

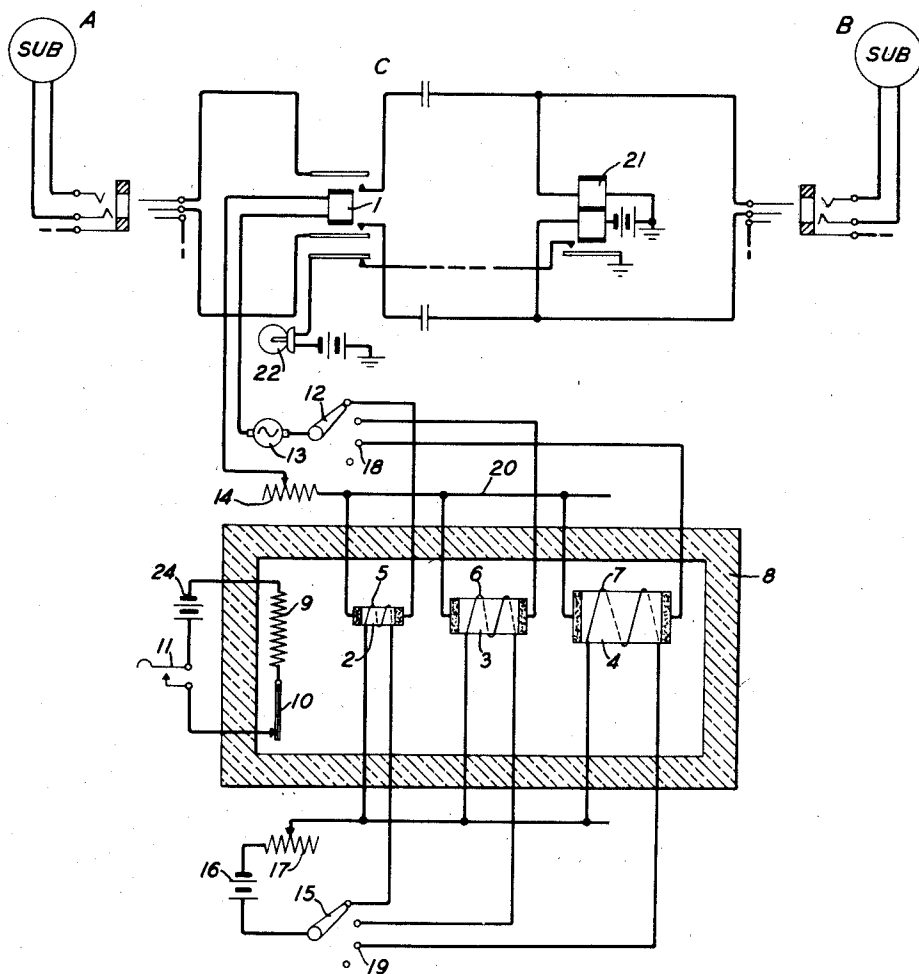
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COMMUNICATION SYSTEM

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COMMUNICATION SYSTEM

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This invention relates to communication systems and particularly to systems and methods for measuring and assessing intervals of telephone conversation.

5 The objects of the invention are to effect simplifications and improvements in the measurement of units of elapsed time during which a communication is in progress and to facilitate the making of assessments in accordance with the intervals measured.

10 Arrangements have been proposed heretofore for measuring periods of time during a telephone conversation for the purpose of notifying the operator of the expiration of each predetermined period in order that she may assess a charge or demand the deposit of further coins in case the calling party is at a coin substation. Usually these prior arrangements involve the use of switches, interrupters, or similar mechanical devices controlled by clockwork for measuring the time intervals.

According to a feature of the present invention, advantages are secured over these prior arrangements by providing a means for timing and by a method of timing in which a resistor having a large temperature coefficient of resistance is included in circuit with the winding of a relay and a source of potential, and in which heat is applied to the resistor by some control means, such as an operator's key, to raise its temperature and permit sufficient current to flow to operate the relay and close the communication circuit so that the parties may converse. The heating current is applied only for a short time by the momentary actuation of the operator's key, but the temperature of the resistor is quickly raised to the point where the control relay operates. Thereupon the resistor begins to cool, and at the end of a predetermined interval, such as one minute, three minutes, or five minutes, its temperature drops, and its resistance increases to the point where the relay releases due to the lack of enough current to hold its armature. Thus the conversational circuit is opened, and at the same time a signal is given to the operator. By another depression of the key the circuit is reclosed, and a new period is measured.

