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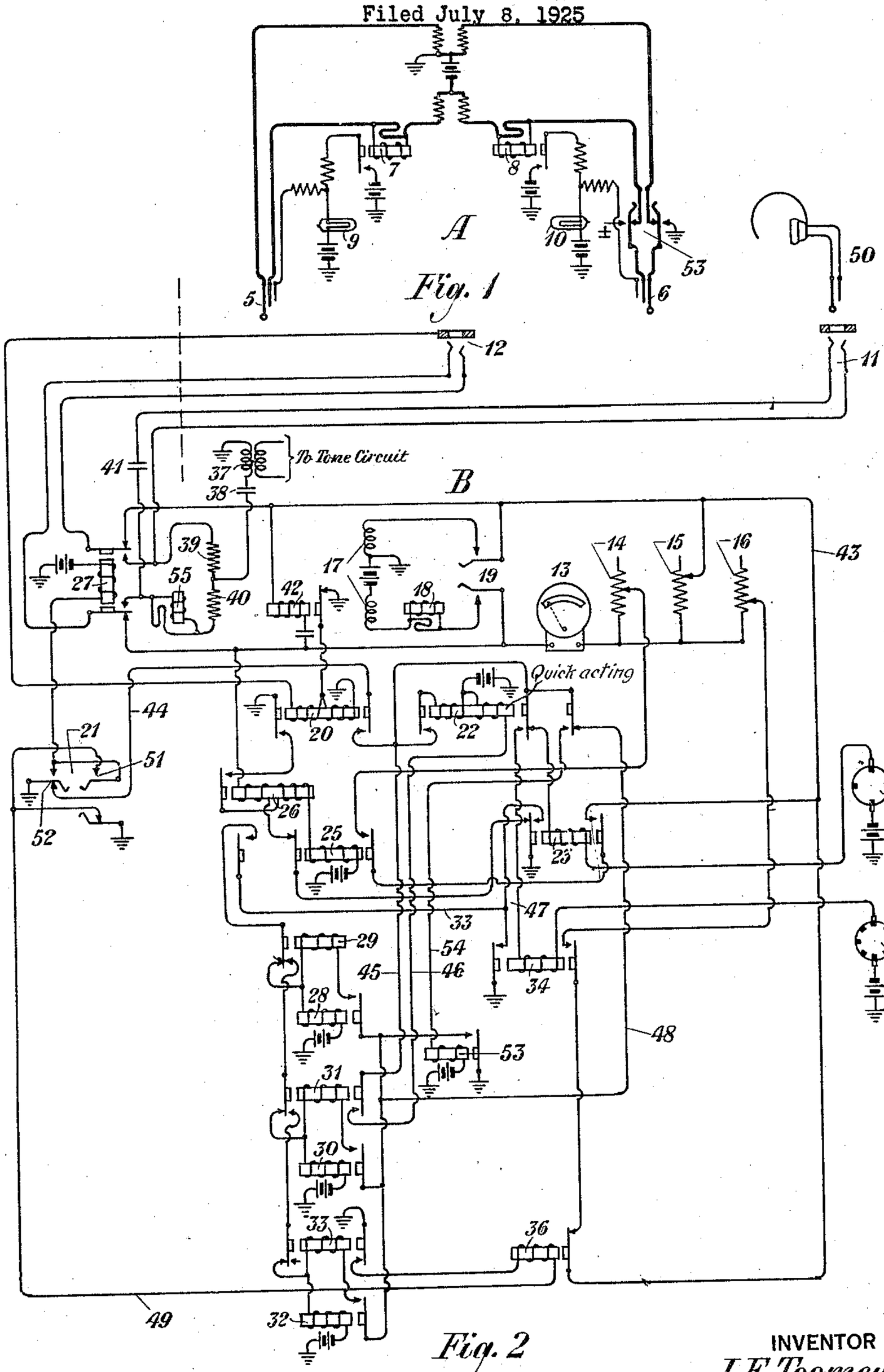

Fig. 1

Fig. 2

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TESTING SYSTEM FOR TELEPHONE CORD CIRCUITS.

