

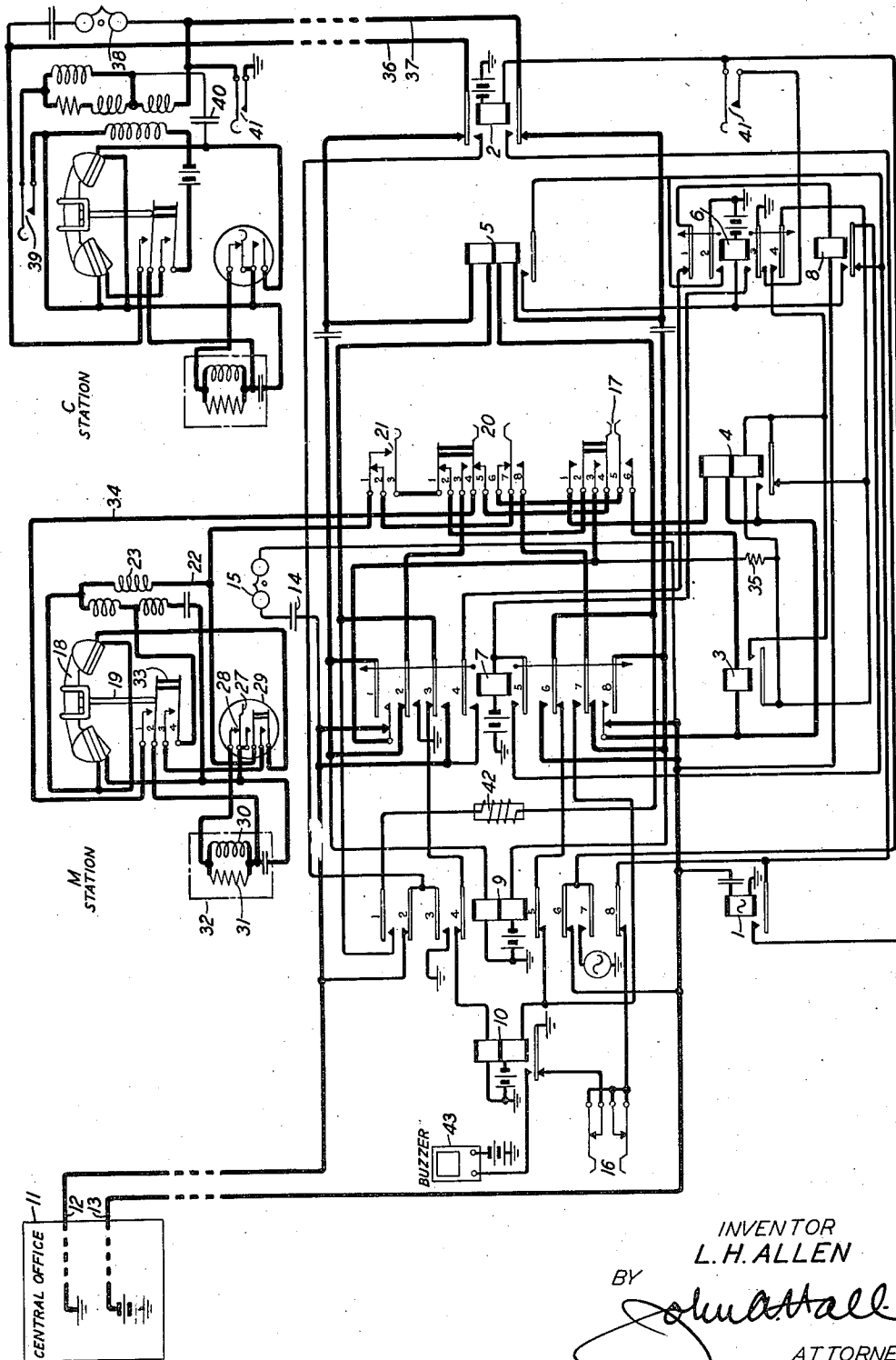
Sept. 2, 1941.