Another feature of the invention is a timing means and a method for accurately timing the selected intervals to be measured in which a plurality of resistor elements of different sizes are arranged to be selected for use in controlling the release time of the circuit control relay. By choosing these elements in proper sizes and shapes, it is possible to derive different meas-

ured intervals of time, such as one minute, three minutes, five minutes, for the conversation units. One element would be used to measure one minute, a different element for three minutes, and a still different one for five minutes.

According to a further feature the accuracy with which these periods of time are measured can be increased by housing the resistor elements in a heat-proof chamber which is maintained at a predetermined temperature above the ambient temperature.

The foregoing and other features of this invention will be explained more fully in the following detailed specification. This specification should be taken in connection with the accompanying drawing which discloses partly in diagrammatic form and partly in detail a telephone system equipped with mechanism for timing the duration of conversational intervals on established connections.

Referring now to the drawing, two subscribers' lines A and B are shown terminating in the central office at an operator's position. A cord circuit C at said position serves for establishing connections between calling and called subscribers. The operator's position is also equipped with a timing mechanism for measuring intervals of conversation taking place over a connection established by the cord circuit C. This timing mechanism includes a relay 1 associated with the cord circuit and a plurality of resistors 2, 3, 4 for introducing a time interval in the operating characteristics of said relay. The relay 1, when operated, closes the talking circuit between the subscribers' lines to begin the measurement of a conversational interval, and the resistors 2, 3, 4, any one of which may be included in the circuit of the relay, serve to bring about the release of the relay at the termination of a predetermined time interval. The release of the relay opens the conversational circuit, and, to start the measurement of a new interval, it is necessary to reoperate the relay 1. By choosing the resistors 2, 3, 4 in different sizes as illustrated, it is possible to obtain any desired predetermined interval for the conversational period. For example, the resistor 2 may be designed to measure a conversational interval of two minutes; the resistor 3, an interval of three minutes; and the resistor 4, an interval of five minutes.

The timing of the connection-controlling relay 1 is obtained by reason of the temperature-resistance characteristic of the resistors 2, 3, 4. These resistors have a high temperature coefficient of resistance. While there are a number

of materials that have such temperature-resistance characteristics, it has been found that silver sulphide, which has an extremely high negative temperature coefficient, is particularly well suited for the present purpose. The resistance of this material undergoes rather large and uniform changes for relatively small corresponding changes in its temperature. It is easily adapted to resistor units at relatively low cost; it requires very little space for mounting purposes; and the maintenance attention it requires is comparatively small. Resistors made of this material also have certain critical voltage characteristics which make them suitable for obtaining measured time intervals. For instance, a given resistor requires a given voltage to produce enough current therein to raise the temperature of the resistor to the critical point beyond which the temperature continues to increase as a result of the increasing current flowing. And voltages below the critical value produce limited currents. One method of making such units of silver sulphide is disclosed in the Patent of J. R. Fisher, No. 2,091,259, dated August 31, 1937.

The resistors 2, 3, 4 are provided respectively with heating coils 5, 6, 7. These coils are shown encircling the respective resistance elements. British Patent No. 472,144, September 17, 1937, discloses the structure of such a resistor and heating coil. They may, however, be located in any desired relation with respect to the elements, the requirement being that the heat they generate be transferred to the resistance element. In order to remove the resistors from the influence of the ambient temperature and to increase the precision with which they are capable of timing the operation of the relay 1, they may be enclosed as shown within a temperature control chamber 8. The chamber 8 is heat insulated and is equipped with a heating element 9 and a thermostat 10, which may be set to hold the temperature within the chamber at any desired value with respect to the ambient temperature. The heating element 9 is supplied with energy from the battery 24, and the circuit therefor is controlled by a switch or key 11. The key 11 should be operated, to close the heating circuit, for a long enough time for the temperature within the chamber 8 to have reached the desired value before the resistors are used for timing a connection. The resistors 2, 3, 4 are connected to the contacts of a switch 12, which may be manipulated by the operator to selectively insert any one of the resistors in circuit with the cord relay 1. The circuit for the relay 1 and the resistor also includes the source of alternating current energy 13 and the variable resistance 14. The heating coils of the resistors are connected to the terminals of a second switch 15, which likewise may be adjusted by the operator to close an energizing circuit for the heating coil of the resistor unit which she desires to employ for timing the operation of the relay 1. The circuit for the heating coils of the resistors also includes the source of energy 16 and a variable resistance 17.

