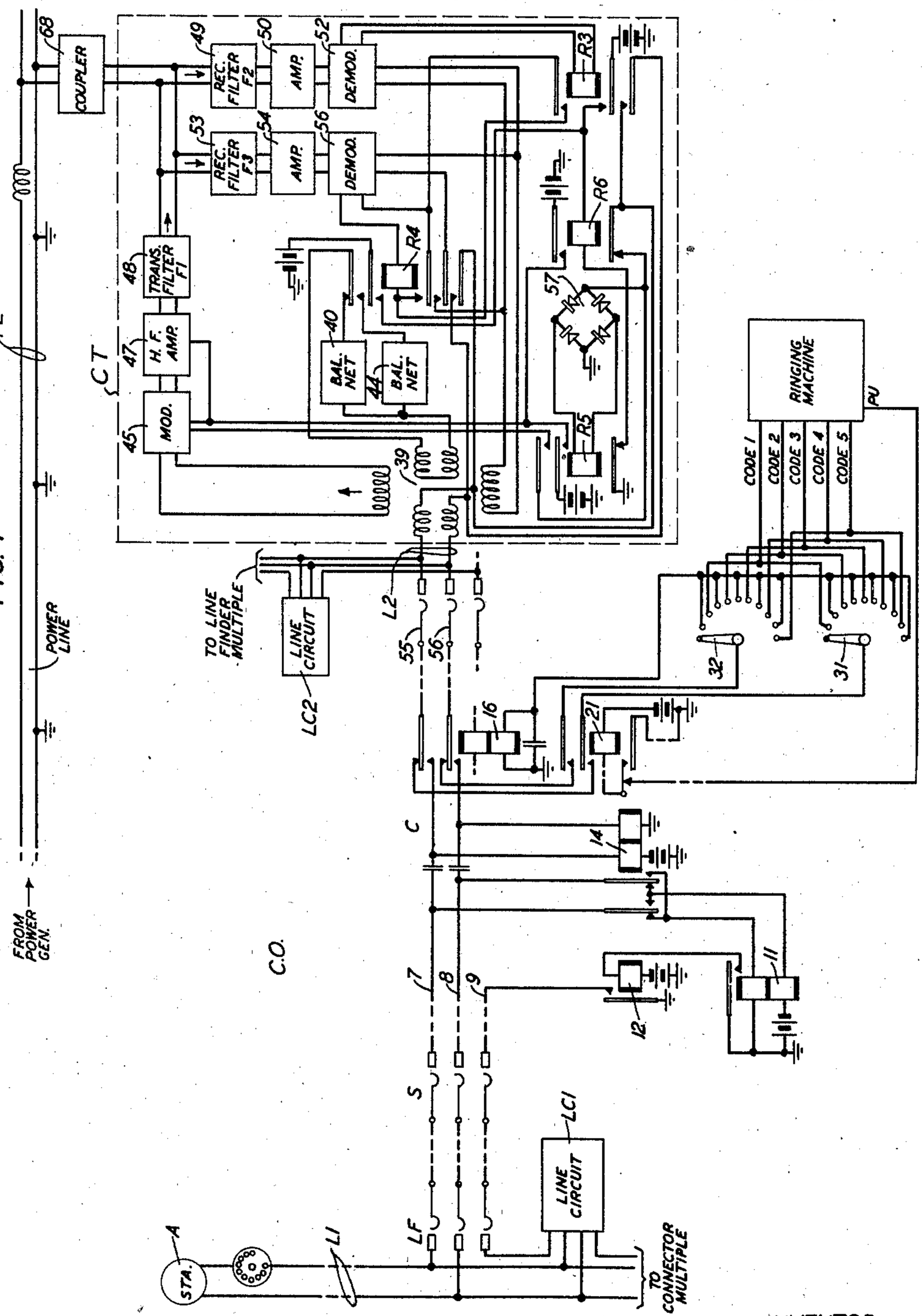
Nov. 11, 1947. A. G. LANG 2,430,471

CARRIER CURRENT SIGNALING SYSTEM

Filed May 31, 1946 2 Sheets-Sheet 1

FIG. 1

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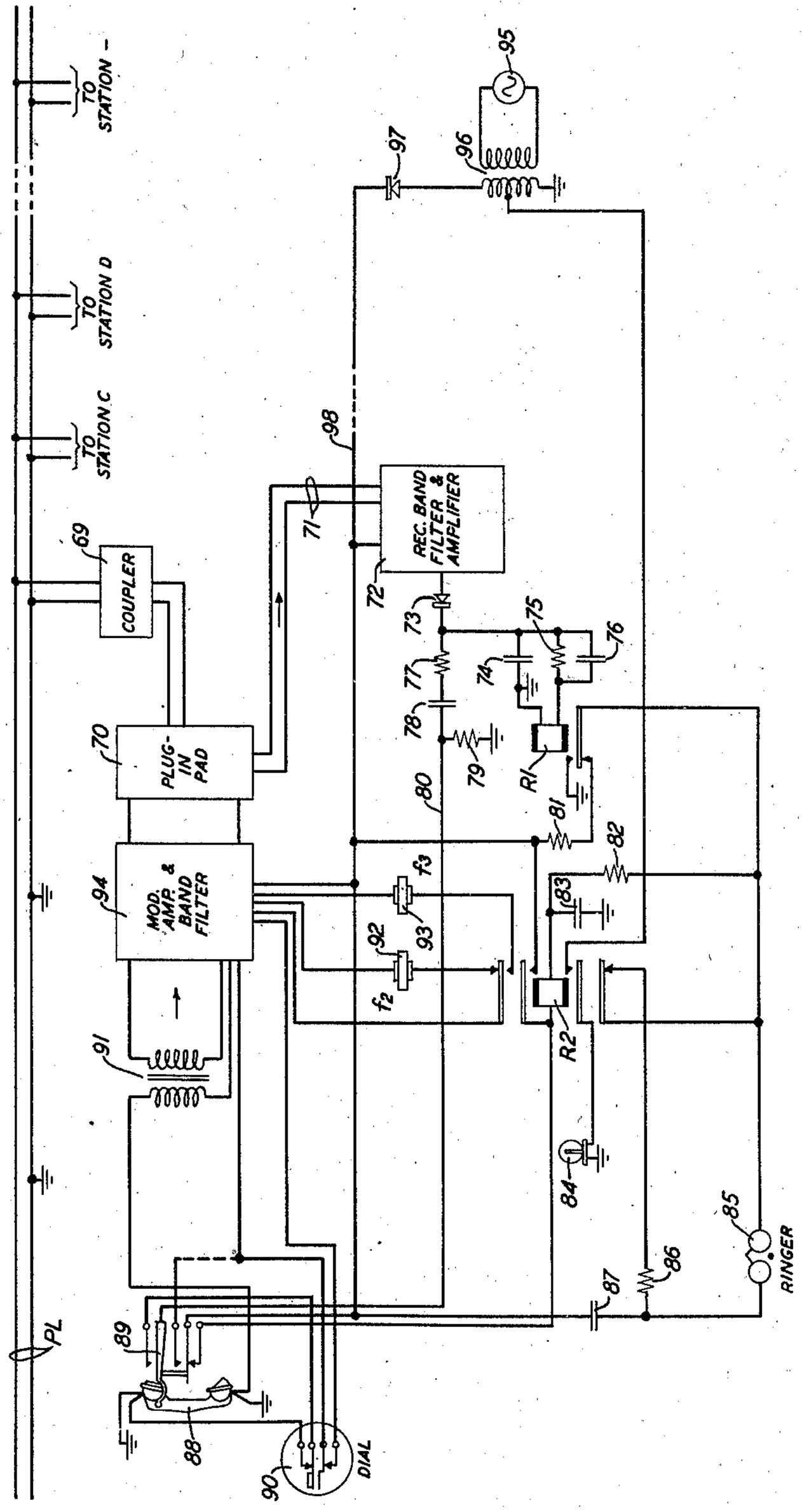


FIG. 2

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Patented Nov. 11, 1947 2,430,471

# UNITED STATES PATENT OFFICE

2,430,471

## CARRIER CURRENT SIGNALING SYSTEM

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Application May 31, 1946, Serial No. 673,270

6 Claims. (Cl 179—2.5)

1

This invention relates to communication systems and particularly to telephone systems including subscribers' stations connected to the telephone exchange over a power line.

