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TELEPHONE LINE SYSTEM

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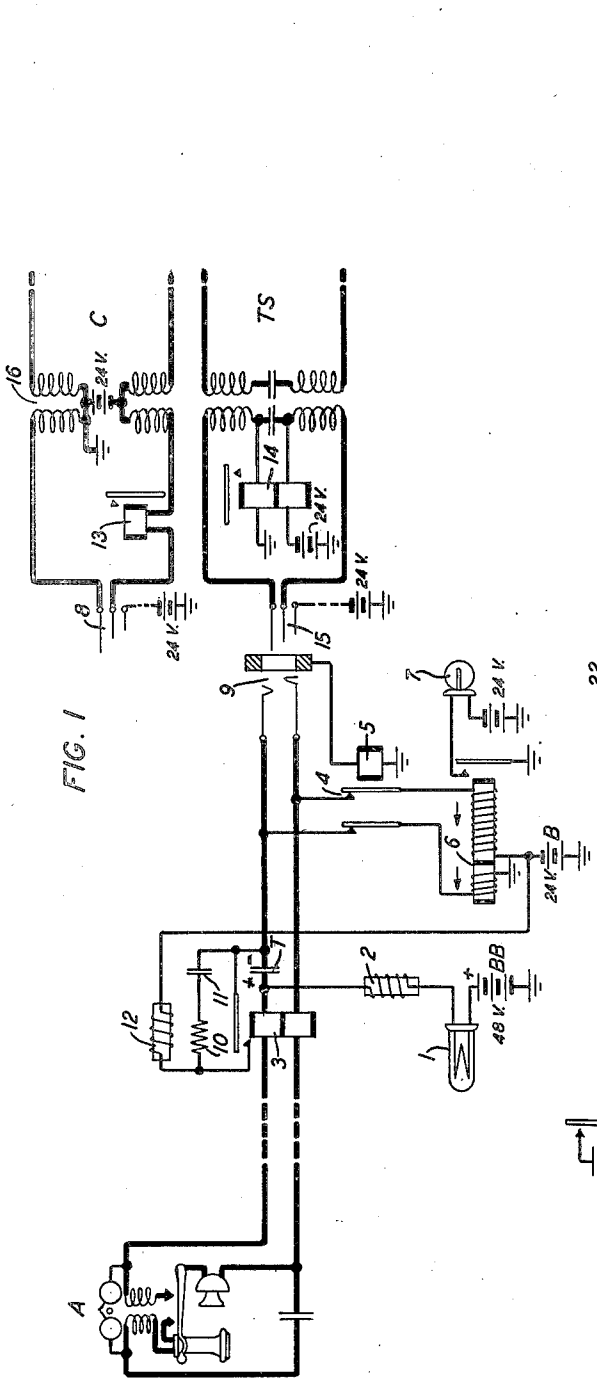

