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W. H. HARDEN ET AL

TESTING SYSTEM FOR MACHINE SWITCHING CIRCUITS

Filed August 25, 1923

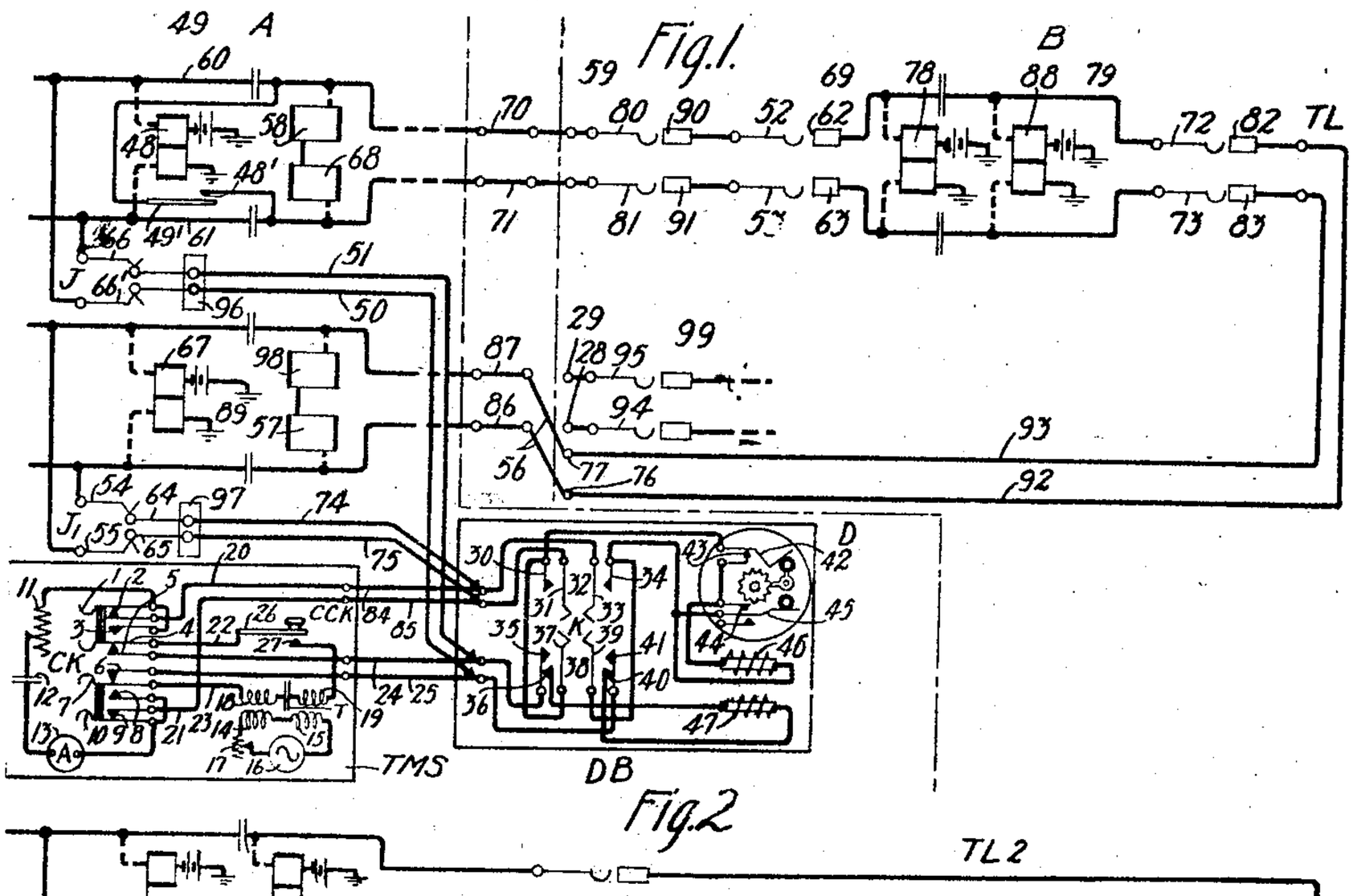

Fig. 1.

