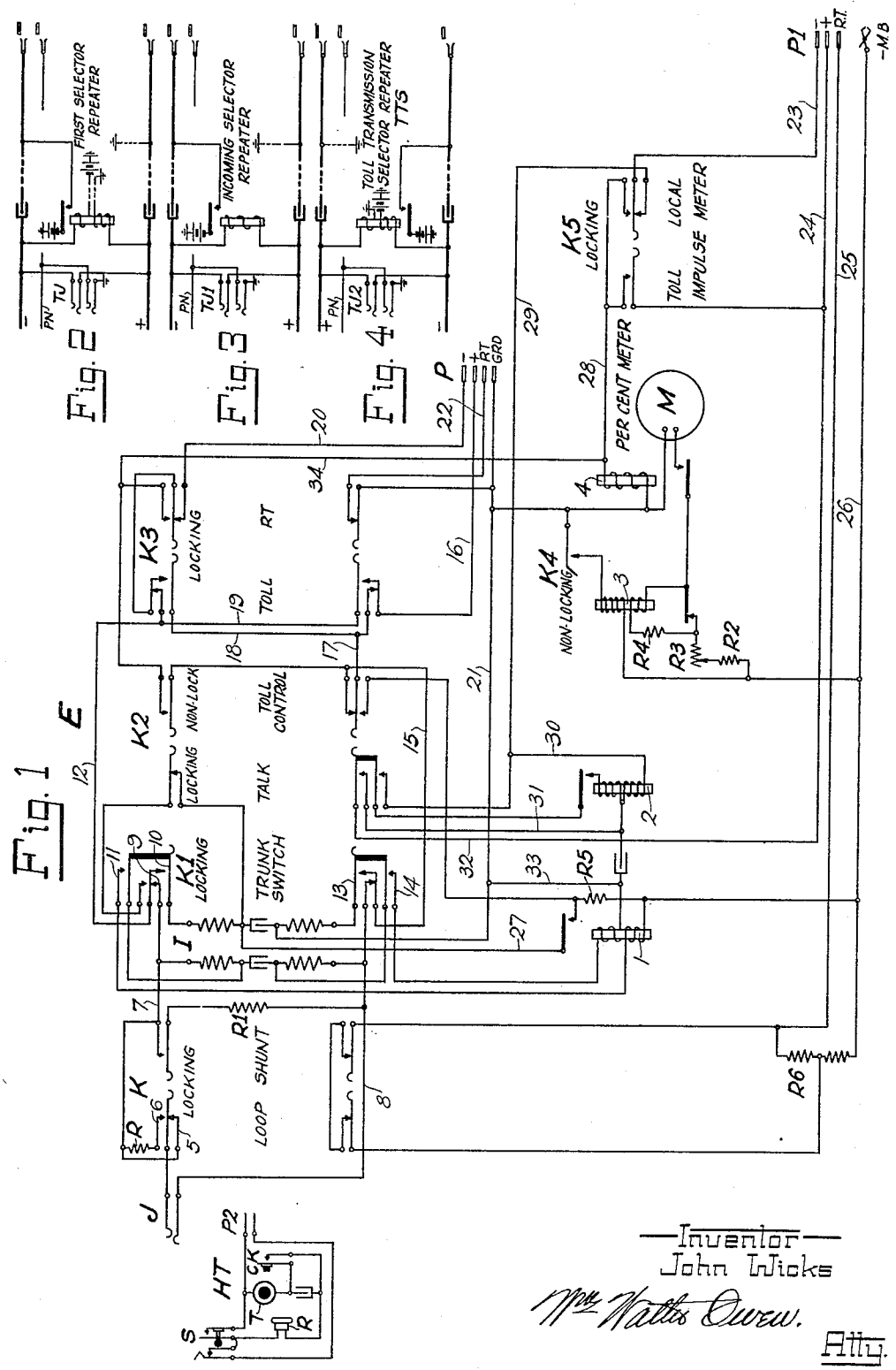
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TESTING EQUIPMENT

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TESTING EQUIPMENT

Application filed April 28, 1930. Serial No. 447,849.

