

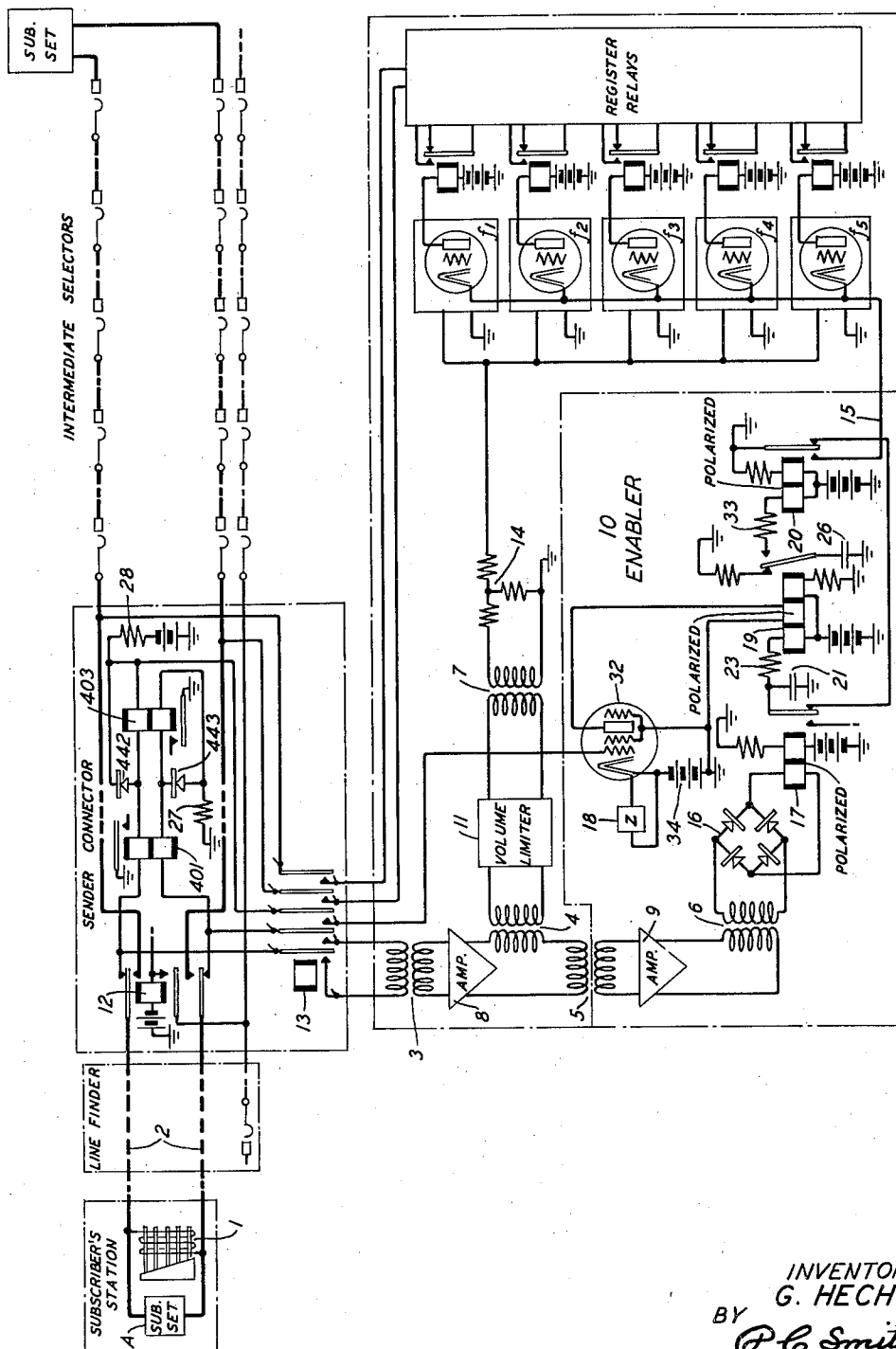
Oct. 28, 1941.

