

W. H. HARRISON.
 TESTING AND ADJUSTING APPARATUS FOR CORD CIRCUITS.
 APPLICATION FILED FEB. 7, 1920.

1,428,631.

Patented Sept. 12, 1922.

2 SHEETS—SHEET 1.

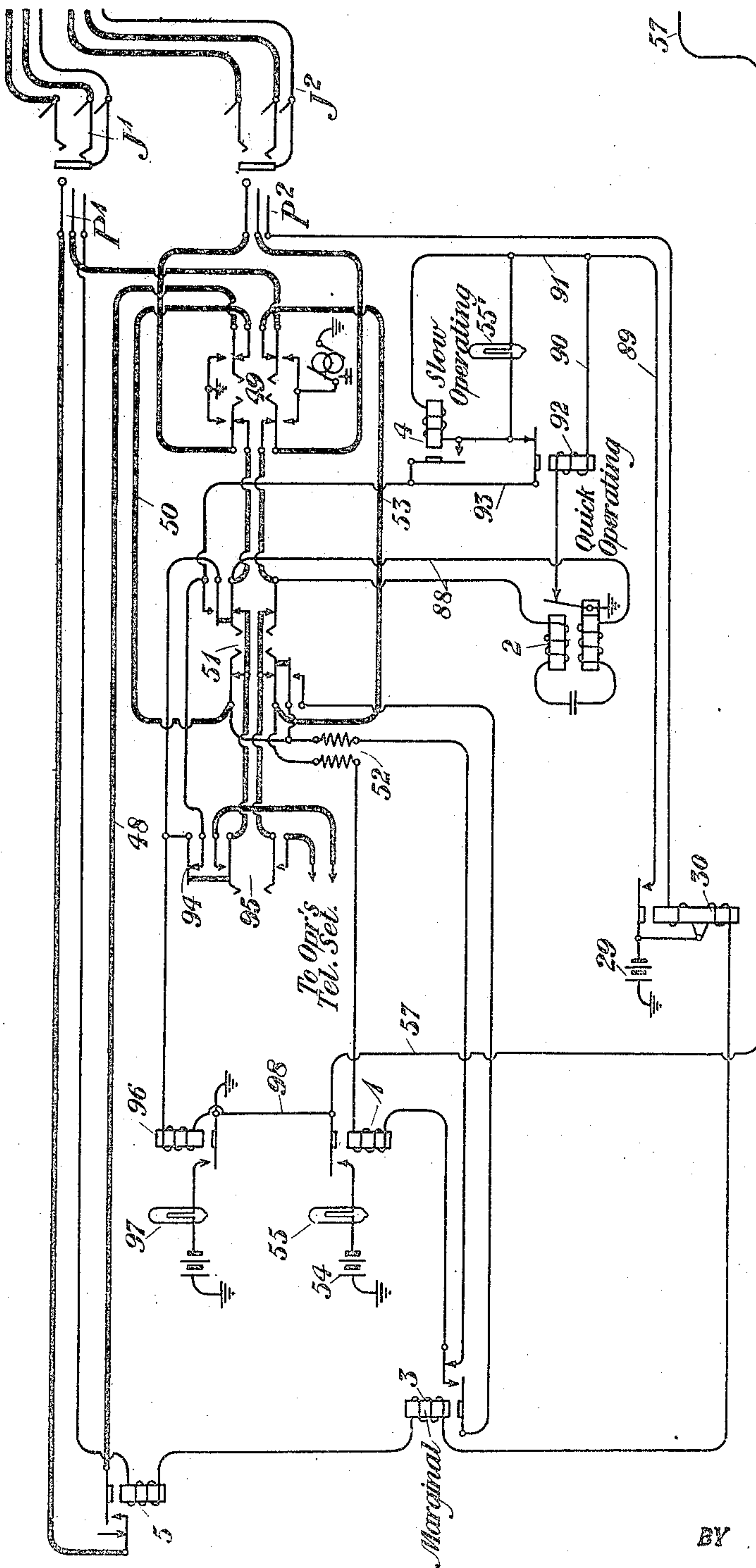


Fig. 1

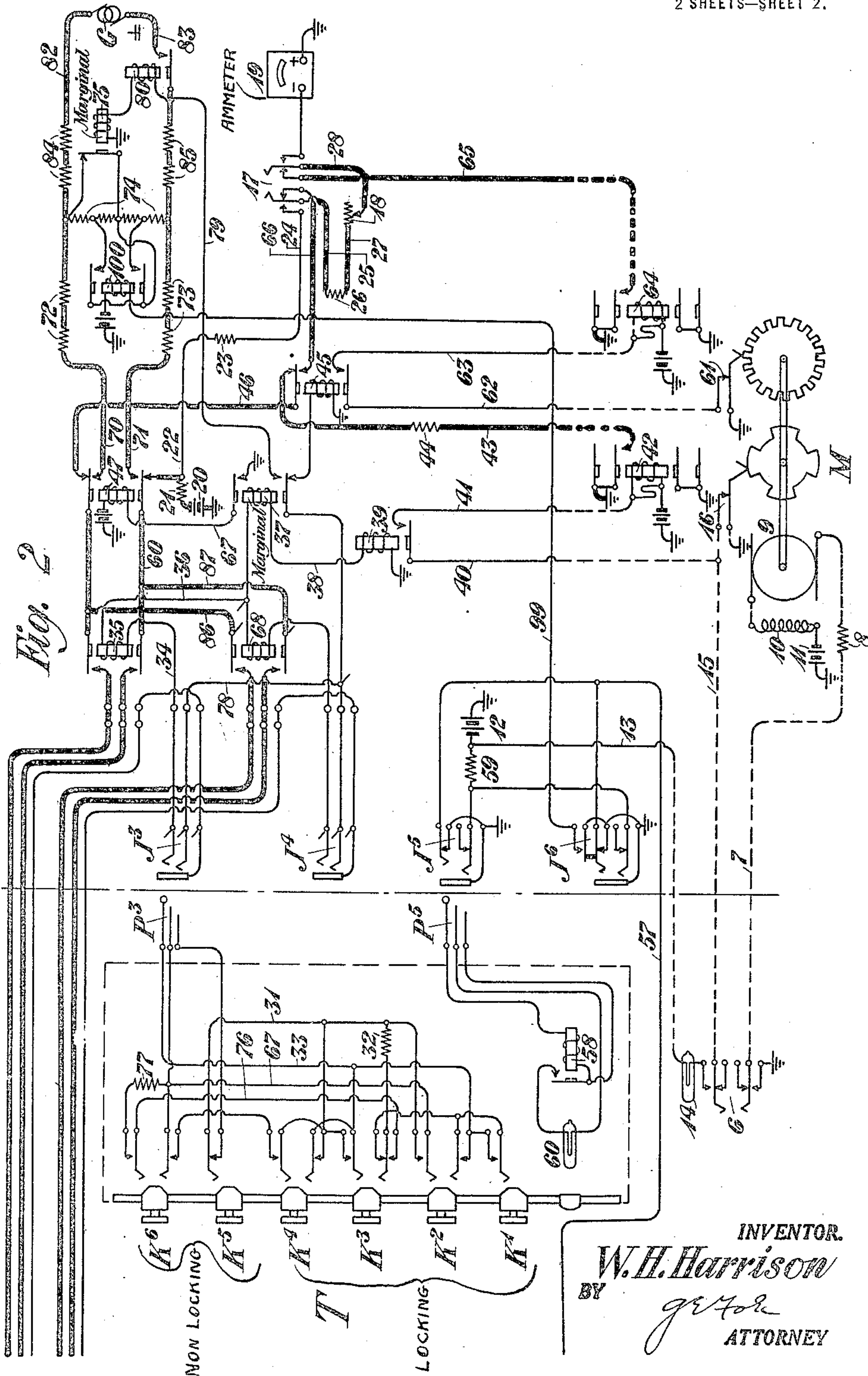
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UNITED STATES PATENT OFFICE.

