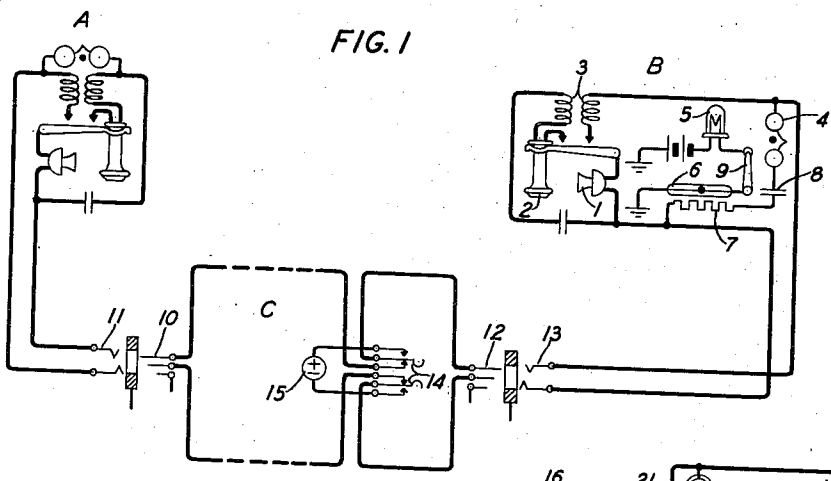
Sept. 27, 1938. C. W. HALLIGAN 2,131,589

SIGNALING SYSTEM

Filed April 23, 1937

FIG. 1



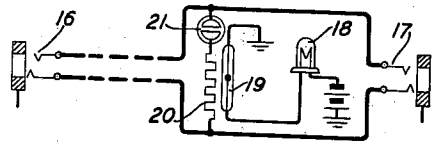


FIG. 2

FIG. 3

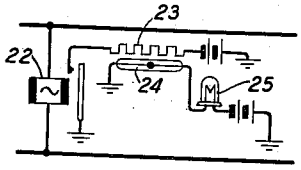


FIG. 4

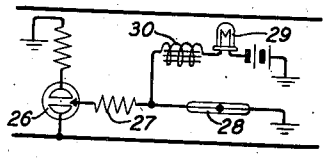
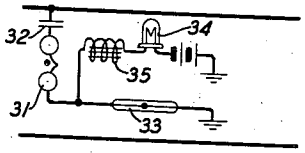


FIG. 5



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SIGNALING SYSTEM

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6 Claims. (Cl. 179—84)

This invention relates to signaling circuits and particularly to those used in telephone systems.

The objects of the invention are to obtain a greater degree of certainty and reliability in the operation of signaling devices; to safeguard these devices from false operations; to obtain steady signal indications in response to intermittent signaling current; and to secure other improvements and advantages in signaling systems.

There are, of course, many specific forms of signaling systems in the prior art, including those in which bells or other devices respond to alternating or pulsating currents to give audible signals during the intervals that the signal current is being applied and remain silent during the non-signaling periods, and including those in which lamps or other visible signal devices are rendered effective in response to the applied signaling current. Where signal lamps are made responsive to the application of signaling current to a transmission line it is customary to provide relay mechanism which responds to the signaling current and remains locked in operated position to display the lamps until some manual act is performed, such as the operation of a key or the insertion of a plug by an operator.

According to a feature of the present invention advantages are obtained over signaling systems of the prior art by means of a signaling arrangement in which the intermittent application of signaling current to a transmission line causes a visual signal, such as a lamp, which is normally unresponsive to other currents flowing over the line, to illuminate in response to the presence of signaling current in the line during the successive signaling intervals and to remain illuminated during the successive intervals in which the signaling source is disconnected from the line. More specifically the advantages of this feature are attained by including the signal lamp in a normally closed circuit containing a source of current, such as a direct-current battery, and a variable-resistance element, the resistance of which is normally so high that no appreciable current flows through the lamp from the direct-current battery. The resistance element, however, has a large negative temperature coefficient of resistance and is equipped with a heating winding or coil which, when energized by signaling current coming in over the line, raises the temperature of the resistance element and lowers its resistance to permit lamp-lighting current to flow in the local lamp circuit. The heating coil is so connected in circuit relation with the transmission line that it receives energizing current during the intervals that signaling current is flowing over the transmission line and is deenergized during the intermediate intervals when the line is free from signaling current.