L. H. ALLEN

2,254,723

SUBSCRIBER LINE CIRCUIT

Filed Sept. 18, 1940



INVENTOR
L. H. ALLEN

BY

John A. Hall
ATTORNEY

UNITED STATES PATENT OFFICE

2,254,723

SUBSCRIBER LINE CIRCUIT

Lawrence H. Allen, Summit, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application September 18, 1940, Serial No. 357,248

4 Claims. (Cl. 179—42)

This invention relates to communication systems and particularly to subscribed line circuits in a telephone system.

The object of the invention is to provide improved facilities for special service to subscribers requiring an extension station at a point distant from his main station. Such distant extension station is spoken of as an off-premise station and is usually located at such a distance that it is impractical to provide more than a single pair of conductors between the two stations. It, therefore, becomes necessary to perform numerous signaling functions between the two stations over this pair of wires as well as to provide for the transmission of voice currents thereover.

A feature of the invention is a relay arrangement located at the main station responsive to various conditions of the main and extension stations and the central office line. Particularly a feature of this invention is a relay arrangement at the main station which will prevent a breakdown when central office battery is disconnected from the line and the extension station, which will hereinafter be referred to as the C (for controlled) station, is connected thereto. Since under the condition where the C station is employing the central office line certain relays have been operated at the M (for main) station and are held so operated under control of the C station, special hold-over means are employed to prevent interference with this condition when the central office battery is lost temporarily as sometimes happens under certain given circumstances.

Another feature of the invention is a busy signal arrangement whereby the M station is notified that the C station is engaged in using the central office line when the M station attempts to set up a connection between the M and C stations.

Still another feature is a circuit arrangement whereby the M station is supplied with talking battery from a local source when both the M station and the C station are effectively connected to the central office line whereby the transmission is not adversely affected by the metallic bridge across the central office line supplied by the C station.

The drawing consists of a single sheet in the form of a circuit diagram showing a telephone line extending from a central office to a main station and an off-premise controlled extension station.

The functions of this circuit are as follows:

1. To signal the M station on calls incoming from the central office;
2. To signal the C station on calls incoming from the central office;
3. To place control of the central office line to the C station under control of the M station;
4. To signal the M station when the C station

is employing the central office line and the M station attempts to call the C station;

5. To signal the M station from the C station;

6. To signal the C station from the M station;

7. To provide for the M station holding a call on the central office line;

8. To provide for releasing the held condition from either the M or C station;

9. To prevent the M station from signaling the C station when the C station is employing the central office line;

10. To supply talking battery to the M station when talking to the C station;

11. To supply talking battery to the M station when both M and C stations are connected to the central office line;

12. To hold the relays in the cut-through position when the C station is talking on the central office line and the battery at the central office is opened.

The function of the various relays shown in the drawing is as follows: Relay 1 operates on ringing current from the central office line to ring the C station on incoming calls. Relay 2 applies ringing to the private line on calls incoming on the central office line and when push-button signaling is employed from the M to the C station. Relay 3 is used for releasing the hold relay when the M station connects to the central office line. Relay 4 is a holding relay used to hold the connection on the central office line. Relay 5 is used as a supervisory relay to control the cut-through equipment on calls from the C station to the central office line. Relay 6 is used to hold up during dialing or switchhook flashing to maintain the cut-through position of calls from the C station to the central office line. Relay 7 is used to cut through the private line from the C station to the central office. Relay 8 is used to hold over the cut-through condition in case of calls in the panel system when line relay battery is removed and before the sender is connected. Relay 9 is used to supply talking battery to the M station on calls between the M and C stations and on calls to the central office when both M and C stations are connected. Relay 10 is used to signal the M station on calls from the C station.