WILLIAM H. HARRISON, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TESTING AND ADJUSTING APPARATUS FOR CORD CIRCUITS.

Application filed February 7, 1920. Serial No. 357,068.

To all whom it may concern:

Be it known that I, WILLIAM H. HARRISON, residing at Brooklyn, in the county of Kings 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, embody a circuit diagram of the testing and adjusting features of the invention.

Fig. 1, illustrates a circuit diagram of a standard toll cord circuit terminating in the usual front and back plugs P^1 and P^2 , which are adapted for insertion into the usual line jacks (not shown) that are installed in a switchboard. A direct current supervisory relay 1, and an alternating current supervisory relay 2 are associated with said cord circuit, whereby the said cord circuit may be used to establish a supervised connection either between two long distance toll lines or between a long distance toll line and a toll switching trunk line or other similar trunks. If two long distance toll lines are connected by inserting plugs P^1 and P^2 into two line jacks (not shown) in which the said toll lines terminate at a switchboard, the alternating current relay 2 may be energized by alternating current which may be transmitted

over each or either of said toll lines. The circuit containing the direct current supervisory relay 1, which is normally bridged across the said cord circuit, is opened by the operation of marginal relay 3 when the cord circuit is used to establish a connection between two long distance toll lines, whereby the loss in transmission due to such bridged relay is prevented. If, however, a long distance toll line is connected by said cord circuit to a toll switching line, over which direct current is transmitted for supervisory purposes, the alternating current relay 2 may be energized by the alternating ringing current transmitted over the long distance toll line, and the direct current supervisory relay 1 may be energized by the direct current transmitted over the toll switching trunk line.

In addition to the usual line jacks special jacks J^1 and J^2 are multiplied at each switchboard section in order that the toll cord circuits located in each switchboard section may be connected with the testing or adjusting circuit shown in Fig. 2.

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

The test set T comprises keys K^1 , K^2 , K^3 ,

K⁴, K⁵, and K⁶. Keys K¹, K², K³, and K⁴ are preferably of the locking type and the two first mentioned keys are adapted to control the adjustment of the direct current supervisory relays of a cord circuit. Keys K⁵ and K⁶ are preferably of the non-locking type and together with the keys K³ and K⁴ are adapted to control the alternating current supervisory relay of a cord circuit. Associated with the set T is the signal 60 which is used for indicating the action of the relays under adjustment.

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

When it is desired to adjust the apparatus of the cord circuit shown in Fig. 1, the key 6 of Fig. 2 is operated, and completes the following circuit: from ground, lower contact of said key, conductor 7, resistance 8, through armature 9, field winding 10 of motor interrupter M to battery 11. The depression of key 6 also closes the following circuit: from battery 12, conductor 13, lamp 14, upper contact of key 6, conductor 15, spring 16 to ground. The closing of the first-mentioned circuit by the depression of key 6, causes the motor interrupter apparatus M to set in motion, and the closing of the second mentioned circuit provides for the intermittent lighting of lamp 14 which indicates whether or not the interrupter is working properly, and serves as a guard signal in case said interrupter is left running when the circuit is not in use.

Key 17 is now depressed for the purpose of providing a circuit through rheostat 18, whereby the ammeter 19 may be adjusted to the proper current value of an actual line over the following circuit: from grounded battery 20, resistance 21, conductor 22, resistance 23, conductor 24, lefthand outer contact of key 17, conductor 25, resistance 26, conductor 27, rheostat 18, conductor 28, outer righthand contact of key 17, through the ammeter 19 to ground. By now adjusting rheostat 18 the current flow over the above traced circuit, which will be indicated by ammeter 19, may be regulated as desired. The circuit is now in condition for testing the apparatus of a cord circuit.

Testing direct current supervisory relay.

