

Aug. 13, 1940.

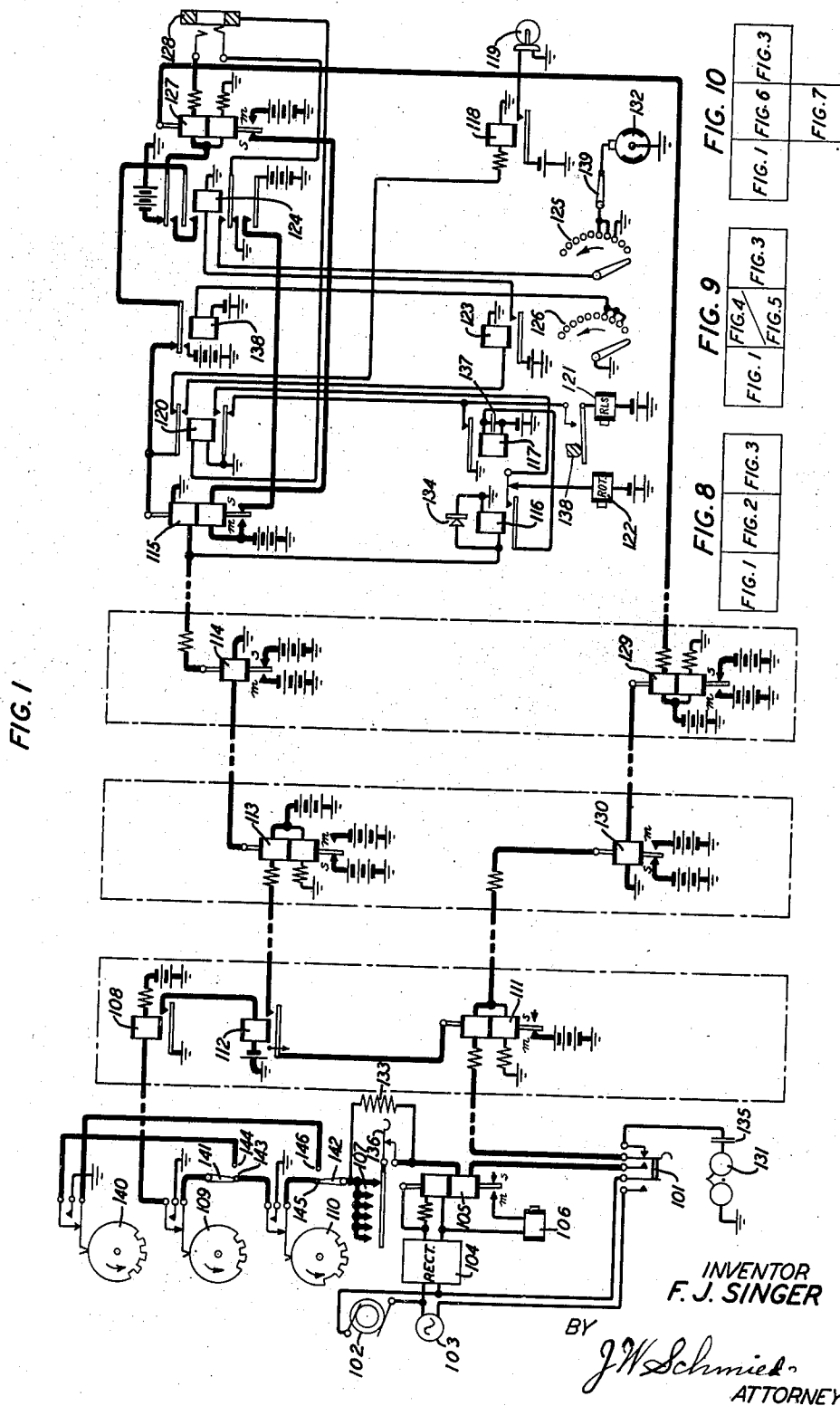
F. J. SINGER

2,211,176

TELEGRAPHIC LINE CIRCUIT

Filed Jan. 26, 1938

6 Sheets-Sheet 1



Aug. 13, 1940.

F. J. SINGER

2,211,176

TELEGRAPHIC LINE CIRCUIT

Filed Jan. 26, 1938

6 Sheets-Sheet 2

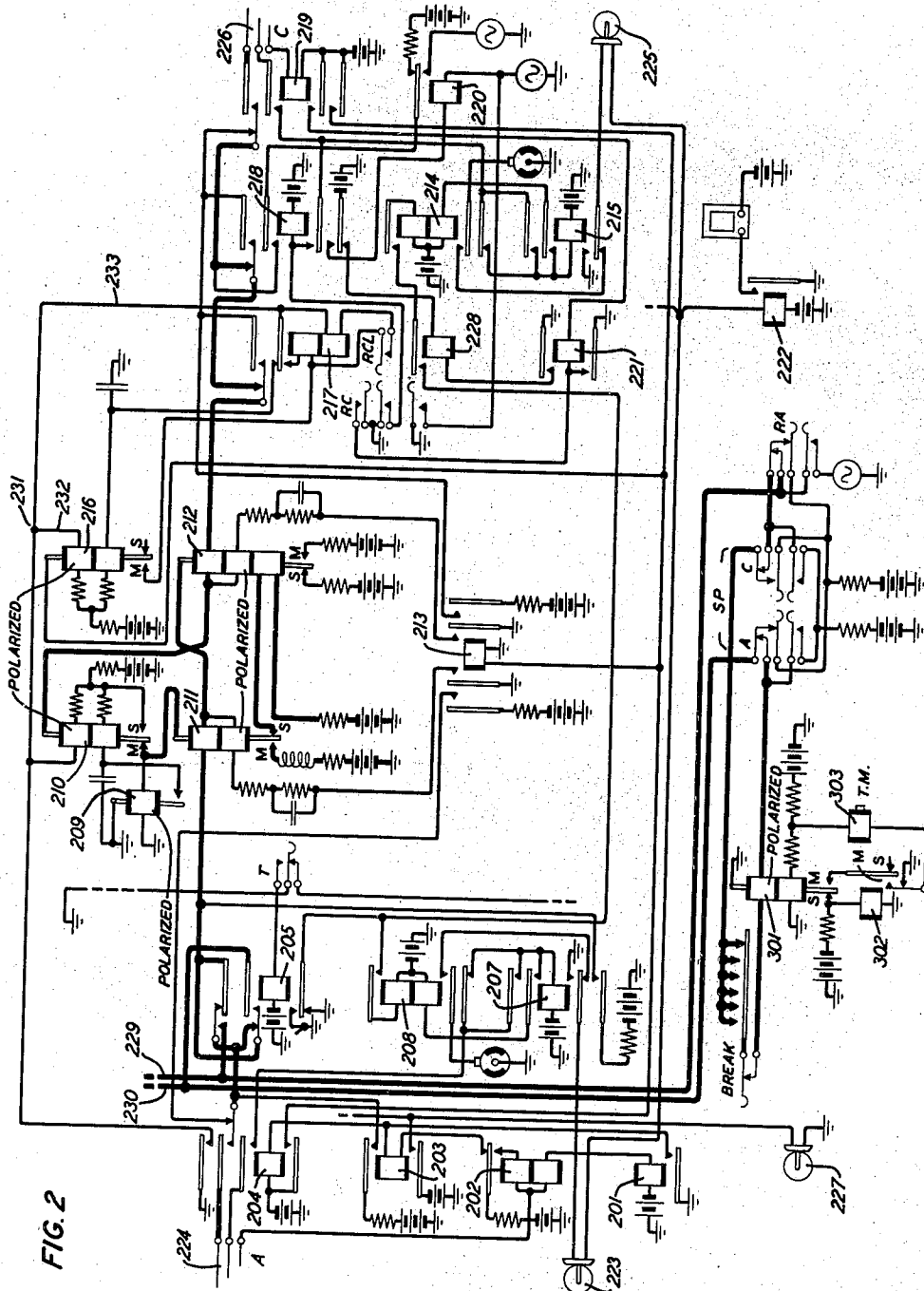


FIG. 2

INVENTOR
F. J. SINGER

BY

J. W. Schmied
ATTORNEY

Aug. 13, 1940.