Having given the foregoing general description of the system and equipment incorporated therein, a detailed description will now be given of the manner in which the system operates. Assume for this purpose that the subscriber of line A wishes to converse with the subscriber of line B. The operator at the central office responds in the usual manner to the calling subscriber's signal and completes the connection by means of her cord circuit C. When the called party

answers, the relay 21 operates, and a circuit is completed for the lamp 22. If the interval of conversation applying to this particular connection is five minutes, the operator, as soon as the called party has answered, also sets the switch 12 on terminal 18 to select the resistor 4 and sets the switch 15 on terminal 19 to select the heating coil 7 of said resistor 4. The closure of the switch 12 establishes a circuit from the right-hand pole of the source 13, through the switch arm 12, terminal 18, thence through the resistance element 4, common conductor 20, variable resistance 14, through the winding of relay 1, to the opposite pole of the source 13. With the resistance 14 properly adjusted, a certain potential, preferably somewhat less than the critical voltage, is applied across the terminals of the resistor 4. The resistance of element 4 at its normal temperature is too high to permit sufficient current to flow in the circuit traced to enable the operation of relay 1. However, the heating coil 7 is also energized at this time over a circuit from the source of potential 16, switch 15, terminal 19, thence through the coil 7, and returning through the variable resistance 17, to the opposite pole of source 16. The heating coil 7 rapidly raises the temperature of the element 4, causing a corresponding rapid decrease in the resistance of said element. Thus the current flowing through the winding of relay 1 rapidly increases to the point where the relay attracts its armatures and completes the talking circuit between the calling and the called lines. As soon as the operator notes the extinguishment of the light 22 indicating that the relay 1 has operated to begin the measurement of the five minute interval, she restores the switch 15 to deprive the heating coil 7 of its energizing current. The element 4 now begins to cool and gradually increase its resistance. By reason of the size and dimensions of the element and the temperature to which it was raised by the heating circuit, an accurately measured interval of five minutes is required for the element 4 to increase its resistance to the point where the current flowing in the relay 1 is insufficient to maintain the relay armatures attracted. At this point the relay releases, opens the conversational circuit between the subscribers and closes the circuit of lamp 22 to apprise the operator that the measured interval has been completed. According to the practice required for the particular connection involved, the operator may either communicate with the subscribers or she may immediately restore the conversational connection for a further interval, which may again be a five minute interval or some lesser time, such as three minutes or two minutes. And at the end of each succeeding interval the same procedure may be followed throughout the duration of the established connection. It will, of course, be obvious that the relay 1 may be arranged to signal the operator at the end of each interval without interrupting the conversational circuit, and the operator may enter charges against the subscriber for each interval of elapsed conversation.

At the end of the conversation the operator is given the usual disconnect signals in response to which she removes the plugs of the cord circuits from the jacks of the subscribers' lines and restores all of the associated equipment to normal.

It will be obvious from an inspection of the system that the timing of the conversational periods may be controlled, by either the resistor 2 or the resistor 3 or by still other resistors not

disclosed, in a manner similar to that already described in detail in connection with the resistor 4. It will also be apparent that the switches 12 and 15, by which the resistors and the heating coils are rendered effective, may vary widely in their construction and operation. Also, the practice followed by the operator in manipulating these circuits may vary. For example, she may close the circuit through the resistor before or after the heating coil of the resistor is energized. Or she may prepare both circuits simultaneously. Furthermore, the temperature to which the elements are raised may be varied by the resistance 17 to obtain the desired control over the measured intervals.