Assuming that it is desired to make a test to determine whether the direct current supervisory relay 1 functions properly, the plug P¹ is inserted in the jack J¹; plug P³ of test set T is inserted in the control jack J³ and plug P⁵ is inserted in jack J⁵. The key K¹ of said test set is now depressed, whereupon the following circuit is closed: from grounded battery 29 of the cord circuit, winding of relay 30, marginal relay 3 and

relay 5, sleeve conductor of said cord, sleeve contacts of plug P¹ and jack J¹, sleeve contacts of jack J³ and plug P³, closed contact of key K⁵ of test set T, conductor 31, resistance 32, closed contact of key K³, contact of key K¹, conductor 33, tip contacts of plug P³ and jack J³, conductor 34, winding of relay 35, conductor 36, winding of marginal relay 37, conductor 38, winding of relay 39 to ground. This circuit will cause the operation of relays 30, 5, 35 and 39. The operation of relay 30 closes a circuit from battery 29 over its armature and contact which will be described later. The operation of relay 39 will complete an intermittent circuit from ground through spring 16 of motor M, conductor 40, armature and contact of relay 39, conductor 41, winding of relay 42 to battery. The relay 42 will be operated intermittently by this circuit, and each time it operates will complete a circuit from ground through its upper armature and contact over conductor 43, resistance 44, upper back contact and armature of relay 45, conductor 46, upper back contact of relay 47, closed armature and contact of relay 35, through tip contacts of jack J¹ and plug P¹, closed contact and armature of relay 5, conductor 48, contact of key 49, conductor 50, through one side of coil 52, contact of marginal relay 3, winding of supervisory relay 1, cut through the other side of coil 52, conductor 53, lower right hand contact of key 49, ring contacts of plug P¹ and jack J¹, lower contact and armature of relay 35, conductor 60, lower armature and back contact of relay 47, resistance 21 to grounded battery 20. This circuit will provide for the intermittent energization of supervisory relay 1. This circuit is of relatively low resistance and the current flow thereover is sufficient to saturate relay 1. The operation of said relay will indicate that it is properly adjusted and that its armature will not stick up under any of the conditions that it is likely to undergo in service. The relay 1 will attract its armature intermittently and close the following circuit: from grounded battery 54 in the cord circuit, filament of lamp 55, contact and armature of relay 1, conductor 57, through the tip contacts of jack J⁵ and plug P⁵, winding of relay 58, sleeve contacts of plug P⁵ and jack J⁵ to ground. Relay 58 will be energized by this circuit and will close a circuit from battery 12, resistance 59, ring contacts of jack J⁵ and plug P⁵, filament of lamp 60, contact and armature of relay 58 to ground. This circuit will cause lamp 60 to light. Thus each time the supervisory relay 1 operates and lights the supervisory lamp 55, the indicating lamp 60 will also be lighted. The flashing of lamp 60 at the proper intervals will indicate that the direct current relay 1 will operate properly under the condition described.

The plug P¹ is left inserted in the jack J¹

and key K^2 of the test set T may now be depressed to provide for the minimum current condition and the fast operation of direct supervisory relay 1. When the key K^2 is depressed a current path similar to that outlined in connection with the key K^1 will be provided, but instead of traversing the key K^1 , as previously described, it passes through the lower make contact of key K^2 and causes the apparatus contained in said circuit to function as described above. An additional current path is also provided, which is similar to the previously described path, to the resistance 32, from which it continues as follows: from conductor 31 of the test set T to the upper contact of key K^2 , back over conductor 67, ring contacts of plug P^3 and jack J^3 , lower armature and contact of relay 37, winding of relay 45, to ground. The second mentioned circuit will cause the relay 45 to operate, and thereby close a circuit from ground, through spring 61 of the interrupter M, conductor 62, lower contact and armature of relay 45, conductor 63, winding of relay 64, to grounded battery. An intermittent circuit will thus be provided by the interrupter, which opens and closes the armature of relay 64, and said armature upon opening and closing provides an intermittent current path from its upper grounded armature by way of conductor 65, right hand normal contact of key 17, conductor 28, rheostat 18, conductor 27, resistance 26, conductor 25, left hand normal contact of key 17, conductor 66, make contact and armature of relay 45, conductor 46, upper back contact and armature of relay 47, armature and closed contact of relay 35, through the tip contacts of jack J^1 and plug P^1 , and thence over a circuit through relay 1 as previously described. As formerly pointed out, the rheostat 18 may be adjusted by operating key 17 so that the above described testing circuit may have characteristics similar to those of an actual line.

