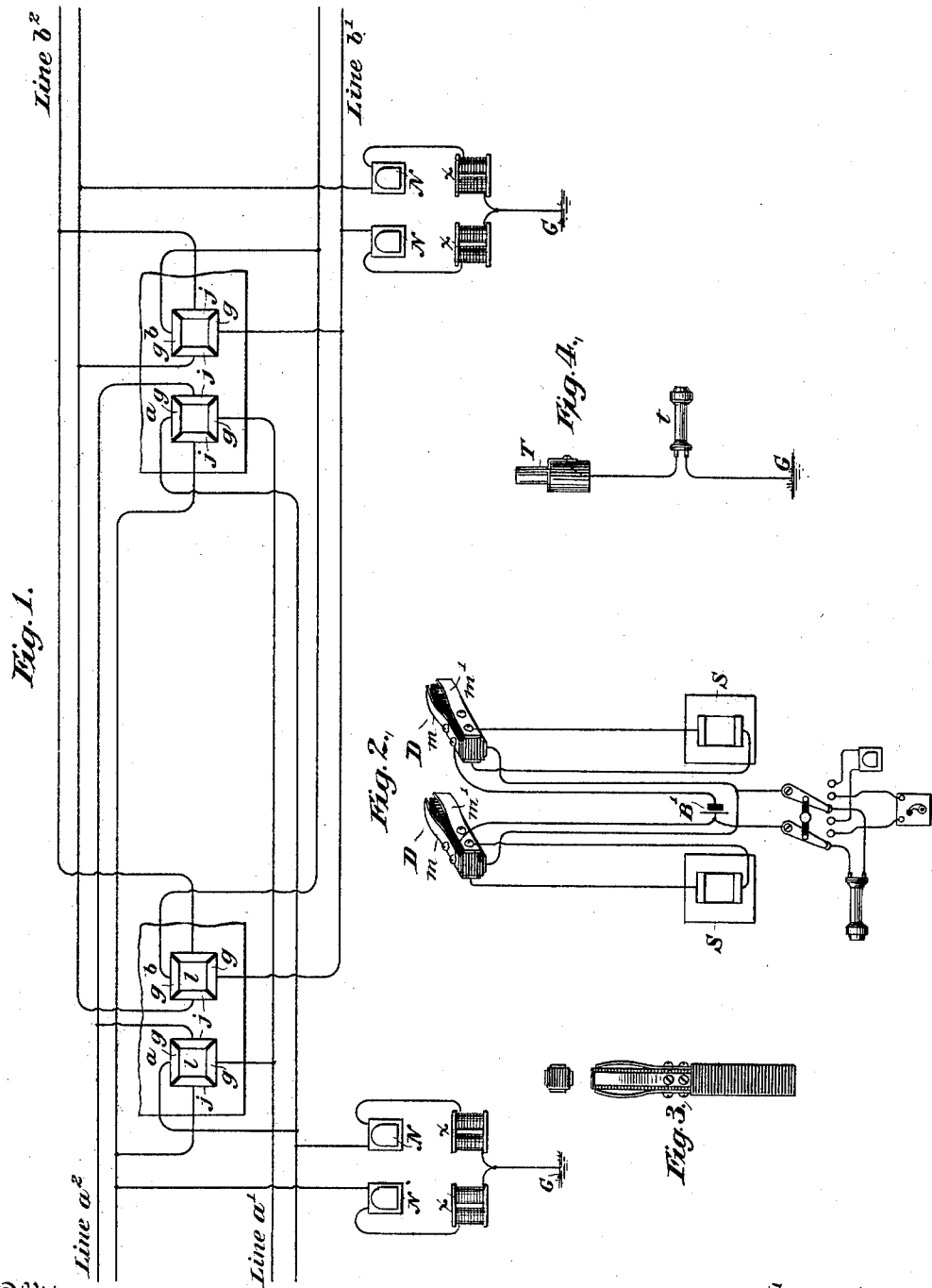


(No Model.)

M. G. KELLOGG.
MULTIPLE SWITCHBOARD.

No. 592,393.

