June 27, 1944. W. V. K. LARGE ET AL 2,352,272

INVERSE NEUTRAL TELEGRAPH REPEATER CONCENTRATION GROUP CORD AND ATTENDANT'S CIRCUIT

Filed March 11, 1941 4 Sheets-Sheet 1

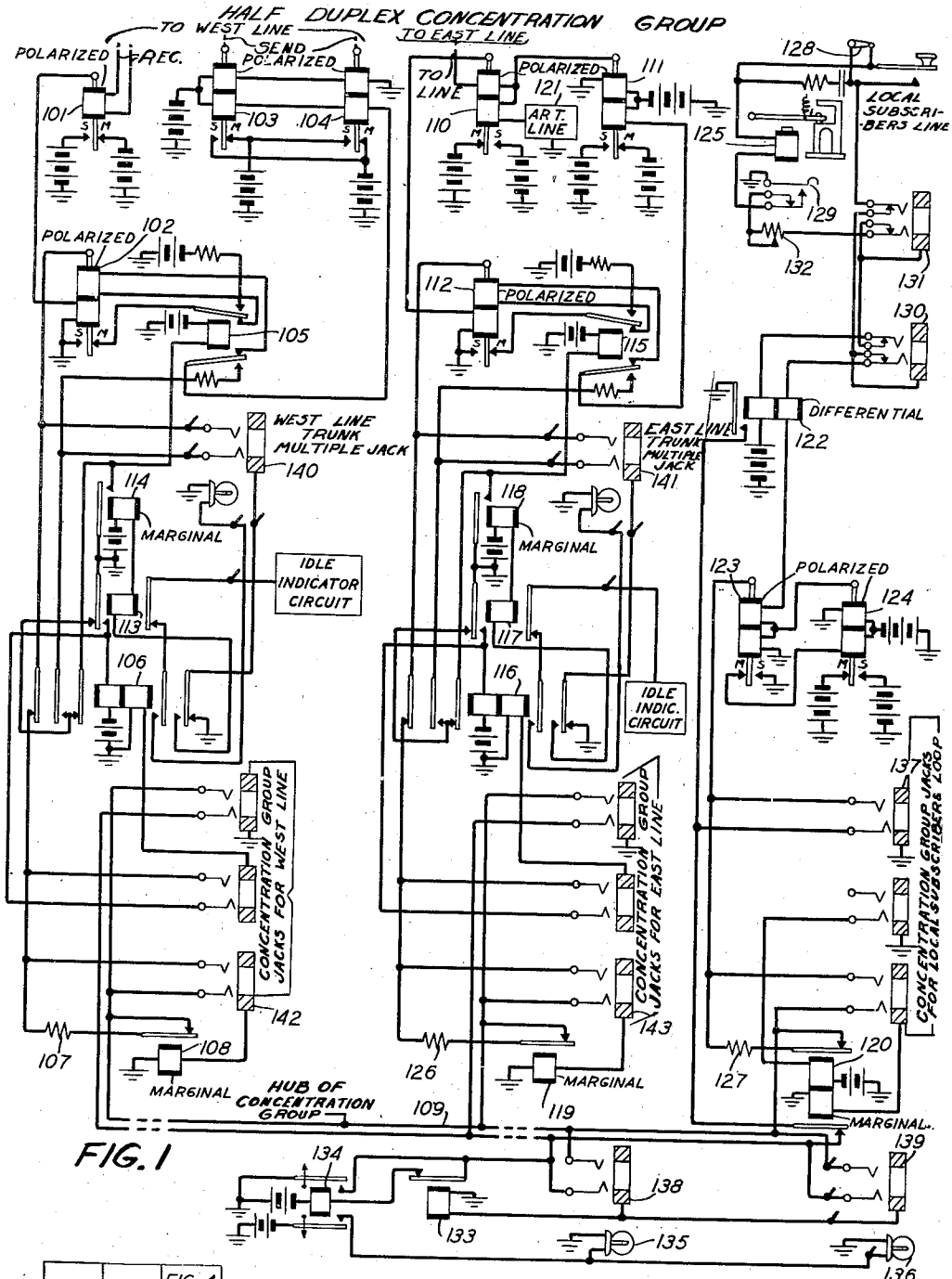

FIG. 1

FIG. 1	FIG. 3	FIG. 4 / FIG. 5
FIG. 2	FIG. 3	FIG. 4 / FIG. 5

FIG. 6

FIG. 7

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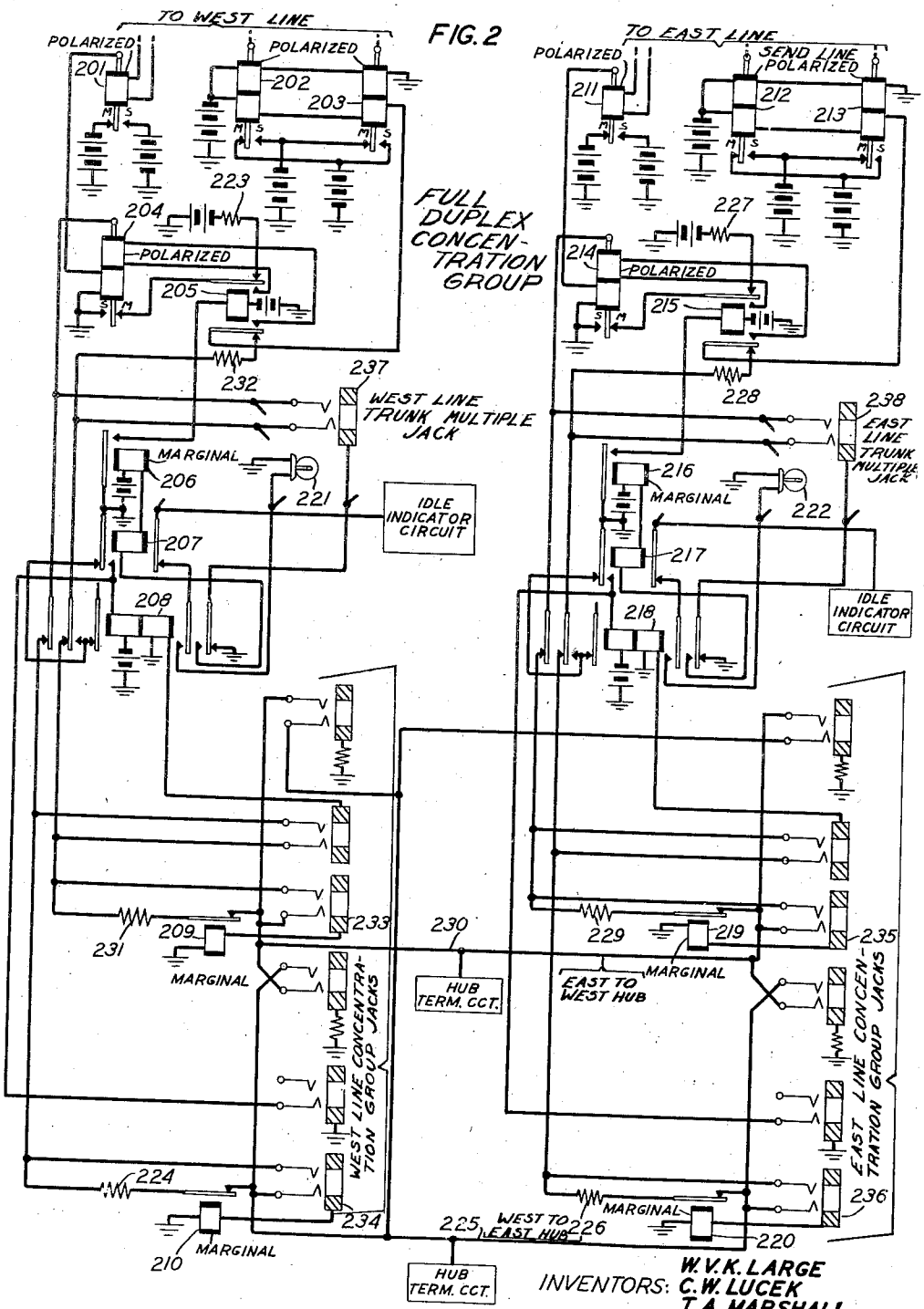
FIG. 2



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INVERSE NEUTRAL TELEGRAPH REPEATER CONCENTRATION
GROUP CORD AND ATTENDANT'S CIRCUIT
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FIG. 3
CORD CIRCUIT

