

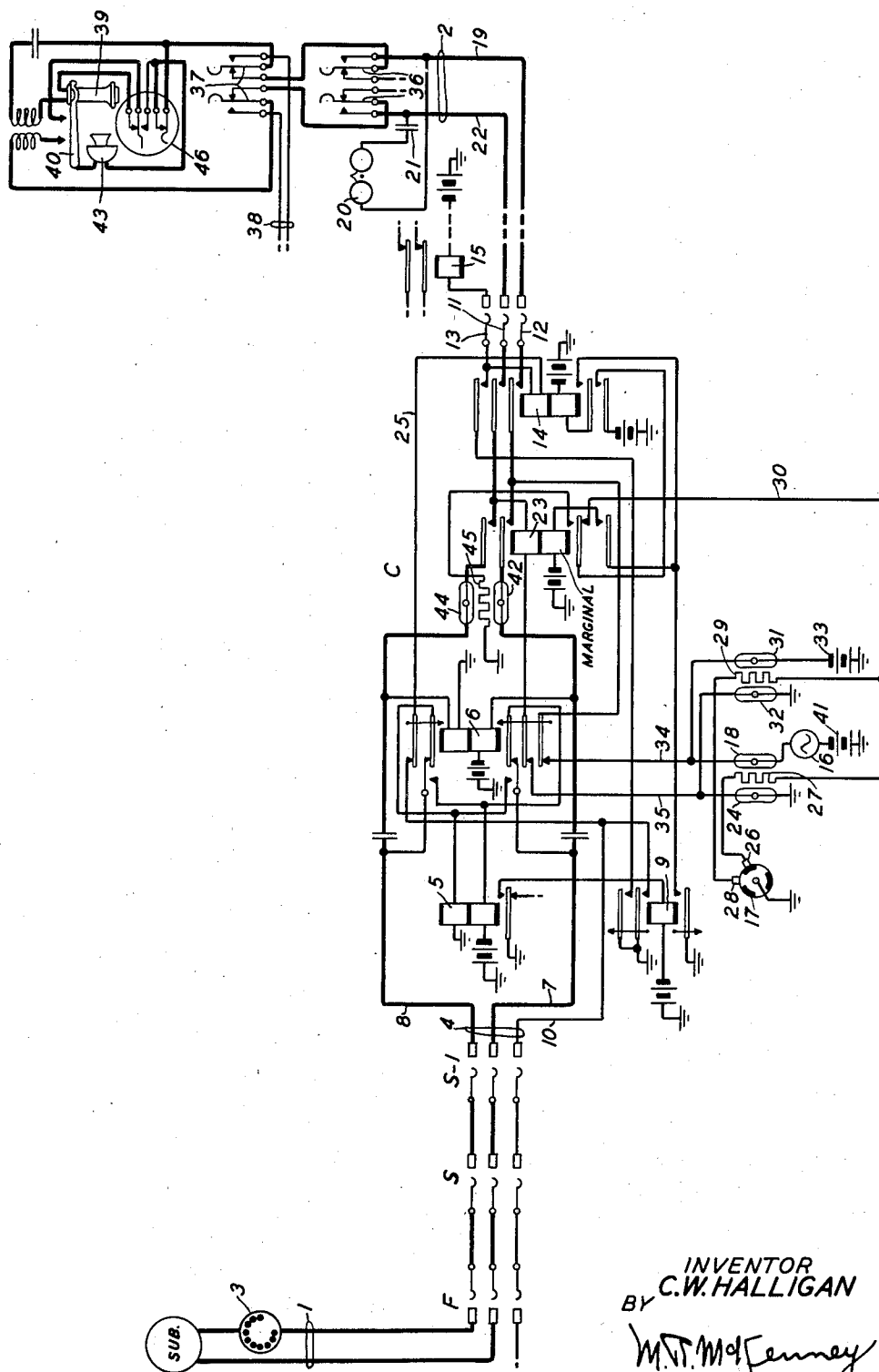
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SIGNALING SYSTEM

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SIGNALING SYSTEM

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

The object of the invention is to reduce the magnitude of shocks, surges, or other undue disturbances in signaling systems caused by the opening and closing of the signaling circuits.

Numerous arrangements have been proposed heretofore for preventing detrimental effects, such as acoustic shock, in communication circuits as a result of current surges which may occur either from some abnormal condition in the system or from some normal circuit-controlling operation.