Patented Oct. 26, 1897.



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UNITED STATES PATENT OFFICE.

MILO G. KELLOGG, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF SAME PLACE.

MULTIPLE SWITCHBOARD.

SPECIFICATION forming part of Letters Patent No. 592,393, dated October 26, 1897.

Application filed May 14, 1891. Serial No. 392,720. (No model.)

To all whom it may concern:

Be it known that I, MILO G. KELLOGG, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Switchboards for Telephone-Exchanges, 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 a telephone-exchange system in which the lines are metallic-circuit lines.

Briefly stated, the invention consists in connecting two or more metallic-circuit telephone-lines to a single switching device or jack, and in the case of multiple switchboards to a switch on each board. In the arrangement of multiple boards shown two pairs of telephone-lines are connected with the different switches on the boards, there being on each board one switch for each pair of lines. Each switch has two pairs of contact-pieces suitably placed and insulated, the two sides of one line of a pair of lines being respectively connected with two contact-pieces of its switch, and the two sides of the other line of the pair being respectively connected with the other pair of contacts of said switch.

The invention further consists in switch-plugs, apparatus, and connections by which, with such lines and switch connections, the calls of the subscribers may be received and promptly attended to and the usual operations of the exchange gone through with.

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

Figure 1 is a diagram illustrative of four metallic-circuit lines, normally grounded on one side at the central office, connected on two different switchboards, with the switches for said lines and annunciators and retardation-coils for said normally-grounded lines. Fig. 2 is a diagram of an operator's plug and cord system and apparatus to be used at the switchboards. Fig. 3 is a view of one of the switch-plugs, and Fig. 4 is a diagram of an operator's test system to be used at each board.

The switches of the lines on the two boards are marked *a a* and *b b*, the two former being located on the two boards shown and the two

latter being also located on the two boards shown, respectively.

l l are the switch-holes through the fronts of rubber strips on which the metal parts of the switches are mounted. These holes are square. On opposite sides of the holes are insulated pairs of contact-pieces *g g*. On the other sides of the holes are insulated pairs of contact-pieces *j j*. There is one pair of contacts *g g* and one pair of contacts *j j* for each switch.

Four lines are shown in the drawings. Line *a'* is connected with the pairs of contacts *g g* of switches *a a*, and line *a''* with pairs of contact-pieces *j j* of the same switches. In like manner lines *b'* and *b''* are connected with the pairs of contacts *g g* and *j j*, respectively, of switches *b b*.

N N are annunciators, and *X X* are retardation-coils, one annunciator and one retardation-coil for each line. The line is connected to the ground through its annunciator and retardation-coil and the annunciator is located at the board where the calls of the line are to be answered.

In Fig. 2, *D D* are a pair of switch-plugs adapted to be inserted into any switch at their board and to form connections when inserted, as will hereinafter be described. *n n* are the rubber insulations of the plugs, while *m m* and *m' m'* are two pairs of contact-pieces of a plug. When a plug is inserted into a switch, it may be inserted in such a direction that its pieces *m m* form connection with pieces *g g* and its pieces *m' m'* form connection with pieces *j j* of the switch, or in such reverse direction that *m m* form connection with *j j* and *m' m'* form connection with *g g*, respectively. For each plug there is a switching device, into which any other plug located at its board may be placed and which has two contact-pieces which connect with the contact-pieces *m m* of the plug thus inserted. The contact-pieces of this switching device are connected through flexible switch-conductors with contact-pieces *m' m'* of their plug. These switching devices are marked *s s*. The contact-pieces *m m* and *m' m'* of a pair of plugs are connected together by two flexible-cord circuits, and in one of these circuits is a test-battery *B'*. There is one test-

battery B' for each pair of plugs with cords. In Fig. 2 but one pair of plugs, with their cords, are shown. Other pairs may be added as required for each operator in the manner substantially as shown and as will be apparent to those skilled in the art.

In the operator's test system shown in Fig. 4, T is the test-plug, and *t* is the test receiving instrument. The contact-piece of the plug is connected to ground through the test receiving instrument. The calls may be sent from the subscribers' stations in a usual manner.

