

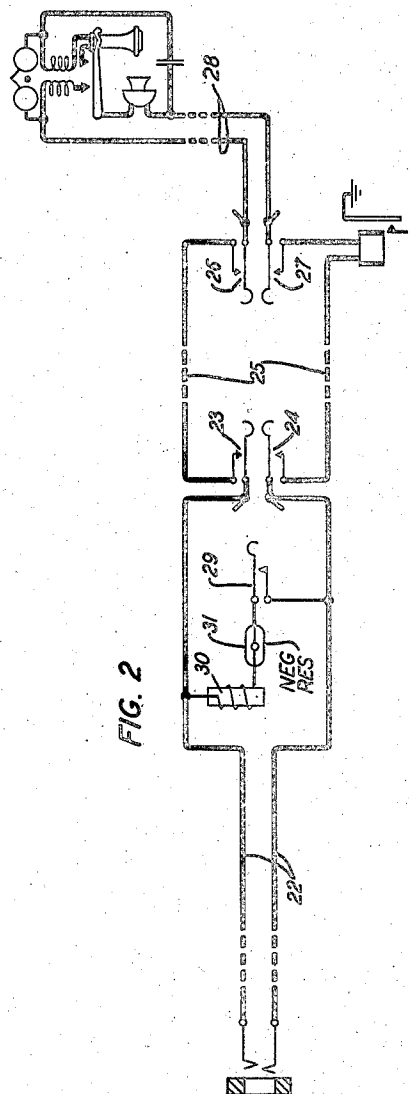
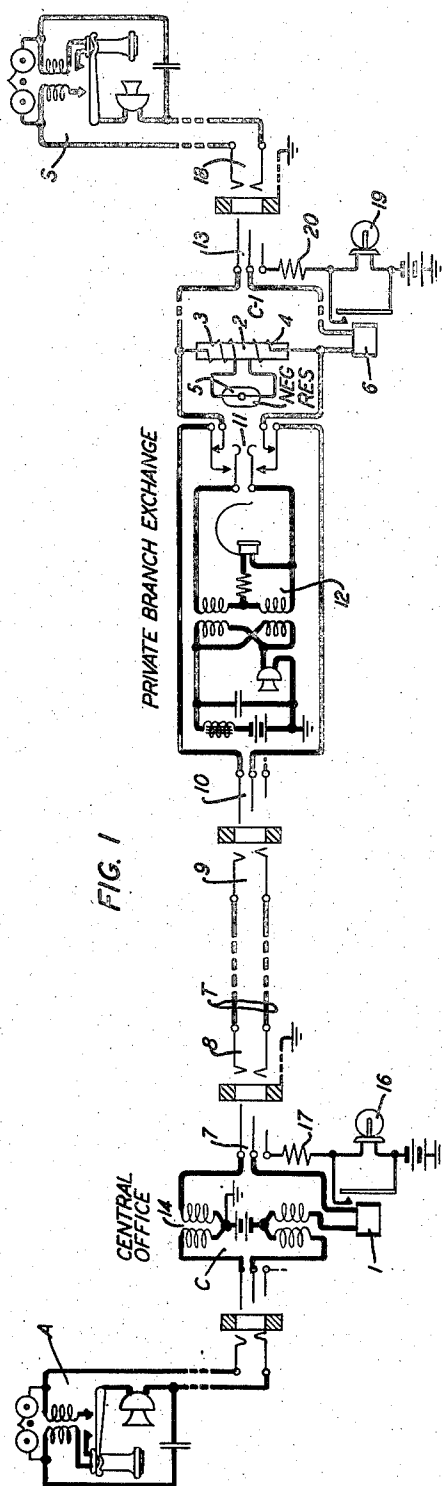
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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5 Claims. (Cl. 179—51)

This invention relates to telephone systems and particularly to supervisory circuits for use in connection with operators' cords or for other switching equipment.

5 The objects are to obtain better holding conditions for connections established by way of operators' cords or other connecting circuits; to insure more positive operation for the supervisory devices in these connecting circuits; to improve the transmission to the station where the holding is controlled manually; and otherwise to improve the operation and usefulness of systems of the foregoing character.