While the invention has been disclosed specifically in connection with a telephone system of the manual type, it should be understood that it is not so limited but may be applied equally as well to other kinds of systems, such, for example, as full automatic telephone systems. Also numerous modifications will suggest themselves for the different parts of the mechanism here disclosed. For example, any suitable source may be used to supply current for the operation of relay 1.

What is claimed is:

1. The method of measuring intervals of time during a communication over an established connection which comprises connecting in the circuit of a relay a resistor having a large negative temperature coefficient of resistance, connecting to said circuit a source of potential, applying heat externally to said resistor to raise its temperature to the point where sufficient current flows in said circuit to operate said relay for the purpose of rendering said established connection effective, and removing the source of heat to allow said resistor to cool until its temperature reaches the point where said relay releases and renders said established connection ineffective.

2. The method of measuring intervals of time during a telephone connection which comprises connecting in circuit with a relay controlling said connection a resistor having a high negative temperature coefficient of resistance and a critical point in its temperature-resistance characteristic, applying a source of potential to said circuit, adjusting the voltage across said resistor to a value such that the resistor will assume a temperature below said critical point when free from external heat, applying heat to said resistor from an external source to raise its temperature and permit sufficient current to flow in said circuit to operate the relay, and allowing said resistor to cool to bring about the release of said relay.

3. The method of measuring intervals of time during the progress of a telephone conversation over an established connection which comprises selecting one from a number of resistors of different sizes and of high temperature coefficients of resistance, connecting the selected resistor in circuit with the winding of a relay which serves to control the established connection, connecting a source of potential to said circuit, applying heat to said resistor to raise its temperature and cause the operation of said relay, and permitting said resistor to cool to lower its temperature and cause the release of said relay.

4. The method of measuring intervals of time during communication over an established connection which comprises selecting one from a number of resistors of different sizes and of high negative temperature coefficients of resistance,

connecting the selected resistor in circuit with the winding of a relay which controls the established connection, applying a source of potential to said circuit, adjusting the voltage across the selected resistor to the desired value, applying heat to said resistor to cause the flow of current in said circuit and the operation of said relay, and permitting said resistor to cool to reduce the flow of current in said circuit and cause the release of said relay.

5. The method of measuring intervals of time during the progress of communication over an established connection which comprises selecting one from a number of resistors of different dimensions which have high negative temperature coefficients of resistance and critical points in their temperature-resistance characteristics, connecting the selected resistor in circuit with a relay which controls said established connection, applying a source of potential to said circuit, adjusting the voltage across the selected resistor to a value such that the resistor will assume a temperature below said critical point when free from external heat, applying heat from an external source to said resistor to increase its temperature and permit sufficient current to flow in said circuit to operate said relay, and permitting said resistor to cool to decrease the flow of current in said circuit and cause the release of said relay.

6. In a telephone system, a calling subscriber's line, a called subscriber's line, means comprising a link interconnecting said lines, a relay for rendering said connection effective for talking, a resistor having a large temperature coefficient of resistance, a circuit including said resistor for operating said relay, the current in said circuit being insufficient to operate said relay when the temperature of said resistor is below a certain value, a heating winding for said resistor, and means for momentarily closing a circuit through said heating winding to raise the temperature of said resistor sufficiently to cause the operation of said relay, said relay being held operated by the current in said operating circuit for a desired interval of time while said resistor is cooling.

7. In a telephone system, a calling subscriber's line, a called subscriber's line, means including a link interconnecting said lines, a relay for controlling the talking connection between said lines, and timing mechanism for measuring a predetermined interval of time, said timing mechanism comprising a resistor having a negative temperature coefficient of resistance, means for closing a circuit through said resistor and the winding of said relay, a circuit including a winding around said resistor for heating said resistor, a switch for closing and opening said heating circuit, said relay being operated by the increase in temperature of said resistor and remaining operated after the opening of said heating circuit until said resistor has cooled sufficiently to cause its release, and indicating means controlled by said relay.

8. In a telephone system, subscribers' lines interconnected for conversation, a relay controlling the talking connection between said lines, timing mechanism comprising a plurality of resistors of different sizes, each of said resistors having a high negative temperature coefficient of resistance, means for selecting a desired one of said resistors for controlling the operation of said relay, a circuit through the selected resistor and the winding of said relay, the resistance of said resistor when at or below a critical temperature being high enough to prevent the operation of

said relay, and means comprising a heating winding for temporarily raising the temperature of said resistor above said critical temperature to cause the operation of said relay, the interval which elapses after said heating circuit is opened before said resistor cools sufficiently to cause release of said relay being a desired and predetermined interval of time.