The operation of the system is as follows:
 15 When an operator receives a call from any line, she places one plug of a pair of her switch-plugs into the switch connected with the line in such a direction that the two contact-pieces *m m* of the plug form connection with the
 20 two contact-pieces of the switch connected to the two sides of the line and, bringing her telephone into circuit with the cords, finds out what line is wanted. She then tests the line wanted, as will hereinafter be described, and
 25 if she finds the line to be free or not in use she connects the other plug of the pair with its switch, as will be described, and may then send a calling-current to the lines and finally leave them in condition for conversation. In
 30 connecting with the line wanted the operator places the switch-plug in the switch connected with the line in such a direction that the two contact-pieces *m m* of the plug form connection with the two contact-pieces of the switch
 35 which are connected with the two sides of the line, provided there is not already another plug in the switch. If, however, there is another plug in the switch, she places the plug with which she is to make the desired
 40 connection into the switching device of the plug which is in the switch in such a direction that the contact-pieces *m m* of the plug form connection with the contact-pieces of the switching device.

45 The test system is as follows: Whenever a line is switched in a complete metallic circuit for conversation, there is a test-battery in circuit with it, and when it is not thus switched it has no battery in its circuit. The test-plug is connected with a line, as will hereinafter be described, when the line is tested. It follows that inasmuch as the complete metallic circuit of two lines switched together
 50 are grounded through their annunciators and retardation-coils and has a test-battery in circuit and that the test-plug is grounded through the test receiving instrument the instrument will sound or respond when either line thus tested is switched for conversation,
 55 while, when the test is made of an unswitched line, having no battery in circuit, the instrument will not respond. The operator can therefore determine on testing any line whether or not it is switched for use. In
 60 making the connection to a line for testing the operator will place the contact-piece of the test-plug on one of the switch contact-

pieces connected with the line, providing there is no switch-plug in the switch. If, however, there is a switch-plug in the switch,
 70 she will place her test-plug in connection with one of the contact-pieces of the switching device of the plug.

With this system and organization for multiple switchboards for metallic-circuit lines
 75 only one-half as many switches are required for a given number of lines, and practically twice as many lines can be placed in a given space as in the usual multiple-switchboard system. It therefore practically doubles the
 80 capacity of a given sized multiple switch-board.

I claim as my invention—

1. In a telephone-exchange system, metallic-circuit lines divided into pairs and
 85 switches for said lines on a switchboard, one switch for each pair of lines, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two
 90 contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs, the plugs having each a pair of contact-pieces and the two contact-pieces of one plug being connected by flexible
 95 conducting-circuits with the two contact-pieces of the other plug of the pair, each plug being adapted to be inserted into each switch in two positions or directions, in one
 100 of which its said contact-pieces are connected with the contact-pieces of one pair of contact-pieces of the switch and in the other of which they are connected with the other
 105 contact-pieces of the switch, respectively substantially as set forth.

2. In a telephone-exchange system, metallic-circuit lines the two sides of which are normally open at the central office, divided
 110 into pairs and switches for said lines on a switchboard, one switch for each pair of lines each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two
 115 sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs, the plugs having each a pair of contact-pieces and the two contact-pieces of one plug being connected by flexible conducting-circuits, with the two contact-pieces
 120 of the other plug of the pair, each plug being adapted to be inserted into each switch in two positions or directions, in one of which its said contact-pieces are connected with the
 125 contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, respectively, substantially as set forth.

3. In a telephone-exchange system, telephone-lines divided into pairs and switches
 130 for said lines, on a switchboard, one switch for each pair of lines, each switch having two

pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs, the plugs having each a pair of contact-pieces and the two contact-pieces of one plug being connected by flexible conducting - circuits with the two contact-pieces of the other plug of the pair, each plug having also a second pair of contact-pieces and a switching device for each plug with two contact-pieces connected by flexible conductors with said second pair of contact-pieces of the plug each plug being adapted to be inserted into each switch in two positions or directions, in one of which its said first-mentioned contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch and its said second-mentioned contact-pieces are connected with the other contact-pieces of the switch and in the other of which the first-mentioned contact-pieces of the plug are connected with the second-mentioned contact-pieces of the switch and the second-mentioned contact-pieces of the plug are connected with the first-mentioned contact-pieces of the switch, each plug being also adapted to be inserted into each of said switching devices and when inserted to connect its said first-mentioned contact-pieces with said contact-pieces of the switching devices respectively, substantially as set forth.

