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TESTING AND ADJUSTING APPARATUS FOR CORD CIRCUITS.

APPLICATION FILED JAN. 30, 1920.

1,406,246.

Patented Feb. 14, 1922.

2 SHEETS—SHEET 1.

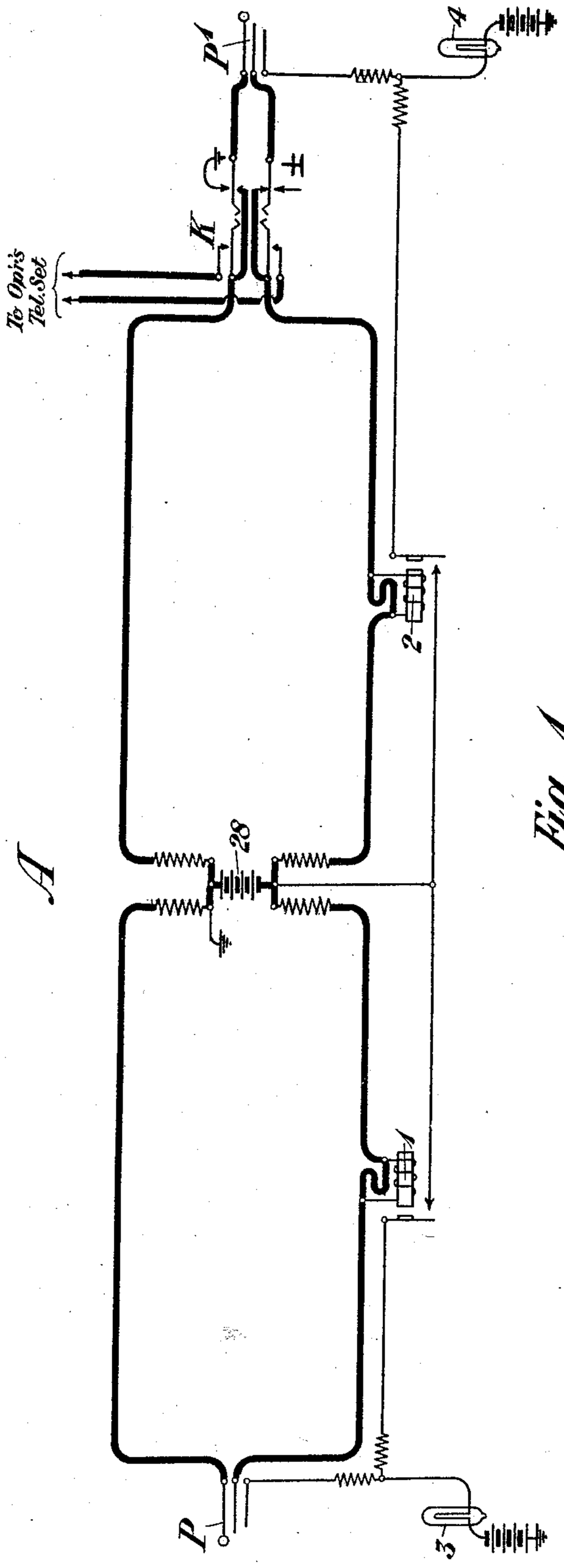

Fig. 1

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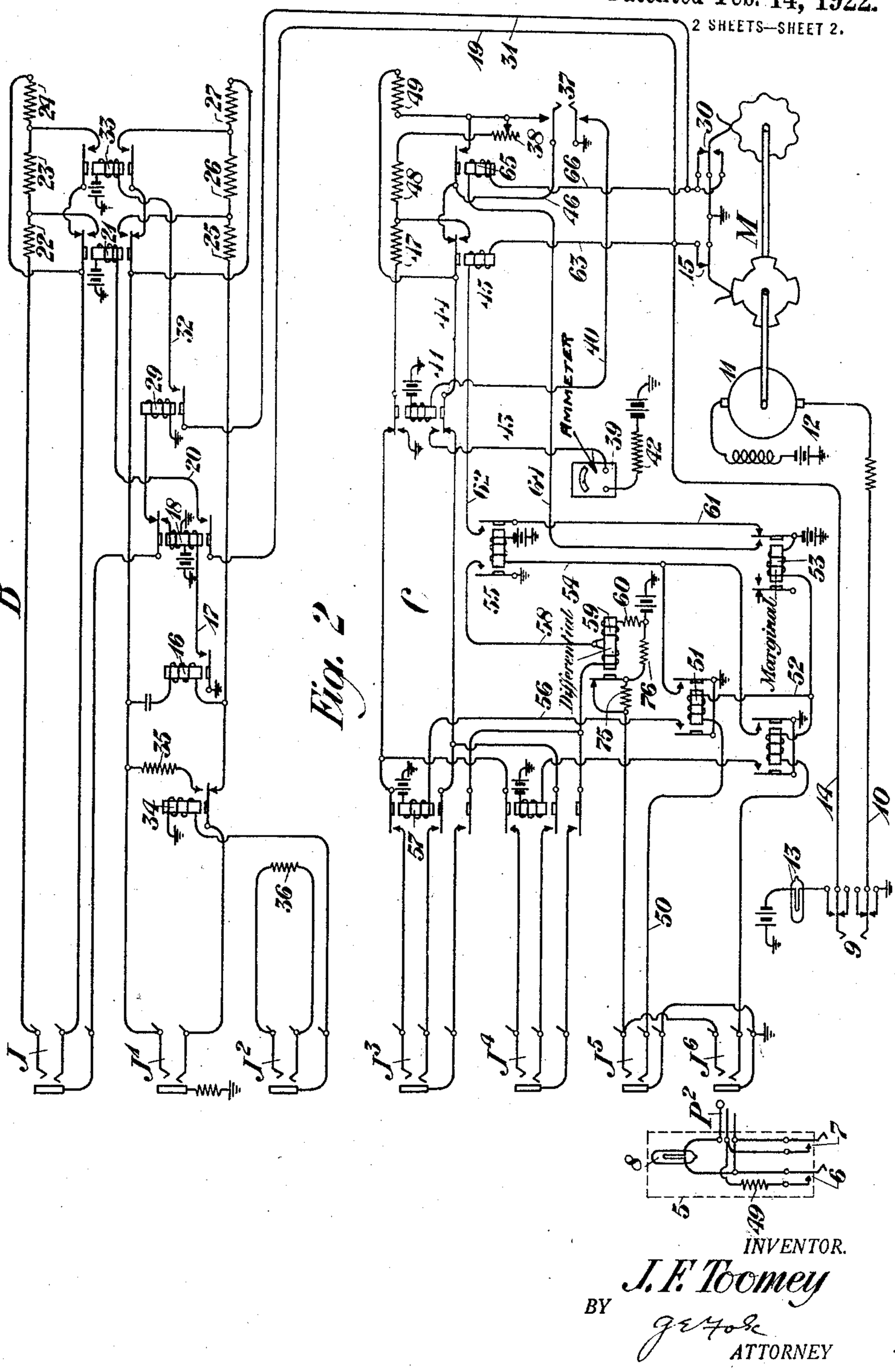

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UNITED STATES PATENT OFFICE.

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TESTING AND ADJUSTING APPARATUS FOR CORD CIRCUITS.

1,406,246. Specification of Letters Patent. **Patented Feb. 14, 1922.**

Application filed January 30, 1920. Serial No. 355,177.

To all whom it may concern:

Be it known that I, JOHN F. TOOMEY, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Testing and Adjusting Apparatus for Cord Circuits, of which the following is a specification.

This invention relates to testing apparatus, and more particularly to equipment for testing and adjusting the various apparatus associated with a telephone cord circuit.

One of the principal objects of this invention consists in providing testing equipment which, when connected to a cord circuit, affords means to determine whether the supervisory relays 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 consists in providing adjusting equipment whereby the adjusting of the supervisory relays to meet the desired operating conditions may be done in an efficient manner.

Other and further objects of the invention will appear from the following description taken in connection with the accompanying drawings, Figures 1 and 2 of which, when arranged with Fig. 2 to the right of Fig. 1, embodying a circuit diagram of the testing and adjusting features of the invention.

