Aug. 25, 1931. R. W. BURNS 1,820,116

TESTING SYSTEM

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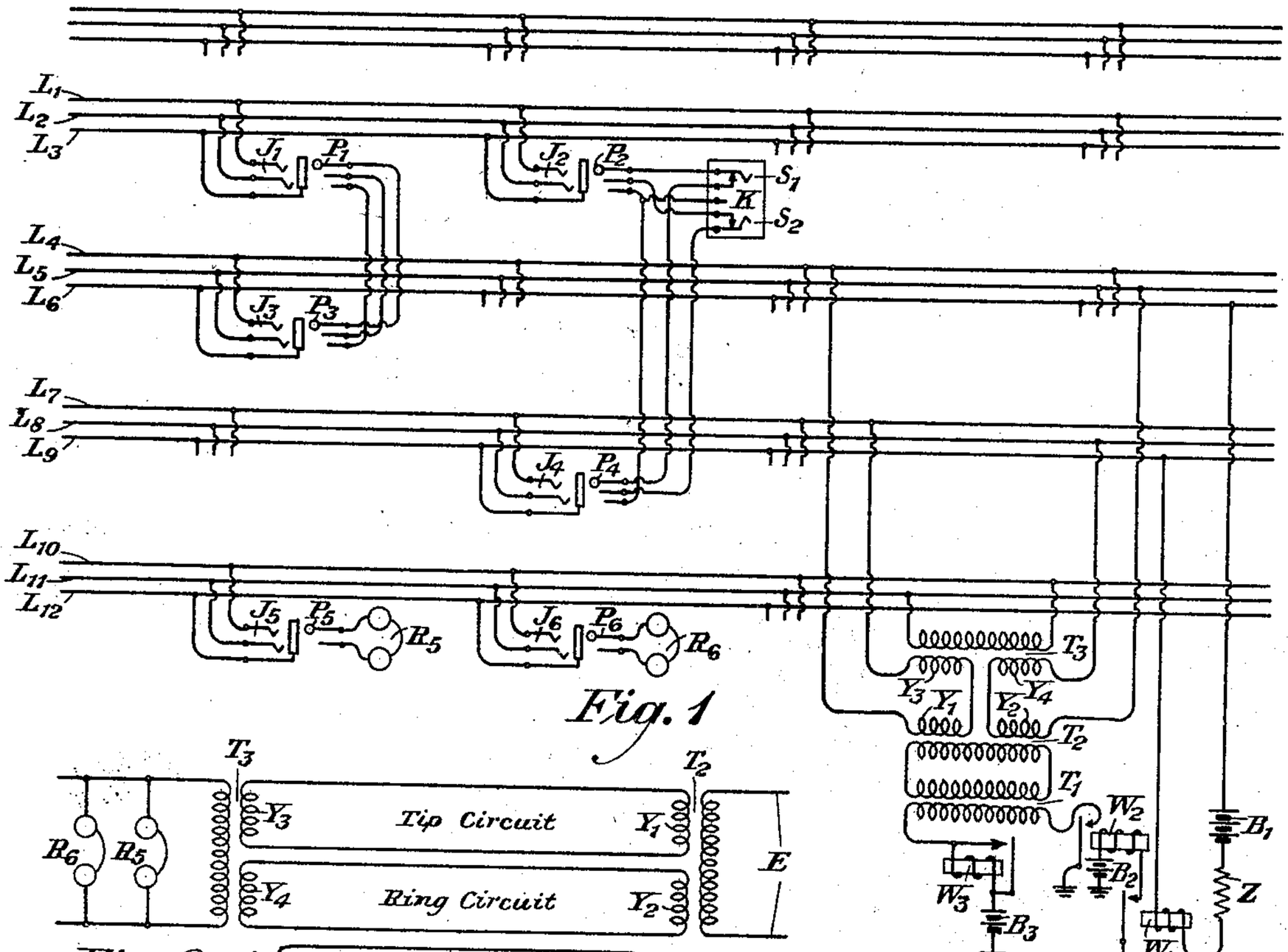