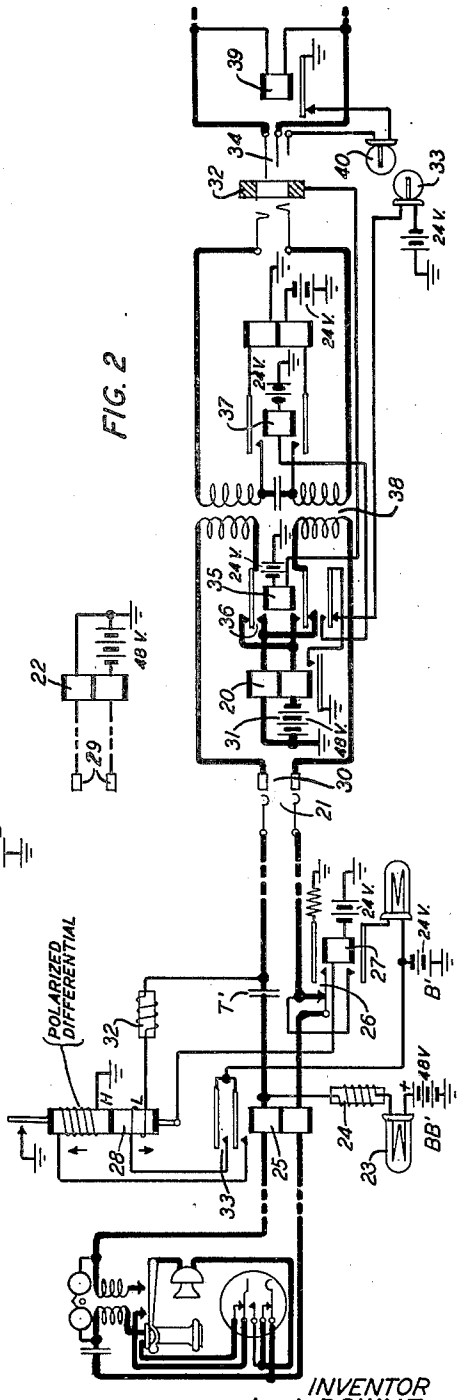

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TELEPHONE LINE SYSTEM

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2 Claims. (Cl. 179—27)

This invention relates to common battery telephone systems and more particularly to arrangements for extending the operating range of long line circuits extending from a central office or private branch exchange to a subscriber's station or the range of long trunk circuits from a central office to a private branch exchange.

In common battery systems it is occasionally desired to employ longer lines or trunk circuits than can be satisfactorily operated with the normal exchange battery. Such circuits, due to the fixed minimum current requirements of the line and supervisory relays used at the central office are limited to a certain maximum loop resistance which cannot be exceeded without the possibility of failure of such apparatus due to insufficient operating current. Circuits of this type may also be used to transmit dial pulses from a substation to the central office and obviously the relay which responds to the pulses must receive sufficient current to insure proper operation. Further, such lines when extended from offices equipped for machine ringing must not exceed such a resistance that will insure proper operation of the tripping relay when the called station answers.

Arrangements for extending the length of such circuits have heretofore taken different forms, as for example, a repeating relay circuit, i. e., at some intermediate point in the long line a voice repeating coil or transformer is located which splits the line into two sections with respect to signal currents, both ringing and direct current. A line relay in series with a battery is connected in bridge of the substation section of the line which responds when the subscriber removes his receiver and follows any succeeding movements of the switchhook or dial. This relay in operation connects a bridge across the central office section of the line which causes the line relay at the central office to operate. Such an arrangement is shown in Patent 1,719,499 dated July 2, 1929.

Another arrangement heretofore used resides in inserting a relatively high capacity condenser, in the ground or tip side of the line or trunk and connecting an auxiliary booster battery or other direct current source, of the desired voltage, to the line side of the condenser through a suitable resistance. The location of the aforesaid condenser may be at any point in the line or trunk circuit but preferably, for obvious reasons, should be located at the central office or private branch exchange. Further, the auxiliary battery should be so poled with respect to the line that it will be series aiding with respect to the central office battery.

Such an arrangement is suitable for use with lines which terminate in central offices where the positive or grounded pole of the office battery is connected to the tip of the line and the negative pole to the ring conductor. This, it will be understood, is the usual practice.

However, in certain automatic central offices the switching apparatus is specially arranged so that if a calling subscriber dials a designated code in order to reach an operator, for example 211, which is the usual code for a long distance operator, the calling line is connected to an operator's trunk in which the line relay supplies battery and ground to the line in a reverse direction, i. e, the positive or grounded pole of the battery is connected to the ring conductor of the trunk and the negative pole is connected to the tip of the trunk Under this condition, due to the fact that the booster battery above referred to is connected to the tip side of the line and so poled that it will be series aiding with respect to a normally poled central office battery, i. e., one which has its positive pole connected to the tip and negative to the ring, a situation arises in which the positive booster battery flowing over the tip of the line, through the calling subscriber's station and thence over the ring to the central office, encounters positive central office battery supplied through the line relay and therefore due to this opposition the line relay will not receive sufficient current to operate and hence the circuit will not function properly to completely extend the calling line to the operator.