Thus it will be apparent from the above descriptions that current may be applied intermittently to the direct current relay over a circuit of relatively low resistance and the relay saturated in order that tests may be made to insure that the armature of said relay will not stick up. Current may also be intermittently applied to the direct current relay over a circuit of relatively higher resistance, such as the resistance of an actual line, and the relay may thus be tested with an operating current such as would be met with under actual conditions. The intermittent application of current to these two testing circuits may be done at different speeds and the slow flash or fast flash of the signal lamp 60 will thus indicate which test is being made. If the direct current supervisory relay operates

satisfactorily under these two tests, it may be considered properly adjusted.

Adjustment of alternating current supervisory relay.

For the adjustment of the alternating current supervisory relay 2, plug P^2 may be connected with jack J^2 , and plug P^3 associated with jack J^4 . The key K^3 is now operated so as to restore any of the keys which may have been locked down during the previous testing. The depression of key K^3 also closes a circuit from grounded battery 29, upper winding of relay 30, sleeve conductor of the toll cord and sleeve contacts of plug P^2 and jack J^2 , sleeve contacts of jack J^4 and plug P^3 , closed contact of key K^5 , conductor 31, upper contact of key K^3 , conductor 33, tip contacts of plug P^3 and jack J^4 , winding of relay 68, winding of marginal relay 37, conductor 38, winding of relay 39 to ground. This circuit will cause relays 30, 68, 37 and 39 to operate. Relay 37 upon operating will close a circuit from ground, over its upper contact and armature, conductor 67, winding of relay 47, to grounded battery; and the closing of this circuit will energize relay 47. The energization of relay 47 will close a circuit over its front contacts and armatures, over conductors 70 and 71, resistances 72, 73, 74, 84 and 85 and conductors 82 and 83, including the back contact and armature of relay 75. It will be obvious from the foregoing description that the operation of relay 47 has resulted in the connection of the alternating current equipment of the adjusting circuit to the cord circuit instead of the direct current equipment previously described.

The key K^6 is now depressed and the following high resistance circuit closed: from battery 29, winding of relay 30, sleeve conductor of toll cord, sleeve contacts of plug P^2 and jack J^2 , sleeve conductors of jack J^4 and plug P^3 , closed contact of key K^5 , conductor 31, resistance 32, lower make contact of key K^3 , conductor 76, upper make contact of key K^6 , resistance 77, ring contacts of plug P^3 and jack J^4 , lower armature and front contact of marginal relay 37, which had been operated as previously outlined, conductor 79, through windings of relays 80 and 75, to ground. This circuit does not operate marginal relay 75, but relay 80 will operate at this time and attract its armatures. The energization of relay 80 will also provide ringing current from the source G, over conductors 82 and 83, resistances 84, 85, 72 and 73, conductors 70 and 71, front contacts and armatures of relay 47, conductors 86 and 87, contacts and armatures of relay 68, tip and ring contacts of jack J^2 and plug P^2 , through contacts of key 49 of the toll cord and over conductors 88 and wind-

ings of the alternating current supervisory relay 2. The relay 2 should not be operated by this circuit since part of the bridged resistance 74 in the ringing circuit is short circuited by the contacts of relay 75, and relay 2 receives its non-operative current value. Should, however, the lamp 60 of test set T light at this time, such indication will show that the relay 2 did operate, and is therefore not working properly. In that case the key K^5 of the test set should be depressed, and relay 2 should be adjusted after which the operation previously described may be repeated until said relay functions properly.