Fig. 1

Fig. 2

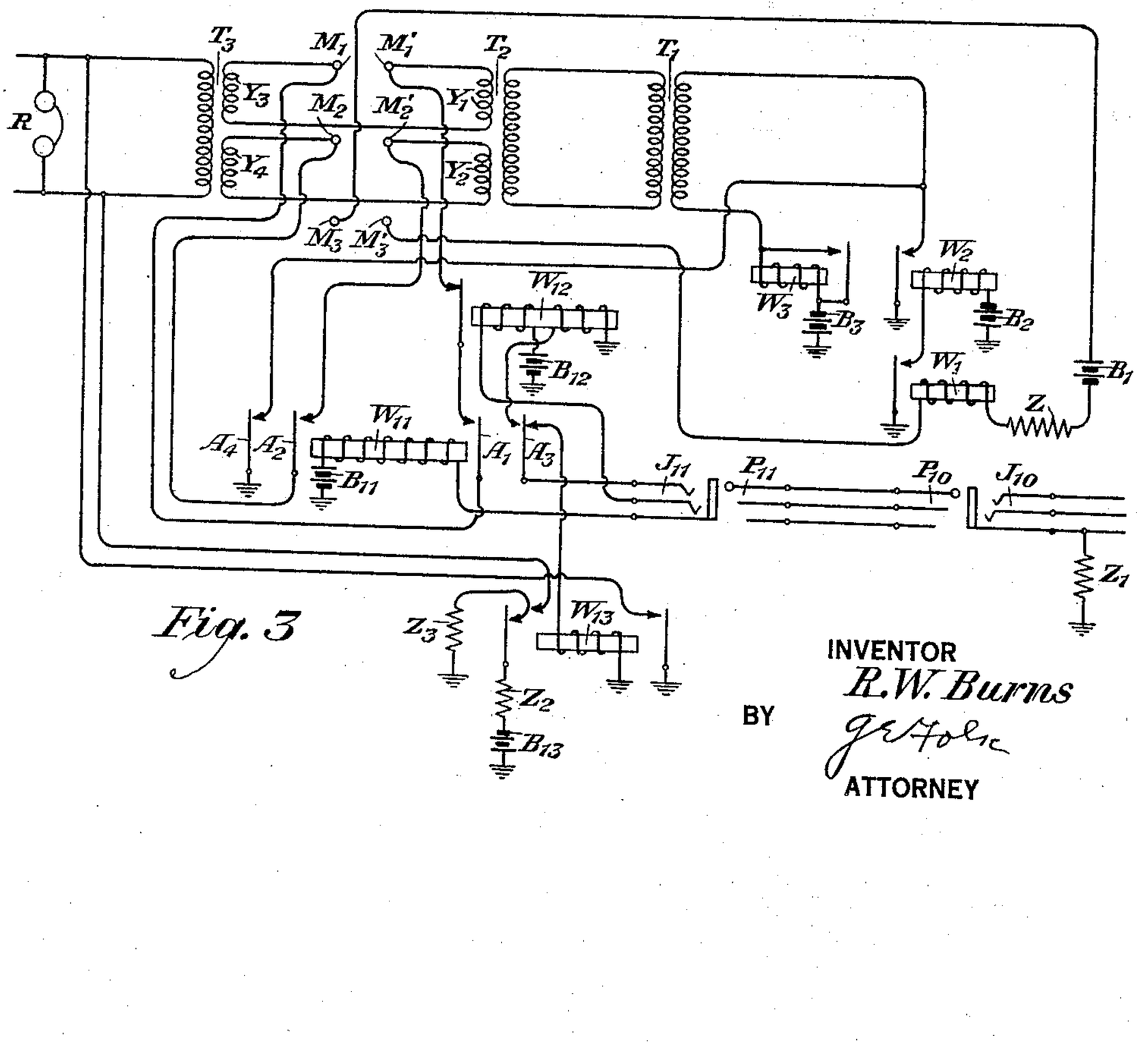

Fig. 3

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UNITED STATES PATENT OFFICE

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TESTING SYSTEM

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This invention relates to testing systems. More particularly, this invention relates to arrangements for testing switchboard jacks.