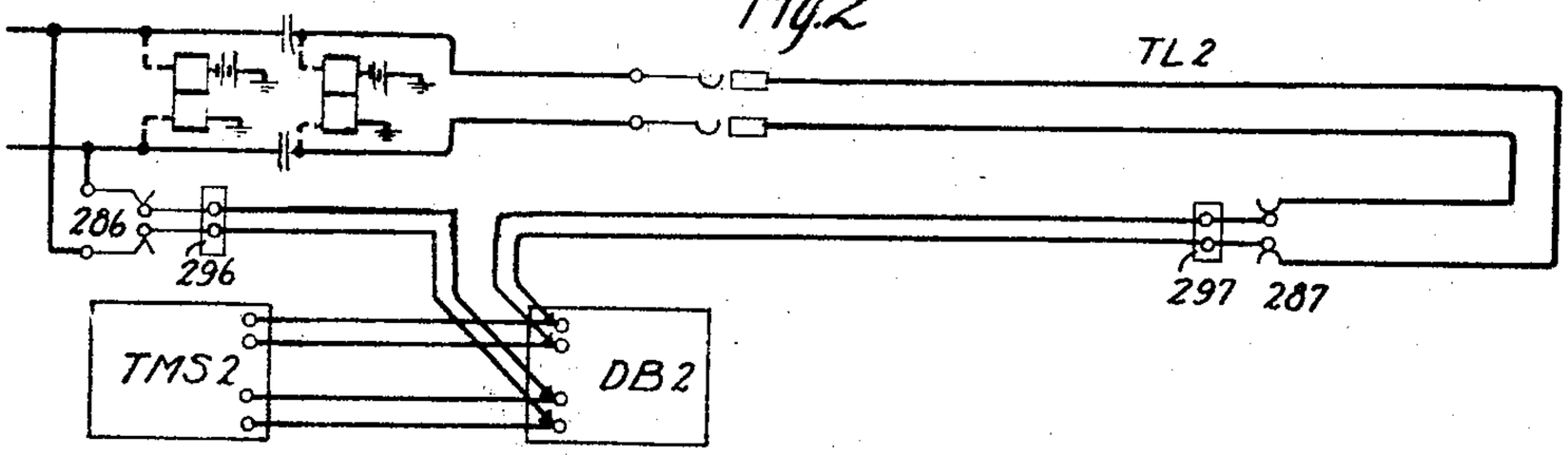

Fig. 2

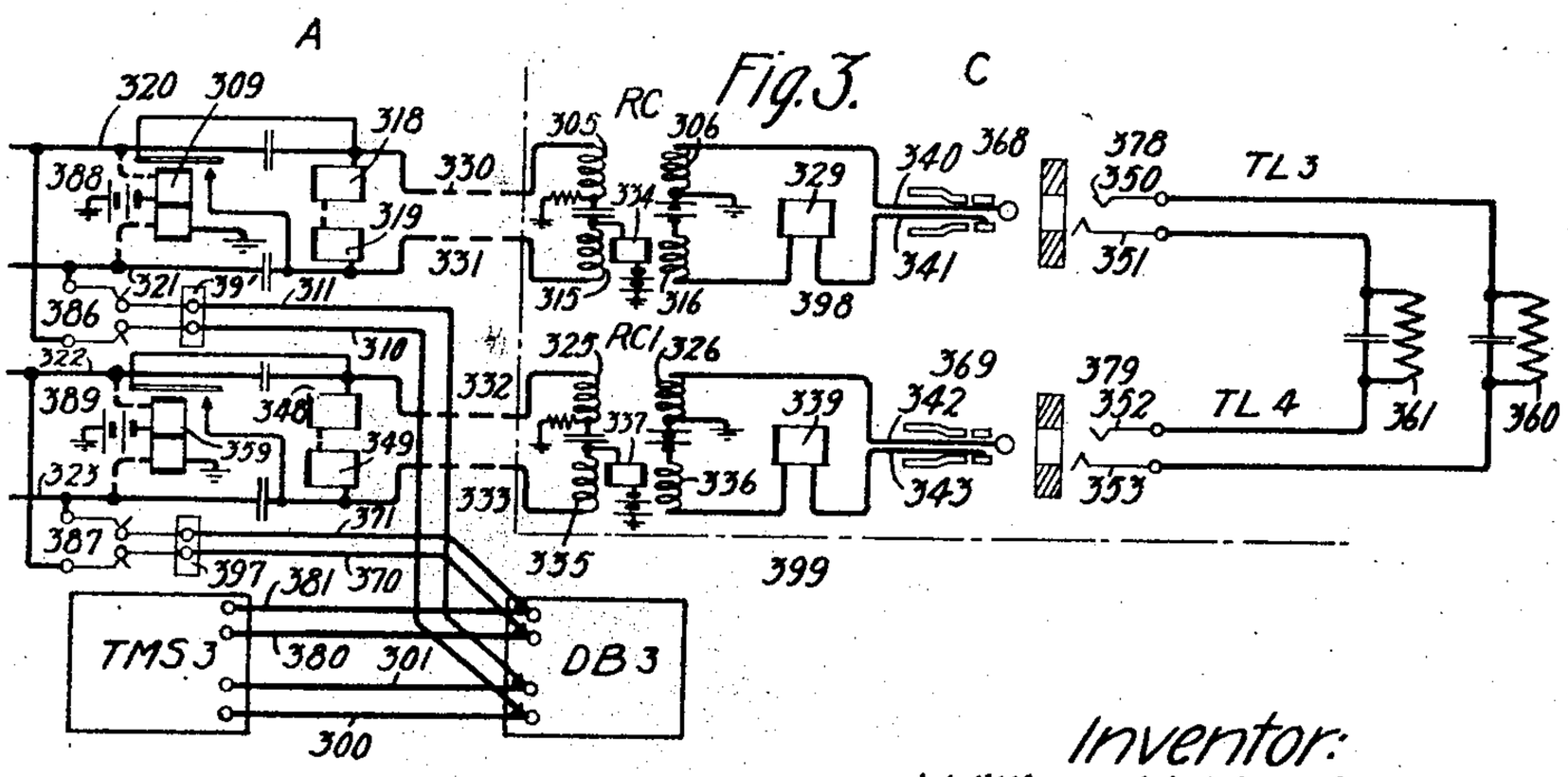

Fig. 3.

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UNITED STATES PATENT OFFICE.

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TESTING SYSTEM FOR MACHINE-SWITCHING CIRCUITS.

Application filed August 25, 1923. Serial No. 659,307.

To all whom it may concern:

Be it known that we, WILLIAM H. HARDEN and MICHAEL A. GRAEFENECKER, residing at Brooklyn and New York, in the counties of Kings and Bronx and State of New York and New York, respectively, have invented certain Improvements in Testing Systems for Machine-Switching Circuits, of which the following is a specification.

This invention relates to a testing method and system and has for its object the provision of a method and system for making transmission tests upon the talking-conductors in a telephone system.

The invention contemplates a method of making transmission tests on telephone lines, which consists in connecting the transmission test set and a calling device to any trunk to be tested, controlling automatic switches to select a predetermined telephone line leading back to the transmission test set at the point of origin, and holding the circuit thus established while the necessary transmission tests are made.

The equipment for carrying out this method, consists of a transmission test set of any well known construction together with a source of current supply, in conjunction with a device for controlling automatic switches, also of any well known type, the last of the train of switches, when set, selecting a predetermined pair of conductors which lead back to the transmission testing set. In making transmission tests between offices, the said pair of conductors are connected to a pair of trunk conductors which normally terminate in a regular incoming selector, these trunk conductors terminating in the transmission test set.

