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TELEPHONE SYSTEM

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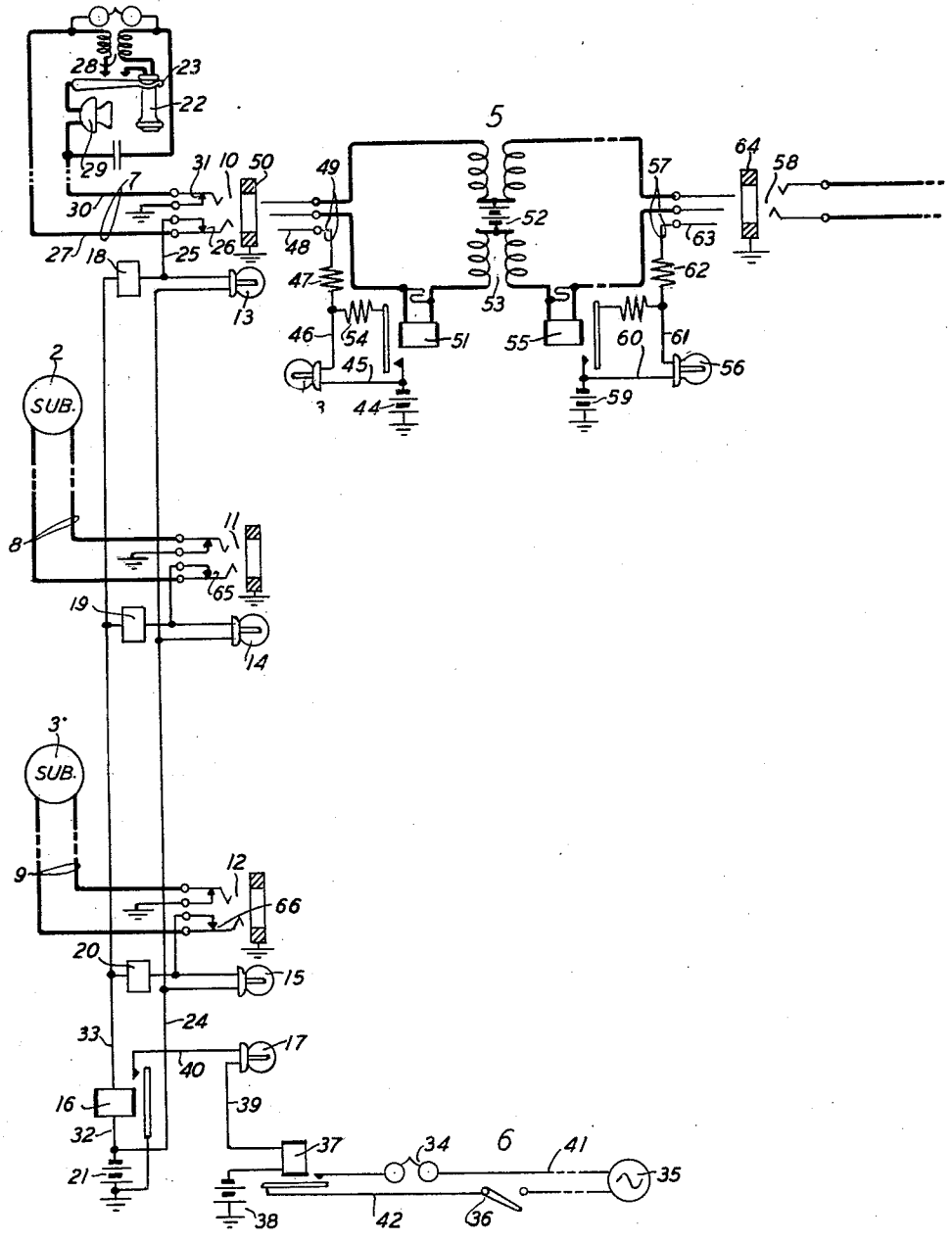


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# UNITED STATES PATENT OFFICE

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## TELEPHONE SYSTEM

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This invention relates to telephone systems and more particularly to the central office equipment therefor.