9. In a telephone system, subscribers' lines, a link circuit for interconnecting said lines, a relay for rendering said connection effective for conversation, a circuit for said relay, a source of current in circuit with said relay, a resistance element, having a large temperature coefficient of resistance, connected in circuit with said relay, the normal resistance of said element being sufficient to prevent the operation of said relay, a heating winding for said resistance element for momentarily raising the temperature of said element sufficiently to cause the operation of said relay, said relay being held operated by current in its operating circuit for a desired interval of time while said resistance element is cooling, and a heat insulated chamber for housing said resistance element and its heating winding.

10. In a telephone system, subscribers' lines, a link circuit for interconnecting said lines, a relay for rendering said connection effective for conversation, a circuit for said relay, a source of current in circuit with said relay, a resistance element, having a large temperature coefficient of resistance, connected in circuit with said relay, the normal resistance of said element being sufficient to prevent the operation of said relay, a heating winding for said resistance element for momentarily raising the temperature of said element sufficiently to cause the operation of said relay, said relay being held operated by current in its operating circuit for a desired interval of time while said resistance element is cooling, a heat insulated chamber for housing said resistance element and its heating winding, and means for maintaining the temperature within said chamber substantially constant.

11. In a telephone system, subscribers' lines, a link circuit for interconnecting said lines, a relay for opening and closing said link circuit periodically to measure intervals of conversation, an operating circuit for said relay having a source of current therein, a plurality of resistance elements having large temperature coefficients of resistance and having different normal resistance values, means for including any desired one of said elements in circuit with said relay, the normal resistance of each of said elements being sufficient to prevent the operation of said relay when the element is included in circuit therewith, heating windings, one for each of said resistance elements, means for energizing any one of said heating windings momentarily to lower the resistance of the corresponding element sufficiently to enable said relay to operate in circuit therewith, said

relay remaining operated while the resistance element is cooling to measure a desired interval of time, a heat insulated chamber including all of said resistance elements, and means for maintaining the temperature of said chamber substantially constant.

12. In a telephone system, a calling subscriber's line, a called subscriber's line, means including a link interconnecting said lines, a relay for controlling the talking connection between said lines, and timing mechanism for measuring a predetermined interval of time, said timing mechanism comprising a resistor having a negative temperature coefficient of resistance, means for closing a circuit through said resistor and the winding of said relay, a circuit including a winding around said resistor for heating said resistor, a switch for closing and opening said heating circuit, said relay being operated by the increase in temperature of said resistor and remaining operated after the opening of said heating circuit until said resistor has cooled sufficiently to cause its release, and means actuated by the release of said relay for indicating the end of the measured interval of time.

13. In a telephone system, subscribers' lines, a link circuit for interconnecting said lines, a relay for rendering said connection effective for conversation, a circuit for said relay, a source of current in circuit with said relay, a resistance element, having a large temperature coefficient of resistance, connected in circuit with said relay, the normal resistance of said element being sufficient to prevent the operation of said relay, a heating winding for said resistance element for momentarily raising the temperature of said element sufficiently to cause the operation of said relay, said relay being held operated by current in its operating circuit for a desired interval of time while said resistance element is cooling, a heat insulated chamber for housing said resistance element and its heating winding, and indicating means actuated by the release of said relay at the end of said desired interval of time.

14. In a telephone system, subscribers' lines, means comprising a link interconnecting a calling line and a called line, a relay in said link controlling the talking connection between the lines, a resistor having a negative temperature coefficient of resistance, a source of current connected in circuit with said resistor and the winding of said relay, means comprising a heating coil for momentarily applying heat to said resistor to effect an increase in the current in said circuit to operate said relay, the current in said circuit being effective to control the cooling of said resistor so that a predetermined interval of time elapses before the current in said circuit is reduced sufficiently to allow said relay to release, and means controlled by said relay for indicating the end of said interval.

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