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2,260,318

TELEPHONE SYSTEM

Filed Oct. 23, 1940



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2,260,318

TELEPHONE SYSTEM

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Application October 23, 1940, Serial No. 362,347

5 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to the receiving equipment of a transmission line over which alternating currents, preferably within the voice frequency range, are transmitted for effecting the operation of said equipment to control, in turn, the selective positioning of switching apparatus. More particularly, the invention is in the nature of an improvement over the enabler circuit for sensitizing the detector channels of the receiving equipment shown and described in my copending application Serial No. 362,346, filed Oct. 23, 1940. In said application is disclosed a telephone system including a plurality of receiving channels each of which is adapted to respond to a particular frequency in an incoming signal composed of several frequencies, and an enabler circuit therefor which is adapted to sensitize the detector elements of said channels for response to the signal some time after its arrival in order to avoid possible false operation of the channels from the transient disturbance set up by the initial impact of the signal energy upon the filtering devices immediately preceding the detector elements of the channels. Since the duration of the disturbance depends upon the intensity of the signal which, in turn, depends upon the length of the loop, the operation of the enabler circuit disclosed and claimed in said copending application depends upon means variably responsive to the breaking down of a gaseous conductor device coupled to the line and responding to the intensity of the signal, the time when the enabler sensitizes the detector elements of the several channels being made contingent upon the quantity of current drawn through the anode of the gaseous conductor device which depends, in turn, upon the difference of potential across the line set up by the signal and, therefore, upon the length of the line itself.

In the preferred embodiment of the present invention the gas-filled conductor device is eliminated and the signal to the enabler is made contingent upon a marking potential, determined by a direct current flowing in the loop, being applied to the grid of a vacuum tube electronic device, the current in the cathode-anode circuit of which is correspondingly altered to function relay means that sensitize the detectors on a time delay basis which corresponds to the quantity of the cathode-anode current which, as said before, is varied, through the potential applied to the grid, in accordance with the length of the loop.

This and other features of the invention will

be more readily ascertained from the following detailed description of said invention, appended claims and attached drawing in which is shown schematically the elements of the telephone system completely disclosed in my above-mentioned copending application and certain other elements to which my invention more directly relates.

Referring, now, to the drawing, A represents a subscriber's station in an automatic telephone system, said station being equipped with a device 1 suitably arranged to produce one or more currents of different frequencies in the voice frequency range in response to the depression of keys or the like that represent digits or other characters making up the wanted designation, 2 represents a line extending from the station instrument to the central office and established therebetween by any suitable means such as, for instance, by line extending switches and the like. The conductors of said line extend to battery and ground serially through the upper and lower windings of relays 401 and 403, respectively, and resistances 28 and 27, respectively, with rectifier 442 bridged across the upper winding of relay 403 and rectifier 443 bridged across the lower winding of relay 403. The line, for the purpose of switching control and further extension, is connected to a free sender through one of a plurality of selectable sender connector relays 13, said sender comprising coupling transformers 3, 4, 5, 6 and 7, amplifiers 8 and 9, volume limiter 11, and the enabler circuit 10, the last functioning to sensitize the channel detectors f1, f2, f3, f4 and f5 which are individually so designated in accordance with the frequency to which each of the channels is respectively assumed adapted to respond, which channels include individually responding relays, and the settable register relays which follow the operation of the channel relays when operated to signalize an incoming impulse. The amplifiers 8 and 9 and the volume limiter 11 are commercially available circuit units while the channels f1—f5 are completely disclosed in Patent 2,237,742, issued to A. A. Lundstrom on April 8, 1941, although it is obvious and therefore understood that the invention is not limited to channels of this description. The enabler 10 comprises the vacuum tube 32, the varistor bridge 16 and the polarized relays 17, 19 and 20 with their intermediate capacitor-resistance networks controlling the operating times of said relays in the manner described hereinafter.

