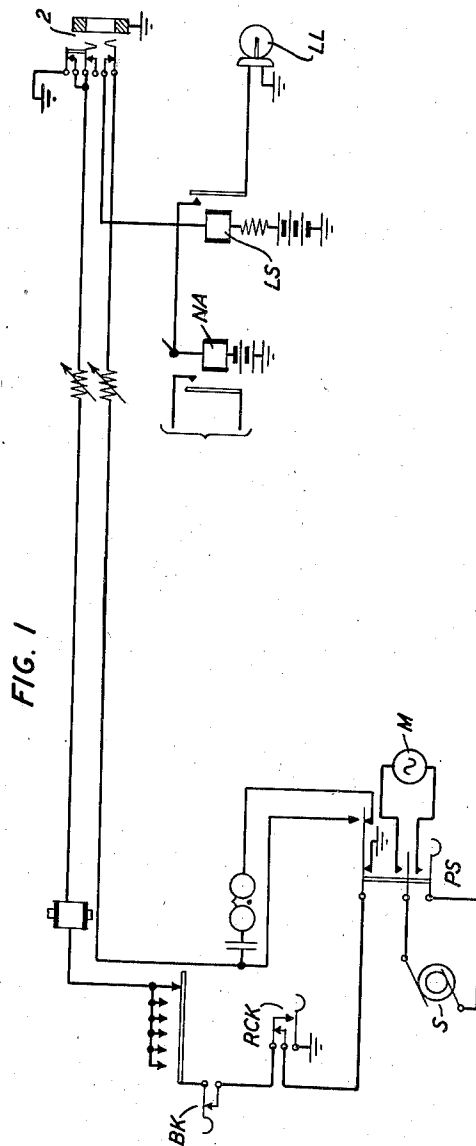
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2,147,720

TELEGRAPHIC EXCHANGE CIRCUIT

Filed Sept. 30, 1936

3 Sheets-Sheet 1



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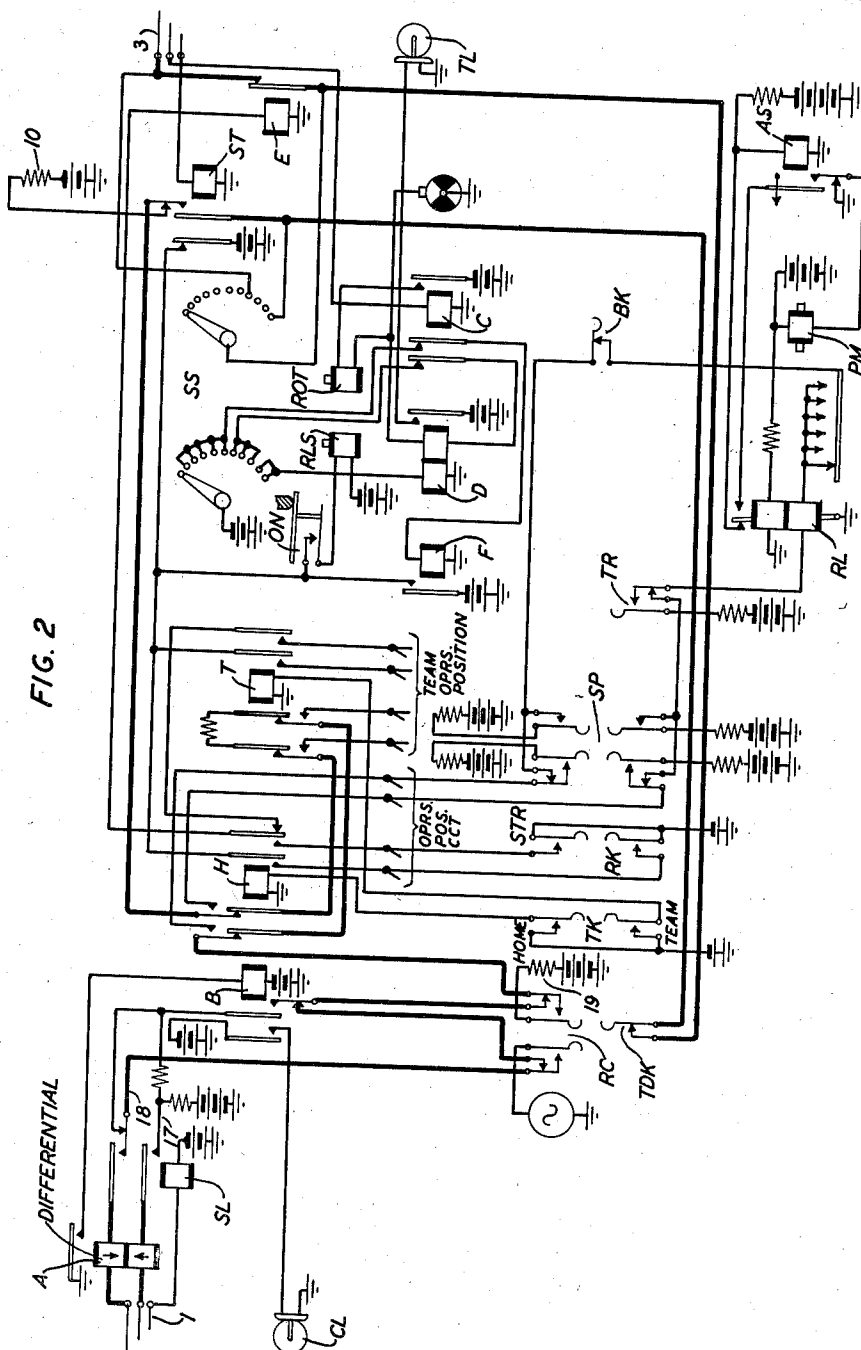
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TELEGRAPHIC EXCHANGE CIRCUIT