Figure 1 represents this invention applied to make transmission tests between two offices in a full mechanical step-by-step system.

Fig. 2 represents the invention applied to make transmission tests on a connector switch in a full mechanical step-by-step system.

Fig. 3 represents the invention applied to make transmission tests between a mechanical office and a distant manual office.

Referring now more particularly to Fig. 1, 49 represents an outgoing trunk repeater circuit at office A, connected by way of cable conductors 70 and 71 to an incoming selector 59, of the well known Strowger type at office B. Similarly, 89 represents a second trunk repeater circuit at office A, ordinarily connected by way of conductors 86 and 87 to another incoming selector 99, at office B. The test line TL of the connector 79 connected to the terminals 82 and 83 of the connector multiple bank is extended by way of the conductors 92 and 93 to the terminals 76 and 77. The leads 56 which ordinarily connect conductors 86 and 87 to terminals 28 and 29 of the selector 99, are connected to terminals 76 and 77 while the transmission tests are in progress, so that the test line TL is now extended by means of the leads 92 and 93, cross-wiring 56, and cable conductors 86 and 87 to the trunk repeater circuit 89 at office A. Thus, whenever the test line TL is called by operating the dial D of the dialing board DB in office A, it is evident that a circuit will be established from the transmission measuring set TMS by way of the repeater 49 in office A, conductors 70 and 71, selectors 59 and 69, connector 79, test line TL, (all in office B), conductors 86 and 87, repeater 89 in office A, to the transmission measuring set TMS. The apparatus shown in Fig. 1 for purposes of illustration, shows one method of accomplishing this object and will now be described in greater detail.

Assuming that the wiring of the test line TL of connector 79 in office B has been extended in the manner previously described and that the transmission measuring set TMS and dialing board DB have been connected to the trunk repeaters 49 and 89 at the jacks J and J^1 by means of the plugs 96 and 97 and their associated cords, the apparatus will then be arranged as shown at A in Fig. 1. To dial the test line TL in office B, the key K, of the dialing board DB, is operated to position 38 closing circuit to operate relay 48 as follows: battery, upper winding of relay 48, 66′, 50, 41, 39, 46, 43, 42, 37, 35, 51, 66 to ground at the lower winding of relay 48. Relay 48 operated closes a circuit at 48′ and 49′ to operate the impulse relay of the incoming selector 59. This selector being well known is not shown in detail, but