F. J. SINGER

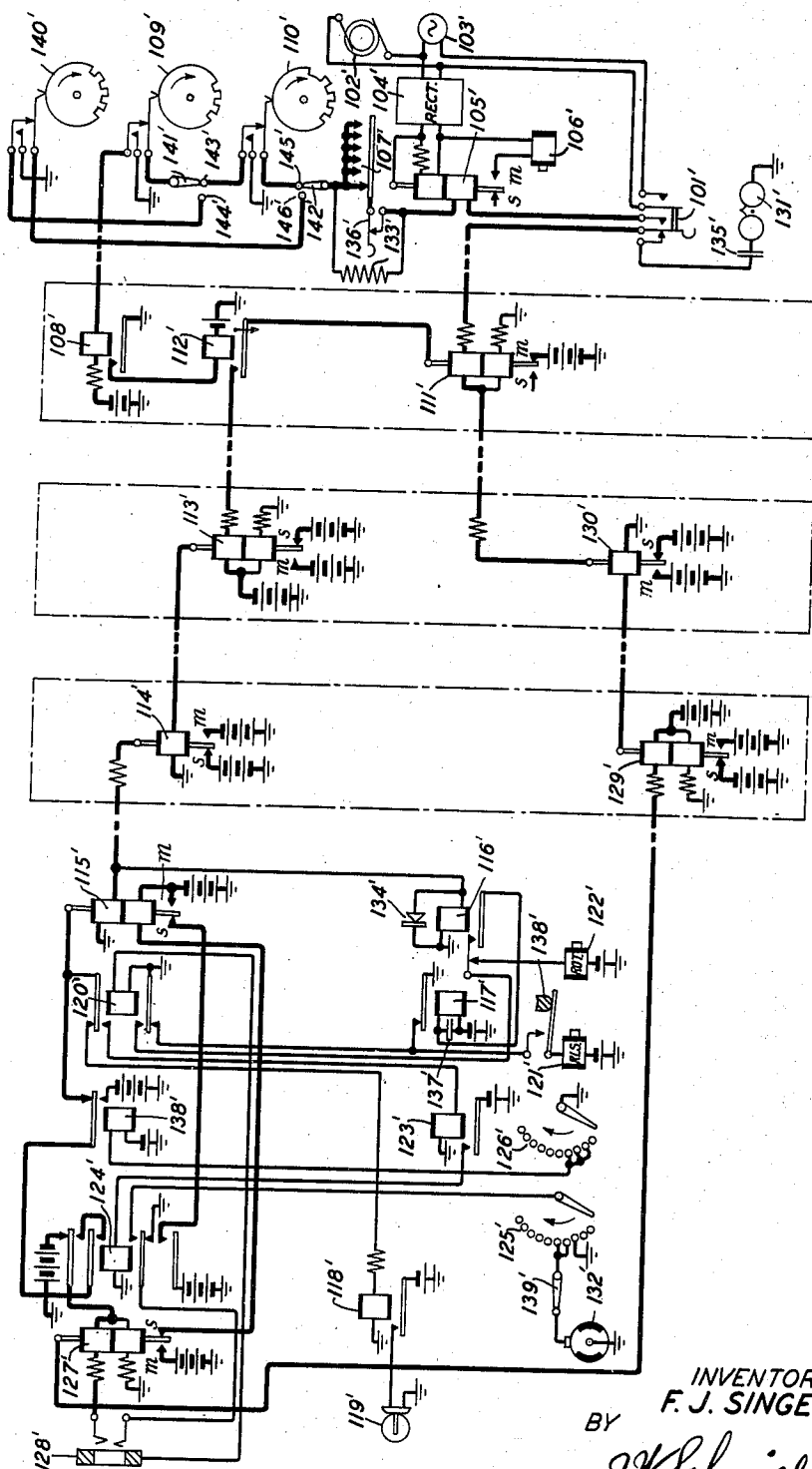
2,211,176

TELEGRAPHIC LINE CIRCUIT

Filed Jan. 26, 1938

6 Sheets-Sheet 3

FIG. 3



INVENTOR
F. J. SINGER
BY
J. W. Schmied
ATTORNEY

Aug. 13, 1940.

F. J. SINGER

2,211,176

TELEGRAPHIC LINE CIRCUIT

Filed Jan. 26, 1938

6 Sheets-Sheet 4

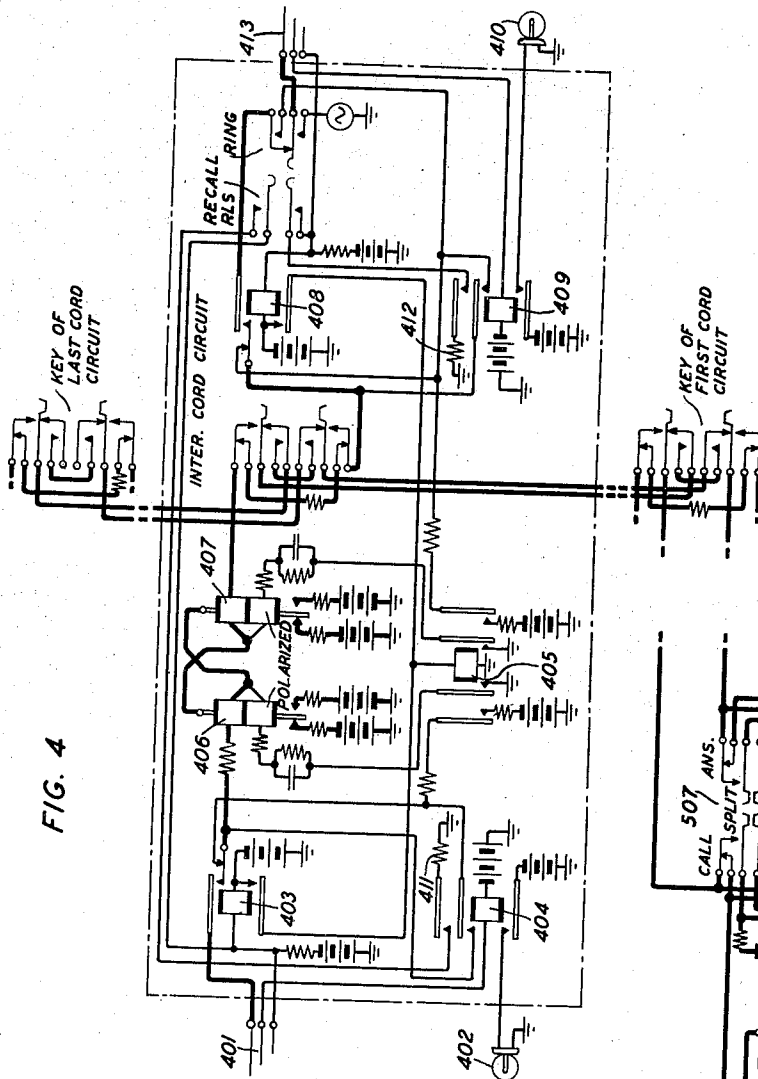


FIG. 4

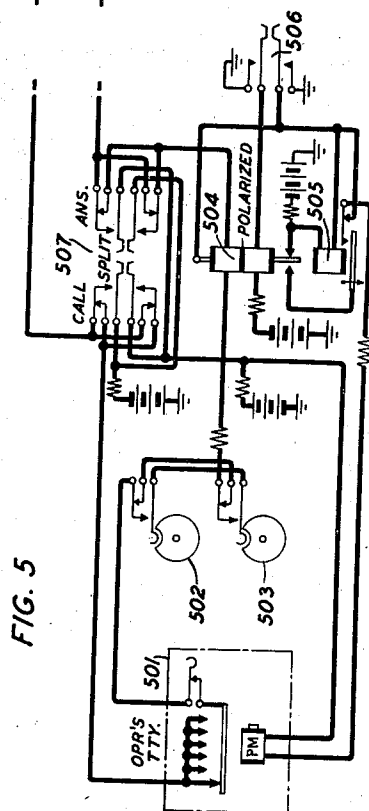


FIG. 5

INVENTOR
F. J. SINGER
BY
J. W. Schmied
ATTORNEY

Aug. 13, 1940.

