(No Model.) 3 Sheets—Sheet 1.

W. D. ALLISON.

TEST SYSTEM FOR MULTIPLE SWITCHBOARDS.

No. 503,115. Patented Aug. 15, 1893.

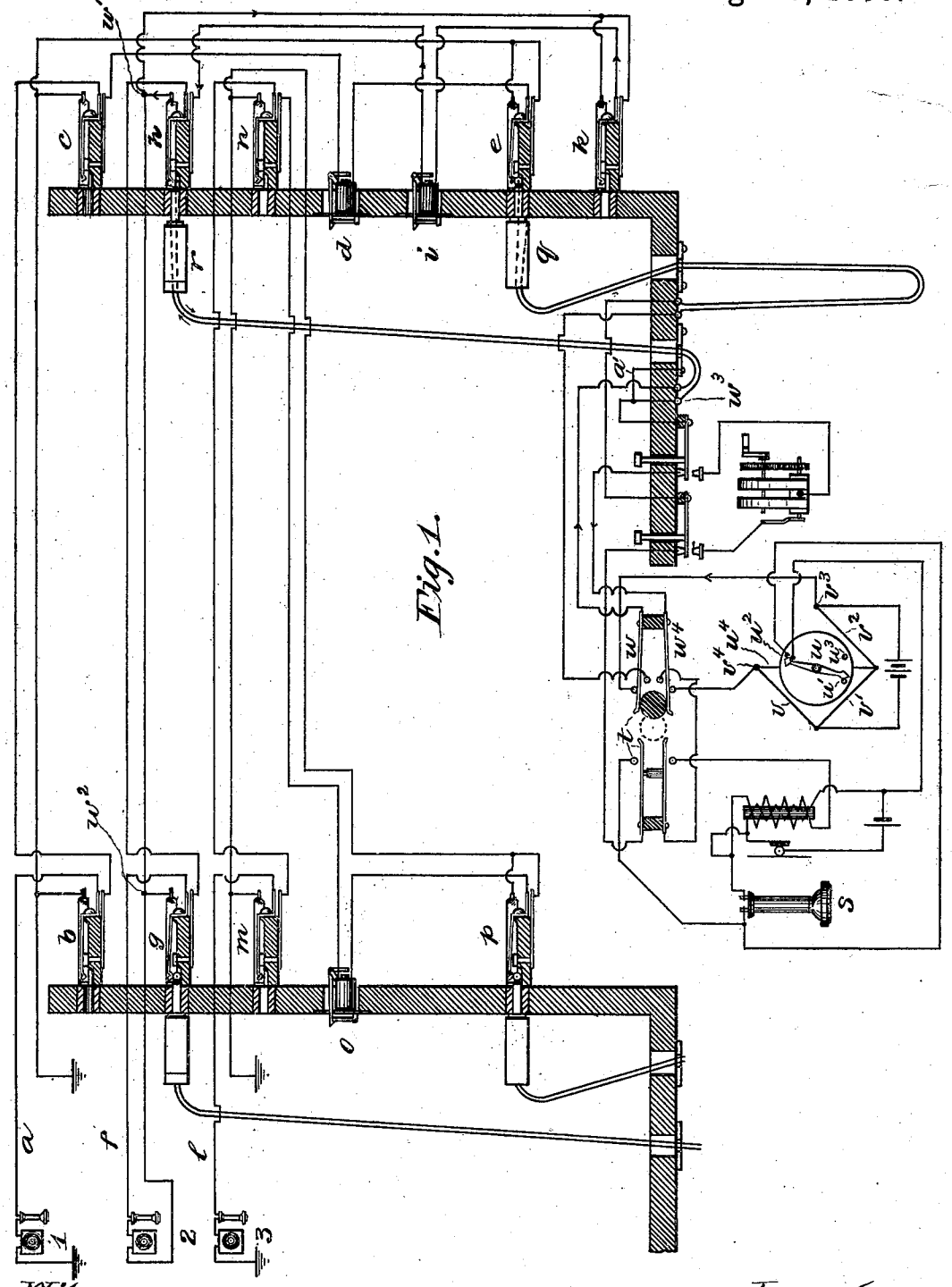

Fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

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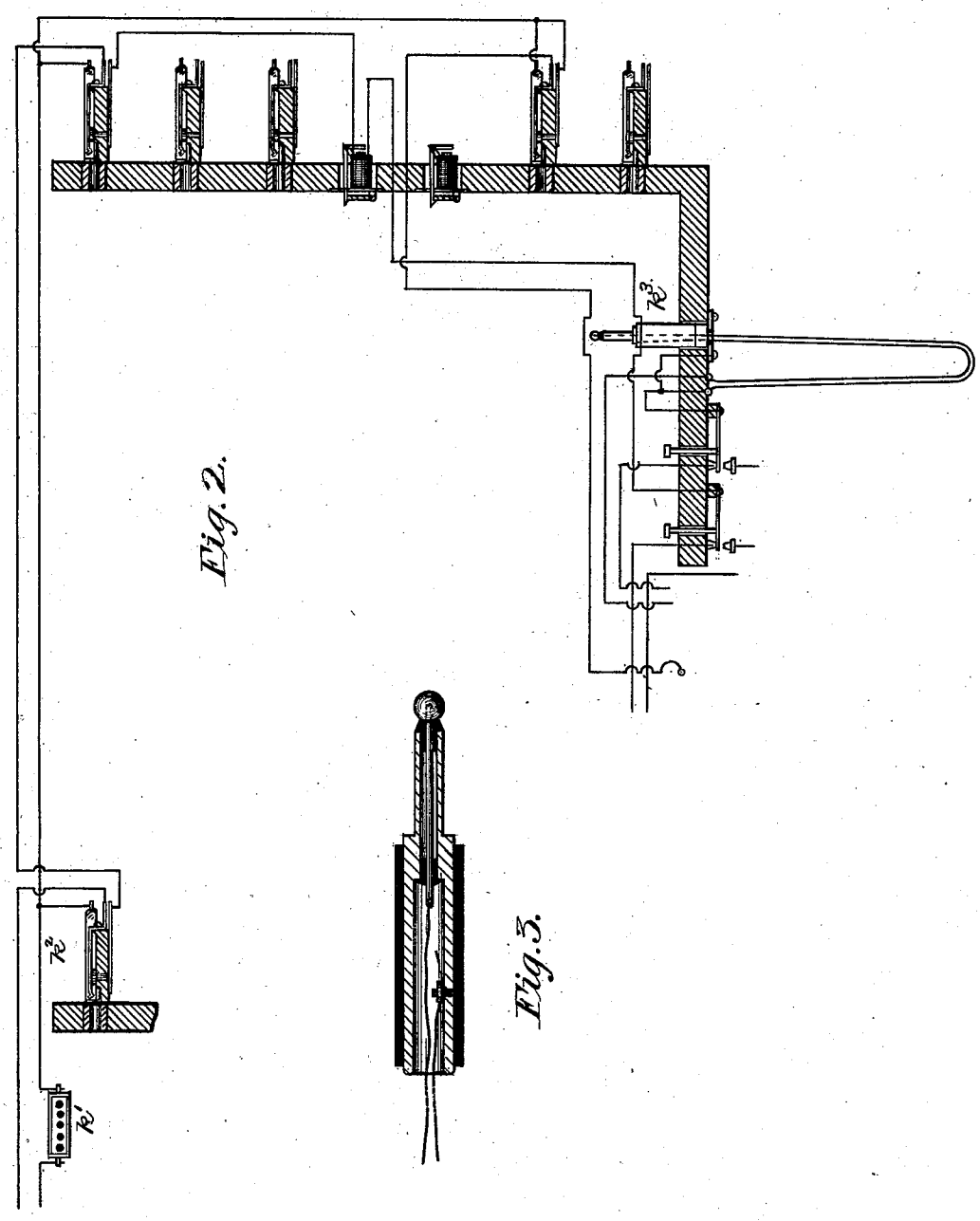

Fig. 2.