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3 Sheets-Sheet 2



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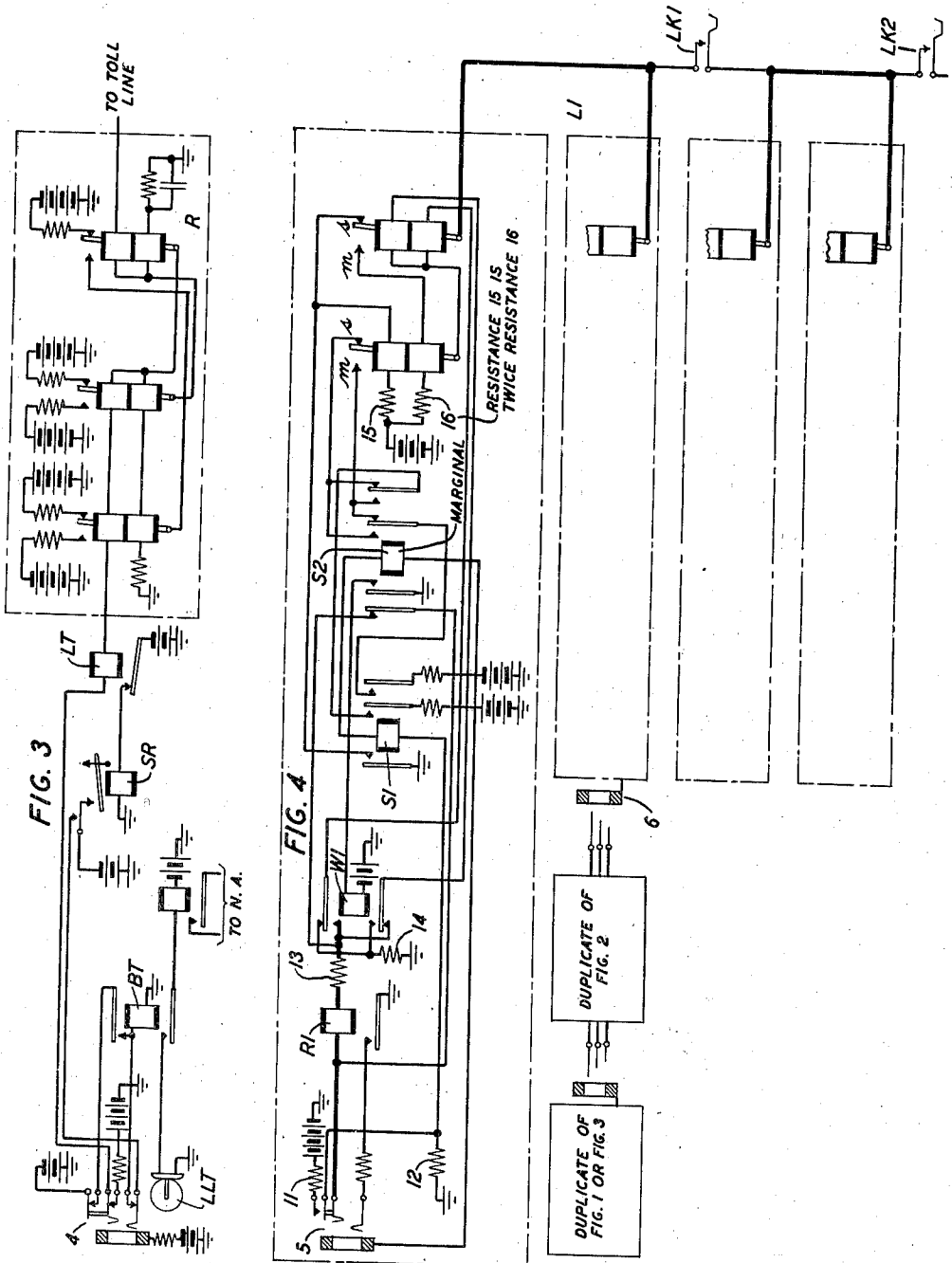
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TELEGRAPHIC EXCHANGE CIRCUIT

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3 Sheets-Sheet 3



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2,147,720

TELEGRAPHIC EXCHANGE CIRCUIT

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Application September 30, 1936, Serial No. 103,332

20 Claims. (Cl. 178—2)

This invention relates to switching circuits for teletypewriter switchboards of the manual type.

