

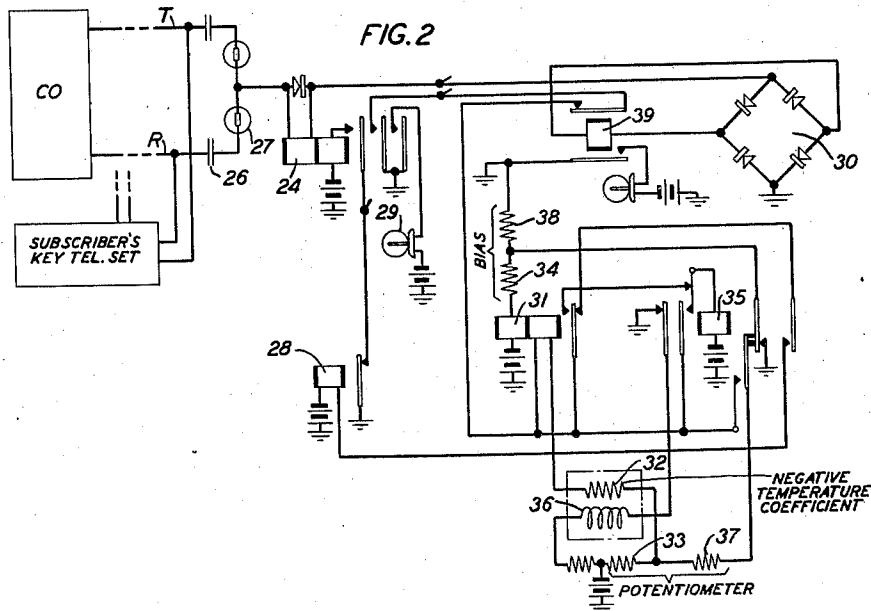
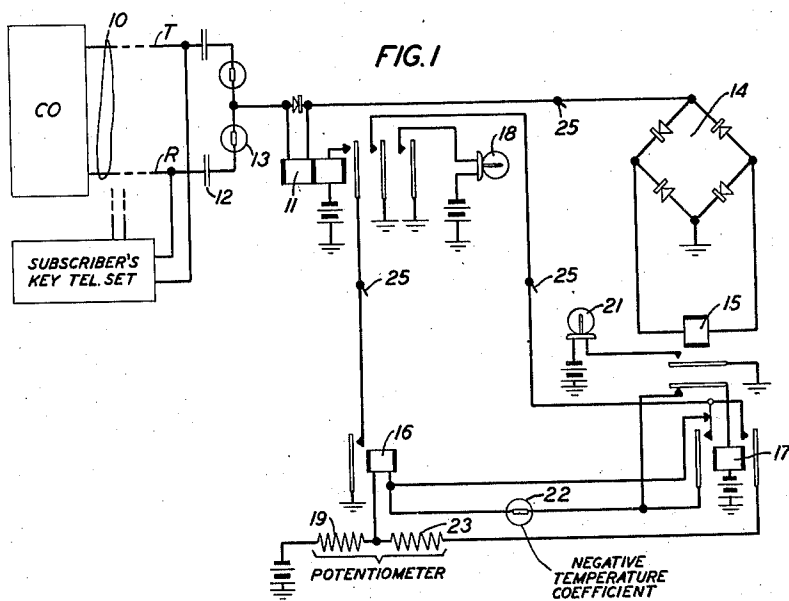
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SIGNALING SYSTEM

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SIGNALING SYSTEM

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This invention relates to signaling systems and particularly to improvements in thermal-electromagnetic timing circuits therefor.

The object of this invention is to provide a more efficient and economical arrangement for introducing time intervals in the operation of electrical switching devices.

It has been the practice heretofore in systems employing switching devices, such as relays, to delay operation thereof by means inherent in the construction of the device, thereby necessitating additional expense in their design and manufacture. Several well known time retardation arrangements have been used, among which are for example, slow operate relays having copper slugs added to the cores thereof, thermostatically controlled relays, dash-pot relays having oil controlled plunger mechanisms, etc. It has also been proposed heretofore, for delay purposes, to introduce into the operating circuit of ordinary relays resistors having high negative temperature coefficients of resistance; but these resistors in their present state of development have large time lags in both their heating and cooling cycles and means must therefore be provided in the circuit itself if immediate reset of the minimum delay cycle is necessary.