My present invention relates to testing equipment in general, but more particularly to testing equipment applicable to the testing of automatic telephone apparatus, and the principal object, briefly stated, is the provision of such testing equipment embodying those novel features necessary to make the testing equipment suitable for the testing of automatic switches known, by those familiar with automatic telephony, as selector-repeaters, and particularly those selector-repeaters employed in what are commonly known as battery-loop-impulsing telephone systems. Systems of this character are shown and described in my co-pending application, Serial No. 395,882, filed September 28, 1929, and in my Patent No. 1,778,204, granted Oct. 14, 1930.

Although the features of my invention are not being specifically mentioned herein, they will be apparent after a study of the detailed description of my invention as depicted by means of the usual circuit diagrams and symbols in the accompanying single sheet of drawings comprising Figs. 1 to 4, inclusive, in which:

Fig. 1 is a representation of the testing equipment of my invention, suitable for testing various types of selector-repeaters, some of which are shown in Figs. 2, 3 and 4;

Fig. 2 is a representation of the selector-repeater, termed the "first selector repeater" in my Patent No. 1,778,204, granted Oct. 14, 1930, showing the battery and ground connections to the line relay, and the battery impulse-repeating contacts;

Fig. 3 is a representation of the selector-repeater, termed in my Patent No. 1,778,204, the "incoming selector repeater", showing the line relay thereof bridged across the incoming trunk conductors, and the battery impulse-repeating contacts of that relay; and

Fig. 4 is a representation of the selector-repeater in the toll system shown in my application, Serial No. 395,882, filed September 28, 1929, which repeater is termed the "toll transmission selector" and is designated "TTS", showing the battery and ground connections to the line relay, and the battery impulse-repeating contacts of that relay. It will be noted that the battery and ground connections of this line relay are reversed to those in Fig. 2 and that the impulse-repeating contacts connect battery to the lower talking conductor.

It has been found preferable to arrange the testing equipment of Fig. 1 as a portable unit. In order to obtain connection with the selector-repeater to be tested, the portable unit E has been provided with the plugs P and P1. Plug P cooperates with the test jack TJ of the selector-repeater to connect the sending end, or dialling circuit, of the testing equipment to the selector-repeater, and the plug P1 cooperates with the contacts of the test level in the switch bank to connect the receiving end, or impulse receiving circuit of the testing equipment with the selector-repeater.

Rather than equip the portable unit with an impulse sender, or calling device, and a transmitter and receiver, use is made of a well known hand test telephone, designated in Fig. 1 as HT, having the calling device S, the receiver R, the transmitter T, and the circuit key, or push button CK. A hand telephone of this type is shown and described in United States Letters Patent, No. 1,613,581, issued January 11, 1927, to Hans Sengebusch. This hand telephone is provided with the connecting plug P2 which cooperates with the jack J of the testing equipment to afford connection of the hand telephone HT to the testing equipment E.

The testing equipment E, Fig. 1, is provided with several keys designated K to K5, inclusive. Of these, keys K, K3 and K5 are of the well-known type wherein the handle normally stands in a neutral position with respect to its left-hand and right-hand contacts, which handle is capable of being moved either to the left or to the right to operate only the left-hand contacts or only the right-hand contacts, respectively, and which handle remains in the position to which it is moved. This feature of the keys is designated on the drawings by the legend "Locking" to denote that these keys remain in whichever position they are placed. Key K1 is similar to the other keys, except that it has contacts only on one side. Consequently, the handle of key

K1 need move in one direction only. Key K2 is similar to the two-way movement keys K, K3 and K5, differing therefrom only in that the key handle when moved to the right does not remain locked in that position. This arrangement is designated on the drawings by the legend "Non-locking". Key K4 is capable of being operated in only one direction and is of the non-locking type of key.