The foregoing and other features of the invention will be discussed more fully in the following detailed specification.

In the drawing accompanying this specification:

Fig. 1 illustrates a telephone system with several of the circuit elements disclosed in diagrammatic form, and showing in detail a subscriber's line equipped with signaling circuits in accordance with this invention;

Fig. 2 shows a modified form of the invention applied to a transmission line, such as an inter-office trunk; and

Figs. 3, 4, and 5 show alternative signaling circuits which may be applied either to subscribers' lines or to trunk lines or to other types of signal transmission circuits.

While there are a number of materials having large temperature coefficients of resistance, experiments show that materials such as silver sulphide and boron are particularly well suited for use in signaling systems of the kind disclosed herein. These materials not only have large negative temperature coefficients of resistance, but they also have critical temperature points and critical voltages which make it possible to attain the desired relations between applied voltages, heating currents, and resistance.

By proper design of the resistance elements it is possible to obtain a wide range between their cold resistance values and their resistance values when their temperatures are raised by the heating coils. When, therefore, one of these units is included in a closed circuit with a source of current and a signal lamp, substantially no current can flow in the circuit at the normal temperature values of the resistance element, and the signal lamp remains dark. But when the temperature of the resistance element is raised by its heating coil, the resistance drops rapidly to a much lower value and current flows therethrough to illuminate the lamp. The flow of current through the unit from the local source also produces heat in the unit and tends to maintain the resistance at a low value independently of the heating coil. And by properly designing the unit it is possible to utilize this heating effect of the local current source to maintain the resistance of the unit at a low value for a sufficient time to span the non-ringing intervals during which no signaling current is present in the transmission line and no heating current is flowing through the heating coil. In this manner the signal lamp remains illuminated steadily during both signaling and non-signaling intervals and extinguishes only after the signaling current has been withdrawn from the line for a time long enough to permit the resistance unit to increase its resistance to the point where the current flowing through the lamp is no longer enough to heat its filament. It is also possible to design these resistance units

in such a way that the current flowing through them in the local circuit produces enough heat in the unit to maintain its temperature above the critical point and consequently to maintain its resistance low indefinitely once the unit has been raised to its critical temperature by means of its heating coil. With such an arrangement the signal lamp is lighted in response to the first application of signaling current to the line and remains lighted after the signaling current is withdrawn from the line and until its circuit is opened by some act, such as the manipulation of a key.

While the present invention is not limited to any particular construction of the resistance units described herein nor to any particular resistance materials employed in these units, reference may be had, for a more complete understanding of units suitable for use in the systems of this invention, to the British Patent No. 472,144, accepted Sept. 17, 1937.

Referring first to Fig. 1 of the drawing, there is here disclosed a calling subscriber's line A terminating in a jack before an operator's position in the central office. The operator's position is equipped with an ordinary cord circuit C with which she makes connections between subscribers' lines. This figure also discloses a second subscriber's line B appearing in a jack before the operator's position. The subscriber's line B is equipped with the usual substation instrument, including a microphone 1, a receiver 2 and an induction coil 3. In addition to these elements the substation of the line B is provided with an audible ringer 4, a signal lamp 5 and a variable-resistance element 6 having a heating coil or winding 7. The audible ringer 4 is bridged across the tip and ring conductors of the line in a circuit including a condenser 8 and the heating coil 7. The signal lamp 5 is included in a normally-closed local circuit containing a direct-current battery, a switch 9, and the variable-resistance element 6.