An object of the invention is to simplify the line termination equipments of such switchboard circuits. In manually switched teletypewriter service as commercially practiced at the present time there are two principal types of lines. One type of line extends from an outlying station, commonly known as a subscriber's station, to a central office switchboard or private branch exchange switchboard and the other type is a trunk circuit extending from one switchboard to another switchboard. In many installations the majority of the calls extend through a switchboard between a subscriber's line and a toll line and relatively few calls extend from one subscriber's line directly to another or from one toll line directly to another.

The objects of fulfilling the simplification of toll line terminations and subscribers' line terminations are carried out in one circuit arrangement embodying the invention described in detail herein. In this circuit arrangement each line appearance at the switchboard consists of a single jack and lamp. The means for indicating recall and disconnect signals are located in the cord circuits rather than in the line terminations. The cord circuits include selectors and relays for sending and responding to recall and disconnect signals. Hence the invention as embodied involves cord circuit supervision as distinguished from line circuit supervision.

Desirable simplification of the cord circuits is accomplished by omitting the repeaters usually employed. This simplifies the connections for the most frequent type of calls which extend between a subscriber's line and a toll line. For establishing such connections a single double ended cord circuit is utilized.

Provision is made for establishing calls between one subscriber's line and another subscriber's line or between two toll lines at the same switchboard by utilizing two cord circuits to connect into the communication circuit a jack ended conference circuit. This conference circuit may also be used for setting up communication circuits involving more than two lines terminating at the same switchboard.

In several types of switchboards as previously employed, each branch of a conference circuit terminating at the switchboard involves three polar relays and each cord involved in the conference circuit contains two polar relays making a total of five polar relays per branch of the conference circuit. In the present arrangement the

total number of polar relays is reduced because each cord circuit is repeaterless and each conference circuit branch involves only two polar relays. In transmitting through the switchboard the number of repetitions of the telegraph signals in conference networks is reduced. This is an advantage which is more important in complicated conference networks where the transmission margins are low due partly to the fact that each repetition of the signal impulses through a relay repeater adds additional distortion.

In the accompanying drawings:

Fig. 1 shows a subscriber's station in simplified diagrammatic form together with the line and line termination equipment at the central office;

Fig. 2 shows in simplified diagrammatic form the essential equipment and circuits of a cord and operator's position circuit;

Fig. 3 shows a toll line termination;

Fig. 4 shows in detail one branch of the conference circuit with block diagrams indicating the manner of connecting other branches of the conference circuit thereto with additional blocks indicating the connection to one of the other branches of circuit arrangements consisting of duplicates of the apparatus of Fig. 1 and Fig. 2, or Fig. 2 and Fig. 3; and

Fig. 5 illustrates the manner of connecting together the three principal figures of the drawings.

One form of subscribers' station is shown in Fig. 1.

Various other types may also be employed for either attended or unattended service. For example, the station equipments shown in applicant's application Serial No. 89,828, filed July 9, 1936, with the telephone equipment omitted or left unused, may be employed. When the subscriber's station is idle the subscriber's loop is opened, the station ringer and condenser are connected between one of the conductors and ground and the other conductor of the loop is grounded.

Local to toll connection

The subscriber's station attendant initiates a call by closing the power switch PS at his station. This connects the typewriter motor M to a public utility power source or any other suitable electric energy supply S. The closure of the switch closes the line thereby causing the relay LS to operate over an obvious circuit beginning at battery on the relay and ending at ground on the tip side of the line. Operation of relay LS causes the line lamp LL to light and, if desired, energizes a night alarm relay NA controlling a suitable

night alarm circuit in a manner well understood in the art.

The cord circuit of Fig. 2 has two ends which are different, the left-hand end being adapted for connection to a subscriber's line and the right-hand end being adapted for connection to a toll line. The plug 1 is inserted in jack 2 by the operator upon observing the lamp LL with the typing key TK of the cord circuit operated. Operation of the typing key to "home" causes the relay H to be operated and plugging the plug 1 into the jack 2 causes the sleeve relay SL to be operated. Consequently, a circuit is closed through. This circuit may be traced from positive battery and resistance 17 on the make contact of relay SL, over the ring of the plug 1, ring of jack 2, over the line back to the tip of jack 2 and tip of plug 1, make contact of relay SL, contact of ringing key RC, contact of relay B, another contact of key RC, make contact of relay H, unoperated contact of split key SP, break key BK, operators' teletypewriter contacts and receiving relay, contact of key TR, other contacts of key SP, another contact of relay H, contact of relay ST, to negative battery and ground over resistance 10. Relay A does not operate since it is a differential type. The station operator and subscriber operator may communicate over the circuit just traced. A teaming operator may answer the call by causing relay T to operate, under control of the TK key operated to "team".

Relay RL moves its armature to the left during teletypewriter spacing signals but anti-spin relay AS does not release on ordinary spacing signal impulses and consequently, during ordinary communication, teletypewriter magnet PM follows relay RL. On long breaks or line opens relay AS releases and teletypewriter magnet PM operates, thus preventing the operator's teletypewriter mechanism from operating continuously on open circuit or when the key TK is released.