The principal test to be performed by the testing equipment E on a selector-repeater is a test of the ratio of the impulses repeated by the selector-repeater. By this impulse ratio is meant the percentage of the time during which the impulse-repeating springs are in engagement with each other as compared with the percentage of time during which the impulse-repeating springs are separated from each other. To those familiar with automatic telephony, these percent ratios are known as the "percent make" and the "percent break", and they will be referred to hereinafter by that nomenclature.

In order to determine the impulse ratio of the impulses repeated by the line relay of the selector-repeater the testing equipment E has been provided with what is commonly termed a percent meter, this meter being designated as M. This meter M is of the voltmeter-type and has its scale divided into one-hundred equal parts to designate percentage. The meter M does not measure the percent make of the impulse contacts of the line relay of the selector-repeater direct, but measures, rather, the percent make of the springs of the relay 4 which, as will be explained hereinafter, follows the impulses delivered by the selector-repeater under test when the testing equipment is connected to that selector-repeater.

It will be assumed that the first selector-repeater to be tested is that shown in Fig. 2. Plug P is thereupon inserted in the test jack TJ and ground on the lower jack-contact is thereby connected to conductor 21 of the testing equipment. This ground is extended by way of the lower-closed-right-hand contacts of key K3, through release trunk conductor 22, and the contact RT of the plug P, and thence by the corresponding contact of the test jack TJ to the private conductor PN of the selector-repeater to mark that switch busy in the banks of the switches having access to it, to which banks the conductor PN is multiply connected.

The plug P1 is then connected to a set of bank contacts in the test-level of the "first selector repeater" and the negative main battery conductor 26, by means of the clip at its end, is connected to a convenient battery terminal on the selector board, for instance, a battery contact in the shelf jack of the switch.

If the plug P2 of the hand telephone HT is not already in the jack J of the testing equipment E, it will now be inserted. The attendant now presses the circuit key CK, thereby closing the loop circuit of the line relay of the "first selector repeater" in Fig. 2 to which the testing equipment has been connected. This circuit may be traced from ground through the lower winding of the line relay of the selector-repeater, and thence by way of that contact of the test jack TJ connected to the positive line-conductor of the "first selector repeater", positive terminal of the plug P, conductor 16, lower-left-hand, normally-closed contacts of key K3, conductor 17, lower-right-hand closed contacts of key K2, conductor 17, lower normally-closed contacts of key K1, conductor 8, lower jack-contact of jack J, lower plug-contact of plug P2, the left-hand normally-closed springs of the calling device S, which are the impulse springs, receiver R, contacts of circuit key CK, transmitter T, upper plug-contact of plug P2, upper jack-contact of jack J, upper-left-hand normally-closed springs 5 of key K, conductor 7, normally-closed upper springs 9 of K1, conductor 12, upper-left-hand normally-closed springs of key K3, upper-right-hand normally-closed springs of key K3, conductor 20, negative contact of plug P, and corresponding contact in jack TJ, and thence through the upper winding of the line relay of the "first selector repeater" to battery. The line relay of the "first selector repeater" operates in this circuit and in the usual manner completes the circuit for the release relay (not shown) to prepare the switch for operation.

The attendant next operates the calling-device S to transmit a number of impulses to the line relay of the "first selector repeater", which impulses, in loop-pulsing systems, are interruptions in the circuit of the energized line relay, in order to cause the "first selector repeater" to elevate its wipers a number of steps in accordance with the impulses received, which in this case will be sufficient to elevate the wipers opposite that level of bank contacts reserved for testing, and to then automatically rotate its wipers into engagement with the contacts in the test level.