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This invention relates to testing systems more particularly adapted for testing the various apparatus associated with telephone cord circuits.

One of the objects of the invention consists in providing testing equipment which, when connected to a cord circuit, affords means to determine whether the supervisory relays and other apparatus associated with the cord circuit function properly under conditions which are either approximately the same or are more severe than those experienced in actual service.

Another object of the invention consists in providing a system of the above character which is simple and accurate in its operation.

Other and further objects of the invention will appear from the following description, when considered in connection with the accompanying drawing.

In the drawing, Figure 1 illustrates a diagram of an operator's cord circuit, and Fig. 2 illustrates a testing system with which the cord circuit of Fig. 1 may be associated.

The cord circuit appearing in Fig. 1 terminates in the usual plugs 5 and 6 which are adapted to be inserted in the usual line jacks (not shown) that are installed in a switchboard. The usual supervisory relays 7 and 8 are associated with the cord circuit, and said cord circuit may be used to establish a connection between two telephone lines. Associated with the said relays in the cord circuit are supervisory signals 9 and 10. When a telephone connection is desired, the plugs 5 and 6 are inserted in line jacks (not shown) in which the said lines terminate at a switchboard.

In addition to the usual line jacks, special jacks 12 are provided at each switchboard section by means of which the cord circuits located in each switchboard section may be connected with testing apparatus. In addition to the jacks 12, jacks 11 are also provided to make certain tests to determine the continuity of the conductors of the cord circuit.

The testing circuit B comprises a milliammeter 13 which has associated with it adjustable resistances 14, 15 and 16 whereby conditions simulating those in actual practice are set up. The resistances 17 and relay 18 constitute a dummy cord which simulates the characteristics of an operator's cord circuit.

In the operation of the improved system, key 19 is actuated and connects the resistance 17 and relay 18 across the circuit. The resistances 14, 15 and 16 are adjusted to give the proper saturate, operate and release values, respectively, to which the elements of the cord circuit should respond when subjected to these tests. The key 19 is released after these values are set up, and the circuit is ready for testing.

The first part of the test is made by inserting one of the plugs of the particular cord circuit under test into jack 12. It will be assumed that plug 5 is the plug selected and inserted in jack 12 and a circuit is closed from battery, lamp 9, sleeve contacts of plug 5 and jack 12, left low resistance winding of relay 20 to ground. The closing of this circuit causes lamp 9 to light and also operates relay 20 which connects ground from the normal contact 52 of key 21, conductor 44, right make contact of relay 20, inner back contact of relay 22, winding of relay 23, through slow speed interrupter 24 to battery. The closure of this circuit causes relay 23 to be intermittently operated by the interrupter 24 about sixty times a minute. The operation of relay 23 at this time, however, does not close the testing circuit which is open at the right contact of relay 25. When the plug of the cord circuit under test is inserted in jack 12, a second circuit is closed from battery over the ring side of the cord and ring side of the plug and jack, left-hand winding of relay 26, back contacts of relays 25 and 23 to ground. This latter circuit constitutes a pick-up circuit and is provided so that the cord circuit under test will always receive two complete applications of testing current. If relays 26 and 25 were not provided, the supervisory relay in the cord under test might receive only a part of the first impulse of testing current because the interrupter 24 at that instant might have its contacts closed. This interval might be so small that the impulse would not cause the operation of the relay in the cord circuit. The operation of the pick-up feature is as follows.