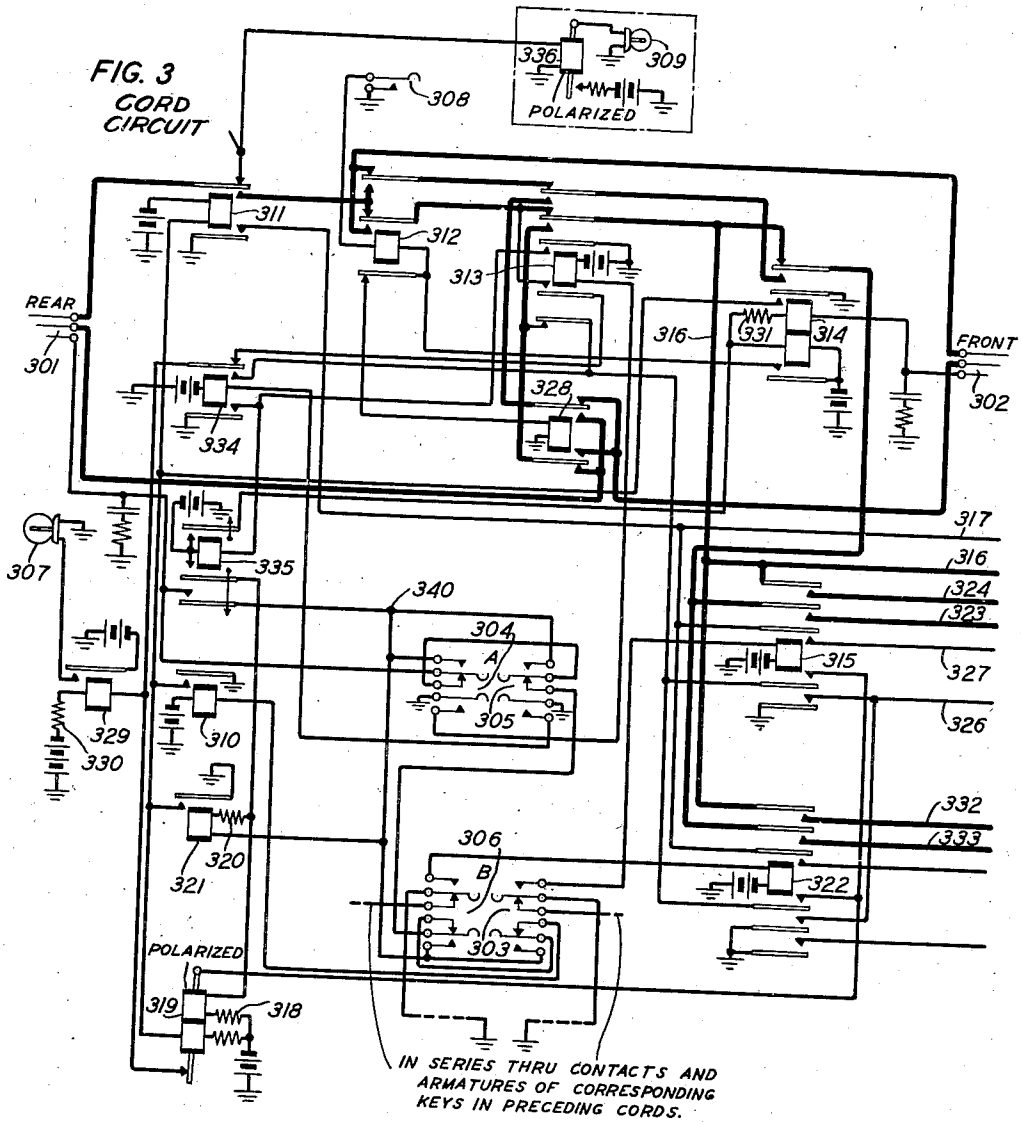

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FIG. 4

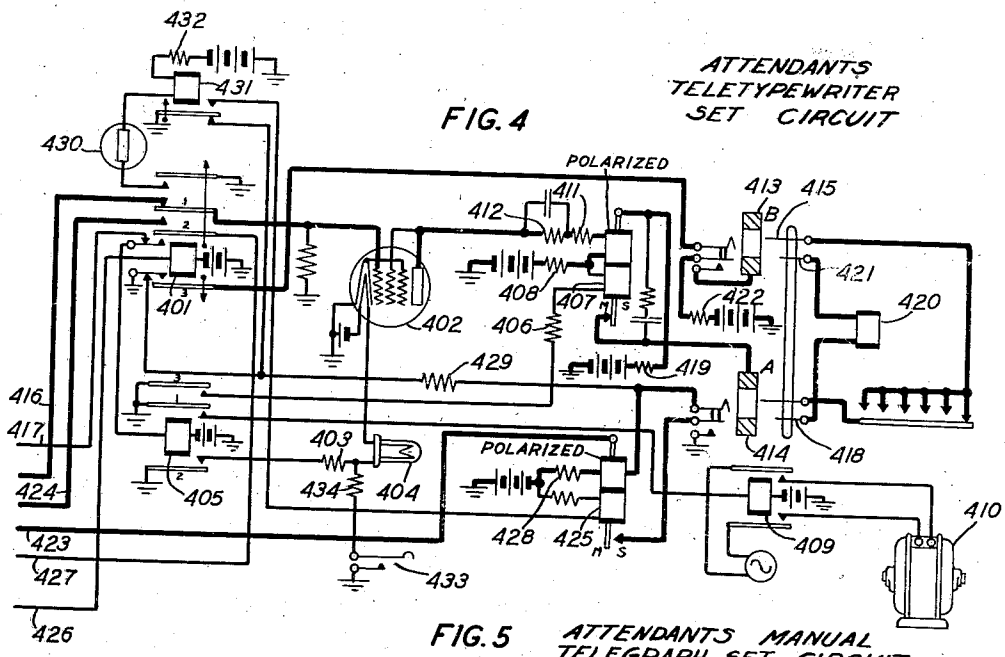
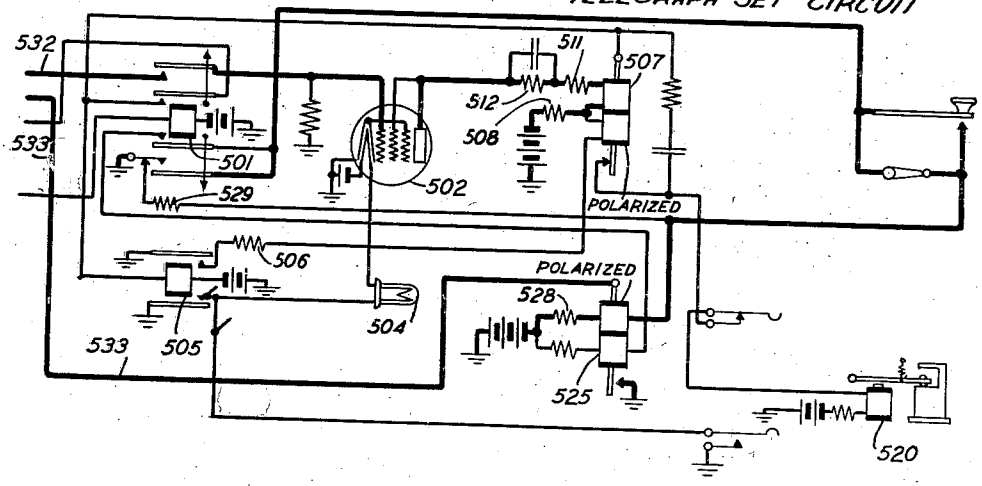


FIG. 5 ATTENDANTS MANUAL TELEGRAPH SET CIRCUIT



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UNITED STATES PATENT OFFICE

2,352,272

INVERSE NEUTRAL TELEGRAPH REPEATER CONCENTRATION GROUP CORD AND ATTENDANT'S CIRCUIT

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Application March 11, 1941, Serial No. 382,684

21 Claims. (Cl. 178—73)

This invention relates to telegraph systems and particularly to inverse neutral repeater telegraph systems. More specifically, this invention is a teletypewriter cord circuit and cooperating attendant's teletypewriter set circuit and attendant's telegraph set circuit, for use in administering inverse neutral repeater concentration groups, arranged either for half duplex or full duplex operation.

Inverse neutral repeater operation is described in patents, 2,056,277, F. S. Kinkead et al., October 3, 1936, 2,069,224, G. C. Cummings, February 2, 1937, and 2,069,251, F. S. Kinkead, February 2, 1937. The administering of inverse neutral repeater concentration groups in a telegraph service board including the basic switching operations, such as adding telegraph lines and stations to a network, releasing lines and stations from a network and substituting a new line for a line forming part of a network is described in patent application Serial No. 362,548, A. R. Bonorden et al., October 24, 1940. The invention herein discloses circuits which cooperate with the system disclosed in the above-mentioned application per Serial No. 362,548. It provides means whereby it is possible for an attendant to monitor on the communication in progress over an inverse neutral concentration group, or to communicate, either over the whole group, or any branch forming part of the group. It also provides supervision, whereby an attendant who is communicating over a branch of the concentration group, or over the circuits remaining in a concentration group after a branch has been cut off from the concentration group, may be summoned, by means of a supervisory signal, either to the branch which has been cut off or to the group of circuits which remain interconnected in the concentration group. It provides, also, other features which will become apparent from the following description when read with reference to the associated drawings, in which:

Fig. 1 shows an inverse neutral repeater concentration group arranged for half duplex operation;

Fig. 2 shows an inverse neutral concentration group arranged for full duplex operation;

Fig. 3 shows a teletypewriter cord circuit arranged to cooperate with inverse neutral repeater concentrations, either half duplex or full duplex;

Fig. 4 is an attendant's teletypewriter set circuit which cooperates with the cord circuit per Fig. 3 and the concentration groups per Fig. 1 or Fig. 2;

Fig. 5 is an attendant's manual telegraph set circuit which cooperates also with the cord circuit per Fig. 3 and the concentration groups per Fig. 1 or Fig. 2;

Fig. 6 is a diagram showing the manner in which Figs. 1, 3, 4 and 5 are to be arranged each with respect to the other for a half duplex concentration;

Fig. 7 is a diagram showing the manner in which Figs. 2, 3, 4 and 5 are arranged each with respect to the other for a full duplex concentration.

Half duplex concentration group

Refer to Fig. 1. It shows a half duplex inverse neutral concentration group. The particular group shown in Fig. 1 may be considered to be a typical half duplex concentration group. It comprises two lines to distant central terminals and a subscriber's station interconnected at a particular central station to form a half duplex concentration group.

One line, which it may be assumed extends to a central terminal to the west, is shown at the left of the figure. A second line, which, it may be assumed, extends to a central terminal to the east is shown in the middle of the figure. The local loop circuit to a subscriber's station is shown at the right of the figure.

The facility illustrated as forming the circuit to the distant western central station is a four-wire full metallic line which is connected through a metallic telegraph terminal repeater to the hub of the concentration group. The facility illustrated as forming the line to the distant eastern central terminal is a one-wire grounded line connected, through a telegraph terminal repeater arranged for differential duplex operation, to the hub of the concentration group. The subscriber's local station equipment is connected to the hub by means of a telegraph loop and a loop repeater.