is merely indicated by brushes 80 and 81. It may be of the type shown and described in detail in Patent No. 1,176,269, issued March 21, 1916, to A. H. Blessing. When the dial D is moved off normal and released, retardation coil 46 is short circuited at 44 and 45 and the circuit to operate relay 48 previously traced, is intermittently opened at 42 and 43 of the dial D. Each time this circuit is opened at 42 and 43, relay 48 releases and opens at 48′ and 49′ the circuit through the impulse relay of the incoming selector 59. It will, of course, be understood that the relays 58 and 68 are not bridged across the talking conductors during the period relay 48 is making and breaking the impulse circuit, but that this bridge is opened during that period by a slow relay as shown and described in detail in said patent. The selector 59 functions in the manner well known in the art and selects an idle trunk in the proper level, which we will assume to be the selector 69. This selector may be of the type shown and described in said patent. When the dial D is again moved off normal and released, relay 48 again opens and closes contacts 48′ and 49′ to interrupt the circuit through the impulse relay (not shown) in selector 69, causing selector 69 to function and hunt for an idle connector in the proper level which we will assume to be the connector 79. This connector may be of the type shown in said patent. The dial D is again moved off normal and released as before and as it returns to normal the circuit through the dial D is intermittently opened at contacts 42 and 43, again intermittently operating relay 48. Relay 48 is turn operates relay 78 which causes the brushes 72 and 73 of the connector 79 to step to the proper level. When the final digit is dialled, the connector 79 rotates to the terminals of the desired line, which we will assume to be the test line TL, and machine ringing is applied to the line. The key K is now operated to position 32, substituting the retardation coil 47 for the retardation coil 46 upon the repeater circuit 49, thus preventing the connector 79 from releasing. With the key K operated to position 32, the retardation coil 46 is connected to the repeater circuit 89 by way of the contacts 33, 34, 30 and 31 of the key K. A bridge is now connected across the conductors 86 and 87 in a manner not shown, causing the machine ringing current supplied from the connector 79 to be removed from the test line TL in a manner well known in the art. A circuit is now established to the transmission measuring set TMS as follows: contact 27 of the circuit closing key CCK, 19, 18, 23, 7, 6, 25, 50, 66′, 60, 70, 80, 90, 52, 62, 72, 82, 92, 76, 86, 54, 64, 74, 84, 20, 2, 1, 11, 12, 13, 10, 9, 21, 85, 75, 65, 55, 87, 77, 93, 83, 73, 63, 53, 91, 81, 71, 61, 66, 51, 24, 5, 4, 22, to contact 26 of the circuit closing key CCK. It will be observed that the retardation coils 46 and 47 and the following relays or groups of relays are bridged across this circuit: 48, 58 and 68, 78, 88, 98 and 57, and 67. The retardation coils 46 and 47 are so arranged as to offer a resistance to direct current sufficiently low to insure the holding of the circuit being tested, while the impedance to alternating current at frequencies ordinarily used in testing is sufficiently high to introduce a negligible transmission loss.

The source of alternating current 16 is connected over an obvious circuit including windings 14 and 15 of the transformer T. Hence when contacts 26 and 27 of the circuit closing key CCK are closed, the circuit previously traced, including windings 18 and 19 of the transformer T, is completed and alternating current is connected over the circuit previously traced to the AC ammeter 13, which will give a certain reading.

When the calibrating key CK is operated, and the circuit closing key CCK is closed, the windings 18 and 19 of transformer T are connected by way of the contacts 4, 3, 8 and 7 of the calibrating key CK to the AC ammeter 13 and variable resistance 11. With all of resistance 11 in the circuit, a certain deflection will be obtained on the AC ammeter 13 and this deflection hereinafter referred to as the "constant reading" will be noted by the tester. The calibrating key CK is now released and the circuit over the lines under test previously traced, is re-established, and another reading will be obtained. The amount of resistance in the circuit is now reduced by varying the variable resistance 11 of the transmission measuring set TMS until the "constant reading" is again obtained. The loss in any desired unit of transmission of the circuit under test may now be read directly from the scale of the resistance 11. The transmission loss of the test line TL, conductors 92 and 93, cable conductors 86 and 87, and the trunk repeater 89, has previously been determined, hence by subtracting this loss from the total loss indicated on the scale of the resistance, the transmission loss and the balance of the network may be determined. If the loss thus determined is not within the proper limits, the tester knows that the transmission characteristics of the circuit are defective. By eliminating the outgoing trunk repeater 49 or the connector 79, or both, from the circuit, a new reading can be obtained which, when resistance 11 is varied as before, will indicate the transmission loss in the balance of the circuit. By eliminating any part of the network, for example, the outgoing trunk repeater 49 or the connector 79 from the circuit and substituting trunk conductors of known resistance therefor the transmission loss for the balance of the net-

work may be completed. If the resulting loss is within the proper limits, the tester knows that the particular network or piece of apparatus eliminated is defective and proceeds to examine the defective apparatus in detail in order to remove the cause of the defect. Ordinarily, when the tester encounters a defective circuit, he will make a memorandum threeof and then proceed to test the balance of the remaining circuits in the group before attempting to locate the nature of the trouble in the defective circuit.