The features of the signaling circuits associated with the subscriber's line B will be understood best by considering the operation of the system as a whole when a call is made to said line. Assume, therefore, that the subscriber of line A wishes to converse with the subscriber of line B. The operator in response to the calling line A inserts her answering plug 10 in the jack 11 of the calling line. She communicates with the calling subscriber and then seizes the calling plug 12 and inserts it in the jack 13 of the called line B. Following this the operator closes the ringing key 14 to connect the ringing-current source 15 to the called line. The ringing-current source 15, which is illustrated schematically herein, may be of any well-known type in which alternating ringing current is applied to the line for a measured interval of time followed by a measured silent interval, followed in turn by another ringing interval, etc., as long as the key 14 is held closed. When ringing current is applied to the line during the first ringing interval, it flows over one of the line conductors through the ringer 4, condenser 8, heating coil 7 and returning over the other side of the line to the source 15. In response to the flow of this current the ringer 4 is sounded to attract the attention of the called subscriber, and the heating coil 7 generates heat and applies it to the variable-resistance element 6. The temperature of the element 6 rises rapidly, and its resistance falls correspondingly to lower the resistance of the circuit including the lamp 5 and the direct-current battery. As soon as the resistance of this circuit has dropped sufficiently, current in increasing intensity flows through the lamp 5 and the element 6, and the lamp 5 illuminates. Following the first ringing interval the ringing current is disconnected from the line, and the silent or non-signaling interval ensues. During the silent interval the bell 4 ceases to ring and current ceases to flow through the heating coil 7. However, the resistance unit 6 retains enough of its heat acquired from the coil 7 and sustained by the flow of current in the local lamp circuit to maintain its temperature and correspondingly its resistance values sufficient to insure the continued illumination of the lamp throughout the duration of the silent interval. At the end of the silent interval, and before the temperature of the resistance element 6 falls appreciably, the next ringing interval begins, and current flowing through the coil reenergizes it, and heat is again applied to the resistor 6. When the key 14 is released and ringing current is disconnected permanently from the line, the temperature of the element 6 falls to its normal value, and its resistance increases correspondingly to extinguish the lamp 5. Thus the ringer 4 at the substation is sounded intermittently and the lamp 5 is lighted steadily throughout the signaling operation, during both ringing and silent intervals, to apprise the subscriber that he is wanted on his telephone.

These signal lamps are particularly useful in locations where a number of telephones are in close proximity to each other and where it is sometimes difficult to determine from the ringing of a bell which telephone station is being signaled.

If desirable, the resistance element 6 may be so constructed that it will maintain its low resistance value by reason of the heating effect of the current flowing through it in the local lamp circuit once the resistor has been subjected to the heating effect of the heating coil 7. With such an arrangement the first application of ringing current to the line causes the lamp to light, and the lamp remains lighted thereafter indefinitely although the source of ringing current is disconnected by the operator at the central office. When in this case the called subscriber answers his telephone he extinguishes the lamp 5 by opening the switch 9. This severs the circuit through the resistor 6 and permits it to assume its normal resistance and temperature values. The reclosing of the switch 9 will not cause the lamp 5 to light because the normally-high resistance of the element 6 is too great to permit any substantial flow of current in the circuit.

In Fig. 2 a modified signaling circuit is shown applied to a trunk which appears at one end in a jack 16 at the operator's position, and at the other end in a jack 17 in a distant exchange. At the incoming end of the trunk in the distant exchange there is provided a signal lamp 18 connected permanently in circuit with a variable-resistance element 19. The element 19 is equipped with a heating coil 20, which is connected in a bridge circuit across the conductors of the trunk in series with a voltage discharge tube 21 of any well-known type. When signaling current is applied to the trunk circuit, the voltage being relatively high, the tube 21 breaks down and permits current to flow across the bridge and through the heating coil 20. This heats the resistance element 19 to reduce its resistance and allow the lamp 18 to light as a calling signal to the opera-

tor. The lamp 18 remains lighted during each ringing and silent interval until it is extinguished either by having its circuit opened by the answering operator in any suitable way or until the ringing operation is discontinued by the calling operator.

In the modification illustrated in Fig. 3 an alternating current relay 22 is connected in the bridge across the conductors of the line. This relay responds during the ringing intervals and closes a local circuit for the heating coil 23. The coil 23 heats the resistance unit 24, and the lamp 25 then receives current and illuminates.