15 The connecting circuits used in private branch exchanges are frequently provided with direct current holding bridges connected across the talking conductors to hold the supervisory equipment at the central office while the private branch operator is obtaining a wanted station. When the called private branch exchange station answers, the current that flows from the central office over the loop of said called station must be sufficient to operate a supervisory relay in the branch exchange operator's cord circuit and to actuate the transmitter at the called station. But the holding bridge is in parallel with the called station and acts as a shunt, preventing full current from flowing through the station transmitter and the supervisory relay, which are connected in series with the station. If the bridge is made of low resistance, insuring a good holding condition, the shunting effect may prevent the operation of the supervisory relay in the private branch cord circuit when the called station answers. In case the holding bridge is applied manually by the operator, the bridge may shunt too much of the current away from the transmitter in the event the operator forgets to remove the bridge before the parties begin conversation. On the other hand, if the resistance of the bridge is made high to insure a safe operating margin for the supervisory relay and to insure sufficient current for conversation should the bridge be left across the line, its resistance may prevent the flow of enough current to hold the supervisory equipment at the central office.

50 According to the present invention these difficulties are overcome and adequate operating currents are obtained for the holding and supervisory and transmitter requirements by means of a novel circuit arrangement in which a variable resistance is included in circuit with the inductive direct current bridge circuit, and which functions to give the bridge a low resistance for hold-

ing purposes and a high resistance when current is needed for supervisory or transmitter purposes.

More specifically this feature is realized by connecting a resistance element having a high negative temperature coefficient of resistance in series with the windings of the inductive holding bridge across the private branch exchange cord. Normally, the resistance of the element is high, but, when the branch exchange operator answers a call over a trunk from central office, current flowing over the trunk from central office and through the bridge in her cord heats the element and lowers its resistance. This lowering of the bridge resistance allows full current to flow in the connection and insures the holding of the equipment at the central office so as not to give the operator thereat a false disconnect signal while the branch exchange operator is setting up the desired connection. When the called station in the branch exchange answers, the loop of this station is closed in parallel with said bridge and diverts some of the current therefrom. This loss of current causes the resistance element to increase its resistance, causing more and more current to flow through the station loop. This increased flow of current through the loop insures adequate current to the station transmitter and the operation of the supervisory relay in the branch exchange cord, advising the operator that the called station has answered, and the called station loop now acts in place of the bridge to hold the connection at the central office. When the called party hangs up his receiver, the opening of his loop removes the shunt from the holding bridge, the resistance element therein again assumes a low resistance, and sufficient current is maintained in the trunk to hold the connection at central office until the branch operator breaks the connection by withdrawing her cord circuit.

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

In the drawing accompanying the specification:

Fig. 1 illustrates a central office and a private branch exchange with a trunk interconnecting them and shows operators' cord circuits at both ends of the trunk, the branch exchange cord circuit being equipped with a variable-resistance holding bridge; and

Fig. 2 shows the variable-resistance holding bridge applied to the trunk circuit in a private branch exchange equipped with key connecting circuits instead of operators' cord circuits.

The resistor connected in the bridge circuit may be constructed in any suitable manner, and any substance having the necessary resistance coefficient may be used. Materials, such as silver sulphide and boron, having large negative temperature coefficients of resistance are particularly well suited for this purpose. Resistors made of these materials have high resistance at normal temperatures and rapidly reduce their resistance by large amounts when they are heated by current flowing through them. The construction and characteristics of resistance elements of this type are more fully discussed in the British Patent 472,144, accepted Sept. 17, 1937. Also other types of resistors, such as those made of copper oxide, which vary their resistance with relation to current may be used instead of those mentioned above.

While the invention has been illustrated as applied to the holding and supervision of private branch exchange connections, it will be clear to those skilled in the art that it is similarly applicable to any type of circuit connection where it is desired to have the connection originally offer a low resistance and later to increase its resistance automatically in response to the closure of a parallel circuit. As an example of another use for the invention it might be applied to a selector or connector switch in an automatic telephone system.