A feature of selector-repeaters of this type is that, in order for the selector to switch-through when its wipers are moved into engagement with a set of contacts to which is connected to the trunk leading to an idle succeeding switch, the private wiper of the selector must encounter battery potential upon the test contact. In the test level, the battery potential for this switch-through operation of the selector is supplied from the negative main battery by way of conductor 26, lower half of resistance element R6, normally-closed lower-left-hand and right-hand contacts of the key K, conductor 25, plug-contact RT of plug P1, to the test contact of the test level. Therefore, when the wipers of the "first selector repeater" have been rotated into engagement with a set of contacts in the

test level of the switch bank, the private wiper encounters this battery potential and the "first selector repeater" switches through. When this switch-through operation takes place, battery and ground are connected, respectively, to the negative and positive bank contacts with which the negative and positive wipers of the selector-repeater are in engagement. This battery is supplied through the impulse-repeating contacts of the line relay and serves as the battery supply for operating the line relay of the "intermediate selector" and finally the "connector" in the system in which the "first selector repeater" of Fig. 2 is used.

The attendant, if he has not already done so, now operates the key K5 to the right to connect the negative conductor 23 to conductor 28. Therefore, when the selector-repeater switches-through the battery from the impulse-repeating contacts of the line relay will be extended from the negative bank contact in the test level, over negative contact of plug P1, conductor 23, operated right-hand contacts of key K5, conductor 28, winding of relay 4, to grounded conductor 21. Relay 4 operates in this circuit and, at its armature and make contact, completes a circuit through the percent meter M from grounded conductor 21, meter M, make contact and armature of relay 4, armature and resting contact of relay 3, variable resistance element R3, resistance element R2, to battery conductor 26. Inasmuch as the current is flowing continuously through the meter M as long as relay 4 remains operated, the needle of the meter M should be in position to point to the one-hundred mark on the meter. In order to set the needle accurately, resistance element R3 has been furnished as a variable resistance.

Now, if the calling-device S should again be operated, the line relay of the "first selector repeater" will again follow the impulses. This time, however, instead of operating a succeeding switch, it removes battery a number of times from the conductor 23 in accordance with the number of impulses delivered thereto. Relay 4 deenergizes with each battery removal and remains deenergized as long as it receives no battery over conductor 23. With the first deenergization of relay 4, the circuit of the percent meter M is opened and the needle thereof commences its movement to its zero position.

If the needle of the meter M is standing in its one-hundred-percent position when the circuit through the meter is opened, the needle would not have time to complete its movement to its zero position before the circuit through the meter will again be closed, because the interruptions or impulses delivered by the calling-device S to the line relay of the "first selector repeater" are delivered at the rate of ten impulses per second. However, if impulses were delivered continuously to the line relay at the rate of ten per second, the needle of the percent meter M would gradually move towards its zero position until it assumes an intermediate position indicative of the percent make of the impulse repeating springs of the line relay of the first selector repeater. Inasmuch as the calling-device S is capable of transmitting a maximum number of ten impulses, the needle of the meter M would not have time to complete its movement towards the the proper indicating position before the transmission of impulses would be completed by the calling-device S. Therefore, an arrangement has been provided to cause the needle of the percent meter M to assume a position approximate to what should be the percent make of the impulse repeating springs of the "first selector repeater", just before that selector-repeater is caused to repeat the impulses.

This is accomplished by the attendant by the depression of the non-locking key K4 when the calling-device S is turned in its off-normal movement and by the release of the key K4 when the calling-device S is allowed to commence its return to normal movement. Operation of the key K4 completes the circuit for the upper winding of relay 3 from grounded conductor 21, operated contacts of key K4, upper winding of relay 3, to battery conductor 26.

Relay 3 operates in this circuit and attracts its armature, thereby removing the shunt about its lower winding and the resistance element R4, including that resistance element and its lower winding in the circuit of the percent meter M in series with the variable resistance element R3 and the resistance element R2. This added resistance in the circuit of the meter M reduces the amount of current flowing therethrough and causes the needle to assume an intermediate position.