As already pointed out, relay 23 is operated intermittently by the interrupter 24 as soon as the plug of cord A is inserted in jack 12. If the cord is inserted during the time that the contacts of interrupter 24 are closed, relay 26 will not operate because its control cir-

cuit is open at the contact of relay 23. As soon, however, as relay 23 releases, a circuit is closed from battery, over the ring side of the cord under test, ring side of the testing circuit, lower back contact of relay 27, left winding of relay 26, back contact of relay 25, back contact of relay 23 to ground, thereby causing relay 26 to operate. When relay 26 operates, ground is connected from the left front contact of relay 20, closed contact and right winding of relay 26, winding of relay 25, to battery, thereby causing relay 25 to operate. Relays 26 and 25 are maintained energized by the closure of this circuit from the grounded contact of relay 20. When relay 25 operates, its left contact opens the circuit through the left winding of relay 26. The right make contact of relay 25 closes the following circuit: from battery, through supervisory relay 7 of the cord under test, ring side of jack 12, lower back contact of relay 27, milliammeter 13, resistance 14, right make contacts of relays 25 and 23, conductor 43, upper back contact of relay 27, tip contacts of jack 12 and plug 5 to ground. As relay 23 is operating intermittently at the rate of approximately sixty interruptions per minute, the making and breaking of the circuit by this relay as just outlined causes the supervisory relay in the cord circuit under test to operate intermittently and flash the supervisory lamp associated therewith. The outer left make contact of relay 25 closes a circuit to the counting relays 28, 29, 30 and 31. These relays will not start to function until relay 25 is energized. Thus when relay 25 operates, a circuit is closed upon the operation of relay 23 through its grounded contact, conductor 33, outer left make contact of relay 25, back contact of relay 29, winding of relay 28 to battery, thus operating the latter relay. Relay 29, however, does not operate at this time because ground is connected to both terminals of its winding. As soon as relay 23 is released by the interrupter 24, this ground is removed from the winding of relay 29 and a circuit is closed from battery, winding of relay 28, winding of relay 29, make contact of relay 28, conductor 48, right contact of relay 22, make contact of relay 20, through grounded contact 52 of key 21. The closing of this circuit causes relay 29 to operate and lock up in series with relay 28. As soon as relay 23 is again operated by the interrupter 24, ground is connected over the circuit previously described, including the outer left contact of relay 25, front contact of relay 29, back contact of relay 31, winding of relay 30, to battery, thereby causing relay 30 to operate. When relay 23 is again released by interrupter 24, ground is disconnected from the circuit just traced, and battery flows through the windings of relays 30 and 31, to front contact of relay 30 over conductor 48 to grounded contact 52 of key 21. The closing of this circuit causes relays 30 and 31 to lock up. When relay 31 operates, a circuit is closed from grounded contact 52 of key 21, right make contact of relay 20, conductor 45, right make contact of relay 31, conductor 46, right winding of relay 22 to battery, thereby causing relay 22 to operate. The operation of relay 22 closes a locking circuit through its left winding and left make contact from battery, right make contact of relay 20, conductor 44 to grounded contact 52 of key 21. The operation of relay 22 at its inner right contact opens the energizing circuit of relay 23 and closes a circuit through the winding of relay 34 from battery, interrupter 35, conductor 47, inner right contact of relay 22, right contact of relay 20, grounded contact 52 of key 21. The interrupter 35 is of high speed and when the last mentioned circuit is closed relay 34 is operated intermittently about 180 times a minute. Relay 22 is of a quick acting type and operates before relay 53, to be presently referred to, has time to become energized. The operation of relay 22 opens its outer right contact and breaks the circuit over conductor 48 which maintained counting relays 28, 29, 30 and 31 operated, thereby causing these relays to release.

It should be noted at this point that two complete applications of saturate and release current have been given the supervisory relay in the cord circuit under test. The circuit is now changed so that the operate current is connected in place of the saturate current and the speed of the interrupter is changed from 60 to 180 interruptions per minute.