An object of the invention is the prevention of bell tapping at telephone subscriber stations which are arranged for carrier current transmission of speech and signaling circuits.

This invention is an improved signaling circuit arrangement at a telephone subscriber's station which is connected for carrier current operation over a power line. A feature of the invention is the provision of means for preventing bell tapping responsive to static disturbances on the power line or to carrier current received over the power line.

A clear and complete description of the invention will be facilitated by considering a system in which the invention is embodied, one such system being illustrated schematically in the drawing. The invention is not limited to the particular system shown, but is generally applicable to telephone systems arranged for carrier current signaling.

The drawing, which consists of two figures, shows schematically an automatic telephone system comprising telephone subscribers' stations connected to the telephone exchange by a power line and arranged for carrier current operation over the power line.

Fig. 1 shows a telephone subscriber's station A connected by a line L1 to a central office CO comprising a line finder LF, selector S and connector C. Fig. 1 further shows another subscriber's line L2 having associated therewith carrier terminal equipment CT which is connected through a coupler 68 to a power line PL; and

Fig. 2 shows the power line PL connected to each of a plurality of telephone subscriber stations B, C, D, the station B being shown in detail.

The subscriber's station A is of the usual type provided in common battery telephone systems and includes a dial for use in establishing desired connections. The line circuits LC1 and LC2 associated with lines L1 and L2, respectively, each consists of a line relay and a line cut-off relay as in the line circuit disclosed in the patent to R. L. Stokley, 1,799,654, April 7, 1931. The line finder, selector and connector switches are of the two-motion step-by-step type; and reference may be had to "Automatic Telephony" by Smith and Campbell, second edition, published in 1921 for a description of the structure of such switches and their operation as selectors and

2

connectors. Reference may be had to the aforementioned patent to R. L. Stokley for a description of the operation of a step-by-step line finder. Each of the switches LF, S and C is represented by a set of brushes and a single set of bank terminals, the relays and other apparatus associated with the line finder LF and selector S being entirely omitted and the relays and other apparatus associated with the connector C being shown only to the extent that is necessary for a clear and complete explanation of the invention. Omitted apparatus is represented by broken lines. The connector C is arranged for ten-party code ringing, and includes a code-ringing selector comprising brushes 31 and 32 for selecting any one of five ringing code supply conductors from the ringing machine. Reference may be had to the patent to C. D. Koechling 2,289,503, granted July 14, 1924, for a complete description of the operation of such a connector.

The carrier terminal apparatus CT, associated with the line L2, is similar to the like designated apparatus in the copending patent application Serial No. 653,254, filed March 9, 1946, by R. C. Edson and J. W. Emling. The apparatus CT comprises a modulator 45 for transmitting voice and signal modulated carrier current of a frequency F1 over the power line on all calls; a demodulator 52 for voice modulated and signal modulated carrier current of frequency F2 and a demodulator 56 for voice modulated carrier current of frequency F3. Reference may be had to the Edson-Emling application for a complete description of the apparatus CT, the description herein being limited to that required for a clear and complete understanding of the invention. The conductors of line L2 are connected to one pair of windings of hybrid coil 39, through which voice and signaling currents are transmitted from line L2 to the modulator 45 and from demodulator 52 to line L2.

