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TELEPHONE SYSTEM

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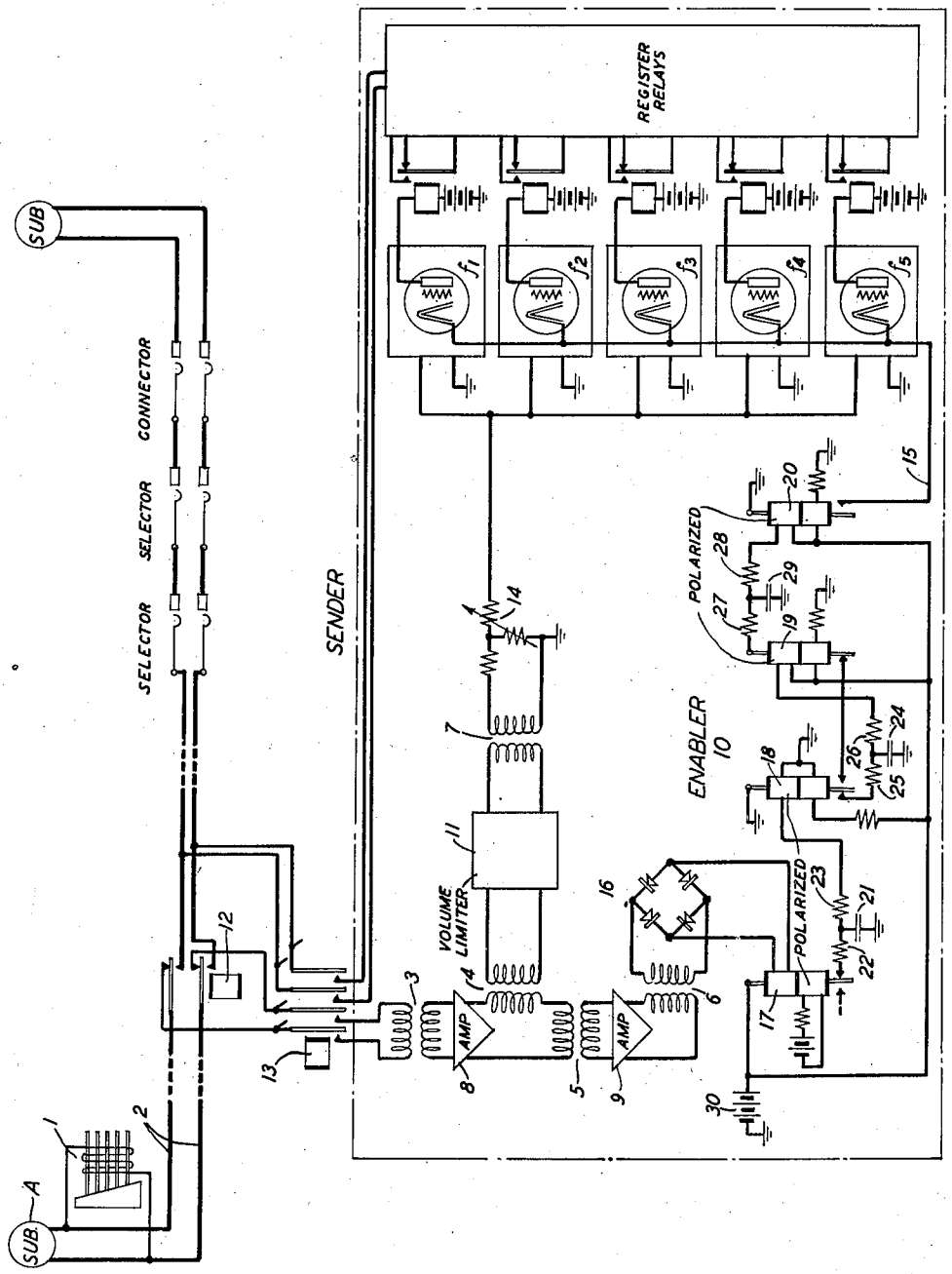

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TELEPHONE SYSTEM

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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 which controls, in turn, the selective positioning of switching apparatus. More particularly, the invention is in the nature of an improvement in the receiving equipment of the telephone transmission line disclosed and claimed in the copending application of A. A. Lundstron Serial No. 306,466, filed November 28, 1939, now Patent No. 2,237,742, granted April 8, 1941. In said application is disclosed a telephone system of the type in which automatic switches are controlled by means responsive to alternating currents of different frequencies generated at a subscriber's station and transmitted over a line which is provided with a plurality of channel detectors each selectively tuned to a different one of the frequencies and responsive thereto to operate a relay which, in combination with a relay operated over another channel detector, serves to function a settable register, or sender, to lock in a record of the digit indicated by the two operated relays; that is, by the two frequencies transmitted from the subscriber's station.