According to the present invention, improvements of this character are secured, particularly where ringing currents are utilized for signaling purposes, by means of a system in which the intensity of the ringing current is increased gradually at the beginning and is decreased gradually at the end of each signaling period; and in which current from the source, applied between ringing periods to trip the ringing operation when the subscriber answers, is likewise gradually increased at the beginning and gradually decreased in intensity at the end of each interval during which this source is connected to the line. This is accomplished by inserting variable-resistance elements in circuit with the ringing source and in circuit with the source of tripping current. The resistance of these elements at normal temperature is sufficiently high to prevent the flow of current over the signaling circuit. But, by increasing their temperature with heating devices, a large and gradual reduction is effected in their resistance value. By this means the intensity of the ringing current is made to increase gradually at the beginning of each ringing interval, and, similarly, the tripping current is gradually increased in value at the commencement of each silent interval. Likewise the current intensity is gradually reduced at the end of each ringing and silent interval by causing the resistance elements to cool and to assume again their normally high resistance values.

Another feature of the invention is a circuit arrangement in which the intensity of either the ringing current or the tripping current is gradually reduced, in response to the called party in answering the call, to a minimum value before the circuit over which it is applied is finally disconnected from the line.

A further feature is a circuit arrangement in which the ringing current is gradually diminished

preceding its removal from the line, and in which a source of talking current is connected to the line immediately upon the removal of the ringing current source, the intensity of the talking current being gradually increased to its full value following its application to the line.

These and other features of the invention will be described in detail in the following specification.

The drawing accompanying the specification illustrates the invention applied to a connector switch in an automatic telephone system.

The line finder F and selectors S and S—1 are illustrated diagrammatically in the drawing. The connector switch C is shown only in sufficient detail to enable an understanding of the present invention. The finder and selector switches and the connector switch may be switches of any well-known type, such as those used in step-by-step systems. For a detailed description of the operation of a connector switch similar to the one illustrated herein, reference is made to the patent to Stokely, No. 1,868,296 of July 19, 1932.

The variable resistance elements shown in the circuits of connector switch C, which will be described in detail hereinafter, may be of any suitable type. Preferably these resistance elements are made of some material, such as boron, silver sulphide or uranium oxide, having a large negative temperature coefficient of resistance. Units of this general class are shown in the British Patent No. 472,144, accepted Sept. 17, 1937.

The invention has been illustrated in connection with the final or connector switch in a dial telephone system. It may, of course, be applied to other kinds of switches, and it may also be used in connection with manual telephone systems and also in other types of communication and signaling systems.

A detailed description of the system will now be given. For this purpose assume that the subscriber of line 1 wishes to call the subscriber of line 2. When the call is initiated, the line finder switch F is set in motion to seize the terminals of the calling line 1. Thereupon the calling subscriber manipulates his dial 3 to operate the selector switch S and the selector switch S—1 to seize a trunk, such as the trunk 4, leading to an idle connector switch C which has access to the called subscriber's line 2.

Upon the seizure of the connector switch C a circuit is closed from battery through the lower winding of the impulse relay 5, lower inner normal contacts of relay 6, ring conductor 7, thence

over the ring side of the connection through selectors S—1 and S and finder F over the loop of the calling line 1 and returning over the tip side of the connection to conductor 8, inner upper normal contact of relay 6 through the upper winding of relay 5 to ground. The impulse relay 5 operates and closes a circuit for operating the slow-release relay 9. Relay 9 places ground potential on conductor 10 to guard the trunk 4 from seizure by other selector switches. The calling subscriber, continuing to dial, transmits the tens series of impulses, and the connector switch C is stepped in the well-known manner to the corresponding level of line terminals. Finally he transmits the units series of impulses, and the connector advances its brushes 11, 12 and 13 over the terminals of the selected level to the terminals of the wanted subscriber's line 2. The called line is tested, and, if idle, a circuit is prepared as follows for the operation of relay 14: Battery, through the winding of the cut-off relay 15, over the sleeve brush 13, upper winding of relay 14, conductor 25, upper back contact of relay 6 to ground at the contact of relay 9. Relay 14 operates and locks in a circuit from battery through its lower winding and inner lower contact to ground through a contact of relay 9.

As mentioned hereinbefore, some of the detailed operating circuits of the connector switch C have been omitted. It will also be noted that other circuits are shown partially. Wherever circuits are omitted or shown only in part it is to be understood that these circuits may be the same as those shown in numerous patents in the prior art, one of which is Stokely Patent 1,868,296, referred to above.