Description of the condition of the various relays of the half duplex concentration group Fig. 1 while in the marking condition

The apparatus per Fig. 1 is shown in the marking condition. When in this condition the armatures of the sending relays **103** and **104** in the west line are held in engagement with their right-hand or marking contacts by the effect of current flowing from negative battery through their top windings to ground. No current flows through the bottom windings of these relays as the circuit extending through these windings is terminated at each end in negative battery of

the same magnitude. The path through the bottom windings of relays 103 and 104, for the marking condition, is part of a three branch parallel circuit interconnected through hub 109. One branch connects the west line to the hub. A second connects the east line to the hub and a third connects the subscriber's loop circuit to the hub. This circuit is traced in detail and explained below under the heading "Reception of signals from west line." The armature of relay 101 is held in engagement with its right-hand or marking contact by the effect of current in the west receiving line loop and the winding of relay 101 during marking. Relay 105 is in the operated condition due to current flowing over a path from negative battery through the winding of relay 105, the left-hand innermost armature and back contact of relay 106, left-hand back contact and armature of relay 113 to ground.

Relays 105, 106, 113 and 114 and the corresponding relays 115, 116, 117 and 118 in the east line are relays which condition a concentration group for either half or full duplex operation. Since the concentration group per Fig. 1 is arranged for half duplex operation, these relays assume the conditions shown when the concentration is established and remain in such condition indefinitely unless the concentration is changed.

The manner in which concentration groups are established and changed is described in the above application per Serial No. 362,548. Since it does not form part of this invention, these operations will not be described herein. For the purposes of this disclosure it should be sufficient to call attention to the fact that relays such as 105, 106, 113 and 114 and their equivalents in other lines remain in the condition shown while a half duplex inverse neutral concentration is established. Relays 108, 119 and 120 are used in disconnecting the line or loop with which each is associated from the concentration group for testing purposes.

The armature of relay 111 is held in engagement with its right-hand or marking contact while the concentration group is in the idle condition or during marking due to the effect of current flowing through its top winding over an obvious circuit. The effect of this current is unopposed as no current flows through the bottom winding of relay 111 since both ends of the circuit extending through the bottom winding of relay 111 are terminated in negative battery of the same magnitude. The armature of relay 110 is held in engagement with its left-hand contact during the marking period by the effect of current flowing through its top or line winding, which effect preponderates over the effect of current flowing in its bottom winding over a circuit from negative battery, through the right-hand contact and armature of relay 111, through the bottom winding of relay 110 and the artificial line, indicated by rectangle 121, to ground, tending to operate the armature of relay 110 to engage with its right-hand or spacing contact.

While the concentration group is in the marking condition, no current flows through the top winding of relay 112 and the armature of this relay is held in engagement with its right-hand or marking contact by the effect of current flowing through its bottom winding from the left-hand or marking contact and armature of relay 110.

In the marking condition the subscriber's local loop circuit is closed. The two ends of the loop are terminated in battery arranged in series-aiding relationship. The magnet of sounder 125 is energized, attracting its armature. The effect of current through the left-hand winding of relay 122 is balanced by the effect of current flowing through the right-hand winding so that the armature of relay 122 remains in the conditions shown. The effect of the loop current flowing through the top winding of relay 123 tending to actuate the armature of relay 123 towards its left-hand or marking contact preponderates over the effect of current flowing through the bottom winding from the left-hand or marking contact and armature of relay 124 and the armature of relay 123 is held in engagement with its left-hand or marking contact. The armature of relay 124 is held in engagement with its left-hand or marking contact, due to the effect of current flowing through its top winding. This effect is unopposed as no current flows through the bottom winding of relay 124 as the ends of the circuit extending through the bottom winding of relay 124 are terminated in battery of the same polarity and magnitude.

Reception of signals from west line

As telegraph signals are received from the west line the armature of relay 101 is actuated between its right- and left-hand contacts. When the armature is on its right-hand contact a circuit may be traced from negative battery through the right-hand contact and armature of relay 101, through the bottom winding of relay 102 to ground. The armature of relay 102 is actuated to its right-hand contact. When the armature of relay 102 is in engagement with its right-hand contact a circuit may be traced from negative battery through the bottom windings of relays 103 and 104, bottom armature and make contact of relay 105, top winding of relay 102, top front contact and armature of relay 105, right-hand contact and armature of relay 102, left-hand outermost armature and back contact of relay 106, resistance 107, armature and contact of relay 108 to the hub 109.

From the hub the circuit extends in parallel branches into the line east and the subscriber's line.

The branch into the line east may be traced through the contact and armature of relay 119, resistance 126, left-hand outermost contact and armature of relay 116, armature and right-hand contact of relay 112, top armature and front contact of relay 115, top winding of relay 112, bottom front contact and armature of relay 115 and through the bottom winding of relay 111 to negative battery. The branch extending into the subscriber's line extends through the contact and armature of relay 120, resistance 127, armature and left-hand contact of relay 123, bottom winding of relay 124 to negative battery.

It should be observed that all of these branches, namely the branch in the line west, that in the line east and the branch into the subscriber's line, all of which radiate from the hub of the concentration 109 are terminated in battery of the same polarity and magnitude, so that no current flows in any of these branches for the marking condition.

Since no current flows in the branch which connects the east line to the hub 109 the bottom winding of relay 111 will not be energized when a marking signal is received from the west line.

Under this condition, as explained above, the current in the top or biasing winding of relay 111 maintains its armature in engagement with its right-hand or marking contact. Negative battery is therefore connected through the right-hand contact and armature of relay 111 and the top winding of relay 110 to transmit a marking signal to the east line.

Since no current flows in the branch which connects the local subscriber's line to hub 109, the bottom winding of relay 124 will not be energized. Under this condition, as explained above, current flowing through the top or biasing winding of relay 124 maintains the armature of relay 124 in engagement with its left-hand or marking contact. A circuit may then be traced from negative battery through the armature and left-hand contact of relay 124, top winding of relay 123, right-hand winding of relay 122, contacts of jacks 130 and 131, switch 128, which is closed to shunt the open contacts of the transmitting key, winding of sounder magnet 125, break contacts of key 129, resistance 132, contacts of jacks 131 and 130 and through the left-hand winding of relay 122 to positive battery. Magnet 125 is energized for the marking condition. The armature of relay 123 is maintained in engagement with its left-hand or marking contact and the armature of relay 122 remains released as shown for reasons explained.

When a spacing signal is received from the line west, the armature of relay 101 is actuated to engage its left-hand or spacing contact. This connects positive battery to the circuit extending through the bottom winding of relay 102, actuating the armature of relay 102 to engage with its left-hand or spacing contact. This disconnects the branch which connects the west line to the hub from the path to negative battery connected to the bottom winding of relay 103, heretofore traced, and connects the armature of relay 102 to ground. This in turn causes current to flow in the other two branches, namely the branch in the east line and that in the subscriber's line through the hub to the ground on the armature of relay 102. As a result of this, the armatures of relays 111 and 124 are actuated to engage their spacing contacts. This results in a spacing signal being impressed on the line east from positive battery through the left-hand or spacing contact and armature of relay 111, through the top winding of relay 110 and out over the line. It also results in a spacing signal being impressed on the subscriber's loop. The loop is ordinarily terminated in battery of opposite polarities so that series-aiding battery is connected to the loop. For the marking condition the loop may be traced from negative battery connected to the marking contact of relay 124 through the armature of relay 124, top winding of relay 123, right-hand winding of relay 122, contacts of jacks 130 and 131, through the switch 128, which shunts the contacts of the transmitting key at the subscriber's station if the circuit is idle or through the closed contacts of the key, winding of receiving magnet 125, through the continuity contacts of calling-in key 129, variable resistance 132, contacts of jacks 131 and 130, and the left-hand winding of relay 122 to positive battery. Current flows around the loop for the marking condition. When current flows through the bottom winding of relay 124 due to the spacing signal from relay 102, as the armature of relay 124 is actuated to engage with its right-hand or spacing contact, positive battery is connected to both ends of the subscriber's loop. Receiving magnet 125 is released to give a spacing signal at the subscriber's station. Relay 122 is deenergized, but the position of its armature remains unchanged. The armature of relay 123 is maintained in engagement with its left-hand contact by current through its bottom winding.

Thus marking and spacing signals may be transmitted from the line west to the line east and the local subscriber's line simultaneously.

Reception of signals from east line

The manner in which signals are transmitted from the east line to the west line and the local subscriber's line will now be described.

In response to signals received from the east line the armature of relay 110 is operated between its marking and spacing contacts. When a marking signal is received the armature of relay 110 is in engagement with its left-hand contact. A circuit is thus established from negative battery, through the left-hand or marking contact and armature of relay 110, through the bottom winding of relay 112 to ground. The armature of relay 112 is operated to engage with its right-hand or marking contact. This establishes a circuit which has been heretofore traced from hub 109 to negative battery connected to the winding of relay 111. When negative battery is connected to this branch, since negative battery is connected to the other branches in the hub no current flows in any branch which is the condition for the transmission of a marking signal in each branch.

When a spacing signal is received over the east line, the armature of relay 110 is actuated to engage its right-hand or marking contact. The armature of relay 112 follows this signal. This connects ground to the branch extending to the hub from the east line. This energizes the bottom windings of relays 103 and 104 which reverses the polarities of the batteries connected to the two ends of the transmitting loop of the west line which results in a spacing signal being transmitted to the west central station.

Ground connected to the hub 109 from the east line of course operates relay 124 in the same manner as ground from the west line.

Reception of signals from local station loop

When signals are to be transmitted from the subscriber's station, switch 128 is opened and the loop is opened and closed by operating the transmitting key. When the key is opened no current flows in the loop. The armature of relay 123 is actuated, under the influence of current through the bottom winding of relay 123 to engage with its right-hand or spacing contact. This connects ground to hub 109 which in turn transmits a spacing signal out over the east and west lines simultaneously.

Transmitting a break signal

The concentration group is arranged so that while either line or the loop is transmitting, any circuit which is receiving may "break."

Let it be assumed that the west line is sending to the east line and the loop and that the party connected to the distant end of the east line wishes to break. Under these circumstances the party connected to the east line transmits a spacing signal. If the armature of relay 111 is in engagement with its marking contact the armature of relay 110 is immediately operated to

engage its spacing contact. If the armature of relay 111 is in engagement with its spacing contact the armature of relay 110 is operated to its spacing contact when the armature of relay 111 is next operated to its marking contact. With the armature of relay 110 on its spacing contact, the armature of relay 112 is operated to engage its spacing contact. This connects ground permanently to the hub as when relay 112 is in engagement with its spacing contact, the path from the hub through the windings of relays 112 and 111 is opened and these relays cannot be operated while the armature of relay 110 remains on its spacing contact. The armature of relay 112 remains on its spacing contact, which connects ground permanently to the "hub" as a break signal for the west line and the local loop.