Calls between central office and M Station—C station cut-off

On incoming calls from the central office the ringer at the M station operates to signal such an incoming call. The central office is here represented by the rectangle 11 in which a ground connection is indicated as being connected to the tip conductor 12 and a battery connection is indicated as extending to the ring conductor 13. When a call has been properly extended in the central office to the conductors 12 and 13 and ringing current applied thereto, such ringing cur-

rent will flow through the condenser 14 and the ringer 15 at the M station for the purpose of signaling the M station. Relay 1 also operates but performs no useful function providing the key 16 is placed in its open position. This key is of a type which may be placed and left in either the open or closed condition. The normal condition when the C station is to be cut off is open. Therefore, in this condition the operation of relay 1 is without effect. The subscriber at the M station, in response to the incoming signal, operates the appropriate pick-up key 17 and removes the handset 18 from its mounting 19, thereby closing the station circuit and causing the relay 3 to operate. The circuit for relay 3 may be traced from the ring conductor 13 through the normal contacts of armature 8 of relay 7, the winding of relay 3, the contacts 5 and 6 of key 17, contacts 6 and 7 of key 20, contacts 1 and 2 of key 21, the ring conductor 22 of the station circuit, winding 23 of the induction coil, the transmitter of the handset, the contacts 27 and 28 of the dial 29, the parallel circuit through the inductance 30 and resistance 31 of the filter 32, contacts 1 and 2 of the hook switch 33, tip conductor 34, springs 4 and 5 of key 20, springs 3 and 4 of key 17, the normal contacts of armature 1 of relay 7 to the tip conductor 12. Relay 3 performs no useful function at this time. On calls originated at the M station on central office line, the central office pick-up key 17 is operated and calls may be originated in the usual manner.

Holding

The central office line may be held by the operation of the hold key 21 in the telephone set at the M station. The hold key when operated opens the operating path for the relay 3, causing relay 3 to be released. Key 21 also closes a circuit for operating relay 4 through its upper winding in series with the central office loop and station telephone set. The circuit for the upper winding of relay 4 may be traced from the point where relay 3 connected to the ringing conductor 13 through the upper winding of relay 4, the springs 1 and 2 of key 17, springs 1 and 2 of key 20 and springs 1 and 3 of key 21. Thus the upper winding of relay 4 is introduced in the loop in place of the winding of relay 3 in the circuit hereinbefore described. When relay 4 operates its lower winding will be connected across the line in a circuit which may be traced from the ringing conductor connected to the upper winding of relay 4, through the front contact and armature of relay 4 and the lower winding thereof, resistance 35, and thence through the normal contacts of armature 1 of relay 7. When the hold key 21 is released, the operated pick-up key will be released by the subscriber at the M station and the upper winding of relay 4 will be opened. Relay 4, however, will be held operated through its lower winding and the station set will be disconnected from the line. The holding condition is released when the M station with the handset off its mounting again operates its pick-up key to operate the L relay since the L relay causes the lower winding of relay 4 to be short-circuited. Similarly, if the C station comes on the line, the operation of relay 5 operates relay 6 which in operation short-circuits the lower winding of relay 4 through its armature 4 and front contact. Thus, after the holding condition has been established it will be released under control of either the M or C station coming in on the central office line.

Terminating calls on the central office line with the cut-off key operated to connect the C station to the central office line

In the case of a call terminating on the central office line the ringer operates at the M station and relay 1 operates. The operation of relay 1 operates relay 2 since the cut-off key 16 is now in the position shown. The operation of relay 2 connects the tip and ring of the central office line to the private line represented by conductors 36 and 37 so that the ringing current now incoming from the central office line causes the ringer 38 at the C station to operate. If the C station answers the ringing signal with key 39 in its operated position where it eventually short-circuits the condenser 40, the relay 5 operates, causing the operation of relay 6, which in turn operates the cut-through relay 7. It will be noted that the windings of relay 5 are now included in series with the tip and ring conductors extending to the C station and since relay 5 is designed to operate on these currents, it closes a circuit from battery, the winding of relay 6, the front contact and armature of relay 5 through the contacts of key 16, the back contact and armature of relay 10 to ground. Relay 6 upon operating locks through its front contact and armature 2 so that this relay will be maintained operated even should the circuit through key 16 be opened. Relay 6 also extends ground through its armature 3 and front contact to the winding of relay 7. Relay 6 in operating removes ground from the lower contact of key 41, thus preventing the M station from signaling the C station under the present circumstances.