The subscriber station B and each of the other stations is similar to station A disclosed in the aforementioned Edson-Emling application, but differs therefrom in some respects including the ringing arrangement. The power line PL is connected through coupler 69 to the plug-in pad 70. The subscriber's station comprises a ringer 85, a handset 88, and associated switch 89, and an impulse dial 90 of usual type for use in establishing desired connections. The station further comprises an induction coil 91 and modulator, amplifier and band filter apparatus represented by the enclosure 94 for transmitting voice and signaling current over the power line PL from sta-

tion B. The station further comprises band filter and amplifier apparatus represented by the enclosure 72 responsive to voice and signaling current incoming over the power line PL, a demodulator 73, signaling relays R1 and R2, and a busy indicating lamp 84. The station is provided with a suitable source of energy which is represented as being an alteranting current source 95, transformer 96 and rectifier 97. The source 95 may be the power line PL or an intermediate transformer connected thereto.

Assume now that a call is initiated at station A, that the line finder LF operates to extend the line L1 to the selector S, that the selector S is operated under the control of the dial at station A to select a group of connectors and is further operated to select an idle connector C in the selected group. When the calling subscriber dials the last three digits of the called subscriber's directory number, the brushes of connector C are advanced to engage the terminals of the called line and the code selector brushes 31 and 32 are advanced to the position corresponding to the ringing code to be used in signaling the called subscriber's station. Assume further that the called station is the station B shown in Fig. 2, that the brushes of connector C are advanced to engage the terminals to which line L2 is connected and that brushes 31 and 32 are advanced to engage terminal 1 in which position code 1 ringing current is transmitted over the upper conductor of line L2. The connection through switches LF and S is maintained under the control of line relay 11 and slow release relay 12 of connector C in usual and well-known manner. The pick-up relay 21 is operated over the pick-up conductor PU at the beginning of a ringing cycle, thereby closing the ringing circuit from the code 1 ringing conductor through brush 31, a front contact of relay 21, outer back contact of ringing relay 16, brush 55 and engaged terminal, one winding of hybrid coil 39, a back contact of relay R6, full wave rectifier 57 and winding of relay R5, to ground. Relay R5 is thereby operatively energized. Relay R5 connects battery to energize modulator 45 and amplifier 47, and extends the ringing circuit to modulator 45; whereby carrier current, modulated by the ringing current, is transmitted through amplifier 47 and transmitting band filter 48, through coupler 68, over power line PL to all of the stations connected to the power line.