When the dial, or calling-device, S is now allowed to move to its normal position to deliver the impulses to the line relay of the selector-repeater in the well-known manner, the key K4 is released and the circuit of the upper winding of the relay 3 is opened. The relay 3 deenergizes, therefore, and excludes the resistance element R4 and the lower winding of the relay from the circuit of the meter. At this time, however, the relay 4 has started to follow the impulses repeated by the line relay of the "first selector repeater" and the circuit of the meter M will be opened and closed a number of times in rapid succession. The needle of the meter M, when the relay 4 falls back to open the circuit of the meter, tends to drop from its intermediate position to its zero position, but, before it can do so, the circuit of the meter M is again closed and the needle of the meter tends to rise again to the one-hundred-percent position. However, the repeated opening and closing

of the meter circuit causes the needle to hover around the point in the scale which is indicative of the percent make of the contact of the relay 4 until the impulses cease.

This percent make of the contacts of the relay 4 corresponds to the percent make of the impulse repeating contact of the line relay of the "first selector repeater". Therefore, if the percent make is not of the proper amount, the contacts of the line relay are adjusted and the test repeated until the desired percent make is obtained.

In the test described, the loop of the line relay of the "first selector repeater" is practically of zero resistance. Under normal working conditions, the line relay of the "first selector repeater" must operate over lines which may have a maximum resistance of one-thousand ohms and over lines which may be shunted by a resistance of ten-thousand ohms. In order to simulate these operating conditions, resistance elements R and R1 have been provided. Operation of key K to the left includes the resistance element R in series with loop of the line relay of the "first selector repeater" and operation of the key K to the right places a shunt across the loop conductors 7 and 8, which shunt includes the resistance element R1. Therefore, the attendant by operation of the key K first to the left and thence to the right may operate the "first selector repeater" with the resistance included in series with the loop and then with the resistance in shunt of the loop to determine that the impulses repeated by the line relay under these conditions are of the proper percent make.

In order to test the talking qualities of the "first selector repeater", the attendant restores the key K5 to its intermediate position and then operates the key K2 to the left. This operation completes the following circuit: from battery through the impulse-repeating contacts of the line relay of the "first selector repeater" and the negative bank-contact and negative contact of plug P1 to conductor 23, normally-closed right-hand contacts of key K5, conductor 29, conductor 30, lower winding of relay 2, conductor 31, lower-left-hand operated contacts of key K2, conductor 32, conductor 24, positive contact of plug P1, positive bank-contact of the selector and the positive wiper in engagement therewith, to ground, over the positive talking conductor. Relay 2 operates in this circuit and by attracting its armature into engagement with its make contact, completes the circuit for its upper winding from battery on conductor 29 over the previously traced circuit, through lower-left-hand operated contacts of key K2, armature and make contact of relay 2, to ground in parallel with its lower winding. The upper and lower windings of the relay 2 are in opposition to each other, so that when both of the windings are energized they neutralize each other and the relay then retracts its armature, opening the circuit of its upper winding. As soon as this takes place, the lower winding again energizes sufficiently to attract the armature again and the same cycle of operation is repeated over and over again as long as the key K2 remains in the left-hand operated position. This operation of relay 2 generates a buzzing sound which can be heard by the attendant through the receiver R of the hand telephone HT, the sound being transmitted to the receiver R, over the talking circuit of the "first selector repeater".

Since the line relay of the "incoming selector repeater" of Fig. 3 obtains its battery and ground from the preceding switch, it will be necessary to supply this battery and ground from the testing equipment in order to operate that switch when the equipment is connected to the "incoming selector repeater" as it was connected to the selector-repeater of Fig. 2. This is accomplished by the operation of key K1 by the attendant.

When the key K1 is operated, the following circuit is completed: from grounded conductor 21, conductor 33, upper winding of relay 1, operated contacts 14 of key K1, lower-left-hand winding of the repeating coil I, conductor 8, lower jack-contact of jack J, through the hand telephone set HT, as before described, upper jack-contact of jack J, normally-closed contacts 5 of key K, conductor 7, upper-left-hand winding of repeating coil I, operated-spring-contacts 11 of key K1, lower winding of relay 1, to battery conductor 26.