Referring now to the drawing and particularly to Fig. 1, the operator at the central office is provided with a cord circuit C by means of which she establishes connections, including those over the trunk T to the private branch exchange. The cord C has the usual equipment, much of which is omitted in the drawing, including a repeating coil 14 and supervisory relay 1. At the branch exchange the operator's cord C-1 likewise includes the listening, ringing, supervisory, and other equipment usually provided for cords of this type. The holding bridge, hereinbefore discussed, for the cord C-1 comprises a choke or inductance coil having a magnetic core 2 and two inductive windings 3 and 4. A variable resistance element 5 is connected between the two windings 3 and 4 and forms a part of the conducting path for the flow of current through the bridge circuit. The cord circuit C-1 is also equipped with a supervisory relay 6 and lamp 19 to give the operator supervision over lines, such as the station line S, to which she makes connections by means of the cord. It will be noted that the bridge circuit in the cord circuit C-1 forms a closed path for the flow of current from the source in the central office cord circuit C over the trunk T to the private branch exchange cord. It will also be noted that a station line S, when the cord circuit C-1 is connected thereto, is in parallel or shunt relation to the bridge in the cord circuit C-1. With the receiver off the hook at the station S, this parallel circuit is closed, and current from the central office battery flows over the talking conductors and through the loop of said station line.

A description of the operation will now be given. Assume that the subscriber of line A terminating in the central office wishes to obtain connection with the station line S in the distant private branch exchange. The operator at the central office, having answered the calling line A, inserts the plug 7 of her cord circuit C in the jack 8 of a trunk T and causes a calling signal (not shown) to appear at the jack 9 in which the trunk terminates at the branch exchange.

The insertion of plug 7 closes a circuit from battery through the supervisory lamp 16, resistance 17, sleeve contacts of the plug 7 and jack 8 and thence to ground. The lamp 16 burns in this circuit.

The branch exchange operator replies by inserting the plug 10 of cord C-1 in the jack 9. The insertion of plug 10 closes a current supply circuit from battery in the central office through the lower right winding of the repeating coil 14, winding of the supervisory relay 1, ring contacts of plug 7 and jack 8, over the lower conductor of the trunk T, through the ring contacts of jack 9 and plug 10, through contacts of the listening key 11, thence through the holding bridge, including coil 4, resistance element 5, and coil 3, thence through contacts of the listening key 11, tip contacts of plug 10 and jack 9, over the upper talking conductor of the trunk T, tip contacts of jack 8 and plug 7 through the upper right winding of repeating coil 14 to ground. When this circuit is first closed, the holding bridge offers a high resistance to the flow of current because the element 5 is at its normal temperature and consequently at its high-resistance value. The flow of current through the bridge, however, and through the element 5 quickly raises its temperature, and its resistance then falls rapidly to a low value. This permits full current to flow immediately over the circuit traced, which includes the winding of the supervisory relay 1. Relay 1 receiving full current operates its armature and short-circuits the supervisory lamp 16 to extinguish it. The private exchange operator, by means of her listening key 11, connects her telephone set 12 across the cord circuit and challenges the central office operator. The operation of listening key 11 opens the cord circuit, depriving the holding bridge of current, and the resistance element 5 quickly assumes its high-resistance value. The supervisory relay 1 in the central office, however, is now held by the connection through the operator's telephone set in the branch exchange. Having obtained the desired information from the central office operator, the branch operator restores the listening key 11, reclosing the holding circuit previously traced through the holding bridge, and inserts the calling plug 13 in the jack 18 of the wanted station line S. The insertion of the plug 13 in jack 18 closes a circuit from battery through the supervisory lamp 19, resistance 20, sleeve contacts of plug 13 and jack 18 to ground. The lamp 19 is illuminated in this circuit. In any suitable manner the branch operator signals the station line S by applying ringing current thereto.

When the party at station S replies by removing his receiver from the switchhook, a direct current path, including the supervisory relay 6, is closed in parallel or shunt relation to the holding bridge in the cord C-1. As previously explained the full current flowing over the trunk from the central office has, up to this point in the operation, passed through the holding bridge in the cord C-1. This current now divides, and some of it flows over the parallel path through the loop of the station line S. The resulting diminution of current in the holding bridge causes a corresponding increase in the resistance of the element 5. This permits still more of the current to pass through the substation loop with a further reduction in the current flowing through the bridge circuit. In this way the variable resistance element 5 automatically increases its resistance as a result of the closure of the shunt

circuit over the station line, and substantially all of the current supplied from the central office is directed over the station line and through the supervisory relay 6. Consequently the relay 6 obtains a full operating current, and the station line S is supplied with adequate current for transmission, although no physical opening has been made in the bridge circuit across the cord C—1. Relay 6 closes a short circuit around the lamp 19 to extinguish it as a signal that the called station S has answered.