Assume now the operator is informed of a call to be completed over a toll line or trunk to a distant city. The plug 3 is inserted in jack 4. The relay ST operates from battery on the sleeve of the jack 4. The transmission path previously traced is now extended through the toll disconnect key TDK and normally closed contact of relay E to the tip of plug 4 and thence through the relay Lt to negative battery at the toll line repeater R the other side of which is connected over a toll line to a similar repeater at a distant switchboard. No additional relays in the cord circuit are operated at this time. The slow release relay SR is held operated by relay Lt except only on open line pulses longer than those which normally occur in teletypewriter sending; in fact the Lt relay may be so slow to release that it follows only very few of the longer teletypewriter break signals. Relay C in the cord circuit remains released so long as relay SR remains operated. It is to be noted that relay SR is a neutral type. Other forms of slow release relays may be used such as a polar relay in conjunction with a condenser shunt.

In order to send a call over the toll line the operator operates the toll ringing key TR for about one second. During this time negative battery on the operated contact of key TR holds the line to the subscriber closed through the central office operator's machine. The circuit to the tip of plug 3 is opened while key TR is operated and hence a spacing or open line signal is sent into the repeater R. The open condition is repeated to the toll line through repeater R. The line lamp LLT

corresponding to a toll line is lighted at a distant switchboard by deenergization of relay Lt, deenergization of relay SR, and energization of relay BT at the distant switchboard. During the interval key TR is operated, the relay Lt (Fig. 3) releases and relay SR releases. Relay C (Fig. 2) operates and this connects battery and interrupted ground at 60 interruptions per minute to the rotary magnet ROT of stepping switch or selector SS. At the first step a circuit is prepared to relay F which does not operate because the circuit is open at the armature of relay C; the off-normal contact ON is also closed as soon as the selector has reached step 1. The selector continues to step but as the operator holds key TR operated only one second the selector will not step beyond the first or second step. When key TR is restored relay Lt reoperates and in turn relay SR reoperates causing relay C to release. Relay F operates, the release magnet RLS is energized, the selector is restored to normal and the contacts ON reopened.

The operator at the distant switchboard answers and teletypewriter communication is established with the called office. The operator at the local office of the calling subscriber may retire from the circuit by releasing the typing key TK which releases the H relay or, if desired, the local operator may remain on the circuit. Any station on the circuit may send and any station may interrupt or "break" the sender by operating the break key BK ordinarily included in series with the sending contacts. A break signal is ordinarily about one second but if the operator or subscriber should hold the break key longer up to a maximum of not over six seconds the supervisory apparatus in the cord circuit will not register a recall or disconnect signal. Relays Lt and SR release during the open period and as relay F is wired up to the first five contacts of the selector the selector will be restored upon deenergization of relay C.

To recall the operator, the calling subscriber operates a recall key RCK which applies ground to the tip side of the line and opens the ring side. Since the upper winding only of the differential relay A is then energized relay A operates and energizes relay B which lights the cord lamp CL. Ground at key RCK also prevents the transmission circuit through the tip circuit of the cord and station from opening. Later when relay B operates battery is connected through resistances 17 and 18 and make-before-break contacts of relay B to the transmission circuit through the cord to retain this closed condition. By intermittent operation of key RCK the relays A and B follow and the lamp CL flashes. If the toll line including relay Lt has failed, for example, has become permanently open the subscriber can nevertheless recall because the relay A operates independently of the toll line. The operator may answer by operating key TK and challenging; during challenging the toll line may be cut off by operating the splitting key SP to the lower position.

If the calling station disconnects by operating the power switch PS, the ring circuit is grounded and the tip opened. Relays A and B, Fig. 2, operate and lamp CL burns steadily. After relay B operates the transmission circuit of the cord is closed toward the toll line from positive battery through resistances 17 and 18.

The operator may pull down the cord, which operation will release the relay SL, but will not open the toll line because the normal make-on-release contact of relay SL will still supply positive

battery through resistances 17 and 18 to the transmission circuit.

Furthermore, the operator may ring back the subscriber by operating key RC which will also maintain positive battery through resistance 19 on the toll line circuit.

To recall the home operator over the toll line the distant operator sends a timed seven second open or break signal by means of a special key or otherwise, for example, manually. Upon receipt of this open signal the relays Lt and SR release. Relay C in the cord circuit releases and the selector steps one step per second until the line closes when the selector arm should be on the sixth, seventh or eighth contact. Upon reoperation of relays Lt and SR and release of relay C, the relay F is not operated but the relay D is operated and the selector does not restore at once. Relay D is connected to interrupted ground over its right-hand winding and it follows the interrupted ground and causes the toll cord lamp TL to flash. A suitable night alarm may be connected in the cord lamp circuit, if desired.

To answer the recall the operator operates key TK and challenges with or without operating the splitting key SP to the upper position. With key TK operated, operation of release key RK supplies battery over a make contact of relay H to energize release magnet RLS and cause the selector SS to restore to normal. When the wiper of the selector leaves the sixth contact the relay D releases which opens the circuit of lamp TL causing that lamp to be extinguished.