Relay 1 operates in this circuit and attracts its armature into engagement with its make contact thereby completing the following circuit for the line relay of the "incoming selector repeater", Fig. 3, to which the testing equipment E is now assumed to be connected: grounded conductor 21, lower-right-hand winding of repeating coil I, operated contacts 13 of key K1, conductor 15, lower-right-hand normally-closed springs of key K2, conductor 17, lower-left-hand normally-closed springs of key K3, conductor 16, positive terminal of plug P, corresponding contact of jack TJ1, positive conductor of the "incoming selector repeater", winding of the line relay, negative line conductor of the "incoming selector repeater", contact of test jack TJL connected to the negative line conductor, negative contact of plug P, conductor 20, upper-right-hand normally-closed contacts of key K3, and upper-left-hand normally-closed contacts of the same key, conductor 12, operated contacts 10 of key K1, upper-right-hand winding of repeating coil I, conductor 27, armature and make contact of relay 1, resistance element R5, to battery on conductor 26. The line relay of the "incoming selector repeater" energizes in this circuit and prepares the "incoming selector repeater" for operation.

Relay 1 follows the impulses delivered by the calling-device S under these conditions and at its armature repeats the impulses to the line relay of the "incoming selector repeater". The first operation of the calling-device S causes the "incoming selector repeater" to operate to raise its wipers in the usual manner and to then rotate them to connect the "incoming selector repeater" with the testing equipment E through the bank contact of the test level and the plug P1. Further impulses to the line relay of the "incoming selector repeater" cause that relay to repeat the impulses into the testing equipment E wherein they may be tested as described in connection with the "first selector repeater". The test for the talking qualities of the "incoming selector repeater" may be performed as described in connection with the "first selector repeater" by the operation of the key K2 to the left, or "talk" position.

When the testing equipment E is connected to the "toll transmission selector repeater TTS", Fig. 4, it will be necessary for the attendant to operate the key K3 to the left to reverse the connection of the testing equipment to the negative and positive conductors of the "toll transmission selector repeater" because of the reverse connection of the battery and ground to the terminals of the line relay. By the operation of key K3 the conductor 12, instead of being connected through the upper-left-hand and right-hand normally-closed contacts of that key to conductor 20, is connected through the lower-left-hand operated contacts of that key to conductor 16, and conductor 15, instead of being connected through the lower-left-hand normally-engaged contacts of key K3 to conductor 16, is connected through upper-left-hand operated contacts and upper-right-hand normally-engaged contacts of the key K3 to the conductor 20, thus performing a reversal of the connection of the testing equipment to the "toll transmission selector repeater".

When the "toll transmission selector repeater" has been operated to position its wipers into engagement with the contacts of its test level to which the contacts of plug P1 have been connected, battery is connected this time to conductor 24 of the testing equipment rather than to conductor 23 as by the other selector-repeaters. This time when key K5 is operated, it is operated to the left, instead of to the right, to connect the winding of relay 4 to conductor 24, instead of to conductor 23.

The "toll transmission selector repeater" may now be tested in the same manner as was the "first selector repeater".

Although the operation of the calling-device S, the relay 1, and the relay 4 are known to be correct before the testing of any of the switches takes place, after a large number of the selector-repeaters have been tested, or for any other reason, the operation of the relay 1 and the relay 4 may be tested by the testing equipment itself in much the same manner as a selector-repeater is tested. To perform these tests, the plug P is inserted in a test jack, such as TJ, to furnish battery and ground connection to the testing equipment, but the plug P1 is not connected to the contacts in the test level of the switch bank. The conductor 26 may be connected to negative main battery at any desirable point.