A feature of the invention therefore resides in an arrangement employing a booster battery whereby when such a reverse battery condition is encountered during the extension of a call at a central office the ring side of the line will be automatically opened, ground connected to the line portion thereof and a second properly poled auxiliary battery connected to the central office portion.

The invention will be understood from the following description and the accompanying drawing, Fig. 1 of which shows a booster battery arrangement as above-mentioned which is arranged to function with all common battery central offices in which the central office battery is always connected to the calling line in the conventional manner, i. e., ground on the tip and battery on the ring, and Fig. 2 shows a modification of this arrangement and in accordance with the present invention arranged in such a manner that in case a line equipped with a booster battery encounters a reverse battery condition at the central office, the circuit will adapt itself to this changed condition in order to cause the central office equipment to function in the proper manner.

In the following description it will be first assumed that the subscribers, A of Fig. 1 and X of Fig. 2, which are connected at the ends of long lines equipped with booster battery, as hereinbefore referred to, initiate calls.

When the receiver at station A of Fig. 1 is

removed from the hook, 48-volt positive battery BB flows through the ballast resistance lamp 1, impedance coil 2, through the upper winding of relay 3 over the tip conductor of the line, through the subscriber's telephone, back over the ring conductor of the line through the lower winding of relay 3 over back contact 4 of cut-off relay 5 and through the right-hand winding of line relay 6 to negative 24-volt central office battery.

It will be observed that booster battery BB and the central office battery B are series aiding with respect to each other and, therefore, relay 6 will operate on its right-hand winding, thereby lighting line lamp 7. Relay 3 also operates in the foregoing circuit and closes its contacts, thereby connecting the negative terminal of 24-volt central office battery B to the tip conductor of the line on the office side of condenser T. Due to the fact that, in practice, the left-hand or tip winding of relay 6 has fewer turns than the right-hand or ring winding the current flowing in the left-hand winding of this relay has little effect and may be ignored.

Resistance lamp 1 is provided to prevent too great a flow of current through the subscriber's transmitter on short lines.

Resistance 10 and condenser 11 provide protection from destructive arcing at the contact of relay 3. Retardation coils 11 and 12 prevent noise from being introduced on the tip side of the line from the booster battery BB and central office battery B.

When the operator answers by inserting plug 8 of the cord circuit C into jack 9 the sleeve cut-off relay 5 operates, thereby disconnecting the line relay. The line is now connected through to battery and ground at the center of the cord circuit repeating coil 16.

Supervisory relay 13 operates in a well-known manner and remains operated in a circuit which may be traced from the negative terminal of central office battery B, lower left winding of the cord circuit repeating coil, winding of relay 13, ring conductor of the cord and line, lower winding of relay 3, through the subscriber's transmitter, back over the tip of the line and upper winding of relay 3, to the positive terminal of the 48-volt booster battery BB, thereby providing sufficient current to hold the supervisory relay 13 operated over the long subscriber's line. Supervisory relay 13 is now under control of the subscriber's switchhook and will release when the subscriber hangs up, and reoperate when the receiver is again removed from the hook.

The reason for connecting the negative terminal of central office battery B to the tip of the line when relay 3 operates is to aid the operation of double-wound supervisory relays, such as 14, which are provided in certain incoming trunk circuits, such as TS, which it may be desired to connect to such long lines equipped with booster battery. In such trunks, the two windings of the supervisory relay have an equal number of turns and the negative 24-volt battery connected to the tip of the line when relay 3 operates, flows through the upper winding of supervisory relay 14 and aids in its operation.