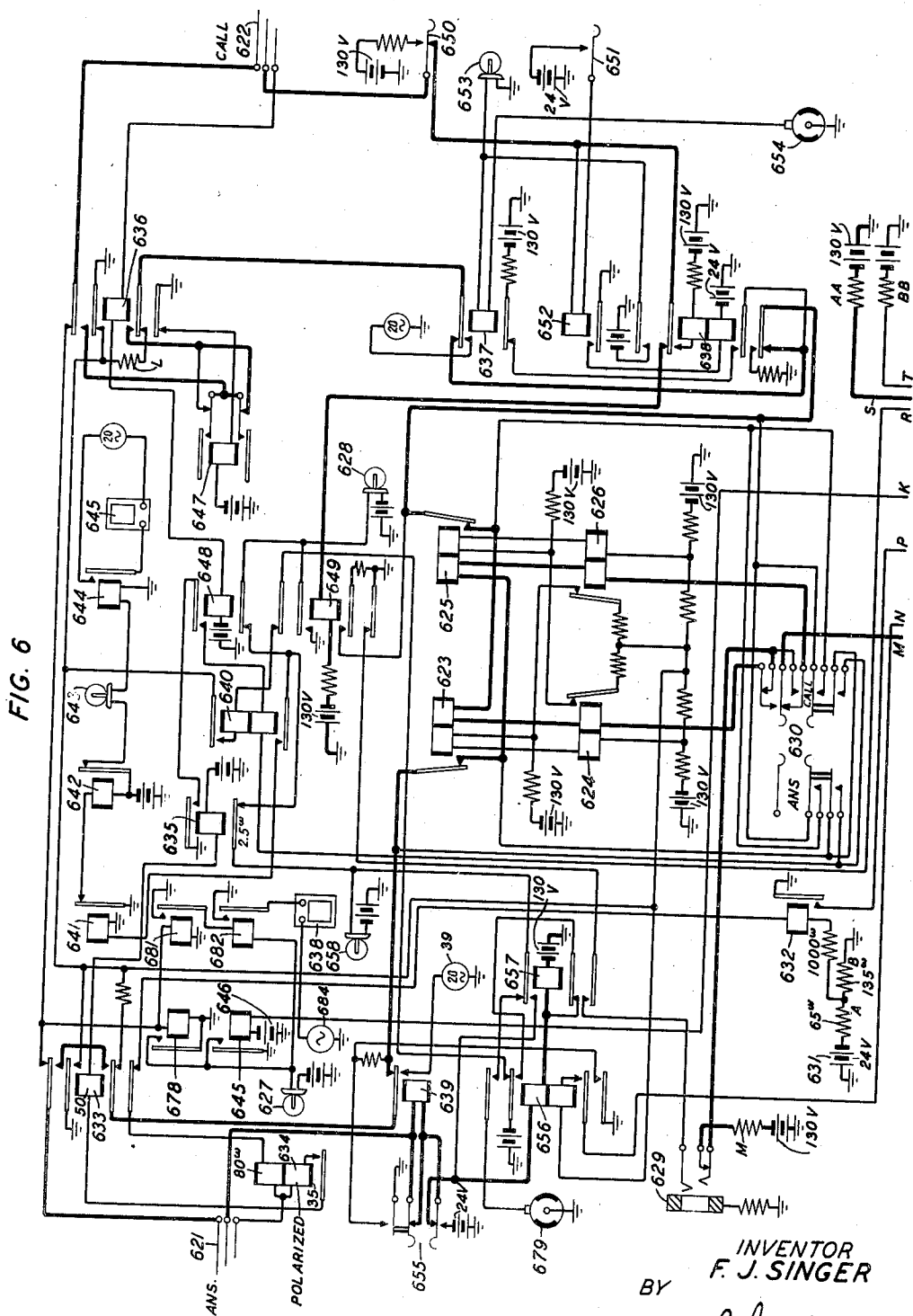
F. J. SINGER

2,211,176

TELEGRAPHIC LINE CIRCUIT

Filed Jan. 26, 1938

6 Sheets-Sheet 5



INVENTOR
F. J. SINGER
BY
J. W. Schmied
ATTORNEY

Aug. 13, 1940.

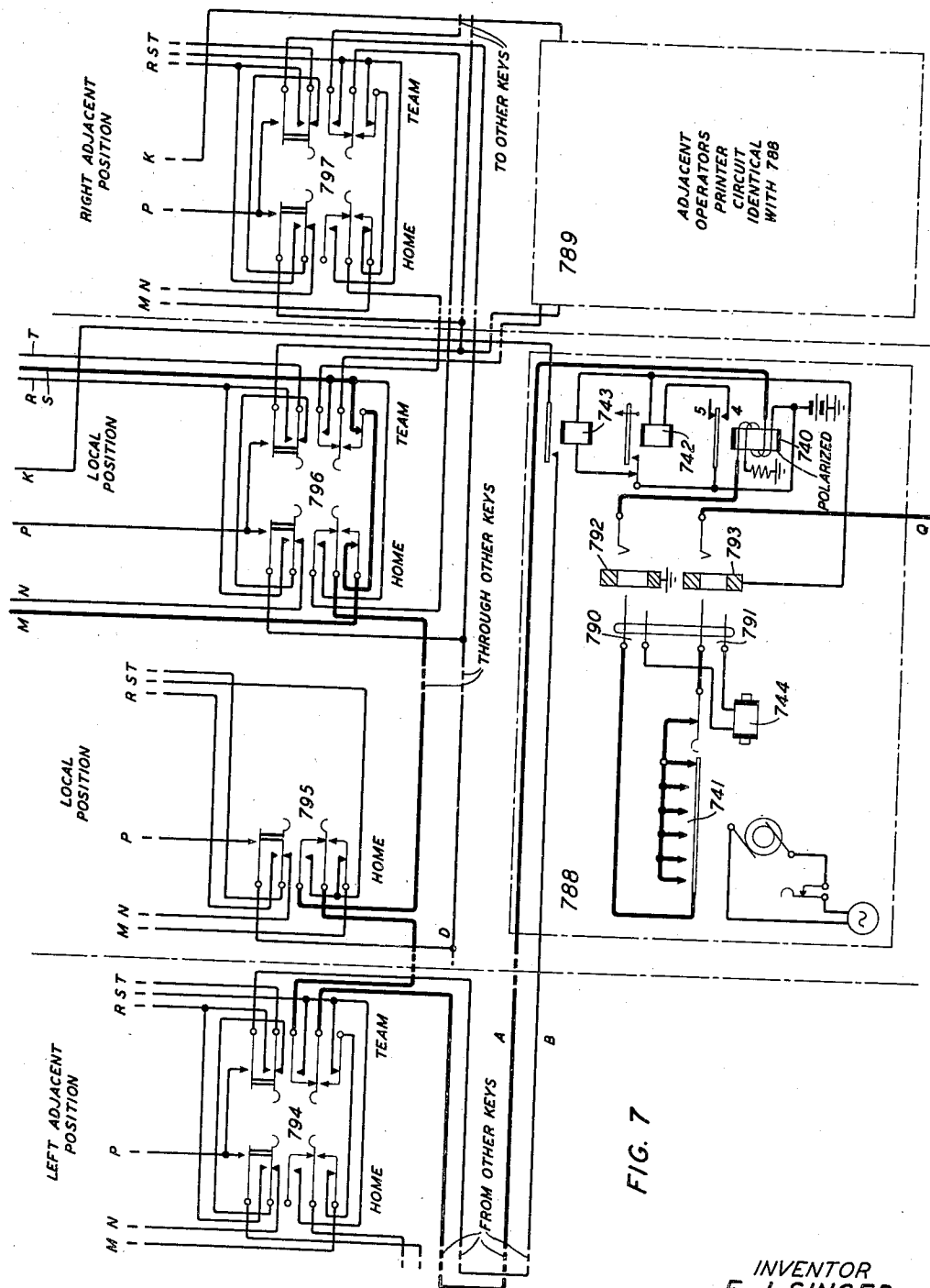
F. J. SINGER

2,211,176

TELEGRAPHIC LINE CIRCUIT

Filed Jan. 26, 1938

6 Sheets-Sheet 6



INVENTOR
F. J. SINGER
BY
J. W. Schmiel
ATTORNEY

UNITED STATES PATENT OFFICE

2,211,176

TELEGRAPHIC LINE CIRCUIT

Fred J. Singer, Rockville Centre, N. Y., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application January 26, 1938, Serial No. 186,963

17 Claims. (Cl. 178-2)

This invention relates to long telegraph or teletypewriter line circuits used to connect remote subscribers' stations to central telegraph or teletypewriter exchanges. These circuits are known in the art as subscribers' toll line extension circuits to distinguish them from simple subscribers' loops.

An object of this invention is to provide improved supervisory features on subscribers' long extension line circuits involving either single or multisection repeaters. It makes use of the full duplex feature of a multisection two-path polar circuit to obtain the desired supervisory signaling arrangements. It is not limited to such a circuit but will function equally well with any full duplex telegraph single or multisection circuit such as carrier, metallic and grounded duplex systems as well as single section two-path polar systems.

In all multisection repeater subscribers' line circuits known to the applicant where the portion of the circuit extending from the subscriber's station to the first repeater point is limited to one pair of wires the system operates on a closed loop basis. That is to say, that portion of the circuit between the station and the first repeater point is closed and current flows continuously through the subscriber's loop. In order to signal the operator at the central station, the subscriber's loop is momentarily opened at the subscriber's station for an interval sufficient to lock in a relay controlling a calling signal, usually a lamp, at the central station. After the relay locks in, the calling signal is no longer under control of the apparatus at the subscriber's station. If the subscriber wishes to abandon the call, he cannot do so before the operator responds at the central station. This objection is overcome by the present invention.

There are other disadvantages to the closed loop. If a continuous break signal is being received at the subscriber's station due to a trouble condition either in the extension circuit or in the connecting circuit beyond the central station, there is no means by which the subscriber operating on a closed loop may signal the central station. The invention herein provides a separate transmitting and receiving channel between the subscriber and the central station. All signaling from the subscriber to the central station is performed over the independent transmitting channel. Therefore, if the transmitting channel is clear, the central office may be signaled during all trouble conditions on the receiving channel or the connecting circuit beyond, except in the case of an open circuit between the subscriber's station

and the first point on the receiving channel where battery is normally applied to the subscriber's loop.

A feature of this invention is that the calling line signal of a multisection repeater telegraph extension line circuit may be operated and restored to the idle condition under complete control of the subscriber's station.

A further feature of this invention is that two generally independent channels are provided connecting the subscriber's station and the central station, one for transmitting and one for receiving. Call, recall and disconnect signaling is performed over the transmitting channel which is substantially independent of the receiving channel. Therefore, the subscriber may signal the central station if his transmitting channel is operative as far as the central station, even though the extension circuit receiving channel and connections beyond the central station may be in trouble.

A further feature of this invention is that whereas signals of various intervals are used for supervisory purposes, discrimination between them is accomplished on the station side of the switchboard while the line beyond is closed, thus preventing possible mutilation of time signals originating in connecting circuits.

A further feature of this invention is the incorporation of the feature of the foregoing paragraph in a subscriber's extension station circuit comprising a plurality of repeater sections.

