April 7, 1942. G. L. KNITTLE 2,278,702

TELEPHONE CIRCUIT

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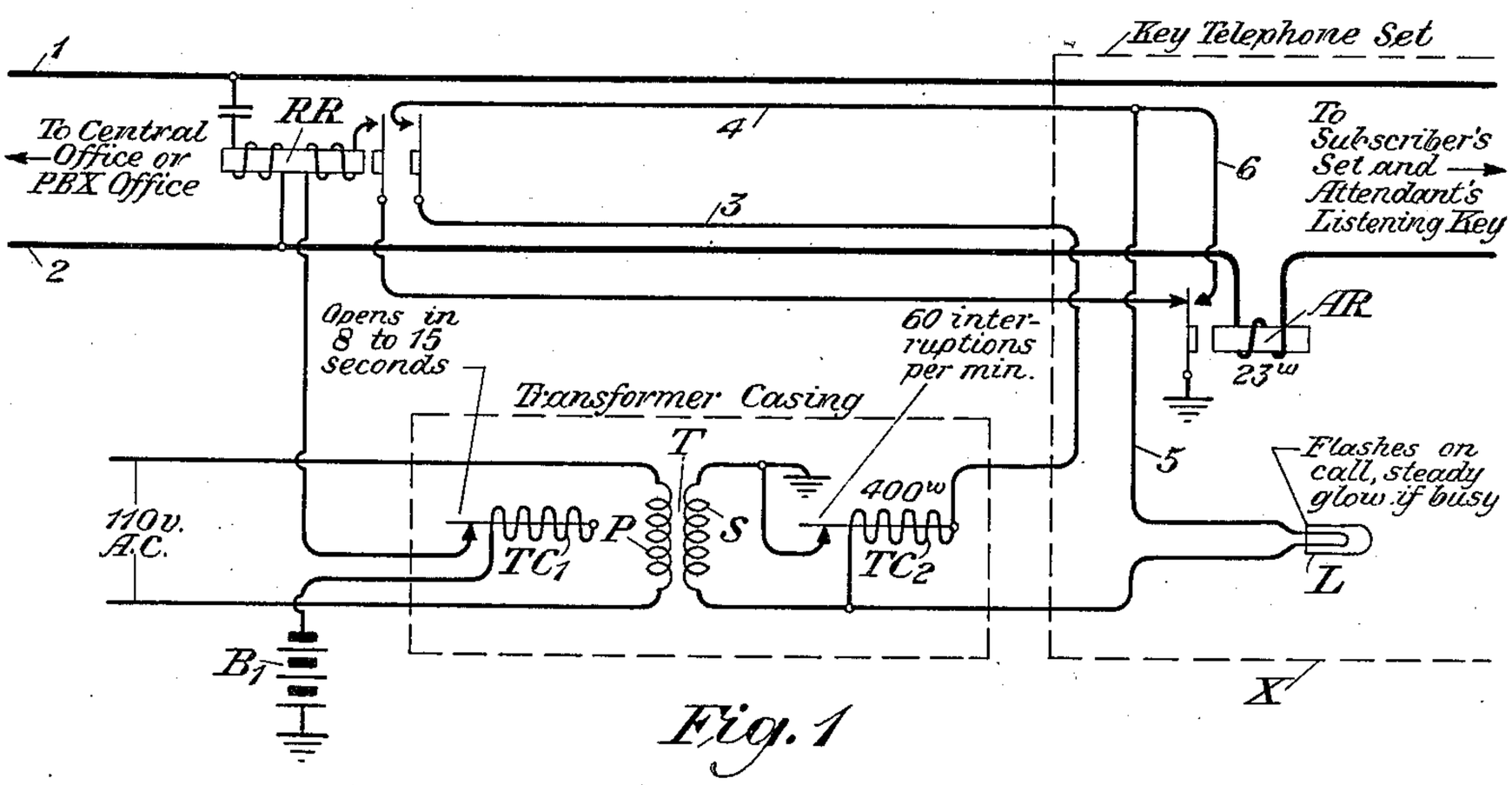