4. In a telephone-exchange system, metallic-circuit lines the two sides of which are normally open at the central office, divided into pairs and switches for said lines, on a switchboard, one switch for each pair of lines, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces, of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs, the plugs having each a pair of contact-pieces and said contact-pieces of a plug being connected by flexible conducting-circuit with the two contact-pieces of its mate each plug having also a second pair of contact-pieces and a switching device with a pair of contact-pieces connected by flexible conductors with said second pair of contact-pieces of the plug each plug being adapted to be inserted into each switch in two positions or directions, in one of which its said first-mentioned contact-pieces are connected with the two contact-pieces of one pair of contact-pieces of the switch and its second-mentioned contact-pieces are connected with the other contact-pieces of the switch and in the other of which the first-mentioned contact-pieces of the plug are connected with the second-mentioned contact-pieces of the switch and the second-mentioned contact-pieces of the plug are connected with the first-mentioned contact-pieces of the

switch, each plug being also adapted to be inserted into each of said switching devices and when inserted to connect its said first-mentioned contact-pieces with said contact-pieces of the switching device respectively, substantially as set forth.

5. In a telephone-exchange system, multiple switchboards, metallic-circuit lines divided into pairs and switches for said lines, one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and the two contact-pieces of a plug being connected by flexible conducting-circuits with the contact-pieces of its mate, each plug being adapted to be inserted in two positions or directions into each switch at its board, in one of which its said contact-pieces are connected with the two contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, respectively, substantially as set forth.

6. In a telephone-exchange system, multiple switchboards, metallic-circuit lines the two sides of which are normally open at the central office divided into pairs and switches for said lines, one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and the two contact-pieces of one plug being connected by flexible conducting-circuits with the two contact-pieces of its mate each plug being adapted to be inserted in two positions or directions into each switch at its board, in one of which its said contact-pieces are connected with the two contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, respectively, substantially as set forth.

7. In a telephone-exchange system, multiple switchboards, metallic-circuit lines divided into pairs and switches for said lines, one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs at each board, the plugs having each a pair of con-

tact-pieces and said contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, each plug having also a second pair of contact-pieces and a switching device for each plug located at its board with two contact-pieces connected by flexible conductors with said second pair of contact-pieces of the plug, each plug being adapted to be inserted into each switch in two positions or directions, in one of which its said first-mentioned contact-pieces are connected with the two contact-pieces of one pair of contact-pieces of the switch and its said second-mentioned contact-pieces are connected with the other contact-pieces of the switch and in the other of which the first-mentioned contact-pieces of the plug are connected with the second-mentioned contact-pieces of the switch and the second-mentioned contact-pieces of the switch are connected with the first-mentioned contact-pieces of the plug, each plug being also adapted to be inserted into each of said switching devices at its board and when inserted to connect its said first-mentioned contact-pieces with said contact-pieces of the switching device, respectively, substantially as set forth.

8. In a telephone-exchange system, metallic-circuit telephone-lines divided into pairs and switches for said lines on a switchboard, one switch for each pair of lines, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs, the plugs having each a pair of contact-pieces and the contact-pieces of a plug being connected by flexible conducting-circuits with the contact-pieces of its mate each plug being adapted to be inserted into each switch in two positions or directions in one of which its said contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and a test-battery in one of said circuits between each pair of plugs, substantially as set forth.

9. In a telephone-exchange system, metallic-circuit telephone-lines grounded at the central office and divided into pairs and switches for said lines on a switchboard, one switch for each pair of lines, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs, the plugs having each a pair of contact-pieces and the contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, each plug being adapted to be inserted into each switch in two positions or directions,

in one of which its said contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and a test-battery in one of said conducting-circuits between each pair of plugs, substantially as set forth.