When the tests on the circuit including 49, 59, 69, and 79 are completed, the circuit closing key CCK is released, removing the alternating current from the line. The plug 96 is now removed from the test jack J and inserted in a similar test jack associated with another outgoing trunk repeater circuit and the tests are then repeated.

Transmission measuring tests may be made on any switch or series of switches in a particular office by arranging the circuit in the manner shown in Fig. 2, where for convenience the circuit is shown arranged for a transmission measuring test on the transmission network of a connector circuit. The transmission measuring set TMS^2 and the dialing board DB^2 are similar in every respect to the transmission measuring set and dialing board shown in Fig. 1. The plugs 296 and 297 are in this case connected to the jacks 286 and 287, respectively, in the manner shown in Fig. 2. The jack 287 is associated with a test line TL^2 which is reached by dialing the proper number of digits, depending upon the number of switches in the series. In accordance with the arrangement shown in Fig. 2, it would be necessary to dial two digits to establish a connection between the connector circuit shown and the test line TL^2.

Fig. 3 shows a method followed in conducting transmission measuring tests on the circuits from a step-by-step mechanical office A, to a manual office C.

In this case, the plugs 396 and 397 are inserted in the jacks 386 and 387, respectively, of the trunks 388 and 389 with which they are associated. The transmission measuring set TMS^3 and the dialing board DB^3 are similar in all respects to the transmission measuring set TMS and dialing board DB in Fig. 1. The test lines TL^3 and TL^4 appear in the multiple before the operator at the call indicator position in the manual office C and are assigned numbers in the regular subscriber's multiple in the usual manner. The key K (Fig. 1) is operated to the position 38 and the number of the test line TL^3 (Fig. 3) is dialled and the impulses transmitted over the conductors 330 and 331 to a call indicator temporarily associated with the circuit 398 at office C, which causes the number of the test line TL^3 to be displayed before the operator at office C. Call indicator circuits are well known and therefore need not be shown. The call indicator may be of the type described on pages 341 to 343 of Smith and Campbell's book on Automatic Telephony, 2nd edition. The plug 368 is thereupon inserted in the jack 378 associated with the test line TL^3, which causes the call indicator to restore in the well known manner. The key K (Fig. 1) is now switched to the position marked "32", thus connecting the retardation coil 47 (Fig. 1) across the trunk 388 (Fig. 3) to prevent the operator at office C from receiving the disconnect signal due to the release of supervisory 334. The contacts 42 and 43 of the dial D (Fig. 1) will now be connected in series with the circuit 389 at office A (Fig. 3) and the number of the test line TL^4 may now be dialled and the number of that line displayed on a call indicator temporarily associated with the circuit 399 at office C. The plug 369 is thereupon inserted in the jack 379 of the test line TL^4. The test lines TL^3 and TL^4 are connected together in the manner shown in Fig. 3. Hence with the plugs 368 and 369 inserted in the jacks 378 and 379, the machine ringing current on circuits 298 and 399 will be removed from the circuit in a manner well known in the art and a circuit will be closed as follows: from the transmission measuring set TMS^5, 301, 311, 396, 321, 331, 315, 305, 330, 320, 396, 310, 300, to the sending circuit of the transmission measuring set TMS^3. It will be observed that this circuit is in inductive relation with a circuit as follows: winding 306 of the repeating coil RC in the trunk 398, 340, 350, 360, 353, 343, 339, 336, 326, 342, 352, 361, 351, 341, 329, 316, to 306. It will be noted that this circuit is also in inductive relation with the transmission receiving set circuit as follows: winding 325 of the repeating coil RC^1 in the trunk 399, 335, 333, 323, 371, 381, transmission receiving circuit TMS^3, 380, 370, 322, 332, to 325. It will be observed that relays 309, 318 and 319, and 334 are connected in bridge with the circuit 388, and relays 359, 348 and 349, and 337 in bridge with the circuit 389. Hence, when the alternating current from the transmission measuring set TMS^3 is applied to the trunk 388, it will be inductively reproduced in the intermediate circuits 398 and 399 and finally reproduced in the circuit 389 and transmission receiving circuit of the transmission measuring set TMS^3. The loss sustained may be determined in a manner similar to that described in connection with Fig. 1. When the necessary tests are completed, the plug 396 is removed from the jack 386, giving the disconnect signal on trunk 398, due to relay 334 releasing, to the operator at the office C (Fig. 3). The connection to test line TL^4 by way of trunk 399 may be