According to a feature of the present invention advantages are secured over the prior arrangements by provision in a signal timing circuit of a resistor having a high negative temperature coefficient of resistance, which controls both the operating period of one relay and releasing period of a second relay, whereby a definite minimum delay is obtained despite recycling of the circuit during any period of its operating cycle. This feature is attained upon initiation of the cycle by heating the resistor to a definite temperature in order to actuate a control relay, which upon operation thereof transfers the resistor to the circuit of a previously operated second relay, the release time of which is controlled by the cooling action of the resistor. Meanwhile, should an interruption occur in the above cycle at any time prior to release of the second relay, the cycle would be resumed by reheating the resistor under direction of the control relay. The cooling phase of the cycle can therefore be made to start always at a definite resistance value by choosing the point at which the control relay operates, so that a minimum definite period, equivalent to the cooling period of the resistor, is insured.

Another feature of the invention resides in a more accurate control of the timing interval

wherein use is made of the characteristics of the electropolarized type of relay. A sensitive electropolarized relay through its biasing winding assumes the properties of a resistance measuring device to provide an accurate measure of control over the action of a variable resistance device such as is inherent in a resistor having a high negative temperature coefficient of resistance. In addition, the electropolarized relay provides a flexible means which may be made to operate at any desired value and to release at any lower value by changing the bias circuit constants at will.

Still another feature of the invention resides in a timing circuit for providing a steadily actuated line signal wherein a minimum delay interval is set at a point greater than the maximum silent period of intermittently applied machine ringing current or wherein the minimum delay is set at an appreciable interval after ringing has ceased on manual ring incoming calls.

A further feature resides in a timing-out circuit arrangement for disconnecting, at a subscriber's switchboard position, incoming telephone call signals a minimum predetermined time after ringing current has ceased. Should a subsequent call be received during the waiting period of a preceding call, the circuit is conditioned to recycle itself for at least another period of the predetermined time delay so that at no time, say during busy periods at the switchboard, would a call signal be so disconnected before an operator could answer the call. This timing-out feature primarily prevents undue battery drain and reduced lamp life during unattended periods of the switchboard, especially over extended periods such as week-ends.

These and other features of the invention will be more fully described in the following specification, taken in connection with the accompanying drawing in which:

Fig. 1 illustrates one embodiment of the invention employing a resistor of high negative temperature coefficient of resistance in a line signaling circuit for timing-out an incoming call signal a predetermined time interval after ringing ceases; and

Fig. 2 illustrates another embodiment of the invention wherein a resistor of high negative temperature coefficient of resistance in conjunction with an electropolarized relay provides the timing-out feature.

Referring to Fig. 1 of the drawing, there is indicated schematically for purposes of illustration a central office connected by a line circuit

to a subscriber's key telephone set having a signaling circuit arranged in accordance with the present invention. The key telephone set is similar to the key box arrangement disclosed in Patent 1,724,903 issued August 20, 1929, to L. J. Bowne while the signaling circuit, described hereinafter, is an improved arrangement over that shown in the Bowne patent.