Fig. 3.

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(No Model.) 3 Sheets—Sheet 3.

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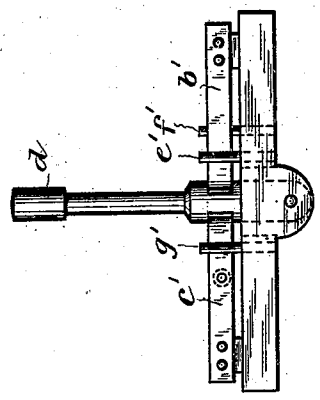

Fig. 4.

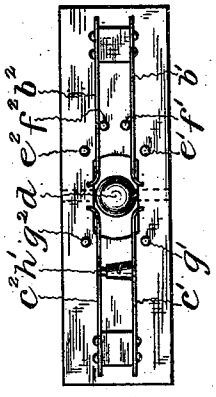

Fig. 5.

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UNITED STATES PATENT OFFICE.

WILLIAM D. ALLISON, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN ELECTRIC COMPANY, OF SAME PLACE.

TEST SYSTEM FOR MULTIPLE SWITCHBOARDS.

SPECIFICATION forming part of Letters Patent No. 503,115, dated August 15, 1893.

Application filed May 14, 1888. Serial No. 273,858. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM D. ALLISON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Test Systems for Multiple Switchboards, (Case No. 1,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to multiple switchboard systems of a telephone exchange, and its object is to provide ready means for testing to determine whether a line called for at one board is connected or in use at any other of the boards. Heretofore various systems of testing have been employed, which systems have been successful as applied to exchanges in which the telephone lines are single wires or grounded lines. It has, however, been found desirable to employ metallic circuits in telephone exchanges for reasons well understood by those skilled in the art. Owing to the large number of wires necessarily employed in metallic circuit systems, it has been found quite difficult to provide suitable and satisfactory means of testing to determine whether a line called for is busy; or, in other words, to find out the electrical condition of any line, as, for example, whether a given line is connected or in use at any other board, or whether the subscriber's telephone of the line tested is hung upon, or removed from, the telephone switch of the subscriber's station of the line.

In exchanges embodying both metallic circuits and single wire circuits, it is necessary and desirable to employ a test which may be the same with respect to all of the different circuits.

My invention, herein, is especially designed for such mixed systems of multiple switchboard exchanges.

The novelty of my invention consists, speaking generally, in a Wheatstone bridge, or some similar indicating device, and circuits so arranged with respect to resistance, that when the test is made the current will be sent through the cross wire or galvanometer of the bridge in one direction, if the line is in one electrical condition, and through the cross wire of the bridge in the other direction, if the line is in its other electrical condition.

It consists, also, in the construction of the listening-in key and certain details of construction of the apparatus, which will be hereinafter particularly described and claimed.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a diagram showing three telephone lines connected with two different sections of a multiple switchboard, one of said lines being metallic and the others being single or grounded telephone lines, the connecting, receiving, testing and signaling apparatus being shown at one of the switchboards. Fig. 2 is a diagram illustrating my invention as used in connection with a single cord system, in which the telephone lines terminate at the central office in a flexible cord and terminal plug. Fig. 3 is a detailed view of one of the loop plugs provided with a metallic heel, the heel being in connection with the sleeve of the plug. Figs. 4 and 5 are detail views of the listening-in key or loop key which I preferably use in connection with my test system.

Like parts are indicated by similar letters and numerals of reference throughout the different figures.

I will first describe my invention as illustrated in Fig. 1.