Fig. 1 illustrates a circuit diagram A of a standard operator's cord circuit terminating in the usual plugs P and P^1, which are adapted for insertion into the usual line jacks (not shown) that are installed in a switchboard. The usual supervisory relays 1 and 2 are associated with said cord circuit, whereby the said cord circuit may be used to establish a connection between two telephone lines. Associated with said relays in the cord circuit are supervisory signals 3 and 4. When a telephone connection is desired, the plugs P and P^1 are inserted into two line jacks (not shown) in which the said lines terminate at a switchboard.

In addition to the usual line jacks, special jacks J, J^1, J^2, J^3 and J^4 are multiplied at each switchboard section, by means of which the cord circuits located in each switchboard section may be connected with the testing and adjusting circuits shown at B and C, respectively, of Fig. 2.

Jacks J^5 and J^6 shown in Fig. 2 and hereinafter designated as control jacks, are associated with jacks J^3 and J^4, and are preferably mounted in the rear of the switchboard sections wherein said jacks J^3 and J^4 appear. In order that the adjusting circuit may be controlled from the point at which the supervisory relays of the cord circuit to be tested are located, a control set 5 is provided, the plug P^2 of which may be inserted in either of the control jacks J^5 or J^6. In order to test the supervisory relays of the cord, the plug P of said cord may be associated with jack J, and plug P^1 may be associated with jack J^1. For adjusting the supervisory relays of the cord, the plugs P and P^1 may be associated with either jack J^3 or jack J^4, and the plug P^2 of the control box may be inserted in either of the control jacks J^5 or J^6. Then by manipulating either of the keys 6 or 7 of the control set 5, the operation of the supervisory relays of the cord circuit may be observed by means of lamp 8 of said control set, and suitable adjustments may be made if said relays are not functioning properly.

Having described generally the circuits and apparatus shown on the drawings embodied in Figs. 1 and 2, the invention may now be made clear from the following description of its operation:

Testing circuit for supervisory relays.

When it is desired to test or adjust the apparatus of the cord circuit shown in Fig. 1, key 9 of Fig. 2 is operated and the following circuit completed: From ground, closed contact of key 9, conductor 10, through armature 11 of motor interrupter M to battery 12. The operation of key 9 also completes a circuit from battery, filament of lamp 13, conductor 14, spring 15 of motor interrupter M to ground. The closing of the first mentioned circuit by the depression of key 9 sets the motor interrupter M in motion; and the closing of the second mentioned circuit causes the intermittent lighting of lamp 13 which indicates whether or not the interrupter is working properly, and also serves as a guard signal in case said interrupter is left running when the apparatus is not in use.

Plugs P and P^1 are now associated with the jacks J and J^1, respectively, and the key K of Fig. 1 is operated, thereby supplying ringing current in the customary

manner over the tip and ring conductors of the plug P^1 and jack J^1 and operating relay 16. The operation of relay 16 completes a circuit from ground, through its armature and contact over conductor 17, lower winding of relay 18 to battery. This circuit causes relay 18 to be energized and closes a locking circuit from ground, through the upper winding of said relay, including its front contact and armature, sleeve conductors of jack J and plug P, through filament of supervisory lamp 3 to battery. This circuit causes the supervisory lamp 3 to light. The operation of relay 18 also closes the following circuit: From ground, through spring 15 of motor interrupter M, conductor 19, armature and contact of relay 18, conductor 20, winding of relay 21 to battery. Relay 21 will be intermittently operated and released by this circuit under control of the slow acting contact of motor interrupter M. When the relay 21 is operated, the resistances 22 and 25 will be bridged across the tip and ring conductors of the jacks J and J^1 of the testing circuit B, and a circuit will be closed over said conductors including said resistances, and also the tip and ring conductors of plugs P and P^1, respectively, of the cord circuit A, including battery 28. When the relay 21 releases, the resistances 22, 23, 24 and 25, 26, 27 are connected in series over the circuits just mentioned. Thus, each time the relay 21 operates, a minimum resistance will be bridged across said circuits, and sufficient current will flow from source 28 over the tip and ring conductors of the cord and testing circuits to operate supervisory relays 1 and 2, thereby extinguishing supervisory lamps 3 and 4 of circuit A. When the relay 21 releases, resistances 22, 23, 24 and 25, 26, 27 will be connected in series across the tip and ring conductors of the circuits A and B in the manner previously described, and said resistances are of such value as to reduce the current flowing over said circuits to such a degree as to cause relays 1 and 2 to release, thereby lighting lamps 3 and 4. The resistances are of such value, and the slow acting contact of motor interrupter M is so designed as to permit the maximum amount of current to flow through relays 1 and 2, and the minimum rate of flashing of the lamps 3 and 4 that will occur under natural operating conditions. If said lamps flash properly, relays 1 and 2 may be considered satisfactorily adjusted for the conditions described.