Let it be assumed that a subscriber connected to the key telephone set is being called and that terminals of the line circuit 10 have been seized at the central office CO in the usual manner and that the customary grounded alternating current of ringing frequency is being transmitted over conductor R of line 10 causing operation of ring-up relay 11. Inasmuch as the use of resistors having a high negative temperature coefficient of resistance for preventing false signal operation of ring-up relays is well known, as exemplified by Patent 2,160,507 issued May 30, 1939, to M. E. Krom, a detailed description of the ringing circuit including resistor 13 is deemed unnecessary especially since it does not form a part of the present invention. Ring-up relay 11 energizes in a circuit that can be traced from the usual grounded source of ringing current (not shown) at the central office CO, over ring conductor R, through condenser 12, negative temperature coefficient of resistance element 13, and secondary winding of relay 11 to ground through varistor combination 14 and relay 15. Relay 11 at its left front contact prepares an obvious locking circuit therefor; at its right front contact energizes signal lamp 18 by connecting ground thereto; and at its intermediate front contact energizes relay 16 and initiates energization of relay 17. The operating circuit for relay 16 may be traced from grounded battery through potentiometer resistance 19, winding of relay 16, and left back contact of relay 17 to ground via intermediate front contact of relay 11. Relay 16 in operating closes the front contact thereof to ground thereby completing the heretofore mentioned locking circuit for relay 11. Lamp 18 therefore remains illuminated at a steady rate as an indication to the switchboard attendant of an incoming call, as long as relay 16 remains operated. Although a signal lamp is shown as an indicating means, audible means, such as a buzzer, may be shown in its stead or in conjunction therewith.

Reverting to the period during which the ringing pulses are being transmitted, it will be noted that during each pulse of ringing current relay 15 is energized in the above traced circuit. In general, for machine ringing a signaling cycle comprises a ringing pulse of 2 second duration and a quiet period of 4 second duration, so that relay 15 releases upon cessation of each pulse and reoperates intermittently for the duration of the ringing period. While operated, relay 15 closes its front contact to illuminate signal lamp 21 in an obvious circuit and opens its back contact to interrupt the timing circuit, which will be described hereinafter. Since illumination of signal lamp 21 follows the intermittent operation of relay 15, lamp 21 flashes accordingly at the signaling rate to indicate to the attendant the receipt of periodic ringing current. At the expiration of the ringing period lamp 21 and relay 15 return to their normal deenergized condition.

Energization of relay 17 is initiated in a circuit traced from grounded battery through winding thereof, back contact of relay 15, resis-

tor 22, back contact of relay 17, and thence to ground over the intermediate front contact of operated relay 11. Resistor 22 has a high negative temperature coefficient of resistance and comprises material such as boron, silver sulphide, or an equivalent thereof and of such dimensions as to have a very high resistance, that is, of the order of 50,000 ohms under normal conditions, but having the characteristic of decreasing its resistance rapidly to a comparatively low value when energized. Relay 17, therefore, cannot immediately operate as the resistance of resistor 22 at normal room temperatures is too high to permit sufficient current flow there-through. However, in a comparatively short time, as the temperature of resistor 22 increases, the resistance thereof drops sufficiently so that relay 17 operates in the above-traced circuit. At the right front contact of relay 17 a circuit, traced from grounded battery through potentiometer resistances 19 and 23 to ground over the intermediate front contact of relay 11, is completed for the purpose of lowering the voltage impressed across the winding of relay 16. Relay 17 at the back contact thereof removes ground from relay 16 while at the left front contact transfers hot resistor 22 from the winding thereof to that of relay 16 and closes an obvious locking circuit therefor. During the above transfer of resistor 22 relays 16 and 17 remain operated, since the front contact makes before the back contact breaks the ground connection therefor.

It will be noted that when resistor 22 had been heated to its predetermined temperature and corresponding resistance relay 17, which may be a marginal relay, operated to transfer the resistor from its circuit to that of relay 16. This phase of the timing interval, that is, from operation of relay 11 to operation of relay 17, may be considered as its heating period. Furthermore, relay 17 effected operation of a potentiometer arrangement comprising resistances 19 and 23 whereby the impressed voltage at relay 16 was reduced by connecting resistance 23 in parallel with the winding of relay 16 and resistor 22. Under the reduced voltage condition resistor 22 cannot maintain its high temperature and as a result gradually cools, thereby increasing in resistance and correspondingly reducing the current flow through relay 16 until a point is reached at which relay 16 releases. This latter phase of the timing interval, that is, from operation of relay 17 to release of relay 16, may be considered as its cooling period. The release of relay 16 causes the front contact thereof to retract to its normal position whereupon the locking circuit for ring-up relay 11 is opened. Relay 11 in releasing extinguishes signal lamp 18 and opens the locking circuit of relay 17 which thereupon releases and places the circuit in readiness for another call. It is apparent that after a predetermined interval of time lamp 18 will be automatically extinguished should the attendant be absent from the switchboard for any appreciable period and therefore fail to answer the call. Thus, with this arrangement undue battery drain and reduced effective lamp life are prevented.