When the party at the called station S hangs up his receiver at the end of conversation, the loop circuit in parallel with the holding bridge is opened and the supervisory relay 6 releases to cause the illumination of the lamp 19 as a disconnect signal. The opening of the shunt through the station loop places full potential across the bridge circuit, and a larger value of current again flows through said bridge and the variable resistance element 5. The element 5 reduces its resistance, and full current immediately flows through the bridge to hold the supervisory relay 1 in the cord C in its operated condition. When finally the branch exchange operator disconnects by removing the plug 10 from the jack 9, the relay 1 releases, and the lamp 16 lights as a disconnect signal to the central office operator.

Referring now to Fig. 2, the trunk circuit 22 incoming from the central office terminates in the contacts of keys at the private branch exchange. The attendant completes an incoming call by first operating the key contacts 23 and 24 to connect the calling trunk 22 to one of her connecting circuits 25. She then manipulates the key contacts 26 and 27 to complete the connection to the called line 28 after having received the necessary information from the calling party.

Should the private branch exchange operator wish to hold a connection on the trunk 22, she may do so by closing her holding key 29 to complete a holding bridge across the tip and ring conductors of the trunk. This holding bridge includes an impedance element 30 and a variable resistor 31. The holding bridge including the element 31 serves the same purpose as the bridge described in connection with Fig. 1. When the bridge alone is across the line, the resistance of element 31 is low, and sufficient current flows to hold the central office connection. When, however, the called station answers, the resistance of element 31 increases, and the bridge does not act as a substantial shunt on the transmitter at the called station should the attendant operator forget to remove it during the conversational period.

What is claimed is:

1. In combination, a telephone line, a switching circuit for making connection with said line, a bridge connected across the conductors of said switching circuit, means for closing said tele-

phone line to establish a path including said line in parallel to said bridge, a source for supplying current over said switching circuit to said bridge and to said line, and a variable-resistance element responsive to the flow of current in said bridge to lower the resistance of the bridge and responsive to the flow of current in said line to raise the resistance of said bridge.

2. In combination, a telephone line, a connecting circuit for making connection with said line, a bridge across the conductors of said circuit, means for closing a path including said line in shunt relation to said bridge, a source for supplying current to said bridge and to said line, and a variable-resistance element responsive to current in said bridge while said shunt path is open to lower the resistance of said bridge and responsive to the reduced flow of current through the bridge caused by the closure of said shunt path to raise the resistance of said bridge.

3. The combination with a telephone line of a cord circuit for making connection therewith, a bridge connected across the conductors of said cord, means for closing a path including said line in parallel relation with said bridge, a source for supplying current to said bridge and to said line, and a variable-resistance element in said bridge responsive to the flow of current to lower the resistance of said bridge and responsive to the reduced flow of current through the bridge when said parallel path is closed to raise the resistance of said bridge.

4. The combination with a telephone line of a cord circuit for extending connections to said line, a bridge connection across the conductors of said cord, a supervisory relay, means for closing a path including said line and said supervisory relay in shunt relation to said bridge, a source for supplying current to said cord circuit, and a variable-resistance element serving to reduce the resistance of said bridge when said shunt path is open and to increase the resistance of said bridge when said shunt path is closed.

5. The combination in a telephone system of an incoming line having a supervisory relay associated therewith, an outgoing line, a cord circuit for interconnecting said lines, a bridge connected across the conductors of said cord circuit, means for closing a path including said outgoing line in shunt relation to said bridge, a current source and circuit means for supplying current through the winding of said supervisory relay to said cord circuit, and variable-resistance means effective when said shunt path is open to lower the resistance of said bridge and permit the full flow of current from said source through said bridge and effective when said shunt path is closed to raise the resistance of the bridge to cause the current from said source to flow over said shunt path.

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