In order to test the operation of the supervisory relays 1 and 2 under the condition of minimum current and maximum rate of flashing of the lamps 3 and 4, plug P is disconnected from jack J, thereby releasing relays 18 and 21 and restoring the circuit B to its normal condition. The plug P is now reinserted and the following circuit is closed: From battery, filament of lamp 3, sleeve conductors of plug P and jack J, back contact of relay 18, winding of relay 29 to ground. Relay 29 is energized by the circuit, and in operating closes a circuit from ground, spring 30 of fast acting contact of motor interrupter M, conductor 31, armature and contact of relay 29, conductor 32, winding of relay 33 to battery. Relay 33 is intermittently energized and released by this circuit under control of fast acting contact of motor interrupter M. When the relay 33 operates the resistances 22, 23 and 25, 26, are bridged across the tip and ring conductors of the jack J and plug P and jack J^1 and plug P^1, respectively, thereby energizing supervisory relays 1 and 2 of the cord A, and said relays in turn cause the lamps 3 and 4 which are associated therewith to be extinguished. When the relay 33 releases the resistances 22, 23, 24 and 25, 26, 27 are connected in series across the tip ring conductors of the jacks J and J^1 and plugs P and P^1, respectively. The intermittent operation and release of relay 33 under control of the fast acting contact of interrupter M thus causes the supervisory relays to operate in unison with said relay, and the supervisory relays in turn provide for the rapid flashing of the supervisory lamps 3 and 4. If the lamps flash properly, the supervisory relays may be considered properly adjusted for the conditions described.

Test for noisy cords.

It sometimes happens that the standard conductors in a cord become open or crossed. If the conductors of the cord circuit are entirely opened or crossed, the trouble will be detected in the test for the adjustment of the relays previously described. If the trouble consists in broken strands in the conductors, which increases the resistance of the cord and impairs the transmission, it may be detected by the following test: Plug P^1 is left inserted in jack J^1, and the plug P is removed from jack J and inserted in jack J^2, thereby closing the following circuit: From battery, filament of lamp 3, sleeve conductors of plug P and jack J^2, winding of relay 34 to ground. Relay 34 is energized by this circuit, and in operating closes a circuit over the bridged resistance 35 across the tip and ring conductors of jack J^1 and plug P^1, including battery 28. The insertion of plug P in jack J^2 also closes a circuit including resistance 36, across the tip and ring conductors of jack J^2 and plug P, including battery 28. The listening key K of cord A is now operated, connecting the operator's head set with said cord in a well known manner. If

the cord is defective, the movement of the cord will cause a varying current to flow through the cord circuit, which will vary the current in the head set, thereby causing therein a sputtering or scratching sound.

Adjustment of supervisory relays.

If the tests previously made show that the supervisory relays need adjustment in order to obtain satisfactory operation, the following procedure is pursued:

Key 37 of circuit C is depressed for the purpose of providing a circuit through rheostat 38, whereby the ammeter 39 may be adjusted to the proper current value of an actual line over the following circuit: From ground, lower contact of key 37, conductor 40, winding of relay 41 to battery. This circuit will energize relay 41 and close the following circuit: From battery, resistance 42, ammeter 39, conductor 43, lower front contact and armature of relay 41, conductor 44, armature and back contact of relay 45, conductor 46, upper contact of key 37, rheostat 38, resistances 48 and 47, upper armature and front contact of relay 41 to ground. By now adjusting rheostat 38 and observing the current flow over the circuit just traced, this circuit may be regulated to simulate the resistance of a line under actual service conditions. The circuit having been adjusted to the desired resistance, the key 37 is released causing relay 41 to become deenergized.