In general, the switchboard operator while in attendance can answer each call as it appears. However, during peak loads the calls may appear with such rapidity that delays of varying duration would ensue and were it not for the minimum delay feature of this invention a number of calls would be lost, to the detriment of the subscriber.

For example, assume that an incoming call has already initiated a timing cycle and that a subsequent call over multiple leads 25 from a similar ring-up relay 11 of the same group is being signaled during the heating period of this cycle. Based on this assumption, relays 11 and 16 will be in an operated condition and resistor 22 will be at a temperature below that, however, to operate relay 17. Upon receipt of the ringing frequency relay 15 operates at each incoming pulse to intermittently interrupt the heretofore traced resistor 22—relay 17 circuit during the ringing interval. Resistor 22 consequently has its temperature lowered and upon cessation of ringing current resumes its heating cycle at a temperature above that of its previous starting point but below that of its interrupted point. Therefore, a minimum period, namely that of the cooling period, has been maintained despite the interruption, as the heating phase of the cycle must be first consummated before the cooling phase thereof is initiated.

As a further example, assume that a subsequent call comes in during the cooling period of resistor 22. In this example relays 11, 16, and 17 are energized and resistor 22 in circuit with relay 16 is rapidly cooling preparatory to releasing relay 16. Relay 15 at each pulse of ringing current energizes to open the locking circuit of relay 17, which in releasing transfers cooling resistor 22 from the circuit of relay 16 to that of relay 17 and disconnects potentiometer resistance 23. Relay 16 remains operated during this ringing period but resistor 22 reverts to its heating period whereby its temperature is increased, as explained heretofore, preparatory to operating relay 17. Should the ringing impulse occur immediately following operation of relay 17, while resistor 22 still has its full quota of heat, this relay would immediately reoperate upon release of relay 15. Thus with this arrangement a minimum period, which is equivalent to the cooling period of resistor 22, is maintained at all times for illuminating signal lamp 13.

In practice, resistors 22 selected for such use have required from about 10 to 15 seconds up to about 200 seconds, dependent, of course, upon the ambient temperature and applied voltage, to reach the degree of heat which will permit sufficient current to energize control relay 17; and once heated have required a minimum of 4.3 seconds to cool sufficiently to release relay 15 under varying conditions. Thus the over-all interval provided by the timing circuit, starting with a cold resistor, will vary from about 14 seconds to about 204 seconds with the cooling period maintained at a minimum of 4.3 seconds, which is slightly greater than the quiet period of the ringing interval used in machine ringing. However, in manual ringing the quiet period is generally greater and accordingly the minimum period is set at a larger time interval.

Referring now to Fig. 2 of the drawing, there is shown another embodiment of the invention in which a more accurate timing arrangement is obtained by the use of a negative temperature coefficient resistor in conjunction with an electropolarized relay normally biased against its back contact. When in this embodiment a ringing signal is received, the ring-up relay 24 energizes in a circuit traced from a grounded source of ringing current (not shown) at the central office CO, over ring conductor R through condenser 26, negative temperature coefficient of resistance element 27, and secondary winding of relay 24 to

ground through varistor combination 30 and relay 39. Relay 24 at the left front contact thereof locks itself in a circuit from grounded battery through its primary winding to ground over the back contact of relay 28; at the right front contact energizes signal lamp 29 in an obvious circuit; and at the intermediate front contact initiates energization of electropolarized relay 31 in a circuit from ground through back contact of relay 39, primary winding of relay 31, high negative temperature coefficient resistor element 32, and potentiometer resistance 33 to grounded battery. Relay 31 doesn't operate immediately because of the limited current flow through the primary winding thereof and because of current flow through the bias winding, which normally biases the armature thereof a certain amount against its back contact in a circuit that can be traced from grounded battery through biasing winding thereof and biasing resistance 34 to ground over right back contact of relay 35. In addition, as heretofore explained, resistor element 32 retards the proper operating current for relay 31 a predetermined interval. In order to make the heating period of resistor 32 as short as possible and also to avoid ambient temperature difficulties, a heater winding 35 is normally energized in an obvious circuit to keep the temperature of resistor 32 above that of the room. The heater winding 36 may be included as part of resistor 32 or other equivalent means may be used to externally heat resistor 32.