If the west line breaks, ground is permanently connected to the hub from the armature of relay 102. If the local loop breaks, ground is permanently connected to the hub from the armature of relay 123.

In the case of a break by the west line or the local loop, the circuit which has been transmitting loses control of the sending relays in the other facilities in much the same manner as described for a break by the east line and it is not considered necessary to explain this in detail for each case.

Calling-in signal for local station loop

The concentration group is arranged in such manner that any local station loop forming part of a concentration group may transmit a signal to the central station where the concentration group is being administered to attract the attention of the operator who is administering the concentration.

In order to transmit such a signal, the attendant at the local station operates key 129. This grounds one side of the loop and opens the other side. Relay 122, as has been explained, is arranged so that when the loop is continuous, the effect of the current in its right- and left-hand windings is balanced for the marking condition. For the spacing condition no current flows in the loop. When one side of the loop is grounded, the right-hand winding only of relay 122 is energized, operating the armature of relay 122. Ground is connected through the bottom armature and back contact of relay 120, armature and contact of relay 133 and the winding of relay 134 to battery operating relay 134. This in turn lights lamps 135 and 136 as a signal that a party connected through a station loop is calling the operator. In response to the lighted lamp, the operator who is administering the concentration group may connect a cord circuit to jack 139 which cord circuit may in turn be connected to a manual telegraph circuit or a teletypewriter circuit for communication with the station attendant. Connection of a cord circuit to jack 139 will release relay 134 extinguishing the calling-in lamps. This will be described in greater detail in the description below.

Full duplex concentration group

A typical full duplex concentration group will now be described.

It is not possible for more than one party to transmit simultaneously through an inverse neutral circuit in which there is but one hub. If two are to transmit simultaneously two hubs are required. Reference to Fig. 2 will disclose the manner in which full duplex communication is provided through two hubs.

In the arrangements per Fig. 2, two four-wire full metallic lines are interconnected through inverse neutral repeaters located at an intermediate central station in such manner as to provide two inverse neutral hubs for simultaneous two-way communication between two distant terminals.

One four-wire full metallic line with its associated repeater and concentration jacks is shown at the left of Fig. 2. It will be assumed that this four-wire line extends to a distant terminal to the west. A second four-wire full metallic line with its associated repeater and concentration jacks is shown at the right of Fig. 2. It will be assumed that this four-wire line extends to a distant terminal to the east. The two four-wire metallic lines, as explained in the above-mentioned application, Serial No. 362,548 are arranged so that they may be switched into a concentration group which functions half duplex. They are arranged also so that they may be connected into a full duplex concentration group such as they are associated with in Fig. 2, in which case they will be conditioned to function full duplex. Relays 205, 206, 207 and 208 in the west line and the corresponding relays 215, 216, 217 and 218 in the east line are relays which control the conditioning of the lines for full and half duplex operation, as well as other switching operations, such as adding a line to a concentration group, subtracting a line from a concentration group, substituting another line for a line forming part of a concentration group, etc. at the present time, the manner in which communication proceeds over a full duplex concentration is to be explained. It is pointed out that since the concentration group is already established for full duplex operation and since no additions, subtractions, substitutions, etc. are to be described at this time, relays 205, 206, 207, 208, 215, 216, 217 and 218, which function only while a concentration group is being established and during such switching operations, will remain as shown. Testing relays 209 and 210 in the west line and 219 and 220 in the east line will also remain as shown.

Description of the various relays of the full duplex concentration group Fig. 2 while in the marking condition

First the condition of the various relays in the repeaters will be described.

During marking, the armature of relay 201 is held in engagement with its left-hand or marking contact by the effect of current flowing in the winding of relay 201 from the receiving line loop which extends to the distant western terminal. The armatures of relays 202 and 203 are held in engagement with their left-hand or marking contacts by the effect of current flowing through their top windings from negative battery to ground over an obvious circuit. No current flows through the bottom windings of relays 202 and 203 as during the marking interval negative battery is connected to each end of the circuit extending through these windings. No current flows through the top winding of relay 204 as the circuit through the winding is broken at the top and bottom back contacts of relay 205. The armatures of relays 211, 212 and 213 are held in engagement with their left-hand or marking contacts. These relays in the east line correspond to relays 201, 202 and 203,

respectively, in the west line and the circuits through them similarly correspond with the circuits through the relays in the west line. The circuit through the top winding of relay 214 is open at the top and bottom front contacts of relay 215.

Reception of signals over west line

As telegraph signals are impressed on the receiving line loop at the distant western terminal, the armature of relay 201 is actuated so as to engage its marking and spacing contacts alternately. When the armature is in engagement with its left-hand or marking contact, a circuit may be traced from negative battery through the left-hand or marking contact and armature of relay 201, through the bottom winding of relay 204 to ground. The effect of this current actuates the armature of relay 204 so as to engage with its right-hand or marking contact.

When the armature of relay 204 is in engagement with its right-hand or marking contact, a circuit may be traced from negative battery through resistance 223, to top back contact and armature of relay 205, the right-hand or marking contact and armature of relay 204, the left-hand outermost armature and back contact of relay 208, resistance 224, the armature and contact of relay 210 to the hub 225, of the concentration group. From the hub 225, the circuit continues through the back contact and armature of relay 220, resistance 226, the left-hand middle back contact and armature of relay 216, resistance 228, bottom back contact and armature of relay 215, bottom winding of relay 213, bottom winding of relay 212 to negative battery. Attention is once more directed to the fact that for the marking condition all branches connected to the hub of the concentration group are terminated in negative battery so that the windings in the path are not energized for the marking condition. When a spacing signal is received over the receiving loop from the distant western terminal, the armature of relay 201 is actuated so as to engage with its right-hand or spacing contact. When the armature of relay 201 is in engagement with right-hand or spacing contact, a circuit is closed from positive battery through the right-hand or spacing contact and armature of relay 201 and the bottom winding of relay 204 to ground. The armature of relay 204 is actuated so as to engage with its left-hand or spacing contact. When the armature of relay 204 moves to its left-hand or spacing contact, ground is connected through the spacing contact and armature of relay 204 through the left-hand outermost armature and back contact of relay 208, resistance 224, armature and contact of relay 210 to the hub 225 of the concentration group. Current will therefore flow from negative battery through the bottom windings of relays 212 and 213 toward the hub. The armatures of relays 212 and 213 will be actuated so as to engage with their respective right-hand contacts. This reverses the connections from positive and negative battery to the two loop conductors extending to the distant eastern terminal which result in a spacing signal being transmitted to the eastern terminal. As the armature of relay 201 follows the marking and spacing signals received from the distant western terminal over the receiving loop, marking and spacing signals will be transmitted from relays 212 and 213 toward the distant eastern terminal.

The manner in which signals are received from the distant eastern terminal and transmitted toward the distant western terminal will now be described.

Relay 211 follows signals received over the receiving group from the distant eastern terminal. The relay is shown in its marking condition. When in the marking condition, negative battery is connected through the left-hand or marking contact and armature of relay 211 and the bottom winding of relay 214 to ground. This maintains the armature of relay 214 in engagement with its right-hand or marking contact. When the armature of relay 214 is in engagement with its right-hand or marking contact, negative battery is connected through resistance 227 and the top back contact and armature of relay 215, through the right-hand or marking contact and armature of relay 214, left-hand outermost armature and back contact of relay 218, resistance 229, armature and contact of relay 219 to the hub 230. From the hub 230, the circuit continues through the contact and armature of relay 209, resistance 231, left-hand middle back contact and armature of relay 208, resistance 232, bottom back contact and armature of relay 205, bottom windings of relays 203 and 202 to negative battery. Once more it should be observed that negative battery is connected to each branch radiating from the hub point of the concentration group for the marking condition.

When a spacing signal is received from the distant eastern terminal, the armature of relay 211 is actuated to engage with its right-hand or spacing contact. This connects positive battery through the spacing contact and armature of relay 211 and the bottom winding of relay 214 to ground. The armature of relay 214 is actuated to engage with its left-hand or spacing contact. When the armature of relay 214 is in engagement with its left-hand or spacing contact, a circuit may be traced from ground through the left-hand or spacing contact and armature of relay 214, through the left-hand outermost armature and back contact of relay 218, resistance 229, armature and contact of relay 219 to the hub 230. This operates relays 202 and 203 so that their armatures engage their right-hand or spacing contacts. When the armatures of relays 202 and 203 are in engagement with their right-hand or spacing contacts, the battery connections to the loop extending to the distant western terminal are reversed and a spacing signal is thereby transmitted to the distant western terminal.

The above explains how telegraph signals may be transmitted between two distant terminals through inverse neutral repeaters located at an intermediate telegraph station on a full duplex basis.

The jacks shown at the bottom of Fig. 2 are provided to facilitate switching operations such as adding a line to the concentration group, subtracting a line from the concentration group or substituting a line for a line forming part of a concentration group. These jacks also provided for disconnecting a line from a concentration group for testing by operating relays 209, 210, 219 or 220 through circuits which may be connected to jacks such as 233, 234 and 236 and for communication with the central station operator.

General description of the teletypewriter cord circuit per Fig. 3

Fig. 3 is a double ended cord circuit known as a teletypewriter cord circuit with two flexible cords and two plugs which cooperate with the

various jacks in a half duplex concentration group exemplified by Fig. 1 or a full duplex concentration exemplified by Fig. 2.

The teletypewriter cord may be connected either to the attendant's teletypewriter set per Fig. 4 or to the attendant's telegraph set per Fig. 5 as desired in a manner to be described hereunder.

By means of Fig. 3, in cooperation with Fig. 4 or 5, it is possible to perform various operations on a half duplex concentration group per Fig. 1 or a full duplex concentration group per Fig. 2 as follows:

1. When the plug **301** is inserted in the appropriate jack of Fig. 1, with all keys normal, it is possible to monitor on a half duplex concentration.