In order to adjust the supervisory relays 1 or 2 for maximum current supply and minimum operation, plug P or P^1, respectively, is inserted in jack J^3 and plug P^2 of the portable set 5 is inserted in jack J^5. The insertion of plug P^2 in jack J^5 will close a circuit from battery, resistance 76, armature and contact of relay 59, tip contacts of jack J^5 and plug P^2, filament of lamp 8, sleeve contacts of said plug and jack to ground. This circuit will cause the lamp 8 to light. The keys 6 and 7 of the portable set 5 are preferably of the usual mechanical locking type. The key 6 is now operated, and the following circuit closed: From ground, sleeve contacts of jack J^5 and plug P^2, closed contact of key 6, high resistance 149, ring contacts of plug P^2 and jack J^5, conductor 50, winding of relay 51, conductor 52, winding of marginal relay 53 to battery. This circuit operates relay 51, but marginal relay 53 will not at this time operate because of the inclusion of the high resistance 149 in the circuit. The operation of relay 51 closes a circuit over its righthand armature and contact from ground, conductor 54, winding of relay 55 to battery, thereby energizing relay 55. The operation of relay 51 also closes a circuit over its lefthand armature and contact from ground, conductor 56, winding of relay 57 to battery, thereby energizing relay 57. The operation of relay 55 closes a circuit from ground over its lefthand armature and contact, conductor 58, righthand winding of differential relay 59, resistance 60 to battery. Differential relay 59 does not operate, however, at this time owing to the insufficient battery supply received because of the inclusion of the resistance 60 in the circuit. The operation of relay 55 also closes a circuit from battery, armature and back contact of marginal relay 53, conductor 61, righthand armature and contact of relay 55, conductor 62, winding of relay 45, conductor 63, spring 15 of slow-acting contact interrupter M to ground. The relay 45 is thus intermittently operated and released under control of the slow acting contact of interrupter M. Each time said relay operates, a circuit is closed from battery 28 in the cord A over tip and ring conductors of said cord, including winding of supervisory relay 1, tip and ring contacts of plug P and jack J^3, contacts and armatures of relay 57, said relay having been operated as previously pointed out, back contacts and armatures of relay 41, conductor 44, and low resistance 47. Supervisory relay 1 is energized by the circuit and the operation of said relay will cause relay 59 to operate in unison therewith upon the closure of the following circuit: Battery 28, sleeve conductor of cord A, sleeve contacts of plug P and jack J^3, lower contact and armature of relay 57, which has been operated as previously outlined, lefthand winding of relay 59, conductor 58, closed contact and armature of relay 55 to ground. When the relay 45 releases the resistance 48 variable resistance 38, and resistance 49 are connected in series with the resistance 47 in the circuit previously traced. Sufficient current will not be provided for the circuit upon the inclusion of the resistances 47, 48 and 49 and variable resistance 38 for the operation of relays 1 and 59, and they will release. The release of supervisory relay 1 will cause the lamp 3 to light and the release of relay 59 will cause lamp 8 of the portable set 5 to light. When the lamp 8 flashes at the proper intervals under this test relay 1 may be considered properly adjusted.

In order to adjust the supervisory relays under the condition of minimum current and maximum rate of operation, plug P^2 of the portable set 5 is left inserted in jack J^5 and key 7 of said set is now operated, thereby releasing key 6. The operation of key 7 closes a circuit from ground, sleeve contacts of jack J^5, plug P^2, closed contacts of key 7, ring contacts of said plug and jack, conductor 50, winding of relay 51, conductor 52, winding of marginal relay 53 to battery. This circuit will provide for the energization of relay 51 which in turn will close