This invention provides arrangements for testing switchboard jacks. The testing arrangements contemplate the use of a number of gauges in the form of plugs, specially designed and specially built, the elements of which are arranged to make electrical contact with the various jack elements in the same manner as the ordinary switchboard plugs. The plugs used for testing purposes are so designed that if the various jacks make satisfactory contact with them, the jacks will function satisfactorily when engaged with the ordinary switchboard plugs used in the telephone service. The arrangements hereinafter described provide means for producing and transmitting a distinctive signal to one or more maintenance men when any one of the various jacks fail to make satisfactory electrical contact with any one of the testing plugs.

The features of this invention represent great improvements over the jack testing arrangements of the prior art. The means heretofore employed for giving the maintenance man or men an indication of the failure of any one of a plurality of jacks to make satisfactory contact with the elements of a corresponding testing plug, involved the application of tone, i. e. alternating current or its equivalent, to the associated line or trunk circuit or the employment of an electrical condition simulating that of the circuit. Before testing any jack, it was necessary for the maintenance man to determine whether the associated circuit was in use and it was further necessary to remove the circuit from service when the test was being made. These difficulties are obviated in the practice of this invention.

While this invention will be pointed out with particularity in the appended claims, the invention itself, both as to its objects and features, will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawings in which Figure 1 represents an arrangement for determining whether the contacts of a plurality of jacks properly engage the contacts of the plurality of test plugs; Fig. 2 schematically represents the fundamental elements of the invention; and Fig. 3 discloses an arrangement for determining whether or not the tip and ring contacts of any one of the plurality of jacks are short-circuited.

The arrangement shown in Fig. 1 is one in which busy circuits as well as circuits not in use may be tested without taking any circuit out of service if it is idle or without interfering with service if the circuit is busy. This arrangement obviously has distinct advantages over those known in the art especially because the jacks may be tested at any time regardless of whether or not the associated circuits are in use and it is unnecessary for the maintenance man or men to perform tests to determine whether any circuit is busy.

Referring to Fig. 1 of the drawings, the reference characters L_1, L_2, and L_3 represent three conductors forming one of a plurality of groups of conductors wired across a telephone switchboard. Conductors L_1 and L_2 extend well beyond the local exexchange and may, for instance, terminate in a subscriber's line. Conductor L_3 is merely considered a sleeve conductor and may be used only for signaling between various parts of the local office. Conductors L_4, L_5 and L_6, conductors L_7, L_8 and L_9 and conductors L_{10}, L_{11} and L_{12} form three other groups which are similarly wired about the telephone switchboard, all of which, however, are local to the exchange and are used merely for testing purposes.

Two jacks designated J_1 and J_2, as well as numerous others, are connected to the conductors L_1, L_2 and L_3. These jacks are thus ordinarily plugged by the telephone operator in connecting a party's circuit terminating conductors L_1 and L_2 with some other circuit. These jacks may be located at adjoining sections of the switchboard, one or more of which may be placed at each section of the board, all being wired, however, in parallel relationship, as shown.

Jack J_3, as well as a number of other jacks

of similar construction, may be connected to the testing conductors L_4, L_5 and L_6. Jack J_4 represents one of a number of jacks similarly connected to testing conductors L_7, L_8 and L_9. Jacks J_5 and J_6, among others, are connected in parallel relationship to the testing conductors L_{10}, L_{11} and L_{12}.

Plugs P_1 and P_2 which are specially designed for testing purposes may be caused to engage the jacks J_1 and J_2, respectively, and plug P_3 which may be of ordinary design may be caused to engage jack J_3. The tip, ring and sleeve sides of plugs P_1 and P_3 are connected in parallel relationship. The plugs P_4, P_5 and P_6 may be caused to engage jacks J_4, J_5 and J_6, respectively. Plugs P_5 and P_6 may be connected to telephone head sets or receivers R_5 and R_6, respectively.

A key is designated K and this key includes two independently operable switches S_1 and S_2. The tip side of plug P_2 is connected to the movable side of switch S_1. The tip side of plug P_4 is connected to the fixed contact of switch S_1. The ring side of plug P_4 is connected to the movable side of switch S_2. The ring side of plug P_2 is connected to the fixed contact of switch S_2. The sleeve sides of plugs P_2 and P_4 are connected to each other.