In the operation of the invention, a call is

initiated at station A by the removal of the station instrument from the switchhook whereupon the line is then extended by any suitable means to the central office at which an available sender is then connected to said line through the medium of a sender connector 13 after which "key tone" is transmitted from equipment, not shown, back to the calling station A as a signal that the sending device 1 may be operated to transmit the number of the wanted station, all in the manner described in the above-mentioned patent to A. A. Lundstrom.

When any one of the ten keys of the sending device 1 is operated, two out of the five defined frequencies $f1-f5$ are generated in the combination required to designate the digit represented by the key depressed, and the resulting current produced thereby is transmitted over a circuit which may be traced from one side of the sending device 1, over the lower conductor of the looped pair 2, the lower back contacts of relay 12, the next to the inner contacts of sender connector cut-in relay 13, the primary winding of transformer 3, the inner contacts of relay 13, the top back contacts of relay 12 and the upper conductor of looped pair 2 to the other side of the station sending device 1. The current composed of the two frequencies is induced in the secondary winding of transformer 3 and fed into the input side of amplifier 8 whence, after suitable amplification, it is applied, through transformer 4, to the volume limiter 11 and, through transformer 7, at a suitable level, to the input pad 14 from which, after passing through suitable filters (not shown) it is available for operating the channel detectors $f1-f5$ when the detector elements of the same have been sensitized by the enabler 10 as explained hereinafter.

Considering that portion of the signal energy which passes into the volume limiter 11, the energy causes the volume limiter to operate and regulate the energy output in accordance with its adjustment which may be such as to limit the final magnitude of output to that required for the satisfactory operation of the channel detectors and no more regardless of the magnitude of the input energy. The reason for doing this is, of course, to prevent overloading any of the channel detectors which, should it occur in the event of a heavy input signal due, say, to a very short loop 2, would be productive of a heavier transient than is actually present when the signal level is reduced. Hence by adjusting the volume limiter 11 to a suitable ceiling of output energy above the operate level of the channel detectors, the transient disturbance will simply be due to that produced by a signal current within the limits of the just operate level of the detectors.

It will be observed that the enabler 10 comprises the varistor bridge 16, the three polarized relays 17, 19 and 20, their associated networks and the vacuum tube 32 which has its grid connected, via the middle contacts of relay 13, to one side of resistance 28. The cathode of the tube is connected to the thyrite impedance element 18 whose function will be shortly described in connection with the operation of the enabler.

It will be further observed that the middle winding of relay 19 is in series with the cathode-anode circuit of the vacuum tube 32. Now when the line loop is established to the sender connector, a direct current circuit is completed therebetween which may be traced from ground, through resistance 27, the lower windings of relays 403 and 401, respectively, the lower back

contact of relay 12, over the loop, the top back contact of relay 12, the upper windings of relays 401 and 403, respectively, and through resistance 28 to negative battery. The current flowing through this loop is, of course, determined by its ohmic resistance, the only variable element of which is the resistance of the loop proper. Since the grid of tube 32 is connected to the line terminal side of resistance 28 a positive potential is applied thereto which determines the current that will flow through the cathode-anode circuit of the tube 32, which circuit may be traced from ground through the middle winding of relay 19, over the internal cathode-anode path of the tube, thyrite element 18, to negative battery. The value of the direct current potential which is applied to the grid prior to the transmission of any of the signal impulses is practically unaffected by the alternating current signal potential superimposed thereon when the signal impulses are transmitted inasmuch as the former is preponderately large in comparison to the unamplified signal voltage which is similarly superimposed upon the grid. Hence the value of the direct current potential applied to the grid is substantially the only potential which determines the quantity of current that will flow through the middle winding of relay 19. On a zero loop, for example, the direct current flowing through the loop is a maximum, the positive potential applied to the grid is a maximum and the current flowing through the cathode-anode circuit and, therefore, through the middle winding of relay 19 is also a maximum. On a maximum loop, on the other hand, the loop current is a minimum, the positive potential applied to the grid is a minimum and, therefore, the current flowing through the middle winding of the relay 19 is a minimum.