circuits previously traced in connection with the operation of key 6, whereby relays 55 and 57 are operated. The marginal relay 53 will also be energized at this time and will close a circuit from battery, through the armature and front contact of said relay, conductor 64, winding of relay 65, conductor 66, closed contact 30 of interrupter M to ground. Relay 65 will thus be intermittently operated and released under control of fast-operating contact 30 of motor interrupter M. When relay 65 operates a circuit is closed from battery 28 over tip and ring conductors of cord A, including winding of supervisory relay 1, tip and ring contacts of plug P and jack J^3, contacts and armatures of relay 57, said relay having been operated as previously pointed out, back contacts and armatures of relay 41, conductor 44, armature and back contact of relay 45, armature and closed contact of relay 65, rheostat 38, and back over resistances 47 and 48. When relay 65 releases resistance 49 is also included in the circuit just traced. The operation and release of relay 65 will, in a manner similar to the operation and release of relay 45 previously pointed out, cause the operation of supervisory relay 1 and also relay 59 in the adjusting circuit C, and the operation and release of the latter relays will likewise cause the lamps 3 and 8 to flash. If the relay 1 functions properly under the conditions outlined, as will be indicated by the rapid flashing of lamp 8, said relay may be considered correctly adjusted for any conditions it is likely to undergo in actual service.

It will be understood that although the operation of the adjusting circuit has only been described in connection with apparatus associated with plug P when said plug is connected with the adjusting circuit, said circuit will function similarly upon connection of the plug P^1 therewith.

The resistances used in the testing and adjusting circuits may be of such value or values that the current which flows through the circuit will be either the same as or somewhat less than the minimum or somewhat greater than the maximum current which flows under actual service conditions.

It will be clear that by this invention a simple, convenient and efficient arrangement of circuits has been devised, whereby a local cord circuit may be plugged into a convenient testing jack and the functioning of the various apparatus associated with the said cord circuit may be readily determined. If any apparatus is found defective on such test, the cord with which the defective apparatus is associated may be plugged into a jack leading to an adjusting circuit and said defective apparatus may be adjusted until it is observed that it is functioning properly.

While the arrangements of this invention have been illustrated as embodied in certain specific arrangements which have been deemed desirable, it will be understood that they are capable of embodiment in many widely varied forms, without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a testing system, the combination of an operator's cord circuit, a source of ringing current included in said circuit, a testing circuit, means for associating said cord circuit with said testing circuit, an interrupter, members of different operating frequencies associated therewith, means operable in response to the application of ringing current upon the association of said cord circuit and said testing circuit for subjecting the cord circuit under control of said interrupter members to conditions simulating normal operating electrical conditions, and signaling means included in said cord circuit indicative of said conditions upon such association.

2. A cord circuit including a supervisory relay and a ringing key, a testing circuit including a plurality of resistance elements normally connected in series therein, short circuits associated with certain of said resistance elements, means for associating said cord circuit with said testing circuit, said resistance elements being of such a value that when all of said resistance elements are included in said testing circuit the supervisory relay will not be operated and when certain of said resistance elements are short circuited the supervisory relay will be operated, and means for intermittently opening and closing certain of said short circuits, said means being controlled selectively by the operation of said ringing key.

3. A cord circuit including a supervisory relay and a ringing key, a testing circuit including a plurality of resistance elements normally connected in series therein, short circuits associated with certain of said resistance elements, means for associating said cord circuit with said testing circuit, said resistance elements being of such a value that when all of said resistance elements are included in said testing circuit said supervisory relay will not be operated and when certain of the resistance elements are short circuited said supervisory relay will be operated, means controlled by the association of said cord circuit with said testing circuit for intermittently closing a short circuit about a relatively small portion of said resistance elements at a relatively rapid rate, and means controlled by the association of said cord circuit with said testing circuit and the operation of said ringing key for intermittently closing a short circuit about a relatively large portion

of said resistance elements at a relatively slow rate.

4. A cord circuit including a supervisory relay, and a sleeve circuit including a signal lamp controlled by said relay, a testing circuit, means for associating said cord with said testing circuit, a plurality of resistance elements normally included in series in said testing circuit and of such a value as to prevent the operation of said supervisory relay, means for regulating the values of certain of said resistance elements to simulate the resistance of a subscriber's line with which said cord might be connected, a test set including a signal lamp and a plurality of keys associated with said testing circuit, means controlled by said keys for intermittently completing said testing circuit through the last mentioned resistance elements, whereby said supervisory relay may be operated intermittently, and said sleeve circuit closed intermittently, and means controlled by the closing of said sleeve circuit for operating the signal lamp in said test set.

In testimony whereof, I have signed my name to this specification this 28th day of January 1920.

JOHN F. TOOMEY.