Fig. 1

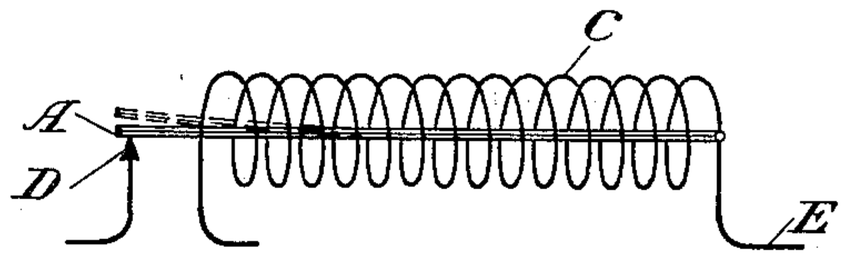

Fig. 2

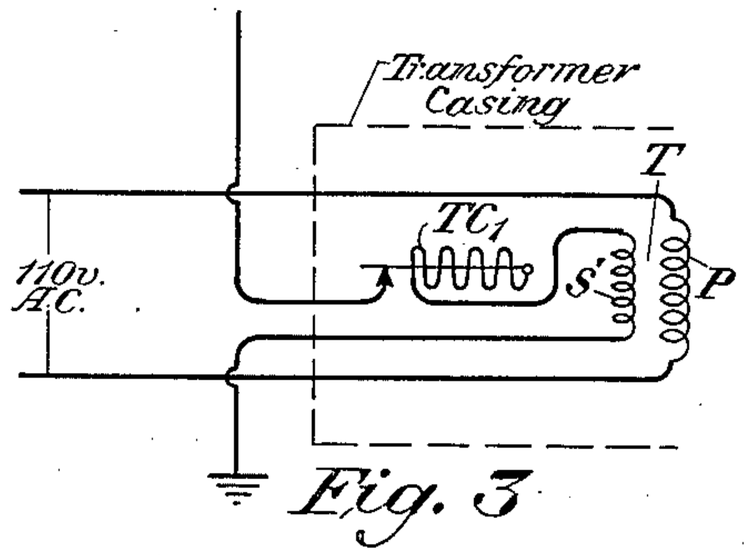

Fig. 3

Fig. 4

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TELEPHONE CIRCUIT

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This invention relates to telephone circuits, and more particularly to subscribers' circuits so arranged that an attendant may intercept the call of any one of a number of subscribers in a common locality in the absence of the subscriber.

In business offices it is a common arrangement to have the subscribers' loops of a number of subscribers in the same business organization or department thereof, or in the same physical locality, connect to a so-called key telephone set to enable an attendant to answer the call of any subscriber who may be away from his desk. In order that such service may be available, a key telephone set is provided which has a number of keys, one for each subscriber's line. A number of signal lamps are provided, likewise one for each subscriber's line. The telephone set, on the operation of the key corresponding to any line, may be connected to the line to answer a call in the place of the subscriber who is absent.

The key telephone set is associated with equipment which, in response to a ringing signal, causes the lamp associated with the particular line called to flash to apprise the attendant of the fact that a call has come in. The attendant is not supposed to answer the call unless the light continues to flash for some length of time, as would be the case when the subscriber is not at his desk. If, however, the light continues to flash, the attendant may operate the key to connect his set to the line which is being called. In order that the attendant may know when the call has been answered and, after the call has been answered, that the line is busy, the circuit is so arranged that under these conditions the signal lamp, instead of flashing, glows continuously. This action of the signal lamp takes place regardless of whether the call is answered by the attendant or by the subscriber himself.

To enable the lamp to flash it is necessary to provide an interrupting device of some sort which ordinarily consists of a train of relays so timed in their operation as to interrupt the circuit of the lamp about 60 times per minute. In addition to this interrupter the equipment is also provided with a second interrupter which performs a somewhat different function. It is desirable that the lamp shall continue to flash even after the ringing signal has ended, and for this reason the ringing relay is locked up to keep the signal lamp flashing until some one answers the call. Under certain conditions, however, particularly at night when not only the subscribers are not present but no attendant is on duty, it is undesirable that the operation of the ringing relay should keep the lamp flashing. Therefore an interrupting arrangement is provided which will interrupt the locking circuit after the expiration of some reasonable length of time such as, for example, from 8 to 15 seconds. This involves the provision of another train of relays so that all together very expensive and elaborate relay circuits are provided in order to make these interrupting devices available.