The manner of running the circuits of the telephone lines is well known. Thus ground circuit *a* may be traced from ground at subscriber's station 1 to its springjack *b* upon the first section of the board through the spring and contact of said springjack switch, and thence to its springjack switch *c* upon the next section of the switchboard in the same manner through the spring and contact of said switch, and thence through the individual annunciator *d* of the line, preferably through an answering springjack *e* and from the contact of said answering springjack to the frame or test piece of said answering springjack switch. Thence the circuit may be traced back to the frames or test pieces of the other springjack switches of the line *c*, *b*, and thence to ground at the central office. The metallic telephone line circuit *f* may be traced from station 2 through the springjack

switch g upon the first section of the board, and thence through the springjack switch h upon the second section of the board, and thence through the individual annunciator i, and thence through answering spring-jack k, and from the contact point of answering springjack k to the frame or test piece of the answering springjack and thence to the test piece of springjack switch h and thence to the test piece of springjack g, and thence to the subscriber's station 2, thus completing the metallic circuit.

It will be observed that the single circuit a is grounded at the subscriber's station 1 and at the central office, while metallic circuit f, instead of passing to ground at the central office, extends to the subscriber's station 2. In other respects the connections of the two lines are the same.

The telephone line l extends from ground at station 3 to the central office through springjack switches m and n of the different boards, thence through individual annunciator o and answering springjack p and thence to the test pieces of springjack switches p, n, m, and thence to ground in the same manner as heretofore described with respect to telephone line a.

At board 1 the lines f and l are shown looped together between springjack switches g and p. At the second board one plug q of a pair is shown inserted in answering springjack e of line a. The other plug r of the pair is shown partially inserted in springjack h as in the act of testing, the tip of this plug being in contact with the spring of switch h, the spring, however, remaining in its normal position, resting against its contact. This is the position of the plugs q, r, when a call has been made over line a and answered by the central office, and the line called for is being tested; that is to say, subscriber at station 1 sends current to line throwing down shutter d. Thereupon the operator inserts plug q in answering springjack e. When plug q is thus inserted, the operator's telephone s, by means of the listening-in key or switch t, is brought into the circuit of line a, plug r resting meanwhile with its metallic heel upon the metallic plate of its socket. The operator listening at telephone s is informed by the subscriber at station 1 what other line is wanted, and thereupon she lifts plug r from its socket and inserts the same, as shown, into the switch of the line called for, the plug, however, being inserted only far enough to close contact between the spring of the switch and the tip of the plug. When plug r is thus inserted in the switch of the line called for, an indication is made, whereby the operator may know the electrical condition of the line tested; that is to say, whether or not the line is connected at any other switch of the line.

The indicator which I use is a Wheatstone bridge or balance u. The line f, being in use at board 1, the pointer of the Wheatstone bridge indicator is brought to the position shown against stop u', and preferably so as to close circuit at contacts u^2. If, however, the line f or other line, whether metallic or single, be not in use, the pointer will be thrown in the other direction against u^3. The operator may, by looking directly at the pointer, determine by the position of the pointer whether or not the line is free. I preferably provide contacts u^2 in circuit with a telephone which are closed when the pointer is brought into position to indicate the busy test. The operator may thus, by listening at the telephone when the test is made, determine the electrical condition of the line.

As is well understood in connection with the Wheatstone bridge, the direction of the current through the cross wire u^4 which contains the galvanometer or indicator is determined by the relative resistances of the different sides of the switch. The amount of resistance in each of three sides of the bridge is fixed. Thus in each of the sides v and v' I place a coil of, say, ten ohms. In side v^2 I place a coil of, say, ninety-five ohms. I make the resistance and connections of the telephone lines such that the resistance between points v^3 and v^4 of the bridge will be greater than ninety-five ohms, or less than ninety-five ohms when a test is made, accordingly as the line tested is or is not in use.