If the distant operator had wished to indicate a disconnect she would have opened the line for ten seconds and the selector would have reached the ninth or tenth contact. Relay D would then be energized over its left winding and the lamp TL would burn steadily whether the line recloses or not. If the line recloses at the end of the ten second period the relays Lt and SR reoperate and relay C releases but the selector wipers remain on contact 9 or 10 and the lamp TL continues to burn until the operator pulls down the toll cord plug 3. Pulling down the cord causes relay ST to release and battery is supplied to the release magnet RLS over the off-normal contacts ON to return the selector to normal. The features of having the lamp TL burn steadily whether the line has reclosed or not after an open of ten seconds is of importance because it indicates a line failure to the operator. Pulling down of cord 3 on a normal disconnect will cause lamp TL to be extinguished, without causing lamp LLT to light, but with an open line, lamp LLT will light as soon as the plug 3 is removed from jack 4.

If the local operator (at Fig. 2) had wished to send a recall to the distant operator over the toll line, she would do so by operating typing key TK to "home" or "team" position and then hold the send toll recall key STR operated until the toll cord lamp TL flashes. Key STR operates relay E which opens the transmission circuit to send a recall to the distant switchboard. At the home switchboard the lamp TL is caused to flash when the selector reaches the seventh point at which point the wiper on the right bank short-circuits the contact of relay E and recloses the transmission circuit. Relays Lt and SR reoperate and relay C releases within one-half second and the interrupted ground is cut off from the rotary stepping magnet ROT. The selector wipers remain on point 7 even though the operator continues to hold key STR operated. However, release of relay C permits relay D to follow the sixty

interruptions per minute and flash the lamp to notify the operator to release the key.

To send a toll line disconnect the typing key TK need not be operated. The toll disconnect key TDK is operated and left or held operated, according to the type of key, until lamp TL lights whereupon the toll cord plug 3 may be pulled down. In this case the cord selector steps until it has reached point 10 whereupon the wiper of the right bank short-circuits the contacts of key TDK and recloses the line. Relay D has meantime operated and lamp TL is lighted until upon pulling down the cord the relay ST releases and energizes the release magnet to restore the selector.

Toll to local connection

When the toll line is idle the loop from the jack to the repeater is closed from negative battery in the repeater R to positive battery on the tip of jack 4. Upon sending a call by the distant operator, who will be assumed to be located at a switchboard having equipment identical to that shown, the relay Lt releases, the relay SR releases and relay BT operates and locks up through contacts on the jack. Toll line lamp LLT lights and the night alarm, if used, is energized. The operator answers by plugging the plug 3 into jack 4 which causes relay BT to release and relay ST to operate. The transmission circuit is extended from the tip of jack 3 through contact of relay E, the toll disconnect key TDK, left contacts of relay ST, contacts of relay H, back contacts of relay T, contact of key RC, make-on-release contact of relay B, another contact of key RC and contact of relay SL to positive battery through resistances 17 and 18. By operating key TK the circuit is transferred to include the operator's teletypewriter and she obtains the desired number and puts plug 1 into the proper jack 2. The tip of the line is open to direct current at the subscriber's ringer, but relay A operates because the motor of the subscriber's station is stopped and relay B operates thereby closing the toll line circuit at the make contact of relay B. The operator rings by operating key RC in the subscriber's station side of the cord which sends 20-cycle ringing current through the subscriber's ringer over an obvious circuit. Relays A and B may follow the ringing signals causing lamp CL to flash. The subscriber answers by closing the power switch PS and typing. Ground is removed from the ring of the loop at the subscriber's station, relays A and B release and lamp CL is extinguished.

Breaking, recalling and disconnecting are performed in the same manner as previously described.

Local to local connections

Local calls are answered in the manner previously described. The operator plugs the cord into the line jack of the calling station and the toll end or plug 3 into a jack 5 of a conference circuit. A cord plug 3 of a second cord is plugged into a jack 6 of a conference circuit and the cord plug 1 of the second cord is used to call the called station by plugging in and operating ring key RC to the station side. The operator may monitor by operating a typing key TK of either but not both cord circuits. During ringing, the relay A of the cord of the called line will operate and the operator and calling station teletypewriters will be cut off and lamp CL will be lighted but when the called station answers the circuit is closed and communication may begin. Recalling and

disconnecting are the same as before; it being understood that the conference circuit acts between two cords of one central office much as the toll line acts between two cords of separate offices.

By reference to Fig. 4, each branch of a conference circuit includes the equipment in one dotted rectangle. A conference circuit repeater CR comprises two polar relays M and N, two sleeve relays S1 and S2 and relays R1 and W1. When the circuit is idle all battery connections are open. All branches of the conference circuit are alike and any number may be used because the common lead L1 has positive battery applied to it by each branch. It is also possible to separate the branches in pairs by locking keys LK1, LK2, etc., thereby making it possible to set up a number of local to local, toll to toll, or small conference circuits at once with some small number, such as six to ten, conference circuit branches.