The ringing modulated carrier current incoming over the power line PL to each of the stations is transmitted through a coupler 69, plug-in pad 70, input conductors 71, receiving band filter and amplifier apparatus 72, to a demodulator 73. At each of the stations, the winding of relay R1 is connected, through a resistor 75 and condenser 76 in parallel, to the demodulator output; whereby relay R1 at each station is operatively energized and deenergized at a 20-cycle rate by the demodulated ringing current. Each operation of relay R1 closes a circuit for operatively energizing relay R2, this circuit being traced from ground through the front contact of relay R1, resistor 82, winding of relay R2, normally closed contact of handset switch 89, to the energy supply conductor 98. Relay R2 is somewhat slow in operating to reduce the probability of both of relays R1 and R2 being operated responsive to static disturbances on the power line. The operation of relay R2 connects its winding to conductor 98 independent of switch 89 so as to hold relay R2 operated after the handset is removed from the hook, closes a circuit for lighting busy lamp 84, and opens the shunt through resistor 86 normally connected across ringer 85 thereby to render the ringer operative. The condenser 87, which is initially charged from supply conductor 98 through resistor 86 in parallel with ringer 85, is discharged through resistor 81 as soon as relay R1 releases. Thereafter the alternate operation and release of relay R1, at a 20-cycle rate responsive to ringing current, effects the alternate charge and discharge of condenser 87 through ringer 85, thereby operating the ringer according to the ringing code of the called station, the ringer at each of the stations being operated in like manner. Relay R2 is slow to release and remains operated while the ringer is being actuated during the ringing intervals of each ringing cycle. During the silent intervals of each ringing cycle, relay R5 releases thereby deenergizing the modulator 45 of carrier terminal apparatus CT and deenergizing relays R1 and R2 at each of stations connected to the power line PL. When the call is answered at the called station by removing the handset from the hook, supply conductor 98 is connected through the lower front contact of the switch 89 to the modulator and amplifier apparatus 94 whereby carrier current of either frequency F2 or F3 is supplied to modulator 91 depending upon whether relay R2 is, or is not, operated. In any event, as soon as there is a silent interval in the ringing cycle, relays R1 and R2 release and with the handset removed, carrier current of frequency F2 is transmitted from modulator 94 through pad 70, coupler 69, over power line PL, through coupler 68, filter 49 and amplifier 50 to demodulator 52, thereby effecting the operative energization of relay R3. The operation of relay R3 closes a short circuit across the windings of coil 39 which are connected to line L2 so as to operatively energize the lower winding of relay 16 of connector C, thereby to open the ringing circuit and complete the talking path through brushes 55 and 56 between the calling subscriber's line L1 and the called line L2. The aforementioned operation of relay R3 also closes a circuit for operating relay R6. Relay R6 opens the connection between ringing relay R5 and line L2 and connects battery to modulator 45 and amplifier 47, whereby carrier current of frequency F1 is transmitted over the power line to again energize relay R1 at each of the stations. At the called station B, the operation of relay R1 does not effect the operation of relay R2 because the handset has been removed from the hook. At each of the other stations the R2 relay operates, but the ringer is not operated since the incoming carrier current is at this time modulated by voice currents from station A instead of by ringing current so that relay R1 remains continuously operated. At the called station B, the transmitter of handset 83 is connected by switch 89 through coil 91 to modulator 94, the voice currents being effective to modulate the carrier current of frequency F2 transmitted over the power line, through coupler 68, filter 49, amplifier 50, to demodulator 52. When the conversation is finished, the return of the handset at the called station B to the hook of switch 89 deenergizes the modulator 94, and the return of the instrument to normal at the calling station causes the successive release of line relay 11 and release relay 12 of connector C. The line finder LF, selector S and connector C are thereupon returned to normal in usual and well-known manner. The carrier terminal relay

R3 releases when the modulator 94 is deenergized at station B; and the release of relay R3 causes the release of relay R6, thereby deenergizing the modulator 45 and amplifier 47.

On a call initiated at station B, carrier current of F2 is transmitted from modulator 91 responsive to removal of the handset 88, thereby causing the operation of relay R3 and energization of modulator 45, as above described. The carrier current of frequency F1 thereupon transmitted from modulator 45 causes the operation of relays R1 and R2 at each of the other stations C, D, so as to light the busy lamp 84 at each of these stations. The operation of relay R3 also closes the short-circuit across the windings of coil 39 which are connected to line L2 to operate the line relay of line circuit LC2 and thus effect the extension of the call through a line finder LF to a selector S. The call is further extended through the selector and a connector to a called line under the control of the dial at the calling station B. If the called station is one of the other stations connected to the power line PL, the handset at station B is replaced on the hook to start ringing. When the called station answers, relays R3 and R6 of carrier terminal equipment CT are operated as above described on a call initiated at station A, and carrier current of frequency F1 is thereupon transmitted from modulator 45 to energize relays R1 and R2 at the calling station B and also at each of the other stations except the called station. When the handset is removed at the calling station B, the modulator 94 thereat is energized to transmit carrier current of frequency F3 over the power line to operate relay R4. Relay R4 locks independent of relay R3, and connects the output of demodulator 56 in parallel with the output of demodulator 52 to the lower winding of coil 39, whereby two-way conversation is carried on through the demodulators 52 and 56 and modulator 45 over power line PL between the calling station B and the called one of the other stations C, D. When the handsets are restored to normal at the calling and called stations, the modulators 94 thereat are deenergized, relays R3, R4 and R6 of the carrier terminal equipment CT are restored to normal, the short-circuit across line L2 is opened by the release of both of relays R3 and R4, and the connector C is thereupon restored to normal in usual and well-known manner.