It is the purpose of the present invention to improve and simplify the apparatus of such key telephone units by using thermal contact devices to perform the interrupting functions above described. These thermal contacts may consist of bimetallic thermal elements surrounded by heating coils. When current flows through the heating coil a given length of time, the metallic element is heated with the result that due to the unequal expansion of the metals, the element is deformed so that it may either open or close the contact. By properly adjusting the value of the current, the number of turns of wire in the coil, and the design of the bimetallic element, the action of the thermal contact arrangement to either open or close the circuit may be controlled to take place within certain time limits. The use of devices of this nature will result in greatly simplifying and cheapening the equipment associated with the key telephone unit.

The invention may now be more fully understood from the following detailed description thereof when read in connection with the attached drawing in which Figure 1 shows a circuit diagram embodying the principles of the invention; Fig. 2 illustrates a thermal contact device of the type used in connection with the present invention; and Figs. 3 and 4 show modifications of the circuits of the thermal contact devices used in the arrangement of Fig. 1.

Referring to Fig. 1, numerals 1 and 2 designate the tip and ring conductors of a telephone loop incoming from a central office or a P. B. X. office to a subscriber's station. At the right the conductors 1 and 2 pass through the key telephone arrangement X to a telephone subscriber's set (not shown).

The key telephone unit is associated with a signal lamp L for the line and adapted to flash about 60 times per minute in response to a call incoming from the central office. For this purpose the lamp is controlled by a ringing relay RR. The same lamp is also used to indicate the busy condition of the circuit, after the subscriber or

attendant has answered the call, by glowing steadily. The circuit of the lamp is controlled under these conditions by an answering relay AR serially included in the conductor 2 so that it receives direct current from the central office when the subscriber's loop is closed. The attendant who has control of the key telephone unit also is provided with a key (not shown) by which her telephone set may be connected to the loop to answer the call in the absence of the subscriber.

In order to effect the flashing of the lamp L in response to the ringing signal received from the ringing relay RR, a thermal contact device TC_2 is used as an interrupter. This thermal contact device is supplied, in the arrangement shown in Fig. 1, with current from an alternating current source through a transformer T having a primary winding P and a secondary winding S associated with the thermal contact device TC_2. The circuit is so arranged that when the relay RR is actuated, the lamp L is supplied with current through the transformer T over the contact of the thermal contact device TC_2, and as the thermal contact device is so designed as to interrupt this circuit at intervals of about once per second, the lamp L of course flashes so long as this circuit is maintained by the ringing relay RR.

The thermal contact device is illustrated in more detail in Fig. 2. It consists of a bimetallic element 2 made up of two metals whose rates of expansion when heated are different. This bimetallic element is surrounded by a heating coil C and when current flows through the coil it heats up the bimetallic element and causes it to be deformed so as to open the contact D after a definite interval. In so doing it interrupts its own circuit so that current no longer flows through the coil C and the bimetallic element is allowed to cool and again close the circuit when the operation is repeated.

An alternative circuit is provided for the lamp L under the control of the answering relay AR, and when this circuit is closed the lamp is supplied with current through the transformer T over a circuit which is not interrupted by the thermal contact device TC_2. As a consequence, under these conditions the lamp glows steadily.

The ringing relay RR is provided with a locking circuit so arranged that the relay RR will be locked up and maintained energized after the ringing current ceases. This locking circuit is opened when the answering relay AR is operated and therefore the lamp ceases to flash when the call is answered but thereafter glows steadily. However, if a call comes in and no one answers the call, the lamp will continue to flash indefinitely unless means is provided to prevent it. This is a condition that may occur at night when the office is closed and no attendant is at the key telephone unit to answer the call. It is undesirable to have the lamp thus continue to flash and therefore a second interrupter of the thermal contact type is shown at TC_1. The contact controlled by this interrupter is included serially in the circuit of the locking winding of the ringing relay RR. This particular thermal contact device is designed to open its circuit after a much longer interval than the device TC_2, thus allowing the locking circuit to be maintained after the cessation of the ringing current for a period of about 8 to 15 seconds. If no one answers the call during this period, the thermal contact device TC_1 opens the locking circuit of the relay RR and restores the apparatus to normal, so that the lamp L no longer glows. In the arrangement shown in Fig. 1 the thermal contact device TC_1 is operated by direct current supplied by battery B_1, whereas the thermal contact device TC_2 is shown operated by alternating current supplied through the transformer T.