When a local to local connection is to be established the toll plug 3 on the first cord circuit to be used is connected to a branch of the conference circuit. Specifically it will be assumed that the plug 3 is connected to the conference circuit jack 5. The auxiliary contact on jack 5 closes and connects positive 130-volt battery to the windings of relays S1 and S2 through the potentiometer resistances 11 and 12. These resistances are of such value that a potential of about plus 24 volts is obtained at relays S1 and S2. The circuit extends through the windings of relays S1, S2 and ST in the cord circuit to ground. In this case the relay S2 does not operate because it is a marginal relay but relays S1 and ST are operated. Relays R1 and W1 in Fig. 4, remain released and the winding of relay R1 and resistance 13 are short-circuited. When relay S1 operates, negative 130-volt battery is connected to the marking contact and positive 130-volt battery is connected to the spacing contact of relay M and ground is applied to the upper winding of relay M. The marking and spacing contacts of relays M and N will hereinafter be identified as *m* and *s*, respectively. When relay ST in the cord circuit operates the transmission circuit is extended to the tip of the cord and current from positive battery closed through the make contact of the relay SL in the cord (previously operated when the operator answered the calling station), lower winding of relay A over the station loop, through the upper winding of the relay A and to the tip of the plug 3 where it extends through the upper winding of the relay N in Fig. 4 to negative battery. This circuit is similar to that obtained for a local to toll connection, relay N and negative battery in Fig. 4 corresponding to the toll line repeater in Fig. 3. Current also flows from ground through resistance 14, through lower winding of relay N and *m* contact of relay M to negative battery in Fig. 4. This current is one-half the value of the current in the upper winding of relay N. In the upper winding of relay N current flows to hold the armature on *m* and in the lower winding of relay M to hold the armature on *s*. Because the upper winding of relay N is of twice the ampere turns the relay armature is held on *m*. Relay M maintains its armature on the *m* contact because there is no current through its lower winding and the current in the upper winding holds the armature on *m*. Relay R1 is short-circuited and remains released.

The relay C in the cord circuit is released and remains released which disables the toll line supervisory elements of the cord circuit which

is quite proper, inasmuch as these features are not required for this circuit connection. The operator may communicate with a subscriber's station attendant provided the typing key TK of the cord is operated. When either the subscriber's station attendant or the operator transmits relay N follows the signals because when a spacing signal is sent current through the upper winding of relay N is reduced to zero and the biasing current through the lower winding causes the relay armature to move to *s*.

The cord circuit thus used to connect the calling station to the conference circuit jack 5 will be designated the calling station cord and the conference circuit branch connected to the jack 5 will be designated the first branch for convenient reference. In order to complete the connection to a second station local to the switchboard the operator connects the plug 3 of a second or answering cord circuit into a second branch of the conference circuit at the jack 6. Relays S1, N and M in the second branch of the conference circuit operate in the same manner as the corresponding relays of the first branch and the relay ST also operates in the same manner extending the transmission circuit to positive battery in the cord. The rest of the connection is established in the same manner as in a toll to local connection hereinbefore described.

The operation of the repeaters of the two branches of the conference circuit will now be described. When the calling station sends to the called station, current through the upper winding on the relay N of the first branch is made and broken. The armature of relay N, therefore, follows the signals. Relay M in the second branch of the conference circuit follows the signals sent from the armature of relay N in the first branch and relay M in the second branch causes these signals to be repeated into the loop extending to the called station. When the armatures of relays N of the first and second branches are on their marking contacts, there is no current through resistances 16 in either branch and the lower windings of relays M of either branch. The armatures of both relays M are, therefore, held on their marking contacts *m* by currents through resistances 15 of the first and of the second branches, respectively. It will be understood that resistance 15 is twice the ohmic value of resistance 16. When the armature of relay N of the first branch is on its spacing contact the armature of relay M in the first branch remains on *m* but the armature of relay M of the second branch operates to *s* because current flows through resistance 16 and the lower winding of relay M of the second branch to ground, through contact *s* of relay N of the first branch and the contact of relay S1 of the first branch. This current is twice the value and opposite in effect to the holding current through the upper winding of relay M of the second branch. When the armature of relay M of the second branch is on contact *s* positive 130-volt battery is applied to the apex circuit of relay N of the second branch and current in the loop of the called station is reduced to zero. For this condition current through the lower winding of relay N of the second branch is reversed and its armature remains on *m*.

When the called station sends, the signals are repeated by the relay N of the second branch and M of the first branch and the armatures of relays M of the second branch and N of the first branch remain on their contacts *m*.

During the time, while the called station is sending, the calling station may wish to stop the sending by "breaking" or opening the loop. If at that instant the armatures of relays N of the second branch and M of the first branch are on their contacts *s*, nothing happens; however, as soon as the called station loop closes the armature of relay N of the second branch returns to contact *m* and the armature of relay M of the first branch also returns to *m*. Negative battery is then applied to the apex of the relay N of the first branch and because the circuit through the upper winding of that relay is opened at the calling station the current remains off and the current through the lower winding of relay N of the first branch causes the armature to move to contact *s*. As soon as the armature of relay N of the first branch reaches contact *s* the armature of relay M of the second branch moves to contact *s* and the circuit to the called station is broken. In a similar manner the called station can "break" the calling station when the calling station is sending.