10. In a telephone-exchange system, multiple switchboards, metallic telephone-lines divided into pairs and switches for said lines, one switch for each pair of lines on each of said boards, each switch having pairs of two contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and the two contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate each plug being adapted to be inserted in two positions or directions into each switch at its board, in one of which its said contact-pieces are connected with the two contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and a test-battery in one of said conducting-circuits between each pair of plugs, substantially as set forth.

11. In a telephone-exchange system, multiple switchboards, metallic-circuit telephone-lines, grounded at the central office and divided into pairs and switches for said lines one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and said two contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, each plug being adapted to be inserted in two positions or directions into each switch at its board, in one of which its said contact-pieces are connected with the two contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and a test-battery in one of said conducting-circuits between each pair of plugs, substantially as set forth.

12. In a telephone-exchange system, multiple switchboards, metallic-circuit telephone-lines divided into pairs and switches for said lines, one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one

pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and said contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, a test-battery in one of each of such conducting-circuits, each plug having also a second pair of contact-pieces and a switching device for each plug at its board with two contact-pieces connected through flexible conductors with said second pair of contact-pieces of the plug, each plug being adapted to be inserted into each switch at its board in two positions or directions, in one of which its said first-mentioned contact-pieces are connected with the contact-pieces of one pair of contact-pieces of the switch and its said second-mentioned contact-pieces are connected with the other contact-pieces of the switch and in the other of which its said first-mentioned contact-pieces are connected with said second-mentioned contact-pieces of the switch and its said second-mentioned contact-pieces are connected with said first-mentioned contact-pieces of the switch, each plug being also adapted to be inserted into each of said switching devices at its board and when inserted to connect its said first-mentioned contact-pieces with said contact-pieces of the switching device, respectively, substantially as set forth.

13. In a telephone-exchange system, metallic-circuit telephone-lines grounded on one of their sides and divided into pairs and switches for said lines on a switchboard, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs, the plugs having each a pair of contact-pieces and said contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, a test-battery in one of such flexible conducting-circuits, each plug being adapted to be inserted into each switch in two positions or directions, in one of which its said contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch, and in the other of which they are connected with the other contact-pieces of the switch, and a test receiving instrument grounded on one side and connected on its other side to a test plug or device adapted to be brought into connection with any of said contact-pieces of said switches, substantially as set forth.

14. In a telephone-exchange system, multiple switchboards, metallic-circuit telephone-lines grounded on one of their sides and divided into pairs and switches for said lines one switch for each pair of lines on each of said boards, each switch having two pairs of

contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and the two contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, a test-battery in one of such conducting-circuits, each plug being adapted to be inserted into each switch at its board in two positions or directions, in one of which its said contact-pieces are connected with the contact-pieces of one pair of said contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and test receiving instruments, one at each board, each instrument being grounded on one side and connected on its other side to a test plug or device adapted to be brought into connection with any of said contact-pieces of said switches at its board, substantially as set forth.

15. In a telephone-exchange system, multiple switchboards, metallic-circuit telephone-lines the two sides of which are normally open at the central office grounded on one of their sides and divided into pairs, and switches for said lines, one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and the two contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, a test-battery in one of such conducting-circuits, each plug being adapted to be inserted into each switch at its board in two positions or directions, in one of which its said contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and test receiving instruments, one at each board, each instrument being grounded on one side and connected on its other side to a test plug or device adapted to be brought into connection with any of said contact-pieces of said switches at its board, substantially as set forth.