In systems of this kind where the signal generating instrument is, usually, a plurality of keys or the like, the operation of one of said keys to set one or more reeds vibrating in a magnetic field to produce the currents of desired frequencies, is liable to produce a jagged "cut-off" of the vibrating reeds when they come under the action of dampers upon the release of the key. The result is that undulating currents are produced in response thereto which, containing components of the different frequencies to which the channel detectors are respectively tuned to operate, are liable to cause said channel detectors to respond falsely to said currents and thereby produce a false registration.

In accordance with a feature of this invention, the channel detectors are normally kept unresponsive until the first impulse of current is received from the generating device at which time circuit means are activated in response to said impulse which apply a sensitizing potential to the cathodes of the individual detector tubes in the several channels, which are thereby activated to respond to the remainder of the current impulse. Since the length of the impulse produced by the depression of a key at the generating device, is longer than necessary to permit the channel detectors to function, it is possible to disable the channels after complete operation but before the entire duration of the current impulse is exhausted and thereby protect those channels which have not operated from falsely operating on signal currents which may be falsely produced on the release of a key at the generating device. Accordingly, this feature of the invention includes as a part of the means which activate the channel detectors, a timing device which is adapted to keep said channel detectors activated for a predetermined interval, measured from the instant the signal arrives, and is then operated to desensitize the detector channels to make them thereafter unresponsive to the signal notwithstanding the fact that the signal current is still on the line.

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 certain elements of the telephone system more completely disclosed in the above-mentioned copending application of A. A. Lundstrom and in which certain other elements to which our invention more directly relates, are shown in detail.

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 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 whence, through one of a plurality of selectable sender connectors 13, the line is extended to a free sender which comprises coupling transformers 3, 4, 5, 6 and 7, amplifiers 8 and 9, volume limiter 11, the enabler circuit 10, and the channel detectors *f1*, *f2*, *f3*, *f4* and *f5* 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 channel relays and the settable register relays which follow the operation of said channel relays when operated in response to an incoming signal 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 the above-mentioned copending application of A. A. Lundstrom to which reference is made for a more complete understanding thereof although

it is to be understood that the invention is not limited to channels of the type described therein.

In the operation of the invention, a call is initiated at station A by the removal of the receiver from the hook 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 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 copending application.

When any one of the ten keys of the sending device 1 is operated, two out of the five defined frequencies *f*1—*f*5 are produced in the combination required to designate the digit or character represented by the key and transmitted over a circuit which may be traced from one side of the sending device 1, lower conductor of the looped pair 2, lower back contacts of relay 12, next to the inner contacts of sender connector cut-in relay 13, primary winding of transformer 3, inner contacts of relay 13, top outer back contacts of relay 12, 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 input side of the volume limiter 11 and is also applied, through transformer 5, to amplifier 9 whence, after suitable amplification, it is applied, via transformer 6, to the enabler circuit 10.

Considering that portion of the signal energy which passes into the volume limiter 11, the energy causes said volume limiter to operate and regulate the energy output in accordance with its adjustment which may be such as to limit the 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 cause false operation of adjoining channel detectors by currents present in the frequency spectrum generated thereby and thus cause the registration of a false number. Hence by adjusting the volume limiter to a suitable level of output energy above the operate level of the channel detectors, their false operation upon heavy line currents is avoided.

The energy output from the volume limiter 11 is applied, through transformer 7, to the variable resistance pad 14 whence it is applied through suitable filtering devices (not shown) to the grids of the detector tubes in each of the channels. These tubes, however, are normally inactive due to the absence of activating potential upon the cathodes thereof, which potential is applied over conductor 15 as explained hereinafter. The channels that would be involved by the two frequency components in the current transmitted through variable resistance pad 14, therefore, do not operate.

Considering, now, that portion of the signal energy which is transmitted to the enabler circuit 10 via transformer 6, it will be observed that said enabler comprises a rectifier bridge 16 and four polarized relays 17, 18, 19 and 20, each having a permanently closed polarizing circuit through its lower winding which causes the armatures thereof to assume the position indicated in the drawing. Further, between each two relays, beginning with relay 17 and ending with relay 20, there is an intermediate condenser-resistance network which joins a contact of the relay on the left with the upper winding of the relay to the right. Considering relays 17 and 18, for instance, the network made up of resistances 22 and 23 and condenser 21 joins the right contact of relay 17 with the upper winding of relay 18. Since the armature of relay 17 is connected to positive battery 30, and condenser 21 is connected to ground, said condenser is normally charged through resistance 22 to the potential of said battery. Condenser 24 of the network between relays 18 and 19, on the other hand, is normally at ground potential since it has ground applied to it through the left contact of relay 18 and resistance 25. Contrariwise, condenser 29 of the network between relays 19 and 20 is charged to the potential of the battery 30 through the upper winding of relay 20 since the short-circuiting ground path for condenser 29 is normally open at the right contact of relay 18, thereby leaving condenser 29 exposed to the charging circuit that traces from the positive pole of battery 30, upper winding of relay 20, resistance 28, condenser 29 to ground.