As soon as relay 22 is operated, the circuit of relay 23 is opened and the circuit of relay 34 is closed in its place. Relay 34 over its right make contact closes the testing circuit over its tip and ring conductors through adjustable resistance 16, thereby giving the supervisory relay its proper operating current. When relay 34 is first operated by the interrupter 35 it closes a circuit through its left make contact from ground, conductor 33, outer left contact of relay 25 to the counting relays 28, 29, 30, 31, 32 and 33, thereby causing these relays to operate in sequence as previously described in connection with their control by relay 23. The operation of relay 22 closes a circuit from battery, winding of relay 53, conductor 54, right outer front contact of relay 22, right front contact of relay 20, to grounded contact 52 of key 21. The closure of this circuit causes the operation of relay 53, which supplies ground through its make contact to permit the functioning of counting relays 28, 29, 30, 31, 32 and 33 instead of the ground supplied from key 21, as previously described. As soon as relay 34 has been operated and

released three times by the interrupter, thereby connecting three complete applications of operate and release current to the supervisory relay in the cord circuit under test, all the counting relays including relay 33 are operated.

The next step in the test is the noise test for testing the conductors in the cord and also the equipment in the cord circuit. For example, if the conductors are defective or if the non-inductive shunt on the supervisory relay in the cord circuit A is open, this condition is indicated by a tone heard in the test receiver 50 which is connected to a plug inserted in jack 11. The noise test is arranged so that it can be made automatically at the completion of the test of the supervisory relays, or it can be made independently of the supervisory relay tests. For controlling the noise test, key 21 has been provided. This key is common to the testing equipment and is mounted with it. When key 21 is in its normal position the noise test will not function. If, however, key 21 is actuated to connect the winding of relay 36 in series with the winding of relay 27 over conductor 49, the noise test will be made automatically at the completion of the test of the supervisory relays. When key 21 is actuated to connect ground directly to the winding of relay 27, the noise test can be first made without testing the operation of the supervisory relays. The noise test is made by connecting a suitable source of tone through the transformer 37, through a condenser 38 to the midpoint of balanced resistances 39 and 40, the outer terminals of these resistances being connected across the talking conductors of the cord circuit under test. The resistances 39 and 40 simulate the resistances in the repeating coil of the cord circuit A. Since the cord circuit under test is equipped with a supervisory relay, a relay 55 simulating the resistance and operative characteristics of said supervisory relay is provided in the testing circuit in series with resistance 40 to balance the supervisory relay in the cord circuit. The test receiver 50 associated with jack 11 is bridged across the circuit in series with the condenser 41. If the cord under test is in proper condition, no tone will be heard in the receiver 50. If, however, the cord is defective, the tone will be heard, as will presently appear.

Assuming that the noise test is to be made automatically at the end of the supervisory relay test, the operation of the circuit is as follows: Key 21 is actuated to connect the winding of relay 27 in series with the winding of relay 36. As already pointed out, relay 33 is the last of the counting relays to operate, this operation taking place at the end of the supervisory relay test. When relay 33 operates it connects ground from its front contact to the winding of relay 36, conductor 49, contact 51 of key 21, winding of relay 27, to battery, thereby operating relays 36 and 27. The operation of relay 36 through its break contact opens the testing circuit over conductor 43 and causes the lamp associated with the supervisory relay in the cord circuit under test to burn steadily, thereby indicating to the tester that the circuit is ready for the noise test. The operation of relay 27 connects the tone and test receiver circuits to the cord under test. As soon as the plug of the cord circuit under test is removed from the jack 12, all the relays are restored to their normal positions and the circuit is ready for testing another cord.

If the noise test is to be made without making the supervisory relay test, key 21 is actuated to connect ground directly to the winding of relay 27, thereby causing this relay to operate and connect the tone circuit across the talking conductors of jack 12. The opening of contact 52 of key 21 removes ground from the contacts of relay 20 so that when a cord is inserted in jack 12, and relay 20 operates, its operation does not cause the testing circuit to function.

When it is desired to test the operation of the ringing key in the cord circuit under test, key 21 is left in its normal position so that the noise test will not function. As soon as the supervisory relay test has been completed, which is indicated by the supervisory lamp burning steadily, the ringing key is operated and this connects ringing current across the terminals of relay 42, causing this relay to operate and remove the ground from the left low resistance winding of relay 20. When this ground is removed the lamp in the cord under test will not receive sufficient current to operate it through the right high resistance winding of relay 20. The lamp will therefore be extinguished, thereby indicating to the tester that the ringing key is in proper operative condition.