It has been the usual practice in telephone systems to provide, in connection with each subscriber's line circuit terminating in a central office switchboard, a line relay which operates to close a circuit to a line lamp individual to the subscriber's line when a subscriber makes a call. An auxiliary or pilot relay common to a group of subscribers' lines is also provided to close a circuit to a pilot signal lamp whenever a call is made by a subscriber in that particular group. Heretofore when efforts have been made to dispense with the line relays by connecting the line lamp directly to the line in order to reduce the cost of the system, it has been found that the combined leakage currents in a group of subscribers' lines have been sufficient to cause operation of the pilot relay. Operation of the pilot relay by these line leakage currents results in the lighting of the pilot lamp and hence a false signal.

An object of the invention, therefore, is to prevent false operation of the auxiliary or pilot relays from leakage currents in such subscribers' line circuits having series line lamps.

A feature of the invention, whereby the foregoing object is attained resides in connecting an individual resistance element or device, having the characteristic of decreasing in resistance in greater than direct proportion to an increase in applied potential, in parallel with each series line lamp and through the auxiliary or pilot relay common to a group of lines to a source of electrical energy. Line leakages will cause insufficient current through the devices and relay in series with them to operate the relay. When a lamp is energized by the closing of its circuit, however, the potential drop across the resistance devices becomes great enough to cause its resistance decrease and a current sufficient to operate the relay results.

More specifically a resistance device whose resistance decreases in greater than direct proportion to the applied potential across its terminals, for example, an element of thyrite, is connected between the ungrounded side of each subscriber's line and the common auxiliary or pilot relay which, in turn, is connected to battery. The resistance of these devices prevents the flow of leakage currents through the relay. Upon the positive grounding of a line in response to the removal of the subscriber's receiver from its switchhook, the line lamp, which is also connected to the line, is lighted. The potential drop across the hot lamp filament is impressed across the resistance device connected to the line and causes its resistance to decrease to a point where the current flow is sufficient to operate the pilot relay.

To more completely describe this invention, reference will now be made to the drawing in which the invention is shown applied to a common battery manual telephone system.

In the figure, 1, 2 and 3 represents three separate substations forming a group of substations terminating in a central office switchboard 4. 5 represents the cord circuit for connecting a subscriber's line to another subscriber's line in the system and 6 represents an alarm system which may be employed, for instance, as a night alarm to indicate an incoming call when a central operator is not in attendance at the board, or when there is no operator at the particular position in which the group of subscribers' lines is located.

The operator's telephone equipment and circuit associated with the cord circuit has not been shown in the drawing because the operation and utility of such equipment is well known and the showing of such equipment is not necessary to a full understanding of this invention.

The subscriber's line circuits 7, 8 and 9 of the substations 1, 2 and 3, respectively, terminate at the central office switchboard 4 in the respective jacks 10, 11 and 12. Connected directly to jack 10 is a line signal lamp 13; connected directly to jack 11 in line signal lamp 14 and likewise to jack 12 is connected line signal lamp 15. The line signal lamps 13, 14 and 15 have a filament which increases in resistance with temperature or current flow.

Tungsten filament lamps have this characteristic and may be used for these line lamps.

Common to the group of subscribers' lines represented by the substations 1, 2 and 3 is pilot relay 16 which operates to close a circuit to pilot lamp 17 whenever a call comes in from a substation in the group. To prevent operation of the pilot relay 16 by leakage currents in the lines of the group, the resistance devices 18, 19 and 20 are provided. The resistance devices 18, 19 and 20 are connected to battery 21 through the winding of pilot relay 16 and have the characteristic of decreasing in resistance in greater than direct proportion to an increase in potential applied. Thyrite, for instance, has this characteristic and blocks of this material I have found are adaptable for the purpose. Resistance device 18 is connected directly to jack 10 and in shunt of line lamp 13, is connected to battery 21 through the winding of pilot relay 16. Resistance device 19 is connected directly to jack 11 and in shunt of line lamp 14, is connected through the winding of pilot relay 16 to battery 21. Resistance device 20 is connected in shunt of line lamp 15 directly to jack 12 and through the winding of pilot relay 16 to battery 21.