The winding of a relay W_1 is connected in series with a resistance Z and a battery B_1 which may be composed of a plurality of dry cells, the series circuit extending between conductors L_6 and L_9. The armature of relay W_1 is grounded and its contact is connected in series with the winding of a relay W_2 and a battery B_2 and ground. The armature of the relay W_2 is also grounded and its contact is connected to one of the terminals of the primary winding of a transformer T_1. The other terminal of this primary winding is connected to the ground through a circuit which includes the winding of a relay W_3 and a battery B_3. The armature of the relay W_3 and its contact shunt the winding of this relay. The secondary winding of the transformer T_1 is connected to the primary winding of a transformer T_2. The latter transformer includes two secondary windings designated Y_1 and Y_2. Y_1 is connected in series with one of the primary windings Y_3 of a transformer T_3, these series windings, however, extending to conductors L_4 and L_7. Winding Y_2 is connected in series with the other primary winding Y_4 of transformer T_3 and these series windings are connected to the conductors L_5 and L_8. The secondary winding of transformer T_3 is connected to the conductors L_{10} and L_{11}.

In operating this arrangement, the plugs P_1, P_2, P_3, P_4, P_5 and P_6 are caused to engage the jacks J_1, J_2, J_3, J_4, J_5 and J_6, respectively. Relay W_1 will operate and it will remain operated while these plugs and jacks are so engaged, current flowing from battery B_1 through resistance Z, the winding of relay W_1, conductor L_9, the sleeve contacts of jack J_4 and the plug P_4, the sleeve contacts of plug P_2 and jack J_2, conductor L_3, the sleeve contacts of jack J_1 and plug P_1, the sleeve contacts of plug P_3 and jack J_3 and conductor L_6. Thereafter relay W_2 will operate and remain operated as long as relay W_1 is operated, current flowing from battery B_2 through the winding of relay W_2, the armature and contact of relay W_1 and ground. Upon the closure of the contact of relay W_2 by its armature, relay W_3 will operate, current flowing from battery B_3 through the winding of relay W_3, the primary winding of the transformer T_1, the armature and contact of relay W_2 and ground. Upon the closure of the contact of relay W_3 by its armature, the winding of relay W_3 will become short-circuited and, therefore, relay W_3 will release. Thereafter, current will flow through the winding of relay W_3 over the circuit just traced, causing this relay to operate, and shortly thereafter this relay again will be released. Thus, it will be apparent that current flowing through the winding of relay W_3 will be regularly interrupted, thereby causing a pulsating direct current to flow through the primary winding of transformer T_1.

The presence of a pulsating current in the primary winding of transformer T_1 will induce alternating voltages in the secondary winding of this transformer and hence an alternating current of definite frequency will flow through the circuit including the secondary winding of transformer T_1 and the primary winding of transformer T_2. If the tip contacts of plugs P_1, P_2, P_3 and P_4 properly engage the tip contacts of the jacks J_1, J_2, J_3 and J_4, alternating current will flow through the windings Y_1 and Y_3, this circuit including, in addition to these windings, conductor L_7, the tip contacts of jack J_4 and plug P_4, the contact of switch S_1, the tip contacts of plug P_2 and jack J_2, conductor L_1, the tip contacts of jack J_1 and plug P_1, the tip contacts of plug P_3 and jack J_3 and conductor L_4. Moreover, if the ring contacts of plugs P_1, P_2, P_3 and P_4 properly engage the ring contacts of jacks J_1, J_2, J_3 and J_4, respectively, alternating current will flow through the windings Y_2 and Y_4, the completed circuit including, in addition to these windings, conductor L_8, the ring contacts of jack J_4 and plug P_4, the contacts of switch S_2, the ring contacts of plug P_2 and jack J_2, conductor L_2, the ring contacts of jack J_1 and plug P_1, the ring contacts of plugs P_3 and jack J_3 and conductor L_5.

Windings Y_3 and Y_4 will be so poled that their effects upon the secondary winding of transformer T_3 will be mutually opposite and, since the amplitudes of the voltages im-

pressed by these windings on the secondary winding of transformer T_3 are equal, substantially no current will flow over the circuit extending from the latter winding to the tip and ring contacts of the jacks J_5 and J_6. Hence, the receivers R_5 and R_6, which are connected in parallel relationship with the tip and ring contacts of jacks J_5 and J_6, respectively, will not be energized. However, if either of the tip contacts of jacks J_1 or J_2 do not make suitable connection with the tip contacts of the plugs P_1 or P_2, current will flow through both of the receivers R_5 and R_6, creating audible signals which notify the maintenance men that there is trouble. Similarly, if either of the ring contacts of the jacks J_1 or J_2 do not make suitable connection with the ring contacts of plugs P_1 or P_2, current will also flow through both of the receivers R_5 and R_6 and similarly attract the attention of the maintenance men.