The resistance of the different individual annunciators is usually about one hundred ohms. The resistance of a metallic circuit and the apparatus included therein varies according to the length of the line and number of instruments included therein. If the resistance of the line, exclusive of the resistance of the individual annunciator, should be less than two hundred ohms, I insert in the line enough resistance so that it will not be below two hundred ohms or thereabout, and in like manner I insert enough resistance in the single lines so that the resistance of any given single line will not be less than the required amount, which, as before stated, should be under ordinary circumstances, about two hundred ohms.

It will be understood, of course, that the resistance of the side v^2 of the bridge may be varied according to circumstances, but I have found that where the resistance of the individual annunciators is one hundred ohms, the resistance included in the side v^2 should be ninety-five ohms, approximately.

I will now trace the circuits as shown in Fig. 1, to demonstrate that when the line is busy and the test is made, the resistance in the circuit between points v^3 and v^4 will be greater than ninety-five ohms. The circuit, as shown, may be traced beginning at point v^3 to spring w of the loop key and thence the circuit may be traced to the strand of the cord which connects with the sleeve of plug r. The sleeve of the plug is in contact with the test piece or frame of the switch, and hence the circuit may be traced to point w' of line f. From point w' through the contact and

springs of answering springjack k and the annunciator i and the contact and spring of switch h we find connection with the tip of plug r. From the tip of plug r the circuit continues through one strand of the cord of plug r to binding post w^3 and thence the circuit may be traced to spring w^4 of the loop key and thence, as shown, to point v^4 of the bridge. The resistance of annunciator i being one hundred ohms, that is to say, greater than the resistance included in side v^2 of the bridge, current will be sent through the galvanometer in the proper direction to make the desired indication. We shall find no other complete circuit between points v^3 and v^4. We will now trace in the other direction from point w' to point w^2 and thence to the test piece of switch g. This test piece of switch g, when a plug is inserted as shown, is in contact with the sleeve of the plug, and thus the circuit continues through the strand of the cord to the sleeve of the plug inserted in switch p of line l and from the test piece of switch p the circuit continues to the test pieces of switches n and m and to ground. Tracing from point w^2 over wire f through station 2, we come back to the spring of switch g which is in contact with the tip of the plug inserted therein. From the tip of this plug the circuit may be traced through the other strand of the cord to the tip of the plug inserted in answering springjack p and thence the circuit may be traced through annunciator o, the contact and spring of switch n, the contact and spring of switch m and thence continuing over line l to ground at station 3. Coming back now to switch h, a circuit may be traced from the spring of said switch to the contact of switch g. The spring of switch g being lifted, its contact is open. Thus, as before stated, it will be seen that there is only one complete circuit between points v^3 and v^4, and this complete circuit is through annunciator i which is of higher resistance than the resistance included in the side v^2 of the bridge.

It will be unnecessary to trace through the circuits which are formed, for example, when a single circuit is connected with another single circuit, or when a metallic circuit is connected with a metallic circuit. With the apparatus and connections as shown in the drawings, it will always be found that when a line tested is busy, the resistance of the circuit formed between points v^3 and v^4 will be greater than the resistance in the side v^2.