2. When the plug **301** is inserted in the appropriate jack of Fig. 1 and key **303** is operated, it is possible to communicate by means of the teletypewriter per Fig. 4 over the half duplex concentration.

3. When plug **301** is inserted in the appropriate jack of Fig. 1, it is possible to split a leg of the concentration group from the hub by operating key **304** or **305**.

4. When the circuits are arranged as described under 3 above and key **303** is operated, it is possible to communicate over the leg which has been split from the concentration group or to communicate over the circuits remaining in the concentration group by means of the teletypewriter circuit of Fig. 4. By operating key **306** instead of key **303**, it is possible to communicate over these facilities by means of the manual telegraph circuit of Fig. 5.

5. When the circuits are arranged as described under 3, above, the supervisory lamp **307** in Fig. 3 responds to signals on the leg when communicating with the hub or signals on the hub while communicating with the leg.

6. When this circuit is used for telegraph or teletypewriter communication over a local trunk to supervisor (not shown in this application) or when it is used to answer the calling-in signal at an answering jack, such as **138** or **139** in Fig. 1, the circuit is arranged to register on the supervisory lamp any supervision signals that may be received over the local trunk or from the concentration group.

7. When the plug **302** of this circuit is inserted in the appropriate jack in one concentration jack circuit per Fig. 2 and the plug **301** into a similar jack of a second concentration jack circuit, this circuit is arranged to permit full duplex communication.

8. Under the condition described in 7, above, the rear cord associated with plug **301** is used for receiving and the front cord associated with plug **302** is used for sending signals.

9. Under the condition described in 7, above, the operation of key **308** will permit the front cord to be used for receiving and the rear cord for sending signals.

10. Under the condition described in 7, above, the operation of key **304** or **305** will split the associated leg from the hub.

11. Under the condition described under 10, above, the operation of key **303** or of key **306** is arranged to permit teletypewriter or manual telegraph signal communication on a full duplex basis on the legs or on the hubs.

12. The rear cord of this circuit is arranged to permit tip-busy test through plug **301**. A busy condition is indicated by the lighting of the common positional busy lamp **309**.

Monitoring on half duplex facilities

Refer now to Figs. 1, 3, 4 and 5 arranged as indicated in Fig. 6.

The left-hand cord of the teletypewriter cord circuit per Fig. 3 is arranged to permit monitoring on half duplex teletypewriter facilities such as shown in Fig. 1. If plug **301** associated with the left-hand cord is inserted into a jack arranged for monitoring such as **142** or **143**, and all keys shown in Fig. 3 are in their normal position, relay **310** in Fig. 3 is operated. The circuit for this may be traced from battery through the winding of relay **310**, the back contact associated with the bottom armature of key **303**, through said armature, the back contact and bottom armature of key **306**, the back contact and top armature of key **305**, the back contact and top armature of key **304** to the sleeve of plug **301** which meets ground connected through the low resistance winding of relay **108** to the sleeve of the above-mentioned monitoring jacks. If it is preferred, connection may be made for monitoring to the leg multiple jacks such as **140** and **141**. The winding of relay **310** is of high resistance to prevent interference with the established sleeve conditions when connection is made to a leg multiple jack. Operation of the splitting key **304** or **305** while monitoring in jacks such as **142** or **143** may seriously interfere with the circuit monitored upon. When monitoring, the operation of relay **310** in turn operates relay **311** over a circuit from ground through the armature and front contact of relay **310**, through the winding of relay **311** to battery. Operation of relay **311** closes the tip circuit extending from plug **301** which is connected to a transmission conductor in the half duplex concentration group per Fig. 1, through the tip of the jack with which it is associated, through to the attendant's teletypewriter circuit.

It will be assumed that plug **301** has been inserted into jack **142**. The tip of jack **142** is connected to the hub **109**, through the armature and contact of relay **108**. Communication signals through the hub **109** will be passed through the tip of jack **142** to a circuit extending from the tip of plug **301** through the top armature and front contact of relay **311**, through the top inner back contact and armature of relay **312**, through the top middle back contact and armature of relay **313**, through conductor **316** into Fig. 4. The leads extending to the right of Fig. 3 connect with corresponding leads in alignment at the left of Figs. 4 and 5. Conductor **316** in Fig. 3 connects with lead **416** in Fig. 4 and extends through the top middle back contact and armature of relay **401** to the grid of vacuum tube **402**. The operation of relay **311** closes a circuit from ground through its bottom armature and front contact over conductor **317** in Fig. 3 which connects to conductor **417** in Fig. 4. The circuit then extends through the top continuity contacts of relay **401**, through the winding of relay **405** to battery, operating relay **405**. This conditions the teletypewriters set to receive teletypewriter signals from the half duplex concentration group per Fig. 1 for monitoring in a manner which will now be described.

The operation of relay **405** closes a circuit from ground through the bottom armature and front contact of relay **405**, resistance **403**, ballast lamp **404** and the filament of tube **402** to grounded battery, heating the filament of tube **402**. The

operation of relay 405 also closes a circuit from ground through the top outer armature and front contact of relay 405, through resistance 406, bottom winding of relay 407 and resistance 408 to positive battery. The effect of current flowing in the circuit last traced through the bottom winding of relay 407 maintains the armature of relay 407 in engagement with its left-hand or marking contact. The operation of relay 405 also closes a circuit from ground through the top inner armature and front contact of relay 405 and the winding of relay 409 to battery, operating relay 409. The operation of relay 409 supplies power to the teletypewriter motor 410, through the top and bottom armatures and cooperating contacts of relay 409, to the motor windings. This starts the motor.

The output circuit of vacuum tube 402 may be traced from positive battery, through resistance 408, the top winding of relay 407, resistances 411 and 412, to the anode of tube 401, and thence through the cathode of tube 402 to ground.

It has been explained in the description of the operation of an inverse neutral concentration circuit that the branches radiating from a hub are all normally terminated in negative battery for the marking condition. Negative potential will, therefore, be impressed between the grid and grounded cathode of tube 402 while the marking condition obtains in the concentration circuit. It has also been explained that when a spacing signal is transmitted through an inverse neutral circuit, ground is connected to the hub of concentration. For a spacing signal, therefore, the grid of tube 402 will be grounded. For the marking condition, therefore, while negative potential is impressed between the grid and cathode of tube 402 no current will flow through the top winding of relay 407 and the armature of relay 407 will be held in engagement with its left-hand or marking contact under the influence of current flowing through the bottom winding. When a spacing signal is transmitted through the concentration group and the grid of tube 402 is grounded, sufficient current will flow through the top winding of relay 407 to actuate the armature of relay 407 to the right.

While the circuit per Fig. 4 is in use, the attendant's teletypewriter apparatus will be connected to jacks 413 and 414 by means of plugs 415 and 418. While these connections are established and the marking condition prevails, a circuit may be traced from positive battery through resistance 419, the armature of relay 407, marking contact of relay 407, the sleeve of jack 414, sleeve of plug 418, receiving magnet 420, sleeve of plug 421, sleeve of jack 413 through the bottom armature and make contact of jack springs 413, which are closed, and resistance 422 to negative battery. When the armature of relay 407 is actuated to the right in response to a spacing signal this circuit is broken. The receiving magnet 420 will, therefore, follow the marking and spacing signals transmitted through the concentration group circuit.

Communication between the attendant's teletypewriter set and the concentration group

When plug 301 of the cord circuit of Fig. 3 is inserted into an appropriate jack, such as jack 142, associated with the half duplex concentration group per Fig. 1 and key 303 in Fig. 3 is operated, a circuit is established from battery, through resistance 318, top winding of relay 319, resistance 320, winding of relay 321, bottom front contact and lower armature of key 303, bottom back contact and bottom armature of key 306, top back contact and top armature of key 305, top back contact and top armature of key 304, to the sleeve of plug 301. From the sleeve of plug 301, the circuit extends through the sleeve of jack 142 in the concentration group circuit per Fig. 1 to ground through the low resistance winding of relay 103. As the cooperating jack sleeve circuit is of low resistance, the armature of relay 319 will be actuated to the right due to the effect of current through its top winding. Relay 321 operates in all cases closing a circuit through the bottom winding of relay 319. But the effect of current through the bottom winding of relay 319 tending to maintain the armature of relay 319 in engagement with its left-hand contact is less than the effect of current in the top winding when the resistance of the sleeve circuit of the jack with which plug 301 cooperates in Fig. 1 is low. The operation of relay 321 causes the operation of relay 311 from ground through the top armature and front contact of relay 321, through the winding of relay 311 to battery. The operation of key 303 operates relay 315 over a circuit extending from ground through the top armature and front contact of key 303, through the winding of relay 315 to battery.

It should be pointed out at this point that a plurality of teletypewriter cord circuits per Fig. 3 as well as other cord circuits are located at each operator's position, whereas only one attendant's teletypewriter set circuit per Fig. 4 and one attendant's manual telegraph set circuit per Fig. 5 are provided. The single attendant's teletypewriter set and the single attendant's manual telegraph set per Figs. 4 and 5 are connected individually to any of these cords as may be required. In order to guard against the connection of Fig. 4 or Fig. 5 to more than one cord circuit at a time, a chain circuit is provided through the various cord circuits. The chain circuit is used to control the connection of the single attendant's teletypewriter set or the single attendant's telegraph set to one cord only. It extends sequentially through the armatures and contacts of keys corresponding to keys 303 and 306 in each cord. It is by means of these keys that ground is applied to relays such as relay 315 or relay 322 which are individual to each cord. If a key corresponding to key 303 or key 306 in a preferential position in its chain circuit is operated, a relay corresponding to relay 315 or relay 322 in the corresponding circuit will be operated to connect the attendant's teletypewriter set or attendant's manual telegraph set to said circuit. In such case, the operation of a key corresponding to key 303 or key 306 in a teletypewriter cord circuit more remote from ground will not be availing to operate the corresponding relays 315 and 322 as the path to ground will be broken where the key is operated. In this manner, the connection of the attendant's teletypewriter set per Fig. 4 or the attendant's manual telegraph set per Fig. 5 through parallel branches to a plurality of cords is avoided.