Whenever a signal is heard at the receivers R_5 and R_6, it will be necessary to determine whether the tip or ring sides of jacks J_1 or J_2 are faulty. Switch S_1 may be opened and if the signal at the receivers R_5 and R_6 persists, there will be positive indication that either of the tip contacts of jacks J_1 or J_2 require adjustment or repair. If, however, the audible signal is removed upon the opening of switch S_1, then switch S_2 will have to be opened and switch S_1 closed. If the audible signal then persists, there will be further indication that the ring sides of either jacks J_1 or J_2 are defective and require adjustment or repair.

Fig. 2 represents a schematic drawing of the circuit arrangement of the invention. Three circuits are here designated "Tip circuit", "Ring circuit" and "Sleeve circuit". These three circuits include, among other things, the tip, ring and sleeve contacts, respectively, of the contacts J_1, J_2, J_3 and J_4, which will be connected to these circuits in the manner shown in Fig. 1.

The completion of the sleeve circuit through battery B and relay W causes an alternating voltage to be applied to the circuit E. This causes alternating current to flow over both tip and ring circuits, the tip circuit including windings Y_1 and Y_3, which form parts of transformers T_2 and T_3, respectively, the ring circuit including windings Y_2 and Y_4 of these respective transformers. Inasmuch as windings Y_3 and Y_4 are oppositely poled, the currents impressed by these windings upon the secondary winding of transformer T_3 will have opposite phases and their effects will neutralize each other. Consequently, the receivers R_5 and R_6 will not be energized by alternating current. If, however, either the tip curcuit or the ring circuit is opened by virtue of a poor contact in one of the associated jacks, current will flow through both of these receivers R_5 and R_6 and thereby create audible signals.

The arrangement shown in Fig. 3 of the drawings may be employed to determine whether or not the tip and ring sides of any one of the various jacks which may be arranged in positions parallel to the jacks J_1 and J_2 of Fig. 1 are short-circuited. This requires a preliminary examination to determine whether or not the line connected to the tip and ring sides of the jacks under test is busy.

Transformers T_1, T_2 and T_3 are connected to each other in the manner shown in Fig. 1. The secondary winding of transformer T_3 is connected to a telephone receiver R. However, the secondary winding Y_1 of transformer T_2 and the primary winding Y_3 of the transformer T_3 are in series with each other in a circuit which includes the armature A_1 of the relay W_{11} and its contact and the armature of the relay W_{12} and its contact. The secondary winding Y_2 of transformer T_2 and the primary winding Y_4 of the transformer T_3 are in series with each other in a circuit which includes the armature A_2 of relay W_{11} and its contact. The points designated M_1, M_2 and M_3 may be considered the tip, ring and sleeve contacts of, for example, the jack J_3 of Fig. 1. Similarly, the points designated M'_1, M'_2 and M'_3 may be considered the tip, ring and sleeve contacts of another jack such, for example, as J_4 of Fig. 1. It is to be noted also that relays W_1, W_2 and W_3 are interconnected in the manner shown in Fig. 1, the winding of relay W_1, however, being connected to the contacts M_3 and M'_3 through a resistance Z and a battery B_1.

The jack J_{10} may be considered the jack under test. The sleeve of this jack is connected to ground through the winding of relay or a resistance Z_1, as shown. The tip, ring and sleeve sides of a plug P_{10} which is specially designed for short-circuiting tests may engage the jack J_{10} and, moreover, another plug P_{11} of ordinary construction may engage a testing jack J_{11}.