A further feature of this invention is that while discrimination between the various supervisory signals is accomplished on the line side of the switchboard, "break" signals readily pass between subscriber's station and subscriber's station through the connecting circuits.

A further feature of this invention is that recall and disconnect signals may be transmitted from the subscriber's station to the central station, even though at the same time a "break" signal is being received at the subscriber's station.

The invention will be readily understood from the following detailed description made with reference to the accompanying drawings, in which:

Fig. 1 is a two-path polar multisection repeater telegraph extension line circuit with a subscriber's loop normally open when idle;

Fig. 2 is a cord circuit together with its associated operator's position circuit illustrative of a means of interconnecting Fig. 1 with a connecting circuit. The connecting circuit may be either a second subscriber's line circuit or a trunk

circuit to a second telegraph office. The second line circuit may be either a simple telegraph subscriber's loop circuit or an extension line circuit. The trunk may be either a local or a long distance, frequently called toll trunk to a second central station;

Fig. 3 is identical with Fig. 1, except that it is shown reversed to better illustrate the interconnection of two multisection repeater telegraph extension line circuits when interconnected by means of a cord circuit;

Fig. 4 is a second cord circuit illustrative of a second type of cord with which Fig. 1 and Fig. 3 will function;

Fig. 5 is the operator's position circuit associated with Fig. 4;

Fig. 6 is a third cord circuit illustrative of a third type of cord with which Fig. 1 and Fig. 3 will function. In so far as Fig. 6 cooperates with Fig. 1 and Fig. 3 to provide supervisory signals it is in general similar to the cord of Fig. 2;

Fig. 7 is the operator's position circuit associated with Fig. 6;

Fig. 8 is a diagram indicating in block form the interconnection of Fig. 1 and Fig. 3 by Fig. 2;

Fig. 9 is a diagram indicating in block form the interconnection of Fig. 1 and Fig. 3 by Fig. 4 and Fig. 5; and

Fig. 10 is a diagram indicating in block form the interconnection of Fig. 1 and Fig. 3 by Fig. 6 and Fig. 7.

The connections illustrated involve one central station only. Trunk connections are not shown because it is believed that they are not necessary to an understanding of the present invention.

Refer now to Fig. 1. A two-path polar subscriber's extension line circuit is shown together with its associated terminating circuit. At the extreme left of Fig. 1 a subscriber's station teletypewriter circuit is shown according to the usual conventions. The circuit is shown in the idle condition with the station loop, indicated by the heavy line, open at power switch 101. Key 109 is used to transmit a disconnect signal to the central station. When operated, it opens and closes the associated contacts three times to send a series of three one-half second pulses. Keys 110 and 140 are alternative recall keys. One or the other is connected to the circuit depending upon the type of cord circuit used at the central office to cooperate with Fig. 1. When key 110 is in circuit and operated, it sends a series of four pulses, the first three being one-half second pulses and the fourth a one-second pulse. When key 140 is in circuit and operated, it sends a series of four one-half second pulses. When key 140 is in circuit, switches 141 and 142 are operated to engage contacts 144 and 145, respectively. Only one of the two keys, namely, 110 and 140, is connected into the circuit at a particular time. With switches 141 and 142 in their present positions as indicated on the drawings, namely, in engagement with contacts 143 and 145, respectively, key 110 is connected and key 140 is disconnected. When switches 141 and 142 are operated to engage contacts 144 and 146, respectively, key 140 is connected into the circuit and key 110 is disconnected from the circuit. Interrupter 132 is required only when key 140 is in circuit. Under these circumstances switch 139 is operated so as to connect interrupter 132 to selector bank 125.

The three dotted rectangles to the right of the subscriber's station equipment include relay resistance and battery equipment at successive re-

peater stations intermediate the subscriber's local station and the teletypewriter central switching station..

The equipment to the right of the three dotted rectangles represents the terminating circuit at the teletypewriter central switching station. The component parts of a two-bank selector in the terminating circuit comprise rotary magnet 122, release magnet 121, selector banks 125 and 126 and off-normal springs 138. When rotary magnet 122 is energized, it rotates both of the arms associated with the selector banks 125 and 126 so that the arms make contact successively with corresponding terminals on the banks as far as the rotary magnet drives them. The bank terminals are represented by the two groups of small circles arranged in the form of arcs. Normally, as indicated, the selector arms do not make contact with the bank terminals. When the arms are stepped from the normal position shown, the off-normal springs are actuated to close, extending the circuit from battery through the winding of release magnet 121. When ground is connected to this circuit at the proper juncture, the bank arms are restored to their normal condition.

Fig. 1 is arranged to be operated in either of two ways to provide the flashing lamp recall feature to be described hereinafter. It is arranged so that the flashing lamp in the cord may be operated by an interrupter located either in the extension line circuit or by an interrupter in the cord. With cords such as Fig. 2 and Fig. 6, the interrupter in the extension line circuit, Fig. 1, is not used. With cords such as Fig. 4, the interrupter in the line circuit is used.

The method of operation of Fig. 1 will now be described in detail. The circuit as shown is in the idle condition. During this condition current drains through the biasing windings of relays 127, 129 and 113. Current drains also through the spacing contact of relay 129 and winding of relay 130 and through the spacing contact of relay 113 and winding of relay 114.

A. Subscriber calls

To call, the subscriber at the local teletypewriter station operates power switch 101 to the left to close the two make contacts. Power is supplied from the 110-volt alternating current power source 103 through power switch 101, left-hand make contact to the lower terminal of the rectifier 104 and the upper brush of motor 102 in parallel. From the other side of the power source 103 power is furnished to the upper terminal of rectifier 104 and the lower brush of motor 102. 110-volt alternating current is connected to the teletype motor and to the alternating side of the rectifier. Direct current is connected to the upper or biasing winding of polar relay 105 and to magnet 106. The teletypewriter keyboard is locked open as an open signal is received from the switchboard end of the circuit. The operation of power switch 101 also closes the loop to the nearby central office containing the telegraph repeater. The circuit through ringer 131 is broken at the break contact of power switch 101. We will assume that switches 141 and 142 are on contacts 143 and 145 respectively so that key 110 is in circuit and key 140 is disconnected. Negative 48-volt battery flows through relay 108 winding, disconnect key 109, break contact, recall key 110, break contact, teletypewriter sending contacts 107, lower winding relay 105, right-hand make contact power switch 101, upper wind-

ing relay 111 through the armature and S contact relay 130 to 130-volt negative battery. This current is of about 25 mils and in a direction to operate relay 111 to S but the current through the lower winding relay 111, of about 42 mils, holds the armature on M. Relay 108, however, operates, furnishing ground to relay 112, which also operates.

The operation of relay 112 closes a circuit from positive 130-volt battery through the M contact and armature relay 111, make contact relay 112, upper winding relay 113 to negative 130-volt battery. The current through the upper winding of relay 113, of about 60 mils, opposes the biasing current, of about 30 mils, in the lower winding and the relay operates to M.

Operation of relay 113 to M furnishes 130-volt negative battery to relay 114 winding, operating relay 114 to M. Operation of relay 114 to M closes a circuit from negative 130-volt battery through the upper winding relay 115 to ground and a parallel circuit through relay 116 also to ground, operating both relays. When relay 116 operates it prepares a circuit for the operation of relay 117 from battery through relay 117 winding, armature and front contact relay 116 to the lower front contact relay 120 which is open at this time so that relay 117 does not operate. The operation of relay 115 closes a circuit from negative 130-volt battery through the M contact and armature relay 115, upper armature and back contact relay 120 through relay 118 winding, operating relay 118. The operation of relay 118 lights lamp 119 over an obvious circuit.

B. Operator answers

To answer, the operator inserts the answering plug of a cord circuit which we will assume to be plug 224 of Fig. 2 into jack 128. Battery is supplied through the cord circuit sleeve, jack 128 sleeve to the winding of relay 120, operating the relay. The operation of relay 120 closes a circuit from ground through the lower armature and front contact relay 120, through the front contact and armature relay 116, through relay 117 winding to battery. Relay 117 operates. The operation of relay 117 removes ground from the selector release magnet 121. The operation of relay 120 also prepares a circuit from ground through the lower armature and front contact relay 120 to the open break contact relay 116 for the operation of the selector rotor magnet 122. The operation of relay 120 also breaks the path over which relay 118 was operated at its upper armature and break contact. Relay 118 releases, extinguishing lamp 119. The operation of relay 120 closes a circuit from negative 130-volt battery through the M contact and armature relay 115 through the upper armature and make contact relay 120 and relay 123 winding to ground, operating relay 123. The operation of relay 123 closes a circuit from battery through relay 123 armature and front contact through relay 124 winding to ground, operating relay 124. The operation of relay 124 removes ground from the ring circuit of jack 128 at the lower inner back contact relay 124 and connects the ring through the lower inner armature and front contact relay 124 to the rotor associated with selector bank 125. Operation of relay 124 also connects positive battery through its lower outer armature and front contact to the S contact relay 115. Operation of relay 124 also transfers the apex of relay 127 from 130-volt negative battery at relay 124 upper outer armature and back contact to negative

130-volt battery through the M contact and armature relay 115, back contact and armature relay 138, upper inner armature and front contact and upper outer armature and front contact relay 124.