In Fig. 4 a three-element discharge tube 26 is connected to one of the line conductors, one of the elements of the tube being connected through a resistance 27 and a variable-resistance element 28 to ground. The signal lamp 29 is connected between the resistance 27 and the element 28 in series with a choke coil 30. When ringing current is applied, the tube 26 discharges, and ringing current then flows through the resistance 27 and the element 28 to ground, lowering the resistance of said element. Choke coil 30 prevents the alternating ringing current from passing through the lamp 29. The lowered resistance of the element 28 permits current to flow from the direct-current source through the lamp and the choke coil 30 and the element 28 to ground. The lamp lights and remains illuminated during the ringing and silent intervals and extinguishes when ringing current is no longer applied to the line.

Fig. 5 is substantially the same as Fig. 4, except that the discharge tube 26 is replaced by a ringer 31 and a condenser 32. The ringing current in this case flows through the condenser 32, the ringer 31 and the variable-resistance element 33 to ground. When the element 33 lowers its resistance, current flows from battery through the lamp 34, the choke coil 35 and the element 33 to ground. In this case, as in the circuit shown in Fig. 1, the subscriber or the operator is signaled by the ringer as well as by the illumination of the lamp.

What is claimed is:

1. The combination with a line of a source of interrupted signaling current, means for applying said source to said line, a signal lamp and a source of current for lighting the same, a resistance element which decreases its resistance with an increase in its temperature, a circuit including said lamp, said second source of current, and said resistance element, the normal resistance of said element being sufficiently high to prevent the lamp from lighting, and circuit means effective when said source of interrupted current is applied to said line to heat said resistance element to maintain the signal lamp lighted throughout each succeeding non-signaling interval.

2. The combination with a line of a source of interrupted signaling current, means for applying said source to said line, a signal lamp and a source of direct current for lighting the same, a variable-resistance element which decreases its resistance with an increase in temperature, a closed lamp-lighting circuit including said lamp, said source of direct current, and said resistance element, the normal resistance of said element being high enough to prevent the lamp from lighting in said closed circuit, and circuit means effective when said source of interrupted current is applied to the line to heat said element and lower its resistance for causing the signal lamp to light and remain lighted throughout each succeeding non-signaling interval.

3. The combination with a line of a source of intermittent signaling current, means for applying said source to said line, a signal lamp and a source of direct current for lighting the same, a variable-resistance element which decreases its resistance with an increase in its temperature, a circuit including said lamp, said direct-current source and said variable-resistance element, a heating coil for said resistance element, and circuit means effective when said signaling source is applied to said line to energize said heating coil and heat said element sufficiently during each signaling interval to light said lamp and maintain it lighted during each succeeding non-signaling interval.

4. In combination a telephone line, a source of alternating current for signaling purposes, means for connecting said source intermittently to said line, a signal lamp and a source of direct current for lighting said lamp, a variable-resistance element connected in circuit with said lamp and said direct-current source and having a normal resistance sufficiently high to prevent the lamp from lighting in circuit therewith, a signaling bridge connected across said line, and a heating coil in said bridge energized by signaling current flowing over said line during the signaling intervals to increase the temperature of said resistance element and allow the flow of current from said direct-current source through said lamp during both the signaling and non-signaling intervals.

5. The combination with a line of a source of interrupted signaling current, means for applying said source to said line, an audible signal, a signal lamp and a source of current for lighting the same, a resistance element which decreases its resistance with an increase in its temperature, a circuit including said lamp, said second source of current, and said resistance element, the normal resistance of said element being sufficiently high to prevent the lamp from lighting, and circuit means effective when said source of interrupted current is applied to said line to operate said audible signal and to heat said resistance element to maintain the signal lamp lighted throughout each succeeding nonsignaling interval.

6. The combination with a line of a source of intermittent signaling current, means for applying said source to said line, an audible signal, a signal lamp and a source of direct current for lighting the same, a variable-resistance element which decreases its resistance with an increase in its temperature, a circuit including said lamp, said direct-current source and said variable-resistance element, a heating coil for said resistance element connected in circuit with said audible signal, and circuit means effective when said signaling source is applied to said line to operate said audible signal and to energize said heating coil and heat said element sufficiently during each signaling interval to light said lamp and maintain it lighted during each succeeding non-signaling interval.

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