The operation of relay 315 operates relay 401 from ground through the bottom outer armature and front contact of relay 315 through the winding of relay 401 to battery.

When relay 315 is operated and relays 311 and 401 are also operated, a circuit may be traced from the tip of plug 301 through the top armature and front contact of relay 311, the top in-

ner back contact and armature of relay **312**, the top middle back contact and armature of relay **313** to parallel branches. One branch extends through the top outer back contact and armature of relay **314** and the top middle armature and front contact of relay **315** to conductor **323**. The second branch extends through the top outer armature and front contact of relay **315** to conductor **324**. Conductor **323** in Fig. 3 connects with conductor **423** in Fig. 4 which extends through the armature of relay **425**. When the armature of relay **425** is on its spacing contact and plug **418** is inserted in jack **414**, the circuit is continued through the bottom armature and front contact of jack **414** to ground. Conductor **324** in Fig. 3 connects to conductor **424** in Fig. 4 and the circuit extends through the top middle front contact and armature of relay **401**, which is operated, to the control grid of vacuum tube **402**. This circuit controls the reception of communication signals through the teletypewriter receiving magnet **420** in the same manner as described above for the monitoring operation. Conductors **323** and **423** form a part of the transmitting circuit, by means of which signals may be sent from the teletypewriter sending contacts in Fig. 4 which control the operation of relay **425**.

The operation of relay **401** transfers the path extending from ground on relay **311**, through the top continuity contacts of relay **401**, to the winding of relay **405**. After the operation of relay **401**, relay **405** is held operated over a path from battery through the winding of relay **405**, through the top innermost make contact and armature of the top continuity contact combination of relay **401**, over conductor **427**, which connects to conductor **327** in Fig. 3, through the top innermost make contact and armature of relay **315** and the bottom make contact and armature of relay **311** to ground.

Relay **405** operated performs the same functions as described in the monitoring operation above.

During the period that Fig. 4 is not arranged to transmit, relays **401** and **431** are released. While so released, a circuit may be traced from negative battery through resistance **428**, top winding of relay **425** and resistance **429** to a parallel circuit, one branch of which extends to ground through the bottom continuity contacts of relay **401** and the other branch of which extends also to ground through the bottom back contact and armature of relay **431**. The effect of current flowing in this circuit maintains the armature of relay **425** actuated to the left or marking position. This prevents ground from being connected from the bottom front contact of jack **414** to the transmission conductor.

The operation of relay **401** establishes a circuit which extends from ground through the bottom front contact and armature of relay **401**, through the tip of jack **413** and tip of plug **415**, through the teletypewriter sending contacts, through the tip of plug **418** and tip of jack **414**, through the top or line winding of relay **425** and resistance **428** to negative battery. The operation of relay **401** further disconnects ground from the circuit which extended through the bottom continuity contacts of relay **401** and resistance **429** and through the top or line winding of relay **425** to negative battery. The operation of relay **401** further establishes a circuit from ground through the top outermost armature and front contact of relay **401**, through thermistor **430**, the winding of relay **431** and resistance **432** to negative battery. When ground is connected to the winding of relay **431** by the operation of relay **401**, current builds up slowly in the winding of relay **431**, due to the action of the thermistor **430**. The minimum time in which the **431** relay can operate is 600 milliseconds. This delay insures at least one revolution of the sending contact cam on the teletypewriter after relay **409** operates, before the bleeder circuit through the top winding of relay **425** to ground through the armature and back contact of relay **430** is broken and the biasing circuit, through the bottom winding of the sending relay **425** which tends to operate the armature of relay **425** to its right-hand or spacing contact is closed through the make contact of relay **431**. If the latch on the teletypewriter is standing open at the instant of the operation of relay **401**, the operation of the circuit, as described above, prevents the transmission of a false signal before the first closure of the latch.

Transmission from the teletypewriter facility is accomplished by operation of the teletypewriter keyboard. Relay **425** follows the teletypewriter signals. The opening of the teletypewriter contacts permits the armature of relay **425** to operate to engage its right-hand or spacing contact under the influence of current in the bottom winding of relay **425**. This results in the connection of ground from the bottom front contact and armature of jack **414**, through the right-hand or spacing contact and armature of relay **425** and over conductors **423** and **323** by a path heretofore traced, to the tip circuit which connects to the communication conductor in the half duplex concentration group. Half duplex reception and transmission can, therefore, take place through the teletypewriter cord circuit and the attendant's teletypewriter set circuit.

At the conclusion of communication, plug **301** is disconnected from jack **142** and key **303** is restored to its normal position. Relay **315** will release as ground is disconnected from the circuit through its winding at the top back contact of key **303**. The release of relay **315** in Fig. 3, in turn, permits relay **401** in Fig. 4 to release as ground is disconnected from the path through the winding of relay **401** at the bottom outer back contact of relay **315**. Relay **321** is released, in turn releasing relay **311**. Relay **319** will also release. With relay **311** released, relay **405** in Fig. 4 will be released as ground is disconnected at the lower armature and make contact of relay **311**. Relay **431** will also release upon the release of relay **401** as ground is removed from the winding of relay **431** at the top outer armature and front contact of relay **401**. Relays **407** and **425** will return to their normal idle condition upon the release of relays **401** and **405**. The circuit through the filament of vacuum tube **402** will be broken upon the release of relay **405** unless key **433** has been operated. Key **433** is known as a position filament key. When it is operated, current is supplied to the filament over a circuit from battery through the filament of tube **402**, filament of lamp **404**, resistance **434** and key **433** to ground. Resistance **434** is of higher value than resistance **403**. This resistance is chosen so that the current through the tube **402**, when key **433** is operated, is sufficient to keep the filament partially heated in order to minimize the time required to heat the filament after relay **405** is operated.

Supervision of half duplex concentration groups

The circuits of this invention are arranged in

such a manner that supervision is provided in the cord circuit to summon the operator's attention to the cord in response to a special signal from one of the facilities in the half duplex concentration group with which the cord, per Fig. 3, cooperates. The manner in which the circuits cooperate to provide a supervisory signal under these circumstances will now be described.

In describing the operation of the half duplex concentration group it was pointed out that if a subscriber at a local station wished to attract the operator's attention at the central station where the concentration group was being administered, key 129 in the local loop circuit of Fig. 1 was operated to ground one side of the subscriber's loop circuit. This operates differential relay 122. Ground through the armature and front contact of relay 122 is connected through the bottom armature and back contact of relay 120 to a parallel circuit. This parallel circuit comprises the rings of jacks 139 and 138 as well as a branch which extends through the armature and back contact of relay 133 and the winding of relay 134 to the negative battery operating relay 134. Relay 134 locks upon operation over a path from ground to its top armature and front contact, the armature and back contact of relay 133 and the winding of relay 134 to battery. The operation of relay 134 lights lamps 135 and 136 in parallel over an obvious circuit. These lamps are associated with jacks 138 and 139 respectively. The operator who is administering the concentration group may respond to this calling-in signal by connecting the plug of her cord circuit to a jack 138 or 139. Upon such connection the calling-in signal lamps are extinguished through the operation of relay 133 over a path which extends from negative battery through the winding of relay 310, through the back contact and bottom armature of key 303, through the back contact and bottom armature of key 306, through the back contact and top armature of key 305, through the back contact and top armature of key 304, through the sleeve of plug 301, the selected jack, and the winding of relay 133 to ground. The operation of relay 133 breaks the locking path of relay 134 which thereupon releases extinguishing the lamps. Attention is called to the fact that as a result of the operation of relay 122 ground was connected to the rings of jacks 139 and 138. If teletypewriter sending key 303 in Fig. 3 is operated, so that relay 315 is operated, and the attendant's teletypwriter set, per Fig. 4, is connected to the cord circuit, per Fig. 3, while Fig. 3 is connected to a jack such as 139 in response to a calling-in signal, it is possible for the attendant at the local station in Fig. 1 to summon the attention of the operator who is administering the concentration group through the operation of key 129. It is not possible for the calling-in lamps 135, 136, etc. to light under these circumstances as, since relay 133 is operated, it is impossible for relay 134 to operate. However, the ground from relay 122 will be connected through the ring of a jack such as 139 to the ring of plug 301. From this point the circuit extends through the bottom back contact and armature of relay 328, through the bottom outer back contact and armature of relay 313, through the bottom inner armature and front contact of relay 315, relay 315 being operated as key 303 is operated, through the armature and left-hand contact of relay 319, relay armature 319 being actuated to the left as the resistance of relay 133 is high, through the winding of relay 329 and resistance 330 to negative battery operating relay 329. The operation of relay 329 closes an obvious circuit for the lighting of lamp 307. The lighting of supervisory lamp 307 is an indication that a station forming part of the concentration group is summoning the attention of the operator. Attention is called to the fact that the supervisory signal for this condition is a steady lamp. If the concentration group operator is sending, when a supervisory signal is received, the operator may suspend sending and receive signals from the attendant at the local station who is calling in. If the concentration group operator prefers, she may split off the circuit from which the supervisory signal is being received in a manner to be described below and communicate exclusively over said circuit.

Full duplex communication

For full duplex teletypewriter communication both the front and rear cords of the teletypewriter cord circuit are used. Plug 301 will be inserted into a jack, such as 237, and plug 302 will be inserted into a jack, such as 238. Ordinarily the cord associated with plug 301 is arranged for receiving teletypewriter signals and the cord associated with plug 302 for sending teletypewriter signals. Key 303 is operated. Relays 321, 319 and 311 are operated as described in the foregoing. Insertion of plug 302 into jack 238 closes a circuit from ground through the right-hand outer back contact and armature of relay 218, sleeve of jack 238, sleeve of plug 302, top winding of relay 314, resistance 331 and the bottom winding of relay 314 to battery, operating relay 314. The operation of relay 314 closes a circuit from negative battery through the bottom armature and front contact of relay 314 and the bottom armature and back contact of relay 312, through the winding of relay 328 to ground, operating relay 328. The operation of relay 314 further supplies an additional ground through its top armature and front contact for the winding of relay 311. The operation of relay 314 further connects the tip of plug 302 through the top outer back contact and armature of relay 312 and the top outermost back contact and armature of relay 313, through the top outer front contact and armature of relay 314 and the top middle armature and front contact of relay 315 to conductor 323. This circuit has been traced and has been shown to connect to the armature of relay 425 from which communication signals may be transmitted under the influence of the teletypewriter transmitting contacts. The tip conductor of plug 301 will be connected to the receiving circuit in Fig. 4 over a path heretofore traced. The teletypewriter therefore receives signals from the concentration group associated with one side of the full duplex circuit over the tip of the cord associated with plug 301 and can send signals over the tip of the cord associated with plug 302 to the concentration group associated with the other side of the full duplex circuit.