In order to prevent bell tapping at any power line carrier station, when relay R1 is energized by carrier current which is not modulated by ringing current, the ringer 85 at each station is normally shunted by a resistor 86 and the ringer is poled so that it is less sensitive to current discharging condenser 87 than to current charging condenser 87. The current which charges condenser 87, when relay R1 operates and relay R2 is normal, is thus divided between resistor 86 and ringer 85, so that the ringer will not be sufficiently energized to tap the bell responsive to the initial energization of relay R1. When relay R2 operates, the path through resistor 86 is opened so that the alternate release and reoperation of relay R1 responsive to ringing current causes the alternate discharge and charge of condenser 87 through ringer 85 alone so that the ringer is actuated according to the ringing code. This shunt, normally connected across the ringer 85 at each station, is also effective to prevent bell tapping responsive to operation of relay R1 by power line disturbances which may occur with sufficient frequency to be annoying if allowed to cause operation of the ringers; and if relay R1 is held operated by a static disturbance long enough to effect the operation of relay R2, the release of relay R1 will be ineffective to tap the bell due to the poling of the ringer.



What is claimed is:

1. In a signaling system, a first relay, a ringer, a condenser, means for operating and releasing said first relay responsive to carrier current modulated by ringing current, means controlled by said first relay for charging and discharging said condenser through the winding of said ringer, a shunt normally closed across said ringer to prevent the operative energization of said ringer, and means comprising a second relay controlled by said first relay for opening said shunt.

2. In a signaling system, a first relay, a ringer, a condenser, means for operating and releasing said first relay at a low rate, means comprising said relay for alternately charging and discharging said condenser in series with the winding of said ringer, a shunt normally closed across said winding to prevent the operation of said ringer responsive to the initial operation of said first relay, and relay means responsive to the initial operation of said first relay for opening said shunt and preventing the reclosure of said shunt while said first relay is being operated and released at said low rate.

3. In a telephone system, a subscriber's station, means for transmitting carrier current to said station, said carrier current being at times modulated by ringing current of a low frequency, a relay at said station actuated continuously responsive to carrier current alone and intermittently responsive to carrier current modulated by ringing current, a ringer and a condenser at said station, means comprising the contacts of said relay for alternately charging and discharging said condenser through the winding of said ringer responsive to carrier current modulated by ringing current, and means comprising a shunt normally connected across said ringer for preventing the operative energization of the ringer responsive to a single energization of said relay.

4. In a signaling system, a relay, a ringer, a condenser, means responsive to signaling current for operating and releasing said relay at a low rate, means comprising the contacts of said relay for alternately charging and discharging said condenser in series with the winding of said ringer, and means comprising a resistor normally connected in parallel with the winding of said ringer for preventing the operative energization of the ringer responsive to a single energization of said relay.

5. In a signaling system, a relay, a ringer, a condenser, means responsive to signaling current for operating and releasing said relay at a low rate, means comprising the contacts of said relay for alternately charging and discharging said condenser in series with the winding of said ringer, means comprising a resistor normally connected in parallel with the winding of said ringer for preventing the operative energization of the ringer responsive to a single energization of said relay, and relay means controlled by said relay for opening the circuit path through said resistor to render said ringer operatively responsive to the alternate release and reoperation of said relay at said low rate.

6. In a signaling system, a relay, a polarized ringer, a condenser, means responsive to signaling current for alternately operating and releas-

ing said relay, means comprising contacts of said relay for charging and discharging said condenser in series with the winding of said ringer, means normally shunting said ringer to prevent the operative energization of said ringer, and means controlled by said relay for opening said shunt a predetermined interval of time after



said relay operates and for maintaining said shunt open while said relay is being operated and released responsive to signaling current, the poling of said ringer being such that the release of said relay is ineffective to operatively energize said ringer.

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