I will now assume that connection is made between lines a and f through springjack switches h and e of the second or last board, and that the test of line f is made at switch g of the first board. The plug inserted in switch g will simply touch the spring of switch g without lifting it, and the cord of the plug inserted in switch g will connect with springs of a loop switch the same as springs w, w^4, these springs being connected with points corresponding to points v^3, v^4 of the indicating apparatus. I will, therefore, only consider the circuits beyond the tip and sleeve of the test plug when inserted so as to touch the spring of switch g, it being understood that the sleeve is connected with point v^3 of the indicating apparatus, while the strand of the cord connecting with the tip of the plug is connected with a point, v^4, of the testing apparatus. Tracing, then, from the tip of the plug to the spring of switch g, the circuit continues through station 2 and thence back to the test piece of switch g, and thence to the sleeve of the test plug. Thus a complete circuit is formed through station 2 over line f, and the resistance of this line is two hundred or more ohms. Again tracing from the tip of the plug to the spring and to the contact upon which the spring rests when the test is made, the circuit continues to the spring of switch h, thence to the tip of the plug which is supposed to be inserted in switch h and thence to the tip of the plug supposed to be inserted in answering springjack e; thence the circuit may be traced through annunciator d and thence through the contact and spring of switch c and thence through the contact and spring of switch b and thence to ground at station 1. The circuit continues through the ground to the ground of line a at the central office. This ground is connected with the test piece of switch b and the test piece of switch c. From the test piece of switch c, circuit continues to the test piece of switch e and thence to the sleeve of the plug inserted therein and thence to the sleeve of the plug supposed to be inserted in switch h and thence the circuit may be traced to the test piece of switch g which is in contact with the sleeve of the plug supposed to be inserted therein. Thus a second circuit is completed, which second circuit will include not only the resistance of annunciator d, but also the combined resistances of the lines which exceed two hundred ohms. We have thus two circuits or paths, each containing more than two hundred ohms resistance. The whole resistance thus included between the tip of the plug and the sleeve of the plug, as traced in multiple, will equal or exceed one hundred ohms. Thus we have a resistance greater than ninety-five ohms, and hence the indicator or pointer u will be thrown in the proper direction.

Let us suppose, now, that the line tested is not busy; that is, suppose the plug removed from switch g and that a test is made at switch h by plug r in the manner shown. Tracing from the sleeve of plug r, we find the circuit closed to the frame or test piece of switch h and thence to point w'. From point w' the circuit may be traced through the contact and spring of switch k and thence through annunciator i and thence to the contact and spring of switch h and thence to the tip of the plug, thus completing one circuit which contains the resistance of annunciator i. Trac-

ing the circuit again beginning at point w' to w^2, and thence through station 2 and back through the spring and contact of switch g and thence to the spring of switch h, another circuit is completed. The resistance of this second circuit will be two hundred ohms or more. Thus we have two circuits in multiple between the sleeve of plug r and the tip of plug r. One of these multiple circuits contains the annunciator i, which is, as before stated, about one hundred ohms, and the other contains the resistance of the line tested, which is two hundred ohms or more. In extreme cases the resistance of the line might be one thousand ohms; but, as will be readily understood, if it should be so high, the joint resistance of the multiple circuits would, in such case, be less than ninety-five, or, say, ninety ohms. Therefore the resistance of the circuits between points v^3 and v^4 would be less than the resistance of side v^2 of the bridge, and hence the current will be sent through the bridge in a direction to throw the needle over against contact w^3. I have described this in connection with the metallic circuit f. It is evident, however, that the test is equally applicable to single wire circuits; that is to say, it would make no difference if line f were grounded at station 2 and at the central office, as described with respect to lines a and l. The ground would then form a portion of the circuit.

The plug r is provided with a metallic heel, which connects with the sleeve, as shown more clearly in Fig. 3. The strand of the cord connecting with tips of plugs r, q, is connected by wire a' with a metallic plate against which the metallic heel of the plug r normally rests when plug r is in its socket. The object of this connection is to bring the telephone s into the circuit of the cords when plug q is first inserted in a switch to answer a call. This connection a' forms no part of my invention, and, therefore, will not be further described.