The cut-through relay 7 when operated disconnects the C station from the relay 10 and connects it instead to the central office line. This function is performed by armatures 3 and 6 of relay 7. Under this condition the C station having a metallic bridge trips the ringing and the conversation may take place.

In case the M station responds to the ringing of the signal after the C station, the M station subscriber's set is connected to the windings of relay 9, which supplies talking battery to the M station. The operation of relay 9 bridges the retardation coil 42 across the central office line. Under this condition both the M and C stations may converse on the central office line, and since the M station now has a local battery supply the transmission is not adversely affected by the metallic bridge of the C station across the central office line.

If the M station had responded to the ringing signal first, it would have tripped ringing as it would have supplied a metallic bridge to the central office. If the C station then answers, the relays 5, 6 and 7 operate and when relay 7 operates it connects the C station across the line and furnishes battery supplied through relay 9 to the M station. When both the M and C stations are connected to the central office line it is necessary, in dial systems and in manual systems with a flashing recall, to immediately provide a holding bridge at the M station in place of the bridge of the C station when the latter disconnects first. This feature is provided by the retardation coil 42, which is bridged across the line. When the C station disconnects relay 5 releases, causing the slow relay 6 to release and in turn to release the relay 7. The release of the cut-through relay 7 bridges the M station across the central office line to maintain the connection in place of the retardation coil 42.

Calls originated at the C station for the central office line

In order to be able to make the central office call from the C station, the cut-off key 16 at the M station must be in the position shown. When the C station originates a call, the key 39 is operated to its closed position and the handset is removed from the mounting, which thereby places a metallic bridge across the line operating the relay 5 on battery supplied through relay 10. Under this condition relay 10 is not operated because its windings are differentially connected. The operation of relay 5 causes the operation of relays 6 and 7 to operate as described hereinbefore, causing the private line to cut the C station through to the central office. The C station may then dial, in case of dial systems, or originate a call manually as in manual systems. Relay 5 may follow dial pulses but the combination of the slow relay 6 and relay 7 insures against the cut-through relay 7 releasing during dialing.

Holding C station cut through on loss of central office battery

In the case of the panel system when line relay battery may be removed before the sender is connected, relay 5 will release, causing the release of the relay 6. Under these circumstances the cut-through relay 7 remains locked up under control of the back contact of the hold-over relay 8. This circuit may be traced from battery, the winding of relay 7, armature 5 and front contact of relay 7, armature and back contact of relay 8, armature 8 and back contact of relay 9, the closed circuit through key 16 and the back contact and armature of relay 10 to ground. When battery is restored to the tip and ring of the line, relay 5 and the hold-over relay 8 receive operate current together. The relay 5 usually operates first, operating the relay 6, thereby holding the cut-through relay 7. Otherwise the operation of the hold-over relay 8 unlocks the cut-through relay 7 but before it has had time to release, ground is supplied to its winding through the front contacts of both the relay 5 and the hold-over relay 8. The relay 6 follows the operation of relay 5 and this in turn applies ground to the cut-through relay 7. The hold-over relay 8 releases upon the operation of the relay 5. Thus the cut-through relay 7 is held operated and the line is maintained in the cut-through condition when the lines 12 and 13 within the central office 11 are opened.

Calls from the M to the C station

When the pick-up key 20 is operated at the M station relay 9 is connected to the subscriber's set providing talking battery. With the handset removed from its mounting the operation of relay 9 opens the tip on the ring of the central office line so that incoming calls will not cause ringing to be applied to the private line. Ringing current is connected to the front contacts of relay 2 through the armatures 7 and 3 of relay 9 and this ringing current may be extended to the C station by the momentary operation of key 41, which causes the operation of relay 2.