Assuming that a call is made by the subscriber at substation 1; when the substation loop is closed by the subscriber lifting the receiver 22 off the hook 23, the line lamp 13 at the central office is lighted to indicate to the central office operator the incoming call. The circuit for energization of line lamp 13 is as follows: ground, battery 21, conductor 24, line lamp 13, conductor 25, contact 26, ring contact of jack 10, conductor 27, left-hand side of inductance coil 28, switchhook 23, transmitter 29, conductor 30, tip contact of jack 10, contact 31 to ground. As the filament in the line lamp 13 heats up, the resistance of the lamp increases. With increase in the line lamp resistance, increased potential is applied to the resistance device 18 to cause operation of pilot relay 16. Resistance device 18, as has been said before, has the characteristic of decreasing in resistance in greater than direct proportion to an increase in potential applied. Therefore, as the potential applied increases, the resistance in the device 18 decreases in greater than direct proportion to the increase in potential applied. An increase in current flow to the pilot relay 16 takes place. The circuit for energization of pilot relay 16 may be traced as follows: ground, battery 21, conductor 32, winding of pilot relay 16, conductor 33, resistance device 18, conductor 25, contact 26, ring contact of jack 10, conductor 27, left-hand side of inductance coil 28, switchhook 23, transmitter 29, conductor 30, tip contact of jack 10, contact 31 to ground.

Pilot relay 16 upon becoming energized closes a circuit to pilot lamp 17 which thereupon becomes lighted to indicate to an attendant at the switchboard an incoming call from one of the subscribers in that particular group.

When a central office operator answers a call by plugging into the jack of the calling line with the cord circuit 5, which in this instance would be jack 10, the tip and ring contacts of jack 10 are separated from the contacts 26 and 31. This disconnects the line lamp 13 and the pilot relay 16 from the subscriber's line circuit causing extinguishment of the line lamp 13 and deenergization of the pilot relay 16 with consequent opening of the circuit to the pilot lamp 17.

The alarm system 6 comprises an alarm signal 34, a source of energy therefor which may be, for instance, an alternating current generator 35 and a switch 36. When the alarm system 6 is to be used to indicate an incoming call, switch 36 is closed. Closing of a subscriber's loop circuit in the group served by the alarm system 6 will, in addition to causing lighting of the line lamp, energization of the pilot relay 16 and lighting of the pilot lamp 17, cause energization of the alarm relay 37. The circuit for the alarm relay 37 may be traced as follows: ground, battery 38, winding of alarm relay 37, conductor 39, pilot lamp 17, conductor 40, front contact and armature of pilot relay 16 to ground. Alarm relay 37 upon becoming energized will close the circuit of the alarm system 6. The alarm signal 34 is operated over the following circuit: alternating current generator 35, conductor 41, alarm signal 34, front contact and armature of alarm relay 37, conductor 42, closed switch 36 to the generator 35.

When in answer to an incoming call the operator at the central station plugs into the jack of the calling substation with the cord circuit 5, answering supervisory lamp 43 is lighted. The circuit for lighting of the answering supervisory lamp 43 may be traced as follows: ground, battery 44, conductor 45, answering supervisory lamp 43, conductor 46, resistance 47, sleeve contact 48 of the answering plug 49, sleeve 50 of the jack of the calling line to ground. When the answering plug 49 is fully inserted into the jack of the calling line, answering supervisory relay 51 becomes energized and causes shunting of the answering supervisory lamp 43. Answering supervisory relay 51 remains energized until the calling subscriber opens the subscriber's line circuit again. The circuit for energization of the answering supervisory relay 51 is as follows: common battery 52, lower left-hand winding of repeating coil 53, winding of answering supervisory relay 51, ring contact of the answering plug 49, ring contact of the jack of the calling subscriber's line circuit, through the calling subscriber's loop, tip contact of the jack of the