The key K^4 should be depressed next and then key K^6 should be operated. The depression of key K^4 releases key K^3 which was previously operated and completes a circuit through the windings of relays 68, 37 and 39 as formerly outlined, thus connecting alternating current generator G of the adjusting circuit to the toll cord. The depression of key K^6 will complete a circuit from grounded battery 29 in the toll cord, winding of relay 30, sleeve contacts of plug P^2 and jack J^2 , sleeve contacts of jack J^4 and plug P^3 , contact of key K^5 , lower and upper contacts of key K^4 , lower contact of key K^6 , ring contacts of plug P^3 and jack J^4 , conductor 78, lower armature and make contact of relay 37, conductor 79, windings of relays 80 and 75 to ground. This circuit is of lower resistance than the previously traced circuit, as the resistances 32 and 77 are not included therein, and will accordingly provide sufficient current for the energization of relays 75 and 80. The operation of marginal relay 75 will cause its armature to be attracted, removing the shunt normally closed about the upper part of bridged impedance 74, thereby increasing the impedance bridged across conductors 82 and 83. The increased impedance bridged across conductors 82 and 83 will decrease the current drain through the bridged impedance 74, and therefore permit sufficient current to flow over the previously traced circuit from generator G to relay 2 and the current now transmitted to said relay from generator G will be equal to the operating current used under actual conditions and said relay should be energized. If the relay 2 responds to this current it is properly adjusted and upon operating will close the following circuit: from grounded battery 29, armature and contact of relay 30, conductor 89 through lamp 55' and relay 4 in parallel to the contact and armature of relay 92, over conductor 93 to contact 94 of key 95, winding of relay 96, conductors 98 and 57, tip contacts of jack J^5 and plug P^5 , winding of relay 58, sleeve contacts of said plug and jack to ground. The relays 96 and 58 will be energized by this circuit. Relay 96 will provide for the lighting of lamp 97 by a circuit from

battery, filament of said lamp through contact and armature of relay 96 to ground, and relay 58 will provide for the lighting of lamp 60 of test set T in a manner heretofore outlined. Thus the relays 96 and 58 and the lamps 97 and 60 will act in unison with each other. The lighting of lamp 60 of test set T under the above described tests will indicate that relay 2 is properly adjusted for actual service conditions.

It sometimes happens that switchboards are equipped with various kinds of relays for which various adjustments must be made. For this purpose there may be provided a lamp jack J^6 corresponding to lamp jack J^5 . When it is desired to adjust one of these special type relays, plug P^5 is associated with the jack J^6 and provision is made for automatically selecting the correct bridged resistance values in the ringing network resistances for adjusting the special alternating current supervisory relays over the following circuit: From ground of lamp jack J^6 , over conductor 99, winding of relay 100 to battery.

Relay 100 will be energized by this circuit and upon operating will associate the special resistance adapted for the correct adjustment of the special type of relay under test with the ringing network in an obvious manner.

It should be understood that the resistances used in the interrupter circuit and in the alternating circuit 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 that flows under actual service conditions.

It will now be clear that by this invention a simple, convenient and efficient arrangement of circuits has been devised whereby any toll cord may be plugged into a convenient adjusting jack and the functioning of the various apparatus associated with the said cord circuit may be determined by manipulating the keys associated with the test set. If any apparatus is found defective on such test, the cord with which the defective apparatus is associated may be controlled by the test set from a point adjacent to such apparatus and thereby the defective apparatus may be adjusted in a convenient and efficient manner.

While the invention has been disclosed as embodied in certain specific organizations and arrangements, it is to be understood that its embodiment may be varied without departing from the spirit of the invention as defined in the following claims.

Having thus described the invention, what it is desired to secure by Letters Patent is:

1. A testing system comprising an operator's cord circuit having a direct current

relay and an alternating current relay, an auxiliary circuit associated with said relays, a testing circuit adapted to be associated with said cord circuit comprising individual equipment for testing the direct and alternating current relays, a portable test set adapted to be associated with the testing circuit and auxiliary circuit, switching means in said set for selectively associating the direct and alternating current relays with their individual equipment, a relay in said test set operable upon such association, and signaling means in said test set controlled by said relay for indicating the operation of the direct and alternating current relays.