The loop switch of the listening-in key, shown in Figs. 4 and 5, consists of two pairs of springs, b', b^2, and c', c^2, a lever d pivoted as shown, the connections e', e^2, f', f^2, g', g^2, and the connecting piece h' between springs c', c^2. These springs are mounted preferably upon rubber blocks and are preferably placed parallel, as shown, and provided with curved ends, these curved or free ends of the two pairs of springs being placed opposite each other and on different sides of the lever d. The portion of the lever d opposite the ends is of such size and shape that when the lever is turned in one direction, one pair of springs will be separated or wedged apart, and when turned in the opposite direction the other springs will be wedged apart. Thus, if the lever be turned to the right, springs b', b^2 will be spread apart and separated from contacts f', f^2, and closed upon contacts e', e^2. It should be noted that springs b', b^2 of Fig. 5 correspond to springs w^4, w of the loop key of Fig. 1. When the lever d is thrown to the left, springs b', b^2 close upon contacts f', f^2, while springs c', c^2 are separated and insulated (the connection h' being broken), while spring c' is connected with contact g' and spring c^2 with contact g^2. The form of loop key thus described I consider specially suited for use in connection with multiple switchboard systems, as shown in Fig. 1.

In Fig. 2 I have shown artificial resistance k' included in the circuit of line k^2. This line terminates in a loop plug k^3 according to the single cord system.

It is evident that my test system may be used in single cord multiple switchboard telephone exchanges. I therefore do not limit my invention herein to any particular system or systems of telephone exchange, since its principal feature may be used in any multiple switchboard system with which I am familiar, with only such formal changes as would readily suggest themselves to anyone skilled in the art.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination with a Wheatstone bridge or balance connected with a loop switch of a telephone exchange, of telephone lines, each line connected with two or more different springjack switches on different switchboards, each including an individual annunciator of given resistance, one side of the bridge containing more resistance than two other sides thereof, but less than the resistance of the individual annunciator or any line, the resistance of the different telephone lines being each substantially twice the resistance of the individual annunciator, and switching apparatus; whereby, on testing a line, the circuit of the fourth side of the bridge is made to contain more resistance than that of the fixed resistance of the side which is highest in resistance, if the line tested be connected or in use.

2. The Wheatstone bridge or balance having its two sides, v, v' of the same resistance, say, ten ohms each, and its third side, v^2, of high resistance, say, ninety-five ohms, the remaining side, that is, between points v^3 and v^4, containing different strands of a cord terminating in a loop plug r, the point v^3 being connected with one terminal of the plug and the other point v^4 being connected with the other terminal of the plug, in combination with a telephone line extending through two or more switches, the switches being on different switchboards, the individual annunciator included in the circuit of said telephone line having a resistance greater than the resistance of the third side of said bridge, say, one hundred ohms, and the resistance of said telephone line, exclusive of that of the annunciator, being more than twice the resistance of the third side of said bridge; whereby, on touching a terminal of said plug to the spring of one of the springjacks in the telephone

line, it may be determined whether a connection has been made at any other of the springjacks of said line.

3. The combination with a telephone line connected with different springjack switches on different boards, of a loop plug inserted in one of said switches, and indicating apparatus adapted to indicate, when the line is busy, a resistance in the line less than the normal, substantially as described.

4. A loop switch provided with springs having their free ends on opposite sides of a pivoted lever, the springs being mounted in pairs, the portion of the lever opposite the spring being thicker than the distance between the springs when in their normal position, said pairs of springs being each provided with contact points; said contact points being outside their respective springs and in the path of said springs when spread apart whereby, on moving the lever in one direction, the members of one pair of springs are spread apart to close upon their respective contacts, while, on moving it in the opposite direction, the members of the other pair of springs are spread apart and disconnected from one another and closed upon their respective contacts, said pairs resuming their normal positions when the lever is upright, substantially as described.

5. The combination with springs c', c^2, mounted upon a block of insulating material and normally connected together, of the pair of springs b', b^2, placed with their free ends opposite the free ends of said springs c' c^2 respectively and mounted upon a block of insulating material and normally pressing against different contact points f', f^2, and a lever or wedge between the free ends of said springs; whereby either pair of springs may be spread apart according to the position of the wedge or lever, substantially as described.

In witness whereof I hereunto subscribe my name this 18th day of April, A. D. 1888.

WILLIAM D. ALLISON.

Witnesses:
CHAS. C. WOODWORTH,
CHAS. G. HAWLEY.