Assuming, therefore, that relays 17, 18, 19 and 20 have their respective armatures in the position shown, and that condensers 21, 24 and 29 are charged, discharged and charged, respectively, as indicated above, ground is normally disconnected from conductor 15 at the front contact of relay 20, which conductor is, in turn, connected to the cathodes of the detector tubes of the several channel detectors *f*1—*f*5, and causes them to be normally unresponsive to signal energy incoming over the resistance pad 14 as above described.

Now when a portion of the incoming energy is applied to the rectifier bridge 16, said energy is rectified and the current thereof is applied to the upper winding of relay 17. The combined effect of the current now flowing through the upper winding of this relay and that normally flowing through its lower winding is such as to cause its armature to swing from the right contact into engagement with its unwired left contact. Since condenser 21 is normally charged to the potential of battery 30 through the armature and right contact of relay 17, the opening of these contacts immediately causes the condenser to discharge to ground through resistance 23 and the upper winding of relay 18, thereby prolonging the flow of current that is normally flowing through this relay winding over the circuit traced from battery 30, armature and right contact of relay 17, resistances 22 and 23, upper winding of relay 18 to ground. The direction of the discharge current as well as the normal current through the upper winding of relay 18 opposes that of the current normally flowing through its lower winding, and since the discharge current is initially of greater intensity through the suitable choice of the ohmic value of resistance 23, the release of relay 18 is delayed and the armature thereof is caused to break away from its left contact at a time subsequent to the operation of relay 17 and to engage its right contact.

During the time that the armature of relay 18

is engaged with its right contact, and remembering that condenser 24 is kept at ground potential while the armature of this relay is making with its left contact, then, as soon as the armature breaks with said left contact, condenser 24 immediately begins to charge over a circuit traced through resistance 26, the upper winding of relay 19 to battery 30 to continue to maintain the current flow over this path for a short time subsequent to the operation of relay 18, whereupon the effect of the current through its lower winding continues to be neutralized for a short time by this changing current rather than by the normal current and the armature of relay 19 is thus caused to break with its left contact at a time subsequent to the operation of relay 18.

At the instant that the armature of relay 18 engages its right contact and before the armature of relay 19 disengages its left contact, a discharge path is completed for condenser 29 which traced from ground, condenser 29, resistance 27, armature and left contact of relay 19, armature and front contact of relay 18 to ground. The energy accumulated on condenser 29 as a result of the charging circuit through the upper winding of relay 20 is quickly drained off through the low resistance 27 and a current flow is quickly established in the upper winding of relay 20 to cause its rapid operation and close ground onto conductor 15 to sensitize the detectors, so that when the armature of relay 19 breaks with its left contact, condenser 29 is in an uncharged condition and immediately starts recharging through the upper winding of relay 20 to prolong the current flow therethrough for a subsequent period. This charging current overcomes the effects of that normally flowing through lower winding of relay 20 and causes the armature thereof to engage its right contact, thus applying ground to conductor 15 which, as said before, is connected to the cathode of each of the detector tubes in the channel detectors *f1*—*f5*. The channel detectors are now made responsive and the two which are adapted to respond to the two frequencies in the input current that flows into their respective input side through resistance pad 14 operate, in turn causing the operation of their respective anode relays which, in their turn, cause the operation of relays in the register which designate the digit or character designated by the two frequencies.

It is to be noted that the armature of relay 18 will make with its right contact at a time subsequent to the energizing of relay 17 by the current through the rectifier bridge 16. This time is, of course, determined by the discharge time of the condenser 21 through resistance 23 which causes the normal current through relay 18 to endure for a time (let us say, for example, 20 milliseconds) after the operation of relay 17. At this time relay 18 releases and its armature engages its right contact whereby condenser 29 is quickly discharged through the low resistance 27 and establishes a current through the upper winding of relay 20 to cause its immediate operation. This, as explained, places ground on conductor 15 to sensitize the detectors at a time 20 milliseconds after the signal was first applied. This delay is for the purpose of allowing the unwanted spectrum energy in adjoining channels to dissipate itself in order to avoid unwanted channel operation from this source. It is the purpose of the condenser 24 to maintain by its discharge current through the upper winding of relay 19 the normal current flowing therein to hold the armature of relay 19 engaged with its left contact for a time sufficient to permit the complete discharge of condenser 29 through resistance 27, contacts of relays 19 and 18 to ground. Relay 19 then operates to break its left contact and thereafter relay 20 is maintained on the charging current from battery 30, top winding of relay 20, resistance 28, to condenser 29. When this discharge current has dissipated itself, relay 20 will operate and cause its armature to break with its right contact to remove ground from conductor 15 regardless of how long thereafter that energy is delivered to relay 17 by the signal.