retained however if desired, until all other trunks in the group have been tested, when the circuits may be restored to normal by removing the plugs 396 and 397 from the jacks associated with the lines under test.

While the method of measuring transmission losses in telephone lines has, for purposes of illustration, been shown in connection with the step-by-step machine switching telephone system, it is not so limited but the general method of determining transmission losses shown herein, may be used in connection with any other testing or transmission testing system in the same general manner.

What is claimed is:

1. Method of establishing a transmission testing circuit which consists in connecting a transmission testing set to separated points in any circuit to be tested and completing a testing loop by controlling automatic selector switches to interconnect the parts of the circuit to which the set is connected and in holding the circuit thus established while the tests are made.

2. Method of establishing a transmission testing circuit which consists in connecting a source of current supply, a transmission testing set and a calling device to a circuit leading to a mechanical office, controlling automatic switches thereat to build up a connection to a circuit which leads back to the transmission testing set in the originating office, and in holding the loop circuit thus established until the transmission tests are made.

3. Method of establishing a transmission testing circuit which consists in connecting a source of current supply, a transmission test set and an impulse sender to a circuit leading to a step-by-step mechanical office, controlling automatic switches thereat to provide a loop circuit back over a predetermined line whose number corresponds to the number dialled to the transmission testing set, and in holding the loop circuit thus established while the transmission tests are made.

4. A method of establishing a transmission testing circuit which consists in connecting a source of current supply, a transmission testing set, and a calling device to a circuit leading to a mechanical office, controlling automatic switches thereat to build up a connection to a circuit which leads back to the transmission testing set in the originating office, closing the loop circuit to be tested, and in holding the loop circuit thus established, until the transmission tests are completed.

5. A method of establishing a transmission testing circuit which consists in connecting a source of current supply, a transmission test set, and an impulse sender to a circuit leading to a step-by-step mechanical office, controlling automatic switches thereat to provide a circuit back over a predetermined trunk whose number corresponds to the number dialled to the transmission testing set, closing the loop circuit to be tested, and in holding the loop circuit thus established, while the transmission tests are completed.

6. In a testing system for testing the transmission characteristics of automatically connected telephone talking circuits, means for connecting a transmission testing set to separated points in any circuit to be tested, means to control automatic switches to complete a testing loop for interconnecting the parts of the circuit to which said set is connected and means to hold the circuit thus established while the tests are made.

7. In a testing system, a source of current supply, a transmission testing set, means for connecting said source of current supply to said testing set, a plurality of sets of conductors, means for connecting said testing set to any predetermined set of conductors, another set of conductors, means for connecting said testing set to the last mentioned set of conductors, means for connecting said predetermined set of conductors to said last mentioned set of conductors, a circuit including the source of current supply, a variable resistance, the current responsive device, and a key of said testing set, for obtaining a reading of the transmission characteristics of said circuit by means of said current responsive device, a second circuit including the elements aforesaid and said predetermined, and last mentioned, sets of conductors, and means for varying said resistance, to produce the reading first obtained.