16. In a telephone-exchange system, multiple switchboards, metallic-circuit telephone-lines grounded on one of their sides and divided into pairs and switches for said lines, one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces

of the other pair, in combination with pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and the two contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, a test-battery in one of such conducting-circuits, each plug having also a second pair of contact-pieces and a switching device for each plug at its board with two contact-pieces connected through flexible conductors with said last-mentioned contact-pieces of the plug, each plug being adapted to be inserted into each switch at its board in two positions or directions, in one of which its said first-mentioned contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch and its second-mentioned contact-pieces are connected with the other contact-pieces of the switch and in the other of which its said first-mentioned contact-pieces are connected with the second-mentioned contact-pieces of the switch and its said second-mentioned contact-pieces are connected with the first-mentioned contact-pieces of the switch, each plug being also adapted to be inserted into each of said switching devices at its board and when inserted to connect its said first-mentioned contact-pieces with said contact-pieces of the switching device, and test receiving instruments, one at each board, each grounded on one side and connected on its other side to a test plug or device adapted to be brought into connection with any of said contact-pieces of said switches and switching devices at its board, substantially as set forth.

17. In a telephone-exchange system, metallic-circuit telephone-lines divided into pairs and switches for said lines on a switchboard, one switch for each pair of lines, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with a switch-plug having a pair of contact-pieces connected through flexible conductors to the two sides of one of said lines, and adapted to be inserted into either of said switches in two positions or directions in one of which its said contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch and in the other of which its said contact-pieces are connected with the other contact-pieces of the switch, substantially as set forth.

18. In a telephone-exchange system, metallic-circuit lines grounded at the central office and divided into pairs and switches for said lines on a switchboard, one switch for each pair of lines, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with retardation-coils, one for each

line and in its ground connection, pairs of switch-plugs, the plugs having each a pair of contact-pieces and the contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, each plug being adapted to be inserted into each switch in two positions or directions, in one of which its said contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and a test-battery in one of said conducting-circuits between each pair of plugs, substantially as set forth.

19. In a telephone-exchange system, multiple switchboards, metallic-circuit telephone-lines, grounded at the central office and divided into pairs and switches for said lines one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with retardation-coils, one for each line and in its ground connection pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and said two contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, each plug being adapted to be inserted in two positions or directions into each switch at its board, in one of which its said contact-pieces are connected with the two contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and a test-battery in one of said conducting-circuits between each pair of plugs, substantially as set forth.

20. In a telephone-exchange system, metallic-circuit telephone-lines grounded on one of their sides and divided into pairs and switches for said lines on a switchboard, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with retardation-coils, one for each line and in its ground connection pairs of switch-plugs, the plugs having each a pair of contact-pieces and said contact-pieces of a plug being connected by flexible conducting-circuits, with the two contact-pieces of its mate, a test-battery in one of such flexible conducting-circuits, each plug being adapted to be inserted into each switch in two positions or directions, in one of which its said contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch, and in the other of which they are connected with the other contact-pieces of the switch, and a test receiving in-

strument grounded on one side and connected on its other side to a test plug or device adapted to be brought into connection with any of said contact-pieces of said switches, substantially as set forth.

21. In a telephone-exchange system, multiple switchboards, metallic-circuit telephone-lines grounded on one of their sides and divided into pairs and switches for said lines, one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with retardation-coils, one for each line and in its ground connection pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and the two contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, a test-battery in one of such conducting-circuits, each plug having also a second pair of contact-pieces and a switching device at its board with two contact-pieces connected through flexible conductors with said last-mentioned contact-pieces of the plug, each plug being adapted to be inserted into each switch at its board in two positions or directions, in one of which its said first-mentioned contact-pieces are connected with the contact-pieces of one pair of contact-pieces of the switch and its second-mentioned contact-pieces are connected with the other contact-pieces of the switch and in the other of which its said first-mentioned contact-pieces are connected with the second-mentioned contact-pieces of the switch and its said second-mentioned contact-pieces are connected with the first-mentioned contact-pieces of the switch, each plug being also adapted to be inserted into each of said switching devices at its boards and when inserted to connect its said first-mentioned contact-pieces with said contact-pieces of the switching device, and test receiving instruments, one at each board, each grounded on one side and connected on its other side to a test plug or device adapted to be brought into connection with any of said contact-pieces of said switches and switching devices at its board, substantially as set forth.