The length of time during which the armature of relay 20 engages its right contact to cause the channel detectors to remain activated depends, of course, upon the constants of condensers 24 and 29 and resistances 26 and 28, which may be chosen to provide any time interval desired. When the condenser 29 is completely charged, the current through the lower winding of relay 20 again becomes effective, the armature of the relay breaks away from its back contact and ground is removed from conductor 15 and, therefore, from the cathodes of the detector element of the several detector channels 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.

The circuit conditions prevailing in the enabler during the presence of signal energy in bridge 16 and after the armature of relay 20 has disengaged its front contact, is that relay 17 will have its armature making with its left contact, relay 18 will have its armature making with its right contact, while relay 19 will have its armature disengaged from its left contact which will in no way effect the charge on condenser 29 or the condition of the armature of relay 20 which is out of engagement with its right contact. Hence it makes no difference how long signal energy prevails upon the line subsequent to the armature of relay 20 breaking away from its right contact, said energy will be ineffective to operate the channel detectors inasmuch as ground has been disconnected from the cathodes of their several detector elements.

When the signal impulse is over, relay 17 will "release," reestablishing quickly thereby the charging circuit of condenser 21 and the current through the top winding of relay 18 to cause the armature of said relay to make with its left contact. Relay 18 operates and causes the quick establishment of current through the top winding of relay 19 to cause the armature thereof to quickly make with its left contact. In this operation the condenser 29 has not been charged since ground via the contacts of relays 18 and 19 has not been removed. The enabler circuit is now ready for another cycle of identical operations upon the reception of the next impulse.

While we have described our invention and the means for utilizing the same in connection with its specific application to a particular kind of a transmission line, it is to be understood that various other applications and 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.

What is claimed is:

1. In a telephone system, the combination with a transmission line comprising a detector channel adapted for response to energy incoming over said line but normally unresponsive thereto,

means responsive to incoming energy for activating said channel to respond to said energy, and means for maintaining said detector channel activated for a predetermined period while said incoming energy is upon said line regardless of the duration of the energy upon said line after the termination of said predetermined period.

2. In a telephone system, the combination with a transmission line comprising a plurality of channel detectors each adapted for response to a specific frequency of a plurality of frequencies present in a signal current transmitted over said line but normally unresponsive thereto, means responsive to a signal current for activating said channels for response to their respective frequencies in said signal current, and means for maintaining said channel detectors activated for a predetermined period while said current is upon said line whereby they will fail to respond to their respective frequencies in said signal current after the termination of said predetermined period.

3. In combination, a transmission line terminating in a plurality of channel detectors each adapted for response to a specific frequency of a plurality of frequencies in a signal current transmitted over said line but normally unresponsive thereto, means responsive to a signal current for activating each of said channel detectors for response to their respective frequencies in said signal current, said means including other means for keeping each of said channel detectors activated for a period less than the period during which said signal endures upon the line.

4. In a telephone system, a transmission line terminating in a plurality of channel detectors each adapted for response to a specific frequency of a plurality of frequencies present in a signal current transmitted over said line, and means responsive to said signal current for activating said channel detectors for response to their respective frequencies in said signal current for a predetermined interval, said means comprising a rectifier coupled to said line, a plurality of relays cascaded from said rectifier of which the first is responsive to said signal current after rectification by said rectifier, the last of which applies activating potential to said channel detectors for a predetermined interval, and impedance networks intermediate said plurality of relays for controlling their operating time to make up said predetermined interval.

5. In a telephone system, a transmission line terminating in a plurality of channel detectors each adapted for response to a specific frequency of a plurality of frequencies present in a signal current transmitted over said line, and means responsive to said signal current for activating said channel detectors for response to their respective frequencies in said signal current for a predetermined interval, said means comprising a rectifier coupled to said line, four polarized relays cascaded from said rectifier of which the first is responsive to said signal current after rectification by said rectifier, the fourth of which applies activating potential to said channel detectors for a predetermined interval, and a resistance condenser network intermediate adjacent ones, said relays beginning with the first relay and ending with but including the fourth relay for controlling the operating time of all relays except the first to make up said predetermined interval.

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