Since positive battery is connected to the tip of the jack through one side of the cord circuit repeater in the switchboard, current of about 60 mils flows through the upper winding relay 127 over the path last traced to negative 130-volt battery on the M contact relay 115. This current is in a direction to operate relay 127 to its M contact and overcomes the biasing current, about 30 mils, flowing through the lower winding relay 127. Relay 127 therefore operates to M. Operation of relay 127 to M closes a path from 130-volt positive battery through the M contact and armature relay 127 through the upper winding relay 129 to negative battery, operating relay 129 to M. The operation of relay 129 closes a path from 130-volt positive battery through the M contact and armature relay 129 through the winding relay 130 to ground, operating relay 130 to M.

When relay 130 is operated to M positive, 130-volt battery is furnished through the M contact and armature relay 130 to the apex of relay 111 and over the loop heretofore traced to negative 48-volt battery connected to the winding relay 138. This current operates the polar station relay 105 to M and the subscriber at the local station is now in a position to communicate with the operator at the central station. When the subscriber sends a spacing signal from the teletypewriter, the resistance 133 prevents current in the loop from dropping to zero and relay 108 remains operated. The current, however, is of small value and the 42 mils biasing current in the lower winding of relay 111 causes relay 111 to operate to S.

A break circuit is provided from negative 130-volt battery through the lower winding relay 115 to the S contact relay 127 to permit breaking the subscriber if the subscriber is sending. A break key in the subscriber's station loop permits the subscriber to "break" a sender on the switchboard side of the line.

C. Operator calls station

To call the subscriber the operator at the central station inserts the plug associated with the calling end of her cord circuit into jack 128 of Fig. 3. Ground is furnished from the lower inner back contact relay 124' through the associated armature through jack 128' ring into the ring of the cord. This causes a relay in the ring circuit of the cord to operate and light the cord lamp indicating that the subscriber has not yet answered. Since Figs. 1 and 3 function with various types of cords, the operation of the cords is discussed separately below. Battery is furnished over the sleeve circuit of the cord to jack 125' sleeve through relay 120' winding to ground, operating the cord circuit sleeve relay and relay 129'. Positive battery is connected to the tip of jack 128' through the teletypewriter cord circuit repeater in the cord. This positive battery meets negative 130-volt battery through the upper winding of relay 127' from the upper armature and back contact of relay 124'. A current of 60 mils flows through this winding causing relay 127' to operate to M and the cord circuit and operator's teletypewriter to close up. Operation of relay 127' to M causes relay 129' to operate to M which in turn operates relay 130' to M. Relay 130' on operation to M causes relay 111' to op-

erate to M. The operation of relay 111', however, is ineffective to operate relay 113' at this time as relays 112' and 110' are not operated. Relays 113', 114' and 115', therefore, remain on S. Relays 123' and 124' do not operate. The operation of relay 120', previously described, prepared a circuit for the operation of relay 123' but as there is no battery on the S contact of relay 115', as relay 124' is unoperated, relay 123' cannot operate.

The operator rings the station by connection to 105-volt ring current to the tip of the cord. Relays 127', 129', 130' and 111' follow these pulses and ringer 131' ultimately responds from the positive and negative 130-volt reversals through the armature of relay 130', upper winding of relay 111', right-hand break contact of the power switch 131', the switch being unoperated at this time through condenser 135' and the ringer 131' to ground.

The subscriber answers by operating power switch 101'. This closes the station loop circuit operating relays 108' and 112' as heretofore described. Relay 111' stops operating even though ringing pulses are still being sent. Therefore, the positive 130-volt battery is now connected through relay 111' armature, relay 112' contact, through the upper winding of relay 113' to negative battery operating relay 113' to M. In turn, relays 114', 115', 116' and 117' operate. Operation of relay 115' completes the circuit to relay 123' over a path from negative battery through the M contact and armature relay 115', upper armature and front contact of relay 125' through relay 123' winding to ground. The operation of relay 123' furnishes battery through its armature and make contact through relay 124' winding to ground, operating relay 124'. When relay 124' operates ground is removed from the ring circuit at its lower inner back contact and armature and the cord lamp is extinguished, indicating to the operator that the subscriber has answered. Operation of relay 124' also connects positive 130-volt battery to relay 115' S contact. It also replaces holding negative 130-volt battery which has been furnished through the upper outer back contact and armature relay 124' to relay 127' apex by negative 130-volt battery from relay 115' M contact and armature through the back contact and armature relay 133', upper inner armature and front contact relay 124', upper outer front contact and armature relay 124' to relay 127' apex. The circuit is now ready for communication.

D. Subscriber breaks

If during communication the subscriber wishes to stop the sending of the distant subscriber or switchboard operator, he opens his break key 136 for one or more seconds. This causes relay 108 and relay 112 to release. Relays 113, 114, 115 and 116 also release regardless of whether relay 130 is on M or S at this time. Release of relay 115 to S connects positive 130-volt battery through the lower outer armature and front contact relay 124, S contact and armature relay 115, back contact and armature relay 133, upper inner armature and front contact and upper outer front contact and armature relay 124 to relay 127 apex. When the next marking signal is sent from the cord positive 130-volt battery in the cord meets this positive 130-volt battery furnished to the apex of relay 127 and no current will flow in the cord. A "break" is therefore obtained.

About one-third second after relay 114 has

operated to S, relay 116 releases since it is shunted by rectifier 134 which short-circuits it for current from positive 130-volt battery. Release of relay 116 closes a circuit from ground through relay 120, lower armature and front contact, relay 116 break contact through the winding of the selector rotary magnet 122 to battery energizing this magnet. After another one-third second relay 117 releases connecting ground through relay 117, armature and front contact to the contact of the off-normal springs 138 to battery. As the selector off-normal springs 138 are not operated until the selector steps from the normally unoperated position, the release magnet is not energized at this time.

When the subscriber releases break key 136, the loop again closes and relays 108, 112, 113, 114, 115, 116 and 117 reoperate. Operation of relay 116 opens the circuit of selector rotary magnet 22 and the selector rotary arms associated with 20 selector banks 125 and 126 step to the first bank contacts. It will be observed that no electrical operations ensue as a result as no wiring is connected to the first contact on either bank 125 or 126. The off-normal contacts of the selector 138 are operated to furnish battery to the release magnet and as relay 117 is released a path is provided to ground through relay 117 back contact and armature. The release magnet operates to restore the selector to normal. Relay 117 winding is shunted by condenser 137 to slow up the operation of relay 117 sufficiently to prevent its operation after relay 116 operates, before selector rotary magnet 122 has stepped the selector to the first contacts on the banks.

E. Subscriber recalls or disconnects

The subscriber may send a recall or disconnect signal to the switchboard operator after a connection is established by operating recall keys 110 or 140 depending on the type of cord used or disconnect key 109. These signals will be received at the central station regardless of whether the subscriber is at that time receiving a break signal from the line since when either of these keys is operated it controls relay 108. Three one-half second open and close pulses are sent from key 109 for the disconnect signal to the switchboard and three one-half second open and close pulses followed by a long open pulse will be sent from key 110 as a recall signal. When key 140 is used four one-half second open and close pulses are transmitted. For each one-half second open, relays 108 and 112 release, equivalent open or break signals are sent over the line. Since these one-half second opens are not of sufficient length to permit relay 117 at the central office to release because relay 117 does not start releasing until relay 116 has released, the selector release magnet circuit remains open and the selector rotary magnet causes the selector to step in accordance with the signal pulses received. The first open pulse is transmitted through relay 127 to the cord circuit and to the toll line or line circuit beyond depending on the type of connection and it will be long enough to interfere with the long open signals if any are being sent at that time over the toll line. Subsequent one-half second opens will be blocked, however, since relay 138 operates as soon as the selector reaches the second point on selector bank 126 from ground through the selector arm through the second, third or fourth contact on bank 126, through relay 138 winding to battery. Operation of relay 138 cuts and closes relay 127 apex to 130-volt negative

battery so that it no longer responds to relay 115.

If a recall signal is being sent from the station when key 140 is used and the interrupter is in the associated cord circuit, the four open and close pulses cause the selector to step to the fourth point where ground at 60 interruptions per minute is applied from interrupter 132 to the fourth contact of selector bank 125 and the selector arm associated therewith through the lower inner front contact and armature relay 124 to the ring of jack 128 and thence to the ring of the cord circuit. This circuit causes the cord lamp to flash. To extinguish the lamp the operator momentarily shunts relay 120 by operating a key in the cord. The shunting of relay 120 releases it and furnishes ground to the selector release magnet through relay 120 lower armature and front contact. The selector, therefore, restores to normal.

If, however, key 110 is being used, when the extension circuit is functioning with a cord having an interrupter, at the end of the third pulse transmitted by key 110 the selector will have stepped to the third point on the banks. Ground will be furnished through the third contact on bank 125 through the lower inner front contact and armature of relay 124 to the ring of jack 128. On the next pulse, which will be long, relay 116 will release, the selector will step to the fourth point on the bank. Then relay 117 will release and the selector will be returned to normal. As soon as the selector leaves the third point, ground will be removed from the ring of the cord and the cord lamp will flash. The operation in the cord will be further described below.