After the temperature of resistor 32 has risen to its predetermined value, sufficient current flows through the above-traced circuit to operate electropolarized relay 31, which energizes relay 35 in a circuit traced from grounded battery through winding and inner left back contact thereof, front contact of relay 31, back contact of relay 39, and to ground over front contact of relay 24. Relay 35 operates and at the outer right front contact thereof prepares an operating circuit for relay 28 while at the inner right front contact connects potentiometer resistance 37 to ground thereby placing resistance 37 in parallel relationship with resistor 32 and thus lowering the effective potential for resistor 32; at the right back contact thereof disconnects ground, which normally short-circuits bias resistance 38, thereby increasing the resistance and correspondingly reducing the current in the bias winding of relay 31, thus decreasing the bias directed towards the back contact thereof and permitting release of relay 31 by a smaller current in the primary winding thereof. At the left front contact relay 35 locks itself in an obvious circuit; and at the left back contact heater winding 36 is disconnected from ground, so that the cooling rate of resistor 32 is under control of the voltage determined by potentiometer resistances 33, 37, as described heretofore. Resistor 32 therefore gradually cools until the current through the primary winding of relay 31 falls below the release value thereof as determined by the aforementioned revised bias current. Electropolarized relay 31 consequently releases but as relay 35 is locked in its operated position, relay 28 is energized in a circuit traced from grounded battery through winding thereof, outer right front contact of relay 35, retracted back contact of relay 31, back contact of relay 39, and intermediate front contact of relay 24 to ground. Relay 28 in operating opens the locking circuit for ring-up relay 24, which thereupon releases to disconnect signal lamp 29 and to release relays 35 and 28. The

circuit is thus restored to its normal condition in readiness for another call, while signal lamp 29 is extinguished after a predetermined timed interval.

It will be noted that in this embodiment of the invention the heating period of the timing cycle is made as short as possible by the additional application of heat through heater 36 so that the desired delay interval is measured chiefly by the cooling period of resistor 32. The delay interval is therefore determined by the amount of heat stored in resistor 32, the established rate of cooling therefor, and the releasing point of electropolarized relay 31. The amount of stored heat required depends upon the operating current of relay 31 in conjunction with the bias current thereof while resistance 38 is short-circuited; the cooling rate is determined by the potential applied to resistor 32 by the potentiometer resistances 33, 37. The releasing point of relay 31 is set by the bias resistances 34, 38. Thus with a given resistor 32 and electropolarized relay 31 it is possible to obtain a wide range of timed intervals by varying bias resistances 34, 38 and the potentiometer resistances 33, 37.

While this invention has been shown and described as embodying certain features merely for the purpose of illustration, it is, of course, understood that various modifications may be made in the details of the circuit and that the features thereof may be applied to many other and widely varied fields without departing from the scope of the invention as defined in the appended claims. For example, the electropolarized relay arrangement shown in Fig. 2 may with slight modifications be used for providing periodic interruptions.

What is claimed is:

1. In a signaling system, a line circuit, signal means therefor, means responsive to signal current over said line for actuating said signal means, and means including an element of high negative temperature coefficient of resistance for maintaining said signal means actuated a minimum interval of time.

2. In a signaling system, a subscriber's line circuit, a signal therefor, means responsive to periodic signaling current incoming over said line for actuating said signal, an element of high negative temperature coefficient of resistance for controlling the actuated period of said signal, and means utilizing the combined heating and cooling intervals of said element for sustaining said signal in an actuated condition a minimum predetermined period, said period being equivalent to an interval slightly greater than the quiet period of said periodic signaling current.