When it is desired to adjust contact springs of the relay 4 to the percent make of the impulse springs of the calling-device S when it is known that the adjustment of the impulse springs of that device is correct, the key K2 is operated to the right. When this operation takes place, battery from the upper winding of the line relay of the selector-repeater in whose test jack the plug P is inserted, is extended over the circuit before described to the upper jack terminal of jack J, and through the hand telephone HT, and then over conductor 8 and conductor 15 to the upper-right-hand operated contacts of key K2, and thence over conductor 34 and through the winding of the relay 4 to ground on conductor 21. Relay 4 will operate in this circuit and will follow the interruptions therein corresponding to the impulses of the calling-device S. The key K4 will be operated as before, just before the delivery of impulses to the relay 4, so that the needle of the percent meter M will assume an intermediate position in order to indicate the true percent make of the contact of the relay 4 when the calling-device S is operated.

When it is desired to test the percent make of the impulses delivered by the relay 1, the key K1 is operated to operate the relay 1, as before described, and the key K3 is operated to the right. This operation of the key K3 to the right connects the conductor 12 to conductor 34 and disconnects the conductor 12 from the conductor 20, thereby supplying battery through the armature and make contact of the relay 1, to the winding of the relay 4 instead of to the winding of the line relay of the selector-repeater to which it would normally be supplied. Relay 4 will thereupon operate and will thereafter respond to the impulses delivered by the relay 1 under control of the calling-device S. In this manner the percent make of the impulses delivered by the relay 1 may be measured and necessary adjustments made to the impulse springs of the relay 1 if they are found to be incorrectly adjusted.

Having thus described my invention, what I consider new and what I desire to have protected by Letter Patent will be pointed out in the appended claims.

What is claimed is:

1. Testing apparatus for testing the impulse-repeating characteristics of repeater

switches, some of which switches repeat impulses of a polarity reversed with respect to the others, said apparatus including testing equipment, means for connecting said equipment with any one of said switches, means for transmitting impulses to the connected switch to cause it to repeat impulses to the testing equipment, and means to adapt the testing equipment to test repeated impulses of either polarity.

2. Testing apparatus for testing the impulse-repeating characteristics of repeater switches, some of which switches repeat impulses reversed in polarity with respect to those repeated by the other switches, said apparatus comprising testing equipment having a circuit for receiving repeated impulse, means for connecting said equipment to one of the repeater switches, means for transmitting impulses to the connected switch to cause it to repeat impulses over said receiving circuit to said equipment, and means for altering said receiving circuit in accordance with the polarity of the impulse repeated by the connected switch.

3. Testing apparatus for testing the characteristics of the impulses repeated by impulse repeaters having different types of impulse receiving circuits, said apparatus comprising impulse testing equipment, an impulse delivering circuit including impulse-generating means, an impulse receiving circuit for delivering repeated impulses to be tested to said equipment, means for connecting said two circuits to a repeater to be tested, and means for adapting said impulse delivering circuit to the type of impulse receiving circuit of the connected repeater, said equipment thereafter testing the impulses repeated by the connected repeater responsive to the impulses delivered to the repeater.

4. Testing apparatus for testing the characteristics of impulses repeated by impulse repeaters of different types, said apparatus comprising testing equipment having an impulse-delivering circuit and an impulse-receiving circuit, means for associating said equipment with any one of said repeaters, means for adapting said circuits to the type of repeater with which said equipment is associated, and means for transmitting impulses over said delivering circuit to the associated repeater to cause it to repeat impulses to said equipment over said receiving circuit, said equipment thereupon testing the repeated impulses.

5. Testing apparatus for testing impulse repeaters of different types as used in automatic telephone systems, said apparatus comprising testing equipment having a control circuit and a receiving circuit, means for associating said equipment with any one of said repeaters, means for altering said circuits in accordance with the type of repeater with which said equipment is associated, means for transmitting impulses over said control circuit to cause the associated repeater to repeat the impulses over said receiving circuit to said equipment, said equipment thereupon testing the repeated impulses, and means rendered effective at will when said equipment is ineffective for transmitting a tone over said receiving circuit and through said repeater to said control circuit to test the talking circuit through said repeater.

In witness whereof, I hereunto subscribe my name this 23d day of April, A. D., 1930.

JOHN WICKS.