If a disconnect signal is being sent from the station, the three open and close pulses cause the selector to step to the third contacts on the banks. Permanent ground is furnished through the third contact on selector bank 125 through the associated selector bank arm, lower inner front contact and armature relay 124, over the ring of jack 128, to the ring of the cord circuit connected thereto. This ground causes the cord lamp to burn steadily. The operator thereupon pulls down the cord, releasing relay 120 and in turn selector release magnet 121 is energized and the selector is restored to normal.

Reference to Fig. 1 and the foregoing description indicate that the tip conductor at jack 128 herein is used for transmitting the positive and negative battery communication signals and the break signal which is a relatively long pulse of positive battery. The ring conductor herein at jack 128 is used for supervisory purposes. It is arranged to furnish steady ground to a lamp relay in the ring of any cooperating cord as a disconnect signal. As to the recall signal, the ring is arranged to furnish interrupted ground to the same cord lamp relay directly in one type of cooperating cord to provide a flashing lamp, or to furnish temporary ground followed by an open to a second type of cooperating cord to transfer the cord flashing lamp from the steady lamp disconnect relay to a relay supplying interrupted ground in a manner well-known in the art. The sleeve of the jack furnishes ground through relay 120 winding to cooperate with a cord supplying battery directly or through relay windings or contacts to perform such cord functions as may be required.

It will be observed that the ring circuit at the jack which controls supervision is independent of the receiving branch of the line circuit. This permits the subscriber to receive a break signal

which could result from a trouble condition in connecting circuits without interfering with a recall or disconnect signal sent by him to the local operator.

Further recall and disconnect signals, though generated on a time basis in the tip loop conductors on the subscribers' side of the switchboard, do not involve protracted tying up of circuits beyond the switchboard as they are translated into conditions furnished to the ring of the jack circuit. Hence, there is no mutilation of recall or disconnect signals transmitted between switchboard operators on toll connections.

It is apparent from the above, that timed supervisory signals generated at the local station are transmitted over one of the subscribers' loop conductors to the central station at which the switchboard is located. There the timed signals are translated into conditions applied to a connecting conductor other than the conductor used to transmit communication and break signals, while the transmission circuit is closed. The conductor to which the conditions have been applied is used to control a supervisory signal circuit local to the switchboard.

The long telegraph or teletypewriter line circuit disclosed herein therefore will function with any of a number of cord circuits arranged to cooperate with the three conductors comprising the jack circuit herein, by arranging the corresponding cord conductors to cooperate with the conditions supplied to the long line circuit jack in any of many manners well known in the art.

In Figs. 8, 9 and 10, the line circuit of this invention is shown cooperating with three different types of cord circuits, together with their respective position circuits. In Fig. 2, the cord and position circuit are included in the one figure. Fig. 4 shows a second type of cord and Fig. 5 its associate position circuit. Fig. 6 shows a third type of cord and Fig. 7 its associated position circuit. These cord and position circuits, in cooperating with the extension line circuit of this invention, function in their usual well-known manner, but their operation will now be described as far as it is necessary to show their relationship to the new circuit of this invention.

In the case of Fig. 8, when Fig. 2 is used with Fig. 1 and Fig. 3, before plug 224 of Fig. 2 is inserted in jack 128 of Fig. 1, in response to the lighted signal lamp, 119, the typing key T is operated to its upper contact. Relay 205 operates from ground through the key armature and upper contact, winding relay 205 to battery, connecting the operator's position circuit to the cord. The transmission circuit is open, however, since relays 204 and 213 are not operated. Relay 301 is on its S contact under control of current through its lower winding. Relay winding 302 is short-circuited and the teletypewriter magnet 303 is closed, preventing the teletypewriter mechanism from spinning. Since the transmission circuit is open operating the position circuit teletypewriter keyboard contacts has no effect on the mechanism.

The operator inserts the answering cord plug 224 into the extension station line jack 128 of Fig. 1 to answer the call. Relays 201 and 202 in the answering cord and relay 120 in the station line circuit are connected in series and operate over a circuit from battery, through relay 201 winding, lower winding relay 202, sleeve of plug 224, sleeve of jack 128, winding of relay 120 to ground. All three relays operate. The sequence of events in the extension line circuit

following the operation of relay 126 has been heretofore described. In the cord circuit per Fig. 2, the operation of relay 201 closes a circuit to relay 204 which operates. Operation of relay 202 removes battery from relay 203 winding, preventing it from operating even though relay 201 has operated.

When relay 204 operates, the ring circuit of jack 123 is connected through the lower break contact of relay 208 to relay 207 winding. Relay 207 does not operate since relay 124 in the extension line circuit is operated removing ground from the ring.

The operation of relay 204 also connects the tip circuit of jack 123 through the tip of plug 226, make-before-break contact of relay 204, top outer make-before-break contact of relay 205, conductor 229, break contacts of ringing key RA, break contacts of C portion of splitting key, SP, teletypewriter keyboard contacts, break key, upper winding relay 301, break contact of A portion of splitting key, SP, conductor 230, top inner armature and front contact relay 205, upper winding relay 211, to positive battery through M contact of relay 212. The transmission circuit to the extension circuit is therefore closed from negative battery on the armature of relay 115 to positive battery on the contact of relay 212. The station and operator's teletypewriters are connected. Relay 301 operates to M and relay 302 operates. The operator's keyboard is no longer locked and the magnet is under control of relay 301. The operator and station subscriber may now communicate. Relay 204 also closed a circuit from battery through its bottom armature and front contact through relay 213 winding to ground operating relay 213. Relay 204 also closed a circuit from ground through its outer armature and front contact through the top winding of relay 210 to positive battery. It also closed a circuit from ground through the same top outer armature and front contact to both windings of relay 210, the circuit through the bottom winding being extended from junction point 231 over conductor 233, through the top inner armature and back contact of relay 217 through relay 216 bottom winding to positive battery. Relay 209 operates when relay 211 operates to M and connects ground to the bottom winding of relay 210. Since the ampere turns through the bottom winding of relay 210 are greater than those through its top winding relay 210 operates to M, even though the current through the top winding is in a direction to operate to S. Relay 216 operates to M since ampere turns through its top winding are greater than through its bottom winding.

Operation of relay 213 connects ground to the bottom winding of relay 211 and the middle winding of relay 212 through the left and right and inner armatures and front contacts respectively. Relay 213 also connects negative battery through its right and outer armature and front contact upper outer break contacts of relay 219, upper outer break contacts of relay 210 and 217 to the top winding of relay 212. The current through the bottom winding of relay 211 and middle of relay 212 are in a direction to cause these relays to operate to S. The currents through the top windings of these relays are in a direction to hold the relays on M and since the effective ampere turns in the top windings are twice as great as those in the bottom winding of relay 211 and middle winding of relay 212

the armatures of relays 211 and 212 remain on their M contacts.

Since the extension line circuit is multiplied throughout the switchboard, there may be several operators attempting to answer the call when the line lamp 119 lights. The cord relays 202 and 203 in the cord which establishes the connection prevent this from happening. When several cords are plugged in simultaneously, one cord makes the connection and relays 201 and 202 operate as described above. As soon as relay 202 has operated, a low resistance battery shunt through the top winding of relay 202 is connected to the sleeve of plug 224. This shunt raises the potential of the sleeve to a value which prevents the 202 relays of other cords from operating. The 201 and 202 relays, in the cord which has become connected, remain operated. In each of the other cords relay 201 only operates and its operation causes relays 203 and 204 to operate. Relay 204 operates over a path from ground through the armature and front contact of relay 201, through 204 winding to battery. Relay 203 operates from ground through the same armature and front contact of relay 201 through the winding of relay 203 back contact and armature of relay 202 to battery. In each of these cords, positive battery is therefore connected to the tip circuit through the upper armature and front contact of relay 203 and the upper middle armature and front contact of relay 204. This potential is equal to that established from the M contact of relay 212. The top winding of relay 301 in each of these operator's position circuits is therefore shunted and does not operate to M. Relay 302 does not operate and the keyboard is locked. The positive battery connected to the tip circuit in each of the lock-out cords also shunts out the 301 relay in the operator's position circuit of the cord that has obtained the connection and that operator cannot communicate. Since relay 203 is not operated in the cord which establishes the connection, but is operated in all other cords in the multiple, the position pilot lamps, 227, of the interfering cords are lighted. These operators then remove their cords. When all interfering cords have been removed, the remaining cord can be used by the operator to communicate with the subscriber.

After the calling subscriber has passed the number of the called subscriber's station to the teletypewriter switchboard operator, the operator is ready to complete the call. She first tests the called subscriber's line in the well-known manner to see if it is busy at another operator's position. The well-known busy test connections in the cord are not shown. If the subscriber's line is not busy, the operator first operates her typing key T and then inserts plug 226 of Fig. 2 into jack 128' of Fig. 3. Fig. 3 and Fig. 1 are identical except that as an aid in visualizing the interconnection, the calling line, the cord, and the called line have been indicated as a chain connection of three figures by reversing Fig. 1 and assigning to it a new figure number, Fig. 3, when it serves in the capacity of a called line. Similar apparatus in the two figures is distinguished by adding the symbol indicating "prime" to Fig. 3 apparatus.