calling subscriber's line circuit, tip contact of the answering plug 49, upper left-hand winding of the repeating coil 53, to the other side of the common battery 52. When the answering supervisory relay 51 is energized, the answering supervisory lamp 43 is shunted by way of the front contact and armature of answering supervisory relay 51 and resistance 54. The current flow through the lamp 43 is thereby reduced to such an extent as to cause extinguishment of the lamp. Opening of the subscriber's loop circuit will cause deenergization of answering supervisory relay 51 and removal of the shunt from the answering supervisory lamp 43. The lamp 43 will then again be lighted to indicate to the operator at the central office that the calling subscriber's loop circuit has been opened and the call has been terminated. The calling end of the cord circuit has been shown as including a calling supervisory relay 55, a calling supervisory lamp 56 and the calling plug 57. A jack 58 representing a subscriber's line circuit terminating in the central office switchboard has also been included in the drawing. The jack 58 represents the termination in the central office switchboard of the line circuit of a called line. Insertion of the calling plug 57 into the jack 58 of the called line will result in lighting of the calling supervisory lamp 56. The circuit for the calling supervisory lamp 56 is as follows: ground, battery 59, conductor 60, calling supervisory lamp 56, conductor 61, resistance 62, sleeve contact 63 of calling plug 57, sleeve 64 of jack 58 to ground. The called party upon answering will cause closing of the called subscriber's loop circuit and energization of the calling supervisory relay 55. The calling supervisory relay 55 upon being energized will place a shunt around the calling supervisory lamp 56. When the called party opens the loop circuit of the called line, the calling supervisory relay 55 will be deenergized, the shunt around the calling supervisory lamp will be removed and the calling supervisory lamp 56 will be lighted again to indicate to the operator at the central office that the called subscriber no longer desires the called connection.

The equipment at substations 2 and 3 is identical with that shown in substation 1 and requires no further description. The resistance device 19 connected through the contact 65 to the ring contact of jack 11 of the subscriber's line circuit from substation 2 prevents leakage current in the substation line from affecting the pilot relay 16. Likewise the resistance block 20 which is connected through contact 66 to the ring contact of jack 12 of the subscriber's line circuit from substation 3 and through the winding of pilot relay 16 to the battery 21 prevents leakage current in the substation line circuit from substation 3 from affecting the pilot relay 16.

If the loop circuit of substation 2 is closed, the line lamp 14 is lighted. The resistance in the line lamp 14 increases and increased potential is applied to the resistance device 19. The resistance in the device 19 decreases in greater than direct proportion to the increased potential applied and the current flow through the pilot relay 16 increases to such an extent as to cause operation of the pilot relay 16. Pilot relay 16 in operating closes the circuit of pilot lamp 17. The lighting of the pilot lamp 17 indicates an incoming call in the group of subscribers' lines served by the pilot relay 16 and the lighting of the line lamp 14 indicates that the call has come in from substation 2.

A call coming in from substation 3 causes lighting of the line lamp 15, increase in the resistance in this lamp, a decrease in resistance in the resistance device 20, and operation of the pilot relay 16.

The normal low resistance of each line lamp allows operation of the line lamp when a subscriber's loop circuit served by the line lamp is closed. The normal high resistance of each of the resistance devices 18, 19 and 20 prevents operation of the pilot relay 16 by leakage current in a subscriber's line circuit. Each resistance device, therefore, blocks off from the pilot relay 16 any leakage current in the particular subscriber's line circuit to which the block is connected. The pilot relay 16, therefore, cannot be operated by leakage current in any particular subscriber's line circuit, nor by combined leakage currents from the group of subscriber's line circuits served by the pilot relay.