If key 308 is operated, a circuit is closed from ground through the contact and armature of said key, winding of relay 312 and the bottom front contact and armature of relay 314 to battery, operating relay 312. The operation of relay 312 releases relay 328 by breaking a circuit through the winding of said relay at the bottom armature and back contact of relay 312. This re-

verses the connections of the attendant's teletypewriter set circuit to the teletypewriter cord circuit and permits reception of signals over the cord associated with plug **302** and the transmission of signals over the cord associated with plug **301**. At the conclusion of communication the withdrawal of both cords from their respective jacks and the restoration of such keys as are operated causes the release of all operated relays and returns the circuits to normal.

Manual telegraph communication

The teletypewriter cord circuit, per Fig. 3, may be connected to the attendant's manual telegraph set, per Fig. 5, which provides facilities for manual telegraph communication over a concentration group when the cord associated with plug **301** is connected to the appropriate jack. It will be assumed that plug **301** of Fig. 3 is inserted into jack **140** of Fig. 1. Key **306** is operated. This closes a circuit from ground through the top armature and front contact of key **306** and the winding of relay **322** to battery, operating relay **322**. It should be pointed out that the circuit through the contacts of key **306** by means of which relay **322** is operated is a chain circuit and extends through the armatures and contacts of a plurality of similar keys in other cord circuits at the position where the concentration group is being administered. If a key in a preferential position in the series circuit, that is to say, closer to the source of ground, is already operated, the attendant's manual telegraph set circuit, per Fig. 5, will be associated with said circuit and since the chain to ground will be broken in said circuit, it will be impossible to operate relay **322** in the circuit more remote from the ground source. The object of this is to prevent the connection of the single attendant's manual telegraph set circuit, per Fig. 5, to more than one cord, per Fig. 3, at one time. The insertion of plug **301** into jack **140** causes the operation of relays **321**, **319** and **311** in the same manner as described heretofore. The path from the tip of plug **301** is divided into two branches in the same manner as described for the operation of the cord, per Fig. 3, with the attendant's teletypewriter set, per Fig. 4. Conductor **332** in Fig. 3 is joined to conductor **532** in Fig. 5. Relay **501** in Fig. 5 is operated over a path extending from the bottom outermost armature and front contact of relay **322** through the winding of relay **501** to battery. The path from conductor **532** is then extended through the top outer armature and front contact of relay **501** to the control grid of vacuum tube **502**. Conductor **333** which is joined to the tip of plug **301** in parallel with conductor **332** in the same manner as described above extends through conductor **533** in Fig. 5 to the armature of relay **525**. Vacuum tube **502** operates in the same manner as vacuum tube **402** described above. Relay **507** follows the signals received from the concentration group and impresses them on the receiving magnet **520** associated with the sounder. Relay **525** follows the signals transmitted from the attendant's telegraph set. These signals are impressed on the transmission conductor in the concentration group over the circuit which extends to the tip of the plug **301** in Fig. 3. The general similarity of Fig. 5 and Fig. 4, except for the obvious differences necessary to equip one with a teletypewriter and the other with a Morse key and sounder, is such that it does not appear necessary to describe the operation of Fig. 5 in any greater detail as its operation will be apparent from the description of Fig. 4 above.

Splitting concentration groups

The circuits herein are arranged in such a manner that it is possible to disconnect any desired facility forming part of a particular concentration group from the group. It is possible to communicate over the facility which has been split off from the group while excluding those facilities still interconnected in the group from the communication. Alternatively it is possible to communicate with the group while excluding the facility which has been split off. While communication is in progress either with the separated facility or with the group, the circuits are arranged so that the supervisory lamp in the cord is flashed in response to signals on the group if the communication is in progress with a separated facility or on the separated facility if communication is in progress with the group. The manner in which this is performed will now be described.

It will be assumed that the circuits are arranged as shown in Fig. 6 and that plug **301** of Fig. 3 is inserted into jack **142**. If it is desired to split a particular leg from a concentration group, key **305** is operated. In order to communicate, key **303** or key **306** is also operated. A circuit is closed from ground through the bottom armature and front contact of key **305**, through the winding of relay **334** to battery, operating relay **334**. It will be assumed that key **303** is operated which in turn operates relay **315** to connect the attendant's teletypewriter set per Fig. 5 to the cord, per Fig. 3. The operation of relay **334** closes a circuit through its bottom armature and front contact and the winding of relay **335** to battery, operating relay **335**. A circuit may be traced from ground through the winding of relay **108**, sleeve of jack **142**, sleeve of plug **301** to a parallel circuit. One branch of the parallel circuit extends through the bottom outer front contact and armature of relay **335** to junction point **340**. The second branch extends through the top armature and break contact of key **304**, through the top armature and front contact of key **305** to junction point **340**. The branches join and the path continues through the winding of relay **321**, through resistance **320** to the bottom inner armature and front contact of relay **335** directly to battery. The resistance of this path to battery is less than the resistance of the sleeve circuit to battery when the circuit is arranged for communication but when the splitting keys are not operated. Under such circumstances, the path to battery, which has been heretofore traced, extends through the top winding of relay **319** and resistance **318** after passing through resistance **320**. When the resistance of the sleeve circuit is low, relay **108** operates. The operation of relay **108** disconnects the west line from the hub by opening the circuit extending from the west line through resistance **107** at the armature and back contact of relay **108**. The communication branch from the west line, however, is connected to the tip of jack **142**. The ring of jack **142** is connected to the hub **109**. This operation, therefore, arranges the circuits so that it is possible to communicate either by teletypewriter or, if key **306** is operated instead of key **303**, by manual telegraph as described above over the tip conductor of jack **142** with the west line. At the same time signals on the facilities which

are still associated together in the concentration group will be passed through the hub and the ring spring of jack 142, through the ring of plug 301, bottom back contact and armature of relay 328, bottom outer back contact and armature of relay 313, bottom inner armature and front contact of relay 315, armature and left-hand contact of relay 319, the winding of relay 329 and resistance 330 to battery, to operate relay 329 intermittently, which results in irregular flashing of the supervisory lamp 307. It should be observed that as the top winding of relay 319 is shunted, the armature of relay 319 will be held in engagement with its left-hand contact by the effect of current through its bottom winding.

If it is desired, instead of communicating with the facility which is split off, to communicate with the facilities which still remain interconnected in the concentration group, key 304 is operated. This closes a circuit from ground through the bottom armature and front contact of key 304 and the winding of relay 313 to battery, operating relay 313. The operation of relay 313, in turn, closes a circuit for the operation of relay 335. This circuit may be traced from ground through the top innermost armature and front contact of relay 313, through the winding of relay 335 to battery. The operation of relay 335 results, as we have seen, in the reduction of the resistance in the sleeve circuit of Fig. 3 and the operation of relay 108, which splits the west line from the hub. It also shunts the top winding of relay 319. In this case, however, the circuits are arranged so that it is possible to communicate with the circuits which still remain interconnected in the concentration group rather than with the facility which has been split off from the group. This communication with the concentration group takes place over the ring circuits of plug 301 and jack 142. The circuit extends from the hub 109 through the ring of jack 142, ring of plug 301, bottom back contact and armature of relay 328, top middle front contact and armature of relay 313 to the circuit which extends into the attendant's teletypewriter set or the attendant's manual telegraph set which has heretofore been traced. In this case also communication signals on the facility which has been split off from the concentration will result in the irregular flashing of lamp 307. This occurs from signals on the tip. The circuit may be traced from the tip of jack 142, through the tip of plug 301, top armature and front contact of relay 311, top inner back contact and armature of relay 312, bottom inner front contact and armature of relay 313, top back contact and armature of relay 334, through the winding of relay 329 and resistance 330 to battery.

If Figs. 3, 4 and 5 are being used in connection with a full duplex concentration group, such as Fig. 2, as per Fig. 7, plug 301 is inserted into jack 234 and plug 302 is inserted into jack 233. If keys 305 and 303 are operated, relays 334 and 315 will be operated as described above. The operation of relay 334 will cause the operation of relay 335 as also described above. This results in the reduction of the resistance of the sleeve circuits of Fig. 3 connected to both jack 234 and jack 233. The change for the sleeve associated with plug 301 is the same as heretofore described. In the case of the sleeve circuit associated with plug 302, the operation of relay 335 shunts the path which previously extended to negative battery through the high resistance bottom winding of relay 314 and connects it instead directly to negative battery through the top armature and front contact of relay 335. Under these circumstances relay 210 and relay 209 will both operate. The operation of relay 210 will disconnect the receiving circuit for the west line from hub 225. The operation of relay 209 will disconnect the sending circuit for the west line from hub 230.

As a result of these operations, the receiving and transmitting circuits for the west line, per Fig. 2, are disconnected from their respective hubs 225 and 230. The transmitting conductors giving access to the receiving and transmitting branches of the west line are connected to the tip of jack 234 and the tip of jack 233, respectively. The ring circuit of jack 234 is connected to the hub 225 and the ring circuit of jack 233 is connected to the hub 230. The receiving circuit of the west line is extended over the tip of jack 301 through a path already traced to the transmitting and receiving branches of the attendant's teletypewriter set, per Fig. 4, or the attendant's manual telegraph set, per Fig. 5, if key 306 is operated. The sending circuit for the west line is connected through the tip of jack 233 and of plug 302 into Fig. 4 and Fig. 5 over a path which has also been heretofore traced.