Since the line loop direct current is to determine the current flowing through the cathode-anode circuit of tube 32, it becomes necessary to guard against any false variation of this current which may be due to the voltage drop in the battery 34 as a result of the current drawn therefrom through the cathode-anode circuit in consequence of the conditions noted above. To guard against such undesired voltage drop, the thyrite element 18 is inserted in the cathode-anode circuit which, because of its well-known property of varying its resistance with the quantity of current flowing therethrough, tends to keep the voltage drop constant so that any variation in the current flowing through the cathode-anode circuit will be due only to the value of the positive potential on the grid of the tube 32 which, in turn, will depend upon the resistance or length of the line loop.

The current flowing through the middle winding of relay 19, regardless of whether it is a maximum or minimum or any value in between, is in opposition to the current flowing through the circuit permanently established through the right winding of the relay and aiding to the current flowing in the circuit normally established from ground over the right contact of relay 20, the right contact of relay 17, resistance 23, and the left winding of relay 19 to battery. As a result of the currents flowing through the three windings prior to the reception of any signal impulse, the armature of relay 19 assumes the position shown in the drawing; that is, the armature makes with its left contact thus keeping condenser 26 short-circuited.

Consider, now, that a signal impulse is trans-

mitted. A portion of the signal energy is applied through transformer 6 and to the varistor bridge 16 whereupon the current is rectified and applied to the left winding of relay 17. This current opposes that which flows through the permanently established circuit through the right winding thereof, causing said relay to operate and remove the normally applied short-circuiting ground to condenser 21 which thereupon begins to charge over the charging circuit extending from positive battery, left winding of relay 19, condenser 21 to ground, and thus temporarily maintain the flow of current through the left winding of said relay, which current is normally established through the right contact of relay 17 to ground on the right contact of relay 20 as already described. When condenser 21 is fully charged, the current flow through the left winding of relay 19 ceases and if current is flowing through its middle winding as above described relay 19 will release but its time of release is, under the conditions described, determined by the intensity of the current flowing through the middle winding which aids the flux produced through the left winding by the normal circuit therethrough and the charging circuit of condenser 21. For a minimum loop, when the current through the middle winding is a maximum due to the direct current over the loop being a maximum, relay 19 releases in its maximum time and, in so doing, closes a charging circuit for condenser 26 through the left winding of relay 20 via resistance 33. The current of the charging circuit opposes that through the circuit of the right winding and operates relay 20 which applies ground to conductor 15 and over said conductor to the cathodes of the detector tubes of the channel detectors f1—f5 thereby activating said tubes for response to the signal energy incoming over pad 14. The length of the closure will, of course, depend upon the capacity of condenser 26 which may be chosen for any value desired.

For a maximum loop, when the current through the middle winding is a minimum, the relay will release in a minimum time to connect condenser 26 to the left winding of relay 20. Between the extreme of maximum direct current at zero loop when relay 19 operates in the maximum time fixed by the capacity of condenser 21, and minimum direct current at maximum loop when relay 19 operates in minimum time, the time of operation of said relay will progressively and inversely vary with the intensity of the direct current fixed by the length of the loop.

The length of time during which the armature of relay 20 engages its left contact to cause the channel detectors to remain activated depends, of course, upon the constant of condenser 26 and resistance 33 which may be chosen to provide any interval desired. However, when the condenser is completely charged, the current through the right winding of relay 20 again becomes effective, the armature of the relay breaks away from its left contact and ground is removed from conductor 15 and, therefore, from the cathodes of the detector elements of the several detector channels f1—f5 which, in consequence, will no longer respond to any signal energy forthcoming over resistance pad 14 and thereby cause their separate anode relays to release.

When the signal impulse is over (assuming the correct depression of a key at device 1), relay 17 will "release," reestablishing the short circuit around condenser 21 and the circuit through the left winding of relay 19 to cause it to make its

left contact. Since relay 20 has already re-established its armature on its right contact, the circuit is normally in readiness to receive the next signal when the operations described above are repeated.