22. In a telephone-exchange system, metallic-circuit lines grounded at the central office and divided into pairs and switches for said lines on a switchboard, one switch for each pair of lines, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with annunciators, one for each line and in its ground connection, pairs of switch-plugs, the plugs having each a pair of con-

tact-pieces and the contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, each plug being adapted to be inserted into each switch in two positions or directions, in one of which its said contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and a test-battery in one of said conducting-circuits between each pair of plugs, substantially as set forth.

23. In a telephone-exchange system, multiple switchboards, metallic-circuit telephone-lines, grounded at the central office and divided into pairs and switches for said lines one switch for each pair of lines on each of said boards, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with annunciators one for each line and on its ground connection pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and said two contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its mate, each plug being adapted to be inserted in two positions or directions into each switch at its board, in one of which its said contact-pieces are connected with the two contact-pieces of one pair of the contact-pieces of the switch and in the other of which they are connected with the other contact-pieces of the switch, and a test-battery in one of said conducting-circuits between each pair of plugs, substantially as set forth.

24. In a telephone-exchange system, metallic-circuit telephone-lines grounded on one of their sides and divided into pairs and switches for said lines on a switchboard, each switch having two pairs of contact-pieces to which the two lines of its pair are respectively connected the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination with annunciators, one for each line and in its ground connection pairs of switch-plugs, the plugs having each a pair of contact-pieces and said contact-pieces of a plug being connected by flexible conducting-circuits, with the two contact-pieces of its mate, a test-battery in one of such flexible conducting-circuits, each plug being adapted to be inserted into each switch in two positions or directions in one of which its said contact-pieces are connected with the contact-pieces of one pair of the contact-pieces of the switch, and in the other of which they are connected with the other contact-pieces of the switch, and a test receiving instrument grounded on one side and connected on its other side to a test plug or device adapted

to be brought into connection with any of said contact-pieces of said switches, substantially as set forth.

25. In a telephone-exchange system, multiple switchboards, metallic-circuit telephone-lines grounded on one of their sides and divided into pairs and switches for said lines, one switch for each pair of lines on each of said boards, each switch having two pairs of
10 contact-pieces to which the two lines are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other pair, in combination
15 with annunciators one for each line and in its ground connection pairs of switch-plugs at each board, the plugs having each a pair of contact-pieces and the two contact-pieces of a plug being connected by flexible conducting-circuits with the two contact-pieces of its
20 mate, a test-battery in one of such conducting-circuits, each plug having also a second pair of contact-pieces and a switching device at its board with two contact-pieces connected
25 through flexible conductors with said last-mentioned contact-pieces of the plug, each plug being adapted to be inserted into each switch at its board in two positions or directions, in one of which its said first-mentioned
30 contact-pieces are connected with the contact-pieces of one pair of contact-pieces of the switch and its second-mentioned contact-pieces are connected with the other contact-pieces of the switch and in the other of which
35 its said first-mentioned contact-pieces are

connected with the second-mentioned contact-pieces of the switch and its said second-mentioned contact-pieces are connected with the first-mentioned contact-pieces of the switch, each plug being also adapted to be
40 inserted into each of said switching devices at its boards and when inserted to connect its said first-mentioned contact-pieces with said contact-pieces of the switching device, and test receiving instruments, one at each
45 board, each grounded on one side and connected on its other side to a test plug or device adapted to be brought into connection with any of said contact-pieces of said switches and switching devices at its board,
50 substantially as set forth.

26. In a telephone-exchange system, metallic-circuit lines divided into pairs and switches for said lines on a switchboard, one switch for each pair of lines, each switch having two
55 pairs of contact-pieces to which the two lines of its pair are respectively connected, the two sides of one line to the two contact-pieces of one pair and the two sides of the other line to the two contact-pieces of the other
60 pair, in combination with switching devices by which any two of said lines may be connected in metallic circuit for conversation.

In testimony whereof I have hereunto subscribed my name.

MILO G. KELLOGG.

Witnesses:

FRANK S. OBER,
EDWARD C. DAVIDSON.