On a call from the central office to a station such as A connected at the end of a long line equipped with booster battery the functioning of the circuit is the same as above described. When the operator inserts either plug 8 of cord circuit C, or plug 15 of trunk circuit TS, in jack 9 and rings the ringing current flows over the ring side of the line through the subscriber's bell and back to ringing ground on the tip side of the line at the central office through the high capacity condenser T. Some of the ringing current may be shunted through the upper winding of relay 3, retardation coil 2, lamp 1 and battery BB to ground. Relay 3 may flutter under this condition but does not interfere with the operation of the circuit and performs no useful function.

In case the cord circuit C, or trunk TS, is arranged for machine or automatic ringing, when the subscriber answers during the ringing period if the loop is short enough, the 48-volt booster battery flowing over the ring side of the line and through the subscriber's instrument causes the usual operation of a tripping relay at the central office. During the silent interval between rings, the tripping relay will operate when the subscriber's receiver is removed from the hook.

Fig. 2, as before mentioned, shows a long subcriber's line equipped with booster battery terminating at an automatic central office which office is arranged in such a manner that if the subscriber dials an operator, the line will be extended to a trunk circuit terminating at an operator's position, which trunk is so arranged that the line relay therein supplies 48-volt battery to the line of a reverse polarity to the usual battery connection, i. e., ground is connected to the ring conductor of the line and the negative terminal is connected to the tip. Such a line relay is indicated as 20 in the lower right-hand corner of the drawing.

It is, of course, understood that the direct selector brushes 21 may be directed to other terminals extending to normal 24-volt central office battery supply which is not reversed, as for example through relay 22.

When the subscriber at station X removes his receiver 48-volt positive booster battery flows from the battery BB' through ballast resistance lamp 23, retardation coil 24, upper winding of relay 25, tip conductor of the line through the subscriber's dial contacts, ring conductor of the line, lower winding of relay 25 and contacts 26 of relay 27 to the negative terminal of the central office battery through the usual line relay, not shown. The line relay operates in this circuit and sets up the well-known condition for receiving pulses from the subscriber's dial.

Relay 25 also operates and closes its contacts, thereby connecting the negative terminal of the 24-volt central office battery B' to both windings of the polarized relay 28, which relay, however, does not operate at this time due to the fact that the two windings are differentially connected.

Operation of the subscriber's dial causes the well-known extension of the call. If the number dialed is for another subscriber the call proceeds in the usual manner and no further operation of the relays associated with the booster battery circuit takes place, as for example, if the number dialed causes the brushes 21 of the district selector to come to rest on terminal 29 and in this case the extended connection continues to meet ground on the tip and negative battery on the ring.

If, however, the district selector brushes 21 are caused to come to rest on terminals 30 of a trunk circuit terminating in a jack 32 at a toll operator's position, arranged for what is known as toll diversion, the calling line encounters a 48-volt battery 31 reversed in polarity with respect to the usual 24-volt central office battery associated with line relay 22, i. e. the ring conductor of the calling line is connected to the negative terminal of a

48-volt battery 31 through the lower winding of relay 20 and the tip conductor is connected to ground through the upper winding of relay 20.

Relay 25 also operates under this condition as before and polarized relay 28 now also operates due to the fact that current flows from negative battery 31 over the tip of the line through retard coil 32 to the right-hand terminal of the upper winding of relay 28 and thence through this winding to the negative terminal of the 24-volt central office battery B'. Hence, current will flow in the upper winding of relay 28 in a direction which will generate a flux in relay 28 which will be in aiding direction with respect to the flux caused and the current flowing in the lower winding and consequently relay 28 will now operate. Relay 28 in operating, operates relay 27 in an obvious circuit which opens the ring conductor of the line at its contact 26, connects the negative terminal of the 24-volt central office battery B' toward the line relay 20 and connects ground through a resistance toward the subscriber's station. Current now flows in both windings of relay 20 in the proper direction to cause its operation. When relay 20 operates it causes the line lamp 33 to light as a signal to the operator to answer by inserting plug 34 of her cord circuit into jack 32 whereupon relay 35 operates in an obvious sleeve circuit. Relay 35 in operating causes battery 31 to be reversed with respect to the calling line whereupon the flux in relay 28 is reduced to a point which permits it to release. Release of relay 28 releases relay 27 and reconnects the ring conductor of the line through, at contact 26, from the calling station to the central office. Relay 20, however, remains operated. Operation of relay 35 also closes its contact 36 thereby completing the circuit for the operation of relay 37 which can be traced from ground, upper contact of relay 20, contact 36 of relay 35 and winding of relay 37 to battery. Relay 37 in operating connects battery and ground to the lower and upper right-hand windings, respectively, of the repeating coil 38 thereby causing the cord supervisory relay 39 to operate and thereby preventing the supervisory lamp 40 from lighting.