8. In a multi-office testing system, a source of current supply, a calling device, a first office, a second office, a plurality of sets of conductors between said first office and said second offices, means for connecting said source of current and said calling device to any predetermined set of conductors at said first office, another set of conductors between said first and second offices, a pair of conductors in said second office having a distinguishing code number, means in said second office for connecting said secondly mentioned set of conductors between said first and second offices with said code numbered conductors in said second office, automatic apparatus in said second office associative with said predetermined set of conductors responsive to said calling device for differentiating between said code numbered conductors and any other conductors terminating in said second office, a device responsive to current at said first office, means in said first office for connecting said current responsive device to said secondly mentioned set of conductors to said second office, and a circuit including said source of

current supply, said predetermined, said secondly mentioned and said code numbered conductors, and said current responsive device.

9. In a testing system, a source of current supply, a calling device, a plurality or sets of conductors, automatic switching apparatus responsive to said calling device, means for connecting said source of current supply and said calling device to any predetermined set of conductors, a second set of conductors multipled before and accessible to the last switch in the train of switching apparatus, a third set of conductors, means for connecting said second to said third set of conductors, a deflectable indicating device responsive to varying transmission characteristics, means for connecting said third set of conductors to said current responsive device, and a circuit including said source of current supply, said predetermined, second, and third, sets of conductors, said switching apparatus, and said current responsive device.

10. In a transmission measuring system, a source of alternating current supply, a plurality of sets of conductors, means for connecting said source of current to any predetermined set of conductors, another set of conductors, a deflectable indicating device responsive to alternating current, means for connecting said current responsive device to said secondly mentioned set of conductors, means to control automatic switches for connecting said predetermined set of conductors to the secondly mentioned set of conductors, and a circuit including said source of alternating current supply, said predetermined and secondly mentioned sets of conductors and said current responsive device.

11. In a multi-office transmission measuring system, a source of alternating current supply, a calling device, a first office, a second office, a plurality of sets of conductors between said first office and said second office, means for connecting said source of current supply and said calling device to any predetermined set of conductors at said first office, another set of conductors between said first and second offices, a set of conductors in said second office having a distinguishing code number, means in said second office for connecting said secondly mentioned set of conductors between said first and second office with said code numbered conductors in said second office, automatic apparatus in said second office associative with said first mentioned predetermined set of conductors responsive to said calling device for differentiating between said code numbered conductors and any other conductors terminating in said second office, means for connecting said first mentioned predetermined set of conductors to said code numbered conductors, a device responsive to alternating current, means in said first office for connecting said current responsive device to said secondly mentioned set of conductors to said second office, and a circuit including said source of alternating current supply, said predetermined, secondly mentioned, and code numbered conductors and said current responsive device.

12. In a transmission measuring system, a source of alternating current supply, a calling device, a plurality of sets of conductors each set associated with automatic switching apparatus responsive to said calling device, means for connecting said source of alternating current supply and said calling device to any predetermined set of conductors, a second set of conductors multipled before and accessible to the last switch in the train of switching apparatus, a third set of conductors, means for connecting said second to said third set of conductors, a device responsive to alternating current, means for connecting said third set of conductors to said current responsive device, and a circuit including said source of alternating current supply, said predetermined, second, and third sets of conductors, said switching apparatus and said current responsive device.

13. In a telephone transmission measuring system, a source of alternating current supply, a plurality telephone lines forming a group, means for connecting said source of alternating current to any predetermined telephone line in said group, a deflectable indicating device responsive to alternating current, means for connecting said current responsive device to a second predetermined line in the group aforesaid, means to control automatic switches for connecting said first and second predetermined lines together, and a circuit including said source of alternating current, said first and second mentioned telephone lines and said current responsive device.

14. In a multi-office telephone transmission measuring system, a source of alternating current supply, a calling device, a first office, a second office, a plurality of telephone lines forming a group between said first and second offices, means for connecting said source of alternating current and said calling device to any predetermined telephone line in the group at said first office, a second predetermined telephone line in said group, a test line in said second office having a distinguishing code number, means in said second office for connecting said second predetermined telephone line to said test line, automatic apparatus in said second office associative with said first mentioned predetermined telephone line responsive to said calling device for differentiating between said test line and any other line

terminating in said second office, a device