While elements of thyrite have been suggested for the resistance devices 18, 19 and 20 and tungsten for the filaments of the line lamps 13, 14 and 15, other devices or materials having the same relative resistance characteristics described, may be used in place thereof without departing from the spirit of this invention.

What is claimed is:

1. A telephone system comprising a substation, a central station, a line circuit connecting said stations, a line signal connected to said line circuit, and a source of energizing current, a relay connected to said source of current and said line circuit in parallel with said line signal, and a resistance element connected in series with said relay to protect the relay against operation by leakage currents in said line circuit.

2. A telephone system comprising a substation, a central station, a line circuit connecting said stations, a line signal connected to said line circuit, and a source of energizing current, a relay connected to said source of current and said line circuit in parallel with said line signal, and a resistance device connected in series with said relay to pro-

tect the relay against operation by leakage currents in said line circuit.

3. A telephone system comprising substations, a central station, line circuits connecting the substations and the central station, a source of energizing current for the system, a line lamp connected to each line circuit and said source of current, a relay common to a group of substations, and a resistance element connected to each substation line and to said source of current through said relay to protect said relay against operation by leakage currents in said line circuits.

4. A telephone system comprising substations, a central station, line circuits connecting the substations and the central station, a source of energizing current for the system, a line lamp connected to each line circuit and said source of current, a relay common to a group of substations, and a resistance device connected to each substation line and to said source of current through said relay to protect said relay against operation by leakage currents in said line circuits.

5. A telephone system comprising substations, a central station, line circuits connecting the substations to the central station, a source of energy for the system, a line lamp connected to each line circuit and to the source of energy, a relay common to a group of line circuits connected to the source of energy and to each line circuit in the group, and an element of resistance material connected to each line circuit in the group and in series with said common relay to prevent operation of said relay by leakage currents in the line circuits, each of said line lamps having a filament, the resistance of which increases with current flow to the lamp, and each of said elements of resistance material having the characteristic of decreasing in resistance in greater than direct proportion to an increase in applied potential, each element of resistance material being in parallel with the corresponding line lamp and permitting increase in current flow around the line lamp and through said common relay when the line lamp resistance increases.

6. A telephone system comprising substations, a central station, line circuits connecting the substations to the central station, a source of energy for the system, a line lamp connected to each line circuit and to the source of energy, a relay common to a group of line circuits connected to the source of energy and to each line circuit in the group, and a resistance device connected to each line circuit in the group and in series with said common relay to prevent operation of said relay by leakage currents in the line circuits, each of said line lamps having a filament, the resistance of which increases with current flow to the lamp, and each of said devices having the characteristic of decreasing in resistance in greater than direct proportion to an increase in applied potential, each device being in parallel with the corresponding line lamp and permitting increase in current flow around the line lamp and through said common relay when the line lamp resistance increases.

7. A telephone system comprising a group of substations, a central station, line circuits connecting the substations to the central station, a source of energy for the system, a relay common to the group of substations connected to the source of energy and to each line circuit in the group, a tungsten filament line lamp connected to each line circuit and to the source of energy in shunt of said common relay, and a resistance block connected to each line circuit in parallel with a corresponding tungsten filament lamp and connected to the source of energy through the winding of said common relay, said resistance block having the characteristic of decreasing in resistance in greater than direct proportion to an increase in applied potential, said resistance block preventing operation of said common relay by leakage currents in the lines but allowing operation of said common relay when the resistance in a line lamp increases.

8. In a telephone system including a group of line circuits, a source of energy for the system and a relay common to the group, an element of resistance material connected to each line circuit and to the source of energy through the winding of the common relay to prevent operation of the common relay by leakage currents in the lines, said element of resistance material having the characteristic of decreasing in resistance in greater than direct proportion to an increase in applied potential and permitting operation of said common relay when a line circuit is closed.

In witness whereof, I hereunto subscribe my name this 25th day of November, 1931.

LANGFORD J. BOWNE.