To determine whether the line connected to the tip and ring sides of the jack J_{10} is busy, the plug P_{11} will be caused to engage the jack J_{11} and the tip contact of plug P_{10} will be moved to make temporary contact with the sleeve side of jack J_{10}. If the line is busy, current will flow over the circuit which includes the resistance Z_1, the sleeve contact of jack J_{10}, the tip contact of plug P_{10}, the tip contacts of plug P_{11} and jack J_{11}, the armature A_3 of relay W_{11} and its back contact, the winding of a low voltage relay W_{13} and ground. The relay W_{13} will operate under these conditions only if the line is busy and the battery B_{13} and resistances Z_2 and Z_3 will be

connected in series with each other, and, moreover, resistance Z_3 will shunt the receiver R. A click will be heard in the receiver. If the line is not busy, however, no such click will be heard.

After it has been definitely determined that the line is not busy, jack J_{10} may be tested to determine whether or not its tip and ring contacts are short-circuited. The plug P_{10} will then be caused to engage jack J_{10}. Relay W_{11} will operate by virtue of the flow of current from battery B_{11} through a circuit which includes the winding of this relay, the sleeve contacts of jack J_{11} and plug P_{11}, the sleeve contacts of plug P_{10} and jack J_{10}, resistance Z_1 and ground. Thus, the windings Y_2 and Y_4 will be connected in a complete circuit through the armature A_2 of relay W_{11} and its contact. Moreover, the windings Y_1 and Y_3 will be connected in a complete circuit through the armature A_1 of relay W_{11} and its contact and armature of relay W_{12} and its contact.

Inasmuch as the armature A_4 of relay W_{11} grounds one side of the primary winding of transformer T_1 and inasmuch as the other side of this winding is grounded through the winding of relay W_3 and battery B_3, an alternating current will be transmitted through the windings Y_1 and Y_2 to the windings Y_3 and Y_4. If the tip and ring contacts of jack J_{10} are short-circuited, however, a similar current of opposite phase will flow through the windings Y_1 and Y_3 to the receiver R. These currents will neutralize each other and no current will flow through the receiver R. If, however, the tip and ring contacts of jack J_{10} become short-circuited when the plug P_{10} is caused to engage the jack J_{10}, the relay W_{12} will then operate, current flowing from battery B_{12} through the left-hand winding of relay W_{12}, the contact of jack J_{11} and plug P_{11}, the ring contacts of plug P_{10} and jack J_{10}, the tip contacts of jack J_{10} and plug P_{10}, the tip contacts of plug P_{11} and jack J_{11}, the armature A_3 of relay W_{11} and its front contact, the right-hand winding of relay W_{12} and ground. The opening of the circuit to the winding Y_3 at the contact associated with the armature of the relay W_{12} causes current to flow through the secondary winding of transformer T_3 to energize the receiver R.

While this invention has been disclosed in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A testing system including a plurality of jacks to be tested, a plurality of plugs each of which engages one of said jacks, a source of alternating current, a pair of circuits coupled to said source of alternating current, the tip sides of said jacks and said plugs being included in series with each other in one of said circuits, the ring sides of said jacks and plugs being included in series with each other in the other of said circuits, and receiving means coupled to said pair of circuits, said pair of circuits being poled so that their effects on said receiving means will be mutually opposite.

2. A testing system including a plurality of jacks to be tested, a plurality of plugs each of which engages one of said jacks, a source of alternating current, receiving means, a circuit coupling said source of alternating current with said receiving means and including the tip sides of said jacks and plugs in series relationship, another circuit coupling said source of alternating current with said receiving means and including ring sides of said jacks and plugs in series relationship, and means connected to both of said circuits to open either of them.

3. The combination of a plurality of jacks, a plurality of plugs, each jack and each plug having tip, ring and sleeve contacts, apparatus including the sleeve contacts of all of said plugs and jacks for producing pulsating currents, a first circuit coupled to said apparatus and including the tip contacts of all of said plugs and jacks for deriving alternating current of one phase, a second circuit coupled to said apparatus and including the ring contacts of all of said plugs and jacks for deriving alternating current of opposite phase, and receiving means coupled to said first and second circuits.

4. The combination of a receiver, a plurality of jacks to be tested, a plurality of test plugs, a source of alternating potential, a first circuit including one of the contacts of each of said plugs and the corresponding contact of each of said jacks and coupling said receiver with said source, and a second circuit including another of the contacts of each of said plugs and corresponding contact of each of said jacks also coupling said receiver with said source.

In testimony whereof, I have signed my name to this specification this 7th day of October 1930.

ROY W. BURNS.