What is claimed is:

1. A testing system comprising a cord circuit including supervisory relays, a testing circuit with which the cord circuit may be associated, resistance elements of different values included in the testing circuit, means for connecting said resistance elements with the supervisory relays, interrupters for intermittently operating said means, means including a plurality of relays operable sequentially for automatically releasing one interrupter and substituting another interrupter to vary the speed of operation and resistance conditions to which said supervisory relays are subjected, and signaling means associated with said supervisory relays for indicating the action thereof.

2. A testing system comprising a cord circuit including supervisory relays, a testing circuit with which the cord circuit may

be associated, resistance elements of different values included in the testing circuit, means for connecting said resistance elements with the supervisory relays, interrupters for intermittently operating said means, means including a plurality of relays operable sequentially for automatically releasing one interrupter after a predetermined interval and substituting another interrupter to vary the speed of operation and resistance conditions to which said supervisory relays are subjected, means for automatically releasing the last mentioned interrupter after a second predetermined interval, and signaling means associated with said supervisory relays for indicating the action thereof.

3. A testing system comprising a cord circuit including supervisory relays, a testing circuit with which the cord circuit may be associated, resistance elements of different values included in the testing circuit, means for connecting certain of said resistance elements with the supervisory relays, a second means for connecting other resistance elements with said relays, an interrupter for intermittently operating said first means at a comparatively slow speed, a second interrupter for operating said second means at a comparatively rapid speed, means including a plurality of relays operable sequentially for automatically releasing the first interrupter and substituting the second interrupter to vary the speed of operation and resistance conditions to which said supervisory relays are subjected, and signaling means associated with said supervisory relays for indicating the action thereof.

4. A testing system comprising a cord circuit including supervisory relays, a testing circuit with which the cord circuit may be associated, resistance elements associated with the testing circuit simulating the saturate, release and operating conditions to which said supervisory relays are subjected in service, means for connecting said resistance elements with the supervisory relays, interrupters of different speeds for operating said means, means including a plurality of relays operable sequentially for automatically releasing one interrupter from control after subjecting said relays to certain tests at one operating speed, means for subjecting said relays under control by another interrupter to other tests at a greater operating speed, means for automatically releasing the last mentioned interrupter from control of said relays after predetermined tests thereof, and signaling means associated with said supervisory relays for indicating the action thereof.

5. A testing system comprising a cord circuit including supervisory relays, a testing circuit with which the cord circuit may be associated, resistance elements associated with the testing circuit simulating the saturate, release and operating conditions to which said supervisory relays are subjected in service, means for connecting said resistance elements with the supervisory relays, interrupters for intermittently operating said means, means including a plurality of relays operable sequentially for automatically releasing one interrupter from control after subjecting said relays to a saturate and release test at a relatively low speed, means for subjecting said relays to an operating test under control by another interrupter at a greater speed, means for automatically releasing the last interrupter from control of said relays after a predetermined interval of the operating test, and signaling means associated with said supervisory relays for indicating the action thereof.

6. A testing system comprising a cord circuit including supervisory relays, a testing circuit with which the cord circuit may be associated, resistance elements of different values associated with the testing circuit simulating the operating conditions to which said supervisory relays are subjected in service, means for connecting said resistance elements with the supervisory relays, interrupters for operating said means, means for automatically releasing one interrupter and substituting another interrupter to vary the speed of operation and resistance conditions to which said supervisory relays are subjected, a test receiver adapted to be directly associated with the testing circuit, and means for automatically releasing said second mentioned interrupter and associating said receiver with the cord circuit to determine the operating condition of the conductors of said cord circuit.