By this means it is possible to communicate over the west line. Signals from the east line meanwhile are impressed through the ring circuit of jack 233 and plug 302 on relay 329 which operates to flash lamp 307 irregularly as an indication of this condition. If key 304 is operated instead of key 305, relay 313 is operated. The operation of relay 313, in turn, operates relay 335. The reduction of the resistance of the sleeve circuits associated with plugs 301 and 302 results from this operation. Relays 209 and 210 will be operated due to the low resistance cord sleeve circuit in each instance. In this case, however, the ring circuit of jacks 233 and 234 will both be extended over paths heretofore traced into Figs. 4 and 5 while the tip circuit in each instance will be connected through the winding of the supervisory relay 329. It is then possible to communicate from Figs. 4 and 5 through the hubs 225 and 230. Signals arising in the west line will be impressed on the winding of relay 329 resulting in the irregular flashing of lamp 307.

The operation of key 308 operates relay 312 as described above, and releases relay 328. This reverses the connection of the front and rear cords to the sending and receiving elements of the circuits per Fig. 4 and Fig. 5 as well as to relay 329.

Restoration of the particular split key, key 304 or 305 which has been operated, causes the release of relays 334 and 335 or 313 and 335 as the case may be and returns the cord sleeve or sleeves to the high resistance condition. This, in turn, causes the release of relays such as 209 and 210 in Fig. 2 and restores the concentration group to normal.

If in changing from the split-to-leg to the split-to-hub condition it is not desirable to have the leg make contact with the hub, the key lever of key 304 or 305, as the case may be, should be operated very quickly. If the key lever is operated quickly enough and without fumbling, relay 335 does not release and the leg remains split from the group due to the fact that the low cord sleeve resistance remains unchanged. At

the conclusion of communication the withdrawal of the plug or plugs and the restoration of all operated keys releases all operated relays returning the circuit to normal.

Busy test feature

The cord circuit, per Fig. 3, is arranged so that it will give an indication of a busy condition existing on a trunk with which Fig. 3 cooperates. Although the cooperating trunk circuits, such as interoffice and local telegraph trunks, are not disclosed in this application as they are not per se a part of this invention, it is to be understood that the cord, per Fig. 3, is arranged to cooperate with facilities other than those described herein, such as interoffice and local telegraph trunks. Fig. 3 is arranged in such a manner that if the tip of plug **301** is connected to a jack having battery potential on the sleeve, a circuit is closed from said sleeve through the tip of jack **301** and the top armature and back contact of relay **311** through the winding of relay **336**. This results in the actuation of the armature of relay **336** to engage with its right-hand contact resulting in the lighting of lamp **309** over an obvious circuit.

What is claimed is:

1. In a telegraph switching system in combination, a hub type telegraph repeater concentration group comprising a plurality of telegraph circuits interconnected through hub type repeaters, a cord circuit, means in said cord circuit for forming an operable telegraph path through said cord and said concentration group, an attendant's teletypewriter circuit including means for communicating through said cord circuit to said concentration group.

2. In a telegraph switching system, a plurality of hub type telegraph repeaters interconnected to form a concentration group, a cord circuit, an attendant's manual telegraph set circuit, and means in said circuits and said group for establishing an operable telegraph path from said set through said cord and through said group.

3. In a telegraph switching system, a plurality of hub type telegraph repeaters interconnected to form a concentration group, a cord circuit, means in said circuit for cooperating with said group, an attendant's teletypewriter set circuit, means in said cord circuit for severing a telegraph branch forming part of said concentration group from said group and means for connecting said severed branch through said cord circuit to said attendant's teletypewriter set circuit, to form an operable telegraph path.

4. In a telegraph switching system, a hub type repeater telegraph concentration group, a cord circuit, means in said circuit for cooperating with said group and means in said cord circuit responsive to the connection of said cord circuit to said concentration group for disassociating a branch of said group from said group.

5. In a telegraph switching system, a hub type telegraph repeater concentration group, a cord circuit, means in said cord circuit for interconnecting said cord circuit and said group, telegraph communication means connectable to said cord circuit and supervisory signal means in said cord circuit, independent of said communication means, responsive to signals from said group.

6. In a telegraph system, a hub type telegraph repeater concentration group, a cord circuit, means for connecting said cord circuit to said group, and means in said cord circuit and said group for splitting a facility from said group after said connection.

7. In a telegraph switching system, a hub type telegraph repeater concentration group, comprising a plurality of telegraph circuits interconnected through individual inverse neutral repeaters to a common hub, a cord circuit, means in said circuit for interconnecting said cord circuit and said group, means for severing a circuit forming a part of said group from said group, a telegraph transmitter and means in said circuits for associating said transmitter with the circuit so severed.

8. In a telegraph switching system, a hub type telegraph repeater concentration group, a cord circuit, means in said circuit for connecting said cord circuit and said group, means for severing a repeater forming a part of said group from said group, a telegraph transmitter, means in said circuits for associating said transmitter with said group and means in said circuit for excluding said severed repeater from said transmitter during said association.

9. In a telegraph switching system, a hub type repeater concentration group, a cord circuit, means for interconnecting said cord circuit and said group, a telegraph receiver, means for associating said receiver through said cord circuit with said group, means in said cord circuit for severing a repeater forming part of said group from said group and means for connecting said receiver exclusively to said severed repeater.

10. In a telegraph switching system, a hub type telegraph repeater concentration group comprising a plurality of telegraph lines interconnected through hub type telegraph repeaters to a common hub, a cord circuit, means for interconnecting said cord circuit and said group, an attendant's teletypewriter set, an attendant's manual telegraph set, means for directly connecting either set through said cord with said group and means in said group, said cord circuit and said sets for selectively establishing operable telegraph paths interconnecting said sets and said group.

11. Two hub type telegraph repeater concentration groups, a double ended cord circuit, means for interconnecting said cord circuit and said groups, means in said cord circuit for selectively associating an attendant's teletypewriter set or an attendant's telegraph set through said cord circuit with said groups and means for communicating through said cord circuit between either of said sets and said groups at separate times.

12. In a telegraph system, in combination, a hub type telegraph repeater concentration group, a teletypewriter cord circuit, means for interconnecting said circuit and said group, means for transmitting and receiving telegraph communication signals through said cord circuit and said group while so connected, a supervisory signal in said cord circuit independent of said communication means and means in said circuit responsive to control means in said group for operating said signal to attract the operator's attention to said group.

13. A hub type telegraph repeater concentration group, a cord circuit, means for interconnecting said cord circuit and said group, and means in said interconnection for conditioning said interconnection for communication exclusively over a single telegraph branch forming part of said group and over said cord circuit.

14. A hub type telegraph repeater concentra-

tion group, a cord circuit connected thereto, means in said cord circuit for disassociating a repeater forming part of said group from said group, a teletypewriter printer, means for connecting said printer through said cord circuit to said group, means for communicating exclusively between said printer and said disassociated repeater and means for communicating between said printer and said group while excluding said repeater.

15. In a telegraph system, a hub type telegraph concentration group comprising a plurality of telegraph lines interconnected through individual hub type repeaters to a telegraph hub, a cord circuit, means for interconnecting said cord circuit and said group, a telegraph transmitting and receiving printer and a manual telegraph set, means for selectively interconnecting said printer or said set through said cord circuit with said group, means in said group, responsive to control means in said cord circuit, for severing a line forming part of said group from said group, means for communicating either between said severed line and said printer or said set or between said group and said printer or said set while excluding said severed line and means in said cord circuit for receiving supervisory signals from the portion of said concentration group not at the moment arranged for communication with either said printer or said set.

16. A hub type telegraph repeater concentration group, a cord circuit including means for cooperating with said group, a teletypewriter transmitting and receiving printer, a manual telegraph set, means in said cord circuit for selectively connecting either said printer or said set through said cord circuit with said group, means also in said cord circuit for severing a repeater forming part of said group from said group and means for communicating, between said printer or said set, through said cord circuit with either said severed repeater or the repeaters remaining associated in said group.

17. In a teletypewriter switching system, a telegraph cord circuit, a communication conductor extending from a flexible connection in said cord circuit through said cord circuit to parallel branches in an attendant's teletypewriter set circuit, a space discharge device in one of said branches, a polar relay having a winding in series with the output circuit of said device, a teletypewriter receiving magnet responsive to said relay, and a polar relay in the other of said branches responsive to teletypewriter sending contacts.

18. In a teletypewriter switching system, a teletypewriter, transmitting contacts thereon, a telegraph relay, means for controlling said relay in response to the operation of said contacts, and time delay means for preventing the response of said relay to said contacts for an interval.

19. In a teletypewriter switching system, a teletypewriter transmitting circuit including a teletypewriter transmitter having transmitting contacts thereon normally closed when idle, a polar telegraph transmitting relay responsive to said contacts, said relay having a first winding in series with said contacts, means for energizing said winding when said transmitter is conditioned for transmitting to place said relay in the marking condition, a second winding on said relay, means for energizing said second winding to oppose the influence of said first winding when said relay is conditioned for transmitting, and means for delaying the energization of said second winding for an interval to insure the closure of said contacts and the energization of said first winding when said transmitter is being conditioned for transmitting, to prevent the transmission of a false signal during the conditioning interval.

20. In a teletypewriter switching system, a plurality of telegraph repeaters interconnected through a common neutral point, a teletypewriter transmitting circuit, means for connecting said circuit to said neutral point, a polar telegraph transmitting relay responsive to teletypewriter transmitting contacts in said circuit, means, including contacts on said relay, for transmitting telegraph signals from said relay through said neutral point to said plurality of repeaters in response to the actuation of said teletypewriter contacts, and means for preventing the transmission of false signals by said relay due to the false operation of said teletypewriter contacts when said teletypewriter is first started.

21. In a teletypewriter switching system, a telegraph transmitting relay, a teletypewriter transmitter, contacts on said teletypewriter controlling said relay, a motor for operating said teletypewriter and said contacts, and electromagnetic means for preventing the operation of said relay as said motor is started when said contacts have been stopped in an abnormal position.

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