While I have described my invention and the means for utilizing the same in connection with a specific embodiment thereof, it is to be understood that various other embodiments thereof may be made by those skilled in the art without departing from the spirit of the invention as defined within the scope of the appended claims. Thus, for instance, the middle winding of relay 19 may be tapped directly to resistances 28 and 27 via two pairs of contacts on relay 13, thereby eliminating altogether the necessity of using tube 32. With appropriate direct current voltages feeding direct current to the line loop, the potential differences developed across resistances 27 and 28 by the flow of the line current could be applied directly to the middle winding of relay 19 whose operating time will be controlled, as before, by the current in the line producing the difference of potential above mentioned.

What is claimed is:

1. In a telephone system in combination, a transmission line provided with a plurality of channel detectors adapted for response to alternating current signals, a source of direct current potential for connection to said line, and an enabler for said channel detectors adapted to sensitize the same for response to said alternating signals comprising means responsive to the difference of potential available across said line in response to the direct current flowing thereover from said source of direct current potential, and means responsive to said incoming signal energy, the speed of operation of said first-mentioned means being dependent upon the value of said potential difference and the response of said second-mentioned means.

2. In a telephone system in combination, a transmission line provided with a plurality of channel detectors adapted for response to alternating current signals, a source of direct current potential connected to said line, and an enabler for sensitizing said channel detectors for response to said alternating current signals at a time subsequent to the arrival of said signals comprising means jointly operative to said alternating current signal and to the difference of potential available across said line in response to the direct current flowing thereover from said source of direct current potential, and other means responsive thereto for sensitizing said detectors, the speed of operation of said first-mentioned means being determined by the value of said potential difference.

3. In a telephone system in combination, a transmission line provided with a plurality of channel detectors adapted for response to alternating current signals, a source of direct current potential connected to said line, and an enabler for sensitizing said channels for response to said alternating current signals comprising an electronic device provided with a cathode-anode circuit the quantity of current flow through which is dependent upon the difference of potential available across said line consequent to the flow of direct current thereover from said source of potential, means responsive to said alternating current signals, and means jointly responsive to the flow of current in the cathode-anode circuit of said electronic device and to said alternating current responsive means for sensi-

tizing said channel detectors, the speed of operation of said jointly responsive means being dependent upon the quantity of current flowing in the cathode-anode circuit of said electronic device.

4. In a telephone system in combination, a transmission line provided with a plurality of channel detectors adapted for response to alternating current signals, a source of direct current potential applied to said line, and an enabler for sensitizing said channel detectors for response to said alternating current signals comprising an electronic device having a grid connected to said line and deriving a potential through the direct current flowing over said line from said source of direct current potential, a polarized relay included in the cathode-anode circuit of said electronic device for sensitizing said channel detectors when operated by the current flowing through said cathode-anode circuit, and means controlled by said incoming alternating current signal for delaying the operation of said relay for an interval contingent upon the intensity of the current flowing through said cathode-anode circuit.

5. In a telephone system in combination, a transmission line provided with a plurality of channel detectors adapted for response to alter-

nating current signals, a source of direct current potential applied to said line, and an enabler for sensitizing said channel detectors for response to said alternating current signals comprising an electronic device having a self-compensating cathode-anode circuit whereby the voltage drop therein is kept constant, a grid for said device connected to said line and deriving a potential through the direct current flowing over said line from said source of direct current potential, a polarized relay having two windings of which one is included in the cathode-anode circuit of said electronic device, means including a second relay and an impedance network operative in response to an incoming alternating current signal for controlling a current flow through the second winding of said polarized relay whereby a current flow is maintained therethrough for an interval after the response of said means to oppose the operation of said polarized relay on the cathode-anode current flowing through the first winding thereof, said interval being dependent upon the constants of said impedance network and the intensity of the cathode-anode current, and means responsive to the operation of said polarized relay for sensitizing said channel detectors.

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