3. In a communication system, a line and signaling circuit, a signal therefor, means responsive to signaling current incoming over said line for operating said signal, and means including a resistor of high negative temperature coefficient material for releasing said signal after a predetermined interval of time, said interval being equivalent to at least one complete heating and cooling period of the resistor.

4. In a communication system, a subscriber's line circuit, a signal therefor, a ring-up relay responsive to periodic ringing current for actuating said line signal, means for locking said relay so that said signal is actuated at a steady rate during the ringing interval, and means including a non-linear resistor for releasing said signal a predetermined time after the ringing current has ceased, said predetermined time be-

ing measured by a combined heating and cooling cycle of the resistor, whereby a minimum time interval equivalent to that of the cooling phase of said cycle is always maintained.

5. In a telephone system, a subscriber's line circuit, a signal therefor, means responsive to periodic signaling current incoming over said line, said means comprising a ring-up relay for actuating said signal and a relay intermittently operated by said signaling current, a flashing lamp energized by said intermittently operated relay, means for locking said ring-up relay so that said signal is actuated continuously, and time-out means for releasing said actuated signal a predetermined time interval after cessation of signaling current, said time-out means comprising a resistor of high negative temperature coefficient of resistance in which the combined heating and cooling cycle thereof measures said predetermined time interval.

6. In a telephone system, a subscriber's station, a group of lines terminating thereat, a signal individual to each line, a ring-up relay for each of said lines, one of said relays being operated by ringing current impressed upon the associated line thereof for actuating one of said signals, means common to said group of lines for locking said relay to maintain said actuated signal at a steady rate during the application of ringing current, and time-out means common to said group of lines for releasing said actuated signal a predetermined time interval after cessation of ringing current, said time-out means comprising a resistor of high negative temperature coefficient material in which the combined heating and cooling cycle thereof measures said predetermined time interval.

7. In a telephone system, a subscriber's key telephone set, a group of lines terminating thereat, means at a central office for impressing periodic ringing current over said lines, a ring-up relay and a signal individual to each of said lines, one of said relays operable in response to said current for effecting operation of one of said signals, a timing circuit common to said lines for controlling the duration of said operated signal, said circuit comprising a resistor having a large negative temperature coefficient of resistance in which a complete heating and cooling cycle thereof normally measures the operating period of said operated signal, a control relay common to said lines for recycling said timing circuit, said control relay responsive to ringing current over another one of said lines whereby said operated signal is held in an operated condition for a further period equivalent at least to the cooling phase of said resistor, and means for releasing said signal at the expiration of said further period.

8. In a telephone system, a subscriber's line, a signal therefor, means for activating said signal, and a timing circuit for rendering said signal ineffective a predetermined time after activation thereof, said circuit comprising a resistor having a negative temperature coefficient of resistance, a control relay connected in circuit with said resistor, said relay being operated by the increase in temperature of said resistor, a time-out relay connected in circuit with said resistor following operation of said control relay, said time-out relay being released by the decrease in temperature of said resistor, and means for releasing said signal.

9. In a telephone system, a subscriber's line, a signal lamp therefor, means for activating said

signal lamp, a resistor having a large negative temperature coefficient of resistance for timing the activated period of said signal lamp, a control relay in circuit with said resistor, the current in said circuit initially being insufficient to operate said relay, said relay being operated by the increase in temperature of said resistor, and a time-out relay operated by said activating means being connected in circuit with said resistor after operation of said control relay, said time-out relay being released by the decrease in temperature of said resistor, whereby said signal lamp is extinguished.

10. In a telephone system, a subscriber's line, a signal therefor, a ring-up relay for activating said signal, a time-out relay operated by said ring-up relay, a resistor having a high negative temperature coefficient of resistance for rendering said signal ineffective, said resistor being operative through a heating and cooling cycle, a control relay in circuit with said resistor during the heating period thereof, said control relay being operated by the increase in temperature of said resistor, and a circuit including said time-out relay and resistor for releasing said signal after said resistor has cooled sufficiently.