Toll to toll connection

This connection is similar to a local to local connection in its principal aspects. The chief difference is that the plugs 1 are connected to the jacks 5 and 6 of the conference circuit.

Let it be assumed that the plug 1 is connected to the jack 5 of the first branch of the conference circuit; 48 volts is supplied to the windings of the relays S1, S2 and SL in series because the sleeve of the plug 1 is connected to negative 24-volt battery. Relays S1, S2 and SL, therefore, operate and when relay S2 operates the short circuit is removed from around relay R1 and resistance 13. The operation of relay S2 causes the negative and positive batteries applied by relay S1 to the apex circuit of the relay N of the first branch to be reversed and causes relay W1 to operate. The operation of relay W1 causes the windings of the relay N of the first branch to be interchanged and to add resistance 13 to the transmission circuit. These changes are required because the tip circuit is in this case associated with the toll circuit repeater shown in Fig. 3, whereas in the local to local connection it was associated with the station loop circuit shown in Fig. 1. The resistance 13 is included for the purpose of reducing the current to proper value. Relay R1 which follows the teletypewriter signals is required to neutralize the current through the upper winding of the relay A in the cord circuit to prevent that relay from operating after a connection is established. Because the relay A is thus rendered ineffective the supervisory apparatus on the station side of the cord, that is, on the side for plug 1, does not function. This is quite proper as its functioning is not required for this connection.

Recall and disconnect signals from distant switchboards can be sent and when received will appear on the toll sides of each of the two cord circuits used in setting up the connection. These signals can be answered and extinguished in the same manner as described under local to toll and toll to local connections.

Conference connections

If several lines which may be either toll lines or subscribers' station lines are to be connected together for a conference connection, this can be done. For each station or line to be connected a cord will be plugged between the jack of that

station and the jack of the conference circuit. In each case of a subscriber's line the plug 1 will be connected to the line and the plug 3 to a jack of the conference circuit. In each case of a toll line the plug 3 will be connected to the line and the plug 1 to a jack of conference circuit. The circuit connections to each line may be set up selectively without opening the circuit of the lines already connected and a ringing or calling signal sent upon each line individually. A sufficient number of the conference circuit branches will be connected together by operating the keys LK1, LK2, etc. After the conference connection has been established any branch can send to all the others and if any one is sending any one of the others can "break" the sending station. Recall and disconnect signals can be sent from the station or toll line and received upon the respective cord connected thereto. During the time the toll line recall or disconnect signal is being received the conference circuit network may open the circuit but it closes up again at the end of the signal. It will be noted that the keys LK1, LK2, etc. connect up points of identical polarity so that any number of branches connected by these keys constitute a common point in the circuit.

What is claimed is:

1. In a telegraph exchange a double ended cord circuit including a stepping switch for stepping to a definite point, a subscriber's line and a toll line into which the ends of said cord circuit may be simultaneously connected, means in said cord circuit whereby special line conditions of extended duration upon one of said lines will cause said switch to step to a definite point, and means whereby a similar line condition of lesser duration will not cause said switch to step.

2. A system in accordance with claim 1 in which the special line condition consists of a line interruption on the toll line of specified duration actuating the stepping switch to a definite point and means whereby a circuit closed at that point actuates a signal lamp as a disconnect signal.

3. A system in accordance with claim 1 in which the special line condition consists of a line interruption of specified duration actuating the stepping switch to a definite point, means whereby a circuit is closed at that point, means whereby a signal lamp is closed thereby, and means whereby said lamp is caused to flash as a recall signal to the operator.

4. A teletypewriter system comprising a cord circuit, a stepping switch in the cord circuit, indicator means in said cord circuit, a plug terminating said cord circuit at each end, a line comprising a jack to which said plug may be connected and devices responsive when said jack and plug are connected whereby a special circuit condition on said line energizes said indicator means.

5. In a system including the combination of claim 4, circuits and elements included therein connected to the contacts of said stepping switch for operating said indicator means differently on making a certain more advanced contact than upon a less advanced contact.

6. In a teletypewriter exchange system, an exchange board, a line local to said exchange having a normally open communication circuit connected to a combined answering and calling jack in said board, a toll line having a normally closed communication path connected to a combined answering and calling jack in said board, and a repeaterless cord circuit for interconnecting said

jacks for intercommunication between said lines.

7. In a telegraph communication system, supervisory signal equipment including a stepping switch for inclusion in a circuit having telegraph communication equipment therein, said supervisory signal including relays actuatable by a line condition long as compared to any normal communication pulse to cause said switch to step, a contact point to which said switch steps, a supervisory signal energized by a circuit through said point, and means whereby said signal is energized thereafter whether said line condition continues or ceases.