When plug 226 is inserted in jack 128' a circuit is established from battery through relay 219 winding, in Fig. 2, through plug 226 sleeve, the sleeve of jack 128', Fig. 3, through relay 129' winding to ground. Relays 219 and 120' operate. When relay 219 operates the tip of the cord

is cut through the upper outer armature and make contact of relay 219, the upper outer break contact of relay 218, the upper outer break contacts of relay 217, top winding relay 212, armature and M contact relay 210, armature and M contact relay 211 to positive battery. In the subscriber's extension line circuit the tip circuit for this condition has heretofore been traced through the upper winding of relay 127', upper outer armature and break contact of relay 124' to negative battery. Relay 212 in Fig. 2 remains on M and relay 127' in Fig. 3 operates to M. The sequence of events which occur in the line circuit, Fig. 3, after the operation of relay 127' to M, has heretofore been described. The ring circuit is now extended from the lower inner break contact and armature of relay 124', through the ring of jack 128', ring of plug 226, upper inner armature and make contact of relay 219, lower outer armature and break contact of relay 214, through the winding of relay 215 to battery operating relay 215. The operation of relay 215, completes a circuit from ground on the lower make contact of relay 215, through the lower armature relay 215, filament lamp 225, through the winding of relay 222 to battery, operating relay 222 and lighting lamp 225 as a signal that the subscriber on the extension line circuit has not yet answered. Relay 222 operated, actuates an audible signal. The operation of relay 215 operates relay 214 from battery, through relay 214 lower winding, through the upper inner armature and make contact of relay 215, through the upper outer armature and make contact, relay 215, through the front contact and upper inner armature of relay 226, through the ring of plug 226, to ground on the lower inner armature and back contact of relay 124'. With relay 214 operated the 60 I. P. M. ground connected through the lower inner armature and front contact cannot flash lamp 225 as relay 215 is operated and direct ground is furnished to the lamp on the front contact associated with relay 215 lower armature instead of the interrupted ground on relay 215 lower armature back contact which functions on recall.

The operator is now ready to ring the called station. To do this the operator operates key RC momentarily. When key RC is operated a circuit is closed from ground, through the upper left-hand armature and front contact of the key, winding of relay 221, front contact and lower inner armature relay 219 to battery. Relay 221 locks from ground through its lower armature and front contact. With relay 221 operated, a circuit is prepared for the operation of relay 228, but this relay does not operate as relay 218 was also operated when key RC was operated from ground through the lower armature and front contact key RC through relay 218 winding to battery. Relay 218 locks from battery through its winding, front contact and lower inner armature relay 218, front contact and upper inner armature relay 219, ring of plug 226 to ground through the lower inner armature and back contact of relay 124'.

With relay 218 operated and locked, relay 228 is prevented from operating. The transmission circuit of the cord is cut and closed toward the calling station and a circuit is established for the operation of ringing relay 220 from battery through the lower outer armature and front contact of relay 218 through relay 220 winding to ground. Relay 220 is connected to a machine ringing generator which applies ground to the

circuit for two seconds and then opens the circuit for four seconds. With relay 218 operated, relay 220 remains operated for two seconds out of every cycle of six seconds duration. During the two second period when relay 220 is operated, a source of twenty cycle alternating current is applied from ground through the front contact and armature of relay 220, top inner armature and front contact of relay 218, front contact and top outer armature of relay 219 to the tip of plug 226. During the four second period while armature 220 is released, positive battery is supplied through a resistance to the back contact and armature of relay 220 over the path last traced to the plug 226. The ringing path in the extension line circuit has heretofore been described. As has been described heretofore, also, the subscriber responds by operating his power switch 101' to the left closing the station loop. A chain of operations heretofore described is set in motion culminating in the extension circuit in the operation of relay 124' which removes ground from the ring of jack 128'. This releases relays 215, 214, 218 and 220 in the cord, Fig. 2, extinguishing the lamp, stopping the ringing and cutting the transmitting path in the cord through so that the subscribers may communicate.

During normal communication between the calling and called subscribers, marking and spacing signals are sent to and fro between the stations. When signals are sent from the calling station the following relays respond to the signals:

Fig. 1—111, 113, 114 and 115

Fig. 2—209 and 211

Fig. 3—127', 129', 130' and 105'

When signals are sent from the called station the following relays respond to the signals:

Fig. 3—111', 113', 114' and 115'

Fig. 2—212

Fig. 1—127, 129, 130 and 105

The manner in which Fig. 2 cooperates with Figs. 1 and 3 when a break signal is sent from the called station to the calling station will now be described.

We have seen in the description of the operation of the extension line circuit that when a break signal is sent from a station, positive battery is connected to the tip of the line jack. For this condition, therefore, positive battery will be connected to the tip of jack 128' of Fig. 3. This circuit is extended through the tip of plug 226, the upper armature and front contact of relay 219, the break and front contacts associated with the upper armatures of relays 218 and 217, the upper winding of relay 212, relay 210 armature and M contact to relay 211 armature. When the calling subscriber sends the next marking signal relay 211 operates to M. Positive battery meets positive battery. The current through the top winding of relay 212 is reduced to zero. The current through the middle winding of relay 212 still persists and relay 212 is operated to S before relay 211 can leave its M contact. With relay 212 on its S contact negative battery on the armature of relay 212 is connected to the tip of the calling end of the cord through the plug and jack to meet negative battery on the M contact of relay 115 in Fig. 1. Negative battery meets negative battery on each side of the upper winding of relay 127. The current through the winding is reduced to zero and relay 127 is operated to its S contact under the influence

of its lower winding. In turn relays 129 and 130 operate to S and the calling station is broken.

When a break signal is sent from the calling station to the called station, when relay 115 operates to its spacing contact as described heretofore, positive battery is connected to the tip of jack 128 in Fig. 1, thence through relay 211 upper winding to relay 212 armature. When the next marking signal is sent by the called station, Fig. 3, relay 212 operates to M. Positive battery is connected to each end of relay 211 upper winding. The current in the winding drops to zero and relay 211 operates to its S contact under the influence of its lower winding. Negative battery is connected through relay 211 armature over the tip of the calling cord through the tip of plug 226, tip of jack 128' to meet negative battery on the marking contact of relay 115'. The current through the upper winding of relay 127' is reduced to zero. Relay 127' operates to spacing and the break signal is propagated to the called station in a manner similar to that described above for the break signal from the called to the calling station.

Now the manner in which the cord circuit per Fig. 2 cooperates with Fig. 1 for a recall signal between the calling subscriber and the operator will be described.

We have seen that when the calling subscriber sends a recall signal when Fig. 1 is cooperating with a cord of the type of Fig. 2, wherein the interrupter which performs the flashing is located in the cord itself rather than in the extension line circuit, the interrupter 132 in Fig. 1 is omitted by opening switch 139. Key 110 is cut into the circuit in Fig. 1 by operating switch 141 to contact 143 and switch 142 to contact 145. Under these circumstances we have seen that operation of recall key 110 sends four open pulses, the fourth pulse being long. A momentary ground from the third contact on bank 125 was connected to the ring of jack 128 followed by an open. When the ground is connected to the ring of jack 128 it is extended through the ring of plug 224, through the upper inner armature and make contact of relay 204 which is operated at this time, through the lower outer armature and back contact of relay 208, which is unoperated, to relay 207 winding, operating relay 207. When relay 207 operates a circuit is closed from the same ground which operated relay 207 through the lower inner front contact and armature of relay 207 through relay 208 lower winding to battery operating relay 208. When relay 208 operates it locks from battery through relay 208 upper winding, upper armature and front contact relay 208, lower armature and back contact relay 205 to ground. Relay 207 then releases because the ground is removed from the ring circuit at the end of the pulsing period. Ground is connected through the interrupter to the lower inner armature and front contact of relay 208, through the lower inner back contact and armature of relay 207, through the filament of lamp 223 through relay 222 winding to battery flashing lamp 223, indicating a recall by the calling subscriber. The operator operates her typing key operating relay 205 and breaking the locking path of relay 208, extinguishing the lamp.

If a disconnect signal is sent by the calling subscriber, we have seen that a permanent ground is connected to the ring of jack 128 and by the circuit heretofore traced to relay 207. Relay 207 remains operated and permanent ground instead of interrupted ground is connected through the

lower inner front contact and armature of relay 207 to the lamp. The lamp burns steadily as a disconnect signal.

On the calling end of the cord similarly when the extension circuit Fig. 3 is connected to Fig. 2, the temporary ground for a recall signal operates relay 215 which in turn operates relay 214, which connects interrupted ground through the lower back contact and armature of relay 215 to lamp 225, which flashes, indicating a recall from the called subscriber. For a disconnect relay 215 remains operated lighting lamp 225 steadily as a signal that the called subscriber has disconnected.

The above will serve to describe how the cord per Fig. 2 cooperates with the subscriber's extension line circuit of this invention.

In the case of the cords per Figs. 4 and 6 and their respective operators' circuits per Figs. 5 and 7, which can also function with this invention, it will not be necessary to an understanding of the invention herein to describe their operation in detail as in cooperating with the extension line circuit per Fig. 1 or Fig. 3 they function in their well-known manner but we will describe them now in a general way.