When the C station responds to the ringing which may be made on a signal basis through the proper manipulation of the key 41 to enable the C station to identify the nature of the incoming call, the normal position of the key 39 places a condenser 40 of the subscriber's set in series with the line, preventing the operation of

the relay 5. The C station, in all cases, obtains its talking battery from the local supply.

Calls originated from the C station to the M station

When the C station operates key 42, its ground is connected to the ring of the private line, causing the operation of relay 10. Relay 10 has been described hereinbefore as being differentially connected and hence with ground now applied to its lower winding and with its upper winding opened by condenser 40, this relay will become operated. Relay 10 in operating causes the buzzer 43 to operate at the M station. The M station in responding to the buzzer signal operates the pick-up key 20 for the private line connecting the telephone set to the windings of relay 9.

Anti-side tone network at C station

When the C station employs a resistance network connection in the anti-side tone circuit, it is so connected that there is no anti-side tone feature for calls from the C station to the M station. In case of calls from the C station to the central office, however, the resistance network is in circuit.

Busy signal at M station when C station is on a central office line

In case the M station attempts to originate a call to the C station at a time when the C station is engaged in a call on the central office line, a steady buzzer signal is given the M station when the handset is removed from the mounting. Under the cut-through condition of the private line the cut-through relay 7 is operated as described hereinbefore. When the M station bridges the tip and ring leads for connecting the M to the C station, ground is applied from the make contacts of the cut-through relay 7 through the winding of the relay 10. This circuit may be traced from ground, the front contact and armature 2 of relay 7, contacts 3 and 4 of key 20, tip conductor 34 through the circuit of the M station, ring conductor 22, springs 1 and 2 of key 21, springs 7 and 8 of key 20, armature 7 and its front contact of relay 7, the lower winding of relay 10 to battery. This operates relay 10 which in turn operates the buzzer 43. The buzzer continues to operate as long as the handset is off its mounting and the private line pick-up key is operated.

What is claimed is:

1. In a telephone system, a central office line extending to a subscriber's station equipped with an extension station, a two-conductor connection between said subscriber's station and said extension station, transmitter and signaling battery being supplied over said central office line, and means at the said subscriber's station for automatically maintaining an established connection from said central office line to said extension station when said transmitter and signaling battery at said central office is disconnected from said central office line.

2. In a telephone system, a central office line extending to a subscriber's station, an auxiliary subscriber's station, an activating switch at said subscriber's station for conditioning apparatus thereat to give central office line service to said auxiliary line, said apparatus including a cut-through relay for transferring control of said central office line from said subscriber's station

to said auxiliary station, and a hold-over relay for preventing the deenergization of said cut-through relay when the normal connection of central office battery to said central office line is temporarily broken.

3. In a telephone system, a central office line extending to a subscriber's station, an auxiliary station associated with said first station by a line extending from said first station to said auxiliary station, relay means at said first station for variously interconnecting said two stations, said central office line and said line extending from said first station to said auxiliary station, a master switch at said first station for giving and depriving said auxiliary switch control over said relay means and included in said relay means, a hold-over relay for maintaining an established connection between said auxiliary station and said central office line over a period during which the normal connections at the cen-

tral office end of said central office line are interrupted.

4. In a telephone system, a central office line extending to a subscriber's station equipped with an extension station, a two-conductor connection between said subscriber's station and said extension station, transmitter and signaling battery being supplied over said central office line, local transmitter battery and a metallic holding bridge and means to substitute said local transmitter battery and said metallic holding bridge for said central office transmitter battery responsive to the simultaneous use of said central office line by both said stations, and means at the said subscriber's station for automatically maintaining an established connection from said central office line to said extension station when said signaling battery at said central office is disconnected from said central office line.

LAWRENCE H. ALLEN.