11. In a telephone system, a subscriber's line, a signal therefor, a ring-up relay for activating said signal, a time-out relay operated by said ring-up relay, said time-out relay completing a locking circuit for said ring-up relay, a resistor having a high negative temperature coefficient of resistance for timing the activated period of said signal, said resistor being operative through a heating and cooling cycle, a control relay in circuit with said resistor during the heating period thereof and operated by the increase in temperature of said resistor, a circuit including a resistance completed by the operation of said control relay for starting the cooling period of said resistor, and a circuit including said time-out relay and resistor maintained operated until said resistor has cooled sufficiently to release said time-out relay, whereby said signal is rendered ineffective.

12. In a telephone system, a subscriber's line, a signal therefor, means for activating said signal, a non-linear resistor for rendering said signal ineffective after a predetermined time, said resistor being operative through a heating and cooling cycle, a control relay in circuit with said resistor during the heating period of said cycle, a time-out relay in circuit with said resistor during the cooling period of said cycle, and means for interrupting said control relay circuit whereby said resistor is reconnected so as to resume its cycle of operation during the heating period thereof.

13. In a telephone system, a subscriber's line, a signal for marking the condition of said line, a ring-up relay for energizing said signal, and a timing circuit for rendering said signal ineffective after a predetermined interval, said circuit comprising a resistor having a high negative temperature coefficient of resistance, said resistor being operable through a heating and cooling cycle, a relay having a winding in series with said resistor, a biasing winding on said relay for retarding the operation of said relay, said relay being operated by the increase in temperature of said resistor, a second relay responsive to the operation of said first relay for initiating the

cooling period of said cycle, said first relay being released after said resistor has cooled sufficiently, and means responsive to the release of said first relay and continued operation of said second relay for deenergizing said signal.

14. In a telephone system, a line, a signal for indicating the condition of said line, means for activating said signal, a resistor having a high negative temperature coefficient of resistance for rendering said signal ineffective, said resistor operable through a heating and cooling cycle, a relay serially connected with said resistor during the entire heating and cooling cycle thereof, a biasing circuit for setting the operating time of said relay, said relay being operated by the increase in temperature of said resistor, a second relay responsive to the operation of said first relay, a potentiometer resistance effective upon the operation of said second relay for starting the cooling period of said resistor, said first relay being released after said resistor has cooled sufficiently, and means responsive to the release of said first relay for deenergizing said signal.

15. In a telephone system, a subscriber's line, a signal therefor, means for activating said signal, a non-linear resistance for controlling the activation of said signal, said resistance being operable through a heating and cooling cycle, an electropolarized relay in circuit with said resistance, a biasing circuit for retarding the operation of said relay, said relay being operated by the increase in temperature of said resistance, a second relay responsive to the operation of said electropolarized relay, a potentiometer resistance effective upon the operation of said second relay for initiating the cooling period of said resistance cycle, a bias resistance effective upon the operation of said second relay for changing the effect of said bias circuit on said electropolarized relay, said electropolarized relay being released after said non-linear resistance has cooled sufficiently, and means responsive to the release of said electropolarized relay and continued operation of said second relay for deenergizing said signal.

16. In a telephone system, a subscriber's line, a signal therefor, means for activating said signal, a non-linear resistor for releasing said signal after a predetermined interval of time, said resistor being operable through a heating and cooling cycle, a heating winding for said resistor normally energized, an electropolarized relay in circuit with said resistor, a circuit for biasing the operation of said relay, said relay being operated by the increase in temperature of said resistor, a second relay responsive to the operation of said electropolarized relay, a potentiometer resistance rendered effective upon the operation of said second relay, said heating winding opened by the operation of said second relay whereby in conjunction with said potentiometer resistance the cooling phase of said resistor cycle is initiated, a bias resistance rendered effective upon the operation of said second relay for altering the effect of said bias circuit on the electropolarized relay, said electropolarized relay being released after said resistor has cooled sufficiently, and means responsive to the release of said electropolarized relay and continued operation of said second relay for deenergizing said signal.

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