As explained above, Fig. 4 is a well-known cord circuit and Fig. 5 its position circuit which will function with the circuit of this invention. When cord circuits of the type of Fig. 4 are used, the interrupter which is used for flashing the lamp for the recall signal is connected to the line circuit, since there is no interrupter in the cord. Key 140 is used in Fig. 1 by operating switches 141 to contact 144 and 142 to contact 146. Key 110 is disconnected. For recall four equal length short open and close pulses are sent by key 140. The selector is stepped to the fourth point on the banks. The interrupter 132 is connected to the fourth point of bank 125 as switch 139 is closed. As relay 124 is operated the circuit from interrupted ground is extended through the lower inner front contact and armature of relay 124 to the ring of jack 128, through relay 404 winding to battery. Relay 404 operates and releases intermittently following the interruptions flashing lamp 402 over an obvious circuit. In the case of the calling cord when the called subscriber recalls, relay 409 follows the interruptions and lamp 410 flashes.

To stop the flashing on the calling cord the operator momentarily operates the recall release key. Prior to this operation the sleeve circuit of the answering end of the circuit extends from ground through relay 120 winding in Fig. 1, through the sleeve of jack 128, through the sleeve of plug 401 through the winding of relay 403 to battery. When the key is closed the path through relay 120 winding in Fig. 1 is shunted through the upper outer make contact and armature of relay 404 as it operates through low resistance 411 to ground. Relay 120 in Fig. 1 momentarily releases, furnishing ground to the selector release magnet which restores the selector to normal, breaking the interrupter path and stopping the flashing.

On the calling end of the cord a similar shunting path is provided when the recall release key is operated through the upper outer front contact and armature of relay 409 as it operates through resistance 412 to ground.

In performing these functions and all other functions involved in this connection the cord per Fig. 4 and its associated position circuit, Fig. 5, operate in their usual well-known manner and further description of it is therefore consid-

ered unnecessary as the various cord and position circuits are not parts of this invention.

Fig. 6 is a third well-known type of cord and Fig. 7 its associated position circuit with which the subscriber's extension line circuit of this invention will function. As far as its relation to the extension line circuit supervisory features is concerned, the operation of the cord per Fig. 6 is in general similar to the operation of the cord per Fig. 2 described above and it will therefore not be described in detail here.

What is claimed is:

1. A multisection repeater telegraph extension line circuit comprising a local telegraph station and a terminating circuit with a multisection repeater therebetween, control means at the local station for generating electric impulse trains of different lengths, means in said repeater for propagating said trains, and means in the terminating circuit for discriminating between the trains.

2. A multisection repeater telegraph extension line circuit comprising a local telegraph station and a terminating circuit with a multisection repeater therebetween, interrupter control means at said local station for generating electric impulse trains of different lengths, means in said repeater for propagating said trains, and relay and selector means in said terminating circuit for discriminating between the trains.

3. A multisection repeater telegraph extension line circuit comprising a local telegraph station and a terminating circuit with a multisection repeater therebetween, control means at said local station for generating electric impulse trains of different lengths, means in said repeater for propagating said trains, means in the terminating circuit for discriminating between the trains, and translating means in the terminating circuit operating to translate said trains into signals of a different character for transmission beyond the terminating circuit.

4. A two-path polar subscriber's line extension circuit comprising a local telegraph station and a terminating circuit with a multisection repeater therebetween, control means in said station circuit for generating trains of electric impulses of different lengths, means in said repeater for propagating said trains, and means in said terminating circuit for discriminating between the trains.

5. A two-path polar subscriber's line extension circuit comprising a local telegraph station and a terminating circuit, interrupter control means at said local station for generating trains of electric impulse of different lengths, and relay means in said terminating circuit for translating said impulse trains into signals different in length from the original impulse trains.

6. A two-path polar subscriber's line extension circuit comprising at least one repeater section intermediate a local telegraph station and a terminating circuit, each connected to said extension circuit, signal control means in said local station operating to generate trains of electric impulse of different lengths, relay and selector means in said terminating circuit discriminating between said impulse trains, and relay means also in said terminating circuit to translate said trains and relay means therein to propagate signals differing in character from the original impulse trains to a connecting circuit.

7. A multisection repeater telegraph extension line circuit comprising a local telegraph station

and a central telegraph station terminating circuit, a jack circuit in said terminating circuit arranged to connect to a cooperating circuit, supervisory signal control means in the local telegraph station for generating a supervisory signal of a fixed duration, and relay and selector means in the terminating circuit for changing the duration of the supervisory signal before it is propagated to said cooperating circuit.

8. A multisection repeater telegraph extension line circuit comprising a local telegraph station and a terminating circuit, said line circuit arranged to connect with a cooperating circuit, supervisory signal control means in said telegraph station arranged to propagate recall signals, and independent relay means in said line circuit for receiving break signals propagated simultaneously from said cooperating circuit.

9. A multisection repeater telegraph extension line circuit comprising a local telegraph station and a terminating circuit, means for connecting said line circuit with a cooperating circuit, supervisory signal control means in said telegraph station arranged to propagate disconnect signals, and independent relay means in said line circuit for receiving break signals propagated simultaneously from said cooperating circuit.

10. A multisection repeater telegraph extension line circuit comprising a local telegraph station and a terminating circuit, means for connecting said line circuit with a cooperating circuit, break signal control means in said station for generating an electric impulse of specific duration, supervisory signal control means also in said station for generating a train of electric impulses, relay and selector means in said terminating circuit for translating a supervisory impulse train into a signal of different length before propagation to said cooperating circuit, and relay means also in said circuit for propagating a break signal to the cooperating circuit of substantially the same duration as the generated break signal.

11. A multisection repeater telegraph extension line circuit comprising a local telegraph station loop circuit and a central telegraph station line circuit with a multisection telegraph repeater therebetween, said local telegraph station loop circuit being normally open when idle, a signal in said line circuit for indicating that said local station is calling, means in said circuits for operating said signal in response to the closing of said loop, and means under control of said local station for restoring said signal to its unoperated condition in response to the reopening of said loop.

12. A central telegraph switching station, a local telegraph station, a multisection telegraph repeater circuit connecting said stations, a line signal connected to said circuit at said central station, signal control means at said local station for operating said signal to indicate that said local station is calling, and signal control means also at said local station for restoring said signal to the unoperated condition.

13. A subscriber's telegraph station, a central telegraph station, a first telegraph repeater station intermediate said subscriber's station and said central station, a two-conductor telegraph loop circuit, normally open when idle, connecting said subscriber's station and said first repeater station, a two-channel telegraph circuit extending said loop circuit from said first repeater station through a plurality of intermediate repeater

stations in tandem, to said central station, a station calling signal connected to said loop at said subscriber's station, and calling signal control means connected to said two-channel circuit at said central station for operating said calling signal as an indication to said subscriber's station to close said loop.

14. A central telegraph station and a plurality of telegraph repeater stations, a two-channel telegraph circuit connecting said stations in tandem, a subscriber's station remote from said central station, a two-conductor telegraph loop circuit, normally open when idle, connecting said subscriber's station to the repeater station most remote from said central station to form with said telegraph circuit a multisection repeater subscriber's telegraph extension line circuit, and a source of power at said most remote repeater station connected to said loop when said loop circuit is closed.

15. A subscriber's telegraph station, a central telegraph station, a plurality of telegraph repeaters in tandem intermediate said stations, a two-wire telegraph loop circuit, normally open when idle, connecting said subscriber's station and its nearest repeater station, independent transmitting and receiving telegraph channels extending said loop through said repeaters to said central station, relay means connected to said loop at said subscriber's station for receiving a break signal, supervisory signal control means connected to said loop at said subscriber's station for operating supervisory signal means connected to said transmitting channel at said central station while said break signal is being received at said subscriber's station.

16. A subscriber's telegraph station, a central telegraph station, a first telegraph repeater station intermediate said stations, a telegraph line

terminating circuit at said central station, a plurality of telegraph repeater stations intermediate said first repeater station and said terminating circuit, a two-conductor telegraph loop circuit, connecting said subscriber's station and said first repeater station, a two-channel telegraph repeater circuit connecting said loop circuit to said terminating circuit through the succeeding repeater stations in tandem, calling, supervisory, communication and break signal transmitting means, and calling, communication, and break signal receiving means connected to said loop circuit at said subscriber's station, calling, supervisory, communication and break signal receiving means, and communication and break signal transmitting means connected to said terminating circuit at said central station, and means in said circuits for transmitting a supervisory signal from said subscriber's station to said supervisory signal receiving means at said central station while said break signal receiving means at said subscriber's station is receiving a break signal.

17. A two-channel multisection repeater circuit connecting a plurality of repeater stations in tandem, intermediate a subscriber's telegraph station and a central telegraph station, a two-conductor telegraph circuit extending said two-channel circuit to said terminating circuit, a two-conductor telegraph loop circuit, normally open when idle, extending said two-channel circuit to said subscriber's station, relay means in said circuits for transmitting and receiving communication signals between said subscriber's station and said central station on a half duplex basis, and relay means in said circuit for transmitting supervisory signals from said subscriber's station to said central station on a full duplex basis.

FRED J. SINGER.