Transmitter and supervisory current is now supplied to the calling station over a circuit similar to that of Fig. 1 which can be traced from the negative terminal of battery 31, lower winding of relay 20, lower alternate contact of relay 35, lower left-hand winding of transformer 38, lower contacts and brush of the district switch 21, ring conductor of the line extending through the switching apparatus indicated by the broken line conductor over contact 26 of relay 27, lower winding of relay 25 through the subscriber's station, back over the tip conductor of the line, upper winding of relay 25, impedance core 24, resistance lamp 23 to the positive terminal of booster battery BB, the negative terminal of which is grounded. Condenser C' provides a path for the voice frequency current between the subscriber's station and the central office.

When the subscriber hangs up the foregoing circuit is opened at the subscriber's switchhook contact thereby releasing relay 20 which causes relay 37 to release thereby releasing relay 39 in the cord circuit which lights the cord supervisory lamp 40 as a disconnect signal.

What is claimed is:

1. In a telephone system, an automatic exchange, an automatic subscriber's station line terminating thereat in a first central battery, a condenser in series with one side of the line, a booster battery connected between ground and the condenser side of the line on the station side of the condenser, said booster battery being so poled with respect to the line that when the subscriber's receiver is removed from the hook it will be series-aiding with respect to the first central battery in which the line terminates, a trunk circuit, comprising a second central battery and a relay in series therewith, terminating at an operator's position, said battery being normally poled in a reverse direction, with respect to the trunk conductors and any line which may be connected thereto, from the polarity of the first central battery in which said subscriber's line normally terminates, means at the subscriber's station for transmitting impulses over the line and means responsive thereto to cause the line to be disconnected from the first central battery and to be extended to said trunk circuit, and means associated with the line responsive to its connection to said trunk to bridge said booster battery across the station line on the station side of the condenser, open the non-condenser side of the line between the booster battery and the trunk circuit and to connect said first central battery between ground and the exchange portion of the non-condenser side of the line in such a direction that it will be series-aiding with respect to the second central battery.

2. In a telephone system, an automatic exchange, an automatic subscriber's station line terminating thereat in a first central battery, a condenser in series with one side of the line, a booster battery connected between ground and the condenser side of the line on the station side of the condenser, said booster battery being so poled with respect to the line that when the subscriber's receiver is removed from the hook it will be series-aiding with respect to the first central battery in which the line terminates, a trunk circuit, comprising a second central battery and a relay in series therewith, terminating at an operator's position, said battery being normally poled in a reverse direction, with respect to the trunk conductors and any line which may be connected thereto, from the polarity of the first central battery in which said subscriber's line normally terminates, means at the subscriber's station for transmitting impulses over the line and means responsive thereto to cause the line to be disconnected from the first central battery and to be extended to said trunk circuit, and means associated with the line responsive to its connection to said trunk to bridge said booster battery across the station line on the station side of the condenser, open the non-condenser side of the line between the booster battery and the trunk circuit and to connect said first central battery between ground and the exchange portion of the non-condenser side of the line in such a direction that it will be series-aiding with respect to the second central battery, said trunk relay being so constructed and arranged that it will operate only when said foregoing switching means responds, and other means responsive to operation of said relay to reverse the polarity of said second central battery, with respect to the trunk and line, to restore said switching means and the connections controlled thereby to their normal condition.

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