2. A testing system comprising an operator's cord circuit, having a direct current relay and an alternating current relay, an auxiliary circuit associated with said relays terminating in a pair of lamp jacks, a testing circuit adapted to be associated with the cord circuit comprising individual equipment for testing the direct and alternating current relays a portable test set, a pair of terminals for said test set one of which is adapted to be associated with the testing circuit and the other terminal with either of said lamp jacks, switching means in said test set for selectively associating the direct and alternating current relays with their individual equipment, a relay in said test set operable upon such association, and signaling means in said test set controlled by said relay for indicating the operation of the direct and alternating current relays.

3. A testing system comprising an operator's cord circuit having a direct current relay and an alternating current relay, a testing circuit adapted to be associated with said cord circuit, direct current equipment in said testing circuit for testing the direct current relay, alternating current equipment of different resistance values in the testing circuit for testing alternating current relays of different operating values, an auxiliary circuit associated with the direct and alternating current relays terminating in a lamp jack, a second lamp jack associated with said auxiliary circuit and with the alternating current equipment, a portable test set, a terminal therefor connecting said test set with the testing circuit, a second terminal for said set adapted to be associated with either the first or second mentioned lamp jack, relay means associated with the alternating current equipment operable upon the connection of said second terminal with said second lamp jack for short circuiting certain of the resistances associated with said equipment, switching means included in the testing circuit for selectively associating the direct and alternating current relays with their individual equipment, a relay in said set operable upon such association, and signaling means in said set controlled by said

relay for indicating the operation of the direct and alternating current relays.

4. A testing system comprising an operator's cord circuit having a direct current relay, an auxiliary circuit associated with said relay, a testing circuit adapted to be associated with said cord circuit, direct current equipment simulating actual service operating conditions associated with said testing circuit, a portable test set adapted to be associated with the testing circuit and auxiliary circuit, switching means in said set for associating the direct current equipment with the direct current relay for testing said relay, a relay in said test set associated with the auxiliary circuit operable upon such test, and signaling means in said set controlled by the last mentioned relay for indicating the operation and acting in unison with the direct current relay.

5. A testing system comprising an operator's cord circuit, having an alternating current relay, an auxiliary circuit associated with said relay, a testing circuit adapted to be associated with the said cord circuit, alternating current equipment simulating actual service operating conditions associated with the testing circuit, a portable test set adapted to be associated with the testing circuit and auxiliary circuit, switching means in said test set for associating the alternating current equipment with the alternating current relay for testing said relay, a relay in said test set associated with the auxiliary circuit operable upon such test, and signaling means in said set controlled by the last mentioned relay for indicating the operation of the alternating current relay.

6. A testing system comprising an operator's cord circuit having an alternating current relay, a testing circuit adapted to be associated with said cord circuit, alternating current equipment of different resistance values in the testing circuit for testing alternating current relays of different operating values, an auxiliary circuit associated with the alternating current relay terminating in a lamp jack, a second lamp jack associated with said auxiliary circuit and with the alternating current equipment, a portable test set, a terminal therefor for connecting said test set with the testing circuit, a second terminal for said set adapted to be associated with the first or second mentioned lamp jack, relay means associated with the alternating current equipment operable upon the connection of said second terminal with said second lamp jack for short circuiting certain of the resistances associated with said equipment, switching means included in the test set for associating certain resistance values in the alternating current equipment with an alternating current relay of certain operating value upon the connection of the second mentioned terminal of the test set with the

first mentioned lamp jack and for associat-
 ing resistances of different value with al-
 ternating current relays of different operat-
 ing value upon the connection of said ter-
 5 minal with said second mentioned lamp jack,
 a relay in said test set, and signaling means
 in said set controlled by said last men-

tioned relay for indicating the operation of
 the alternating current relay under test.

In testimony whereof, I have signed my 10
 name to this specification this 5th day of
 February 1920.

WILLIAM H. HARRISON.