8. In a telegraph exchange system, a central station, telegraph lines of a first type and of a second type connected to said station, universal cord circuits in said station, one of said cord circuits cooperating with one line of each of said types to form an operable two-way telegraph path, an interconnecting circuit also entirely in said station comprising two branches, cooperating with two lines both of either of said types through two of said universal cord circuits to form therewith an operable two-way telegraph path in each instance.

9. In a telegraph exchange system, an exchange station, an interconnection circuit located entirely at said station having two symmetrical branches each including a jack terminal, a cord circuit having a first control comprising a plug with a normally grounded sleeve and a second control comprising a plug at the other end with a polarized sleeve, and a relay in each of said branches responding differently to association of one of said controls with said branch than to association of the other of said controls with said branch.

10. In a telegraph exchange station, a cord circuit having a toll plug and a subscriber's plug, a supervisory terminal upon each of said plugs adapted to contact with a supervisory terminal of a jack, interconnecting circuits wholly local to said station terminating in two jacks therein, a repeater in said circuit, relay and battery conditioning means in said repeater individually controlled by a jack thereof, said repeater being conditioned differently by association of a plug with said jack depending on whether it is a toll plug or a subscriber's plug.

11. A jack ended circuit having a repeater in each branch, said branches being electrically symmetrically arranged as to circuit elements and potentials thereon with respect to a common point, a circuit closing element for connecting other similar circuits to said common point, telegraph circuits connectable to said jacks by plugs and repeaters in said jack ended circuits whereby telegraphic signal pulses in any one of said telegraph circuits are repeated into all the others.

12. A system in accordance with claim 11 in which plugs with grounded or polarized sleeves may be connected to said jacks, a marginal device in each of said branches and connecting elements whereby operation of said device conditions its associated repeater differently than with non-operation of said device.

13. A cord circuit for teletypewriter line interconnection, comprising a relay for connecting the stepping magnet of a rotating selector switch to a source of stepping current, a plug having a contact connected to said relay, a second plug having a similar contact of different potential, a jack connected to an intercommunicating circuit, a supervisory contact on said jack cooperating with either of said contacts connected to

said plugs, a second relay in said intercommunicating circuit, and devices causing said second relay to selectively condition said first named relay according to which of said plugs is associated with said jack.

14. A cord circuit for teletypewriter communication comprising a differential relay connected to tip and ring of a plug for connection to a line, said relay normally operating on unbalance of the signal current through its two differential windings, a special jack connected to a one-wire signal circuit, a supplemental path for opposing the current in one of said supplemental windings when said one-wire signal circuit is closed, and a relay in said one-wire signal circuit opening said supplemental path when said one-wire signal circuit is opened.

15. In a telegraph switching system, a telegraphic transmission line, means extending said line through a given station, a key in said station means whereby actuation of said key to a given position modifies the normal condition of said line for the purpose of sending a supervisory signal, and means restoring the normal condition of said line after a predetermined interval even though said key continues to be actuated.

16. A telegraph line, a stepping selector switch, a key, means operated by actuation of said key to a given position to open said line, means whereby actuation of said key to said given position causes said switch to step, and means operated by said switch upon stepping to a given point to reclose said line even though said key remains actuated to said given position.

17. A telegraph communication line terminating in a jack, a cord circuit for connection to said jack, a communication path continuous with said line in said cord circuit, a differential relay having a winding included in said line when said cord is connected to said jack, means whereby said differential relay is operated in response to a supervisory calling condition, and means under control of said relay maintaining the continuity of said communication path in said cord circuit when said relay operates.

18. A link circuit for interconnecting telegraphic lines, said link circuit having a local line supervisory relay electrically adjacent one terminus thereof and a toll line supervisory relay adjacent the other terminus thereof, a conference circuit for interconnecting two link circuits, and a relay instrumentality in said conference circuit for disabling whichever of said supervisory relays is adjacent the terminus of said cord circuit connected to said conference circuit.

19. In a telegraph exchange system, a central station, a plurality of telegraph lines of a first type and of a second type connected to said station, universal repeaterless cord circuits in said station, two unsymmetrical ends on each of said cords, said cords cooperating with a said line of the first type and a said line of the second type to form an operable two-way telegraph path, circuit means comprising a symmetrical two-branch interconnecting circuit entirely in said exchange, a repeater in each interconnecting circuit, said interconnecting circuit cooperating through two of said universal cords to interconnect two lines of the first type or two lines of the second type to form operable two-way telegraph paths in each instance.

20. In a telegraph system, a first telegraph exchange, a plurality of subscribers' line circuits connected to said exchange, a plurality of cord circuits at said exchange, a plurality of trunk

circuits connecting said first exchange with a second exchange, two telegraph transmission conductors in each of said lines, one telegraph transmission conductor in each of said trunks, 5 relay and relay control means in said lines, cords, and trunks cooperating upon the interconnection of one line through one cord to one trunk to form a two-way telegraph path, a plurality of symmetrical two-branch interconnecting circuits entirely at said first exchange relay and relay control means in said two-branch circuit cooperating with relay and relay control means in two of said cords to interconnect two of said lines or two of said trunks to form in each instance two-way operable telegraph paths. 5

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