7. A testing system comprising a cord circuit including supervisory relays, a testing circuit with which the cord may be associated, resistance elements associated with the testing circuit simulating saturate, release and operating conditions to which said supervisory relays are subjected in service interrupters of different speeds, means controlled by said interrupters for connecting said resistance elements with the supervisory relays, means for automatically transferring the control from one interrupter to another interrupter, means for disconnecting the latter interrupter from the testing circuit after a predetermined interval, signaling means associated with said supervisory relays for indicating the action thereof, a test receiver adapted to be directly associated with the testing circuit, and means responsive to the disconnection of the second interrupter for associating the test receiver with the cord circuit to determine the continuity of the conductors thereof.

8. A testing system comprising a cord cir-

cuit including supervisory relays and a ringing key, a testing circuit with which the cord may be associated, resistance elements associated with the testing circuit simulating operating conditions to which said supervisory relays are subjected in service, interrupters of different speeds, means controlled by said interrupters for connecting said resistance elements with the supervisory relays, means including a plurality of relays operable sequentially for automatically transferring the control from one interrupter to another interrupter, means for disconnecting the latter interrupter after a predetermined interval, means associated with the testing circuit responsive to the operation of said ringing key for applying current to determine its operative condition, and signaling means associated with the cord circuit for indicating the action of said relays and said ringing key.

9. A testing system comprising a cord circuit including supervisory relays, a testing circuit with which the cord circuit may be associated, a test receiver adapted to be associated with the testing circuit and thereover with the cord circuit to determine the continuity of the conductors of the cord circuit, resistance elements of different values included in the testing circuit, means for connecting said resistance elements with the supervisory relays, interrupters for intermittently operating said means, means including a plurality of relays operable sequentially for automatically releasing one interrupter and substituting another interrupter to vary the speed of operation and resistance conditions to which said supervisory relays are subjected, signaling means associated with said supervisory relays for indicating the action thereof, and means for automatically disconnecting the last interrupter from the testing circuit after a predetermined interval and associating said test receiver with said cord circuit.

10. A testing system comprising a cord circuit including supervisory relays, a testing circuit with which the cord circuit may be associated, resistance elements of different values included in the testing circuit, means for connecting said resistance elements with the supervisory relays, interrupters for intermittently operating said means, means including a plurality of relays operable sequentially for automatically releasing one interrupter after a predetermined interval and substituting another interrupter to vary the speed of operation and resistance conditions to which said supervisory relays are subjected, means for automatically releasing the last mentioned interrupter after a second predetermined interval, signaling means associated with said supervisory relays for indicating the action thereof, a test receiver adapted to be associated with the testing circuit and thereover with the cord circuit to determine the continuity of the conductors of said cord circuit, means for associating said test receiver with the cord circuit to make tests of its conductors independently of supervisory relay tests, and means for associating said test receiver with the cord circuit upon the release of said second interrupter.

11. A testing circuit comprising a cord circuit including supervisory relays and a ringing key, a testing circuit with which the cord circuit may be associated, resistance elements of different values included in the testing circuit, means for connecting certain of said resistance elements with the supervisory relays, a second means for connecting other resistance elements with said supervisory relays, an interrupter for intermittently operating said first means at a comparatively slow speed, a second interrupter for operating said second means at a comparatively rapid speed, means including a plurality of relays operable sequentially for automatically releasing the first interrupter and substituting the second interrupter to vary the speed of operation and resistance conditions to which said supervisory relays are subjected in service, means associated with the testing circuit responsive to the operation of said ringing key for applying current to determine its operative condition, signaling means associated with said supervisory relays for indicating the action of said relays and said ringing key, a test receiver adapted to be associated with said testing circuit and thereover with said cord circuit to determine the continuity of the conductors of the cord circuit, and means for connecting said test receiver to make independent tests and also to make such tests in conjunction with other of the above tests automatically upon the release of said second interrupter.

In testimony whereof I have signed my name to this specification this 2nd day of July, 1925.

JOHN F. TOOMEY.