Relay 14 in operating prepares the connector for ringing the called subscriber's line. The ringing circuit may be traced from battery 41, through the ringing generator 16, variable resistance unit 18, conductor 34, lower back contact of relay 6, upper inner contact of relay 14, brush 12, conductor 19, through the substation ringer 20, condenser 21, conductor 22, brush 11, upper middle contact of relay 14, upper winding of relay 23, middle lower contact of relay 6, conductor 35, variable resistance unit 24 to ground. At the time this ringing circuit is closed the elements 18 and 24 are at their normal temperatures, in case the brush 26 is on an insulating segment of the interrupter 17. This is true because the circuit of the heating coil 27, which heats both resistors 18 and 24, is open, although the circuit for this coil is otherwise closed through the inner lower back contact of relay 23 and the lower closed contact of relay 14. The normal resistance of elements 18 and 24 is so high that no ringing current flows over the line at this time. As soon thereafter as the interrupter 17 advances the next conducting segment into engagement with the brush 26, the heating winding 27 is energized, and the temperature of elements 18 and 24 rises. This is accompanied by a corresponding gradual decrease in their resistance, resulting in the gradual increase of the intensity of the ringing current over the called line 2. As the ringing current reaches its full intensity, the bell 20 is sounded at the subscriber's station. The interrupter 17 continues to rotate and, after an interval, advances the next insulating segment into engagement with the brush 26. The heating coil 27 becomes currentless, and the elements 18 and 24 gradually increase their resistance, in turn gradually decreasing the intensity

of the ringing current in the line 2. As the elements 18 and 24 reach their high resistance value, the bell ceases to ring, thus measuring the first ringing period. At the same time, or shortly after the brush 26 engages an insulating segment, the associated brush 28 engages a conducting segment of the interrupter 17. A circuit is thereby closed from ground through the brush 28, heating coil 29, conductor 30 to battery at the lower closed contact of relay 14. The coil 29 heats the resistance units 31 and 32 to lower their resistance. As the resistance of these units lowers, current from the tripping source 33 flows in increasing intensity over the subscriber's line. The circuit for the tripping battery 33 may be traced from the live pole of said battery through the element 31, conductor 34 thence as previously traced over the subscriber's line and returning through conductor 35 through the element 32 to the grounded pole of battery. Current from the tripping battery 33 continues to flow over the line during the silent interval for the well-known purpose of operating the tripping relay 23 in the event the called party answers during this silent interval. If the called party does not answer at this time, the interrupter 17 soon advances the next insulating segment into engagement with the brush 28. This deenergizes the coil 29, and elements 31 and 32 restore to their high-resistance value, causing a corresponding decrease in the intensity of the current from the tripping source 33. At about this time the brush 26 encounters the next conducting segment, and coil 27 is reenergized to cause the beginning of the next ringing period. This procedure continues, and the subscriber's bell 20 is rung intermittently until he answers.

The line 2 is shown extending to a subscriber's station equipped with keys which serve to connect the telephone instrument to any one of a number of lines, including the lines 2 and 38. The key 36 serves to connect the instrument to the line 2, the key 37 connects the instrument to line 38, and other keys may be provided for other lines. To answer a call on any one of the lines, the subscriber removes his receiver 39 from the switchhook 40 and operates the key individual to such line. In so doing he may have the receiver 39 at his ear before the key is operated, in which case any surges of current, if these were permitted to be present in the line, would flow into the instrument and cause excessive acoustic shock. In some cases the receiver may be of the headset type, making it particularly desirable to avoid as much as possible abnormal currents in the line.

Returning to the ringing operation, when the subscriber of line 2 responds to the ringing of his bell 20 by removing the receiver 39 and operating the key 36, a low-impedance circuit is closed across the line at the substation. If this occurs during the ringing interval, the increase in current from the battery 41 and generator 16 caused by the closure of the low-impedance bridge at the substation is sufficient to operate the marginal ringing-trip relay 23. Relay 23 in operating locks through its lower winding and lower front contact to ground at the contact of relay 9. Relay 23 at its inner lower contact opens the circuit over conductor 30 for the heating coils 27 and 29. Coil 27 thereupon deenergizes, and elements 18 and 24 gradually resume their high-resistance state, and the intensity of the ringing current decreases accordingly.