Suppose now a ringing signal is sent out from the central office. Usually such a ringing signal consists of a succession of spurts of ringing current continued at regular intervals until somebody answers the call or until the operator decides that the party is not going to answer and pulls down the connection. The first spurt of ringing current operates the left-hand winding of the relay RR and causes it to pull up its armatures. At its inner right-hand contact a locking circuit is completed from the grounded battery B_1 through the coil of the thermal contact device TC_1 and over the contact of said thermal contact device, thence through the right-hand locking winding of relay RR, over its inner front contact and over the back contact of relay RR to ground. As the thermal contact device TC_1 does not interrupt this circuit for at least 8 seconds, this locking circuit is maintained between the intervals of the spurts of ringing current and for at least 8 seconds after the expiration of the last spurt.

During the time that the ringing relay is locked up, a circuit is closed for the signal lamp L at the outer right-hand contact of relay RR. This circuit extends from the grounded side of the secondary winding S of the transformer T, over the contact of the thermal contact device TC_2, over the conductor 3, outer right-hand contact of relay RR, over the conductors 4 and 5, and thence through the signal lamp L to the opposite terminal of the secondary winding S. Alternating current is thus supplied from the A. C. source through the transformer T to the signal lamp L. It will be noted, however, that the winding of the thermal contact device TC_2 is bridged across the secondary of the transformer beyond the interrupting contact of said device so that alternating current also flows through the coil. The coil is therefore heated and after a short interval opens its contact, thereby interrupting the circuit of the lamp L and also the circuit of the coil itself. The coil now begins to cool and the thermal element closes its contact when the operation is of course repeated. The result is that the A. C. current supplied to the lamp L is interrupted about once per second due to the action of the thermal contact device and the lamp therefore flashes, indicating to the attendant at the key telephone unit that a call has come in over the line. The line lamp continues to flash without interruption until the thermal contact device TC_1 operates to open its contact and interrupt the locking circuit of relay RR about 8 seconds after the last spurt of ringing current has been received.

If the subscriber should answer before this interruption takes place, the answering relay AR will be operated to interrupt the locking circuit of the relay RR and cause it to become deenergized, thus opening the flashing circuit of the lamp L at the outer right-hand contact of the relay RR. The operation of the relay AR connects ground over its front contact, over the conductors 6 and 5, through the lamp L and thence through the secondary winding S of the transformer T to ground. This circuit, it will be noticed does not pass through the interrupt-

ing contact of the thermal contact device TC_2 and consequently the lamp now glows steadily, apprising the attendant at the key telephone unit that the call has been answered by the subscribed.

If, on the other hand, the subscriber delays answering his call until the interrupter TC_1 has come into play and unlocked the ringing relay RR, the lamp L will cease to flash and will no longer glow. If thereafter the subscriber closes his switchhook contact, thereby actuating the relay AR, relay AR will cause the lamp to glow steadily over the circuit controlled by its front contact as just described. Again the attendant at the key telephone unit is apprised of the fact that the subscriber has answered by the steady glowing of the lamp. If, however, the subscriber delays unduly in answering the call, the lamp L will cease to flash after ringing ceases and the attendant, depending upon her instructions or her judgment as to the exigencies of the situation, may come in and answer the call by throwing her key and connecting her set across the conductors 1 and 2 at the right (not shown). This will result in energizing the answering relay AR and again the lamp L will be caused to glow steadily over the circuit closed over the front contact of the answering relay AR as already described.