Relay 23 also extends the closed loop of the

called line 2 through to the windings of the current supply relay 6. The circuit for this purpose may be traced from battery through the lower winding of relay 6, variable resistance element 42, inner upper contacts of relays 23 and 14, brush 12, thence over conductor 19 of the line 2, contacts of keys 36 and 37 and dial 46, through the transmitter 43 and switchhook contacts 40, contacts of keys 37 and 36, and returning over the other conductor 22 of the line 2, brush 11, through the middle upper contact of relay 14, uppermost contact of relay 23, variable resistance element 44 and the upper winding of relay 6 to ground. Relay 23 in operating also closes a circuit through its inner lower front contact for the heating coil 45 of the elements 42 and 44. The elements 42 and 44 gradually reduce their resistance and the intensity of the current flowing through the winding of relay 6 over the subscriber's line is gradually increased until it reaches its full value. The relay 6 is made somewhat slow in operating for the purpose of measuring an appreciable interval between the time relay 23 operates to de-energize the heating coil 27 and the time the lowermost contacts of relay 6 are opened to disconnect the ringing source 16 from the subscriber's line 2. During this interval the elements 18 and 24 increase their resistance as above explained so that the flow of ringing current over the line has substantially ceased before the ringing source is disconnected therefrom.

Should the called subscriber respond to the ringing of his bell 20 during one of the silent intervals, the increased flow of current from the tripping source 33, caused by the closure of the low resistance bridge at the substation, results similarly in the operation of the marginal trip relay 23. Relay 23 performs the same functions above described, and the tripping source of current is gradually reduced in intensity before it is finally disconnected from the line, and the talking current supply through the relay 6 is gradually increased to its full intensity by the resistance elements 42 and 44.

After the subscribers have finished their conversation, the equipment is released in the usual manner by the replacement of the receivers at the substations.

With the arrangement disclosed herein a subscriber's line is protected from current surges that might otherwise be caused either by the source of ringing current, by the source of current for tripping the ringing operation, or by the application of the talking current source to the line after the ringing operation has been completed.

What is claimed is:

1. The combination with a line of a source of ringing current, a supply circuit for connecting said source of current to said line, a variable-resistance element in said supply circuit having a normal resistance sufficiently high to prevent the flow of ringing current to said line, and automatic means operating periodically to cause a gradual reduction in the resistance of said element to permit a corresponding gradual increase in the flow of ringing current from said source over said line.

2. The combination with a line of a source of ringing current, a supply circuit for connecting said source of current to said line, variable-resistance elements in said supply circuit having a normal resistance sufficiently high to prevent the

flow of ringing current to said line, and automatic means operating periodically first to cause a gradual reduction in the resistance of said elements to permit the flow of ringing current in increasing intensity over said line and then to cause the gradual increase in the resistance of said elements to discontinue gradually the flow of ringing current over said line.

3. The combination with a telephone line of a source of ringing current, a supply circuit for connecting said source to said line, a thermosensitive element in said supply circuit having a normal resistance sufficiently high to prevent the flow of current over said supply circuit to said line, a heating device for raising the temperature of said element to produce a corresponding reduction in its resistance, and periodic means for energizing said heating coil to cause the periodic flow of ringing current in said line, the intensity of the ringing current being gradually increased at the beginning of each period.

4. The combination with a telephone line of a source of ringing current, means for connecting said source to said line, tripping means for causing the disconnection of said source from said line, a source of current for operating said tripping means, variable-resistance elements in circuit with said ringing source and said tripping source and having a normal resistance sufficient to prevent the flow of current from either of said sources over said line, and periodic means for causing a gradual variation in the resistance of said elements to cause alternate periods of current flow in said line from said ringing source and from said tripping source, the intensity of the current flow increasing gradually at the beginning and decreasing gradually at the end of each of said periods.

5. The combination with a telephone line of a source of ringing current, means for connecting said source to said line, tripping means for causing the disconnection of said ringing source from said line, a circuit closed when the called party responds for operating said tripping means, and variable-resistance means responsive to the operation of said tripping means for automatically reducing the intensity of the ringing current in said line before said ringing current source is disconnected therefrom.

6. The combination with a telephone line of a source of ringing current, circuit means for connecting said source to said line, a source of talking current for said line, variable-resistance elements in circuit with said ringing source and having a normal resistance sufficient to prevent the flow of ringing current over said line, variable resistance elements in circuit with said talking source and having a normal resistance sufficiently high to prevent the flow of current from said talking source, periodic means for controlling said first-mentioned elements to cause the flow of ringing current in said line periodically, and means effective when the called party responds for controlling said first-mentioned elements to cause a gradual reduction in the intensity of the ringing current, to disconnect said ringing source from said line, to cause the connection of said talking source to said line, and to control the second-mentioned resistance elements to cause a gradual increase in the intensity of the talking current flowing in said line.

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