It will be obvious, of course, that the thermal contact device TC_1 operates to unlock the ringing relay RR and open the flashing circuit of the lamp L after a predetermined interval. This prevents alternating current being wasted through the resistance of the lamp L at night, or during other periods when the key telephone unit is unattended and calls come in which are not answered.

Thermal contact devices such as TC_1 and TC_2 being temperature-controlled devices will vary somewhat in their time of operation with changes in the temperature of the room in which they are located. Consequently on hot summer days they will operate more frequently and after a shorter interval than in colder weather. This, of course, changes the rate at which the lamp L will flash and also may change the interval during which the relay RR remains locked up after the last spurt of ringing current. It is not essential, however, that the lamp L should flash always at the same rate of speed. The essential thing is that it does flash when a call comes in. Neither is it essential that the thermal contact device TC_1 shall open the locking circuit of the ringing relay RR in exactly 8 seconds or 15 seconds or some other period of time that may be set. If, under the conditions under which it operates after the shortest period of time, it takes, for example, 8 seconds to open its contact, its operation will be satisfactory because the delay of a few more seconds in cold weather will be of little consequence. However, the operation of these thermal contact devices may be stabilized as to period of operation by enclosing them in the same casing with the transformer T. Alternating current from the power source is continuously flowing from the primary of the transformer T whether current passes through the transformer to the signal lamps or not. The result is that the transformer winding is heated to some extent and the temperature within the transformer casing is above that of the room in which it is located. The heat from the transformer therefore serves to maintain the thermal contacts at a more uniform temperature under varying weather conditions.

As shown in Fig. 1, the thermal contact device TC_1 is operated from a direct current source while the thermal contact device TC_2 is operated from an alternating current source. In actual practice, however, they may be operated by either direct or alternating current. For example, in Fig. 3 the thermal contact device TC_1 is shown with its contact and winding connected in series with the secondary winding S' of the transformer T. Therefore the circuit previously traced through the locking winding of relay RR of Fig. 1 is supplied with alternating current. The timing of the thermal contact device may be controlled by proper design to cause the actuation of the contact in the desired time under the conditions of current supply thus existing. The locking winding of the relay RR, of course, must be designed to hold up the armature of the relay when supplied with current alternating at 60 cycles or whatever rate may characterize the current supply.

Under the conditions just described, with the alternative arrangement of Fig. 3 the circuit of the thermal contact device TC_2 may be actuated by alternating current from the power source as shown by the circuit arrangement of Fig. 1. However, the thermal contact device TC_2 may also be operated by direct current if the circuit of Fig. 4 is used. Here it will be seen that the secondary winding S is omitted and the direct current battery B_2 is connected in its stead. The direct current from the battery flows over the contact of the thermal contact device TC_2 and through the winding thereof to cause the contact to open and close at the desired rate. Direct current will now be supplied through the lamp L over the circuit controlled by the left-hand front contact of the relay RR to cause the lamp L to flash in response to a call. When the call is answered the lamp L will be supplied with direct current over a circuit from ground, through the battery B_2, through lamp L, and thence over conductors 5 and 6 and the front contact of the answering relay AR to ground. As this circuit is independent of the interrupting contact of the thermal contact device TC_2 the lamp will flash continuously under these conditions.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, means responsive to a call on said line to establish a circuit for flashing said lamp, a thermal contact device including a contact in said lamp circuit and a thermal element, and means to supply alternating current over said contact to said thermal element and to said lamp, whereby said thermal element is heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash.

2. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, means responsive to a call on said line to establish a circuit for flashing said lamp, a thermal contact device including a contact in said lamp circuit and a thermal element, means to supply alternating current over said contact to said thermal element and to said

lamp, whereby said thermal element is heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, and means responsive to the answering of said call to disestablish the circuit of said lamp passing over said contact.

3. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, a ringing relay responsive to ringing current to establish a circuit for flashing said lamp, a locking circuit for said ringing relay, a thermal contact device including a contact in said lamp circuit and a thermal element heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, and means responsive to the answering of the ringing signal on said line to open said locking circuit of said ringing relay and disestablish the circuit of said lamp passing over said contact.

4. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, a ringing relay responsive to ringing current to establish a circuit for flashing said lamp, a locking circuit for said ringing relay, a thermal contact device including a contact in said lamp circuit and a thermal element, means to supply alternating current over said contact to said thermal element and to said lamp, whereby said thermal element is heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, and means responsive to the answering of the ringing signal on said line to open said locking circuit of said ringing relay and disestablish the circuit of said lamp passing over said contact.

5. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, means responsive to a call on said line to establish a circuit for flashing said lamp, a thermal contact device including a contact in said lamp circuit and a thermal element heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, and means responsive to the answering of said call to disestablish the circuit of said lamp passing over said contact and to establish a circuit for said lamp independent of said contact so that said lamp will glow steadily to indicate that the call has been answered.

6. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, means responsive to a call on said line to establish a circuit for flashing said lamp, a thermal contact device including a contact in said lamp circuit and a thermal element, means to supply alternating current over said contact to said thermal element and to said lamp, whereby said thermal element is heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, and means responsive to the answering of said call to disestablish the circuit of said lamp passing over said contact and to establish a circuit for said lamp independent of said contact so that said lamp will glow steadily to indicate that the call has been answered.

7. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, a ringing relay responsive to ringing current to establish a circuit for flashing said lamp, a locking circuit for said ringing relay, a thermal contact device including a contact in said lamp circuit and a thermal element heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, and means responsive to the answering of the ringing signal on said line to open said locking circuit of said ringing relay and disestablish the circuit of said lamp passing over said contact and to establish a circuit for said lamp independent of said contact so that said lamp will glow steadily to indicate that the call has been answered.

8. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, a ringing relay responsive to ringing current to establish a circuit for flashing said lamp, a locking circuit for said ringing relay, a thermal contact device including a contact in said lamp circuit and a thermal element, means to supply alternating current over said contact to said thermal element and to said lamp, whereby said thermal element is heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, and means responsive to the answering of the ringing signal on said line to open said locking circuit of said ringing relay and disestablish the circuit of said lamp passing over said contact and to establish a circuit for said lamp independent of said contact so that said lamp will glow steadily to indicate that the call has been answered.

9. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, means responsive to a call on said line to establish a circuit for flashing said lamp, a thermal contact device including a contact in said lamp circuit and a thermal element heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, and a second thermal contact device to operate after a predetermined interval to disestablish the circuit of said lamp passing over the contact of said first thermal contact device.

10. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, means responsive to a call on said line to establish a circuit for flashing said lamp, a thermal contact device including a contact in said lamp circuit and a thermal element, means to supply alternating current over said contact to said thermal element and to said lamp, whereby said thermal element is heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, and a second thermal contact device to operate after a predetermined interval to disestablish the circuit of said lamp passing over the contact of said first thermal contact device.

11. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, a ringing relay responsive to ringing current to establish a circuit for flashing said lamp, a locking circuit for said ringing relay, a thermal contact device including a contact in said lamp circuit and a thermal element heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, means responsive to the answering of the ringing signal on said line to open said locking circuit of said ringing relay and disestablish the circuit of said lamp passing over said contact, and a second thermal contact device including a thermal element and contact controlled thereby in said locking circuit, to operate after a predetermined interval to disestablish

said locking circuit and thereby disestablish the circuit of said lamp passing over the contact of said first thermal contact device.

12. In a telephone system, a subscriber's line arranged for the interception of a call by an attendant, a signal lamp, a ringing relay responsive to ringing current to establish a circuit for flashing said lamp, a locking circuit for said ringing relay, a thermal contact device including a contact in said lamp circuit and a thermal element, means to supply alternating current over said contact to said thermal element and to said lamp, whereby said thermal element is heated by current passing over said contact to open and close said contact and thereby cause said lamp to flash, means responsive to the answering of the ringing signal on said line to open said locking circuit of said ringing relay and disestablish the circuit of said lamp passing over said contact, and a second thermal contact device including a thermal element and contact controlled thereby in said locking circuit, to operate after a predetermined interval to disestablish said locking circuit and thereby disestablish the circuit of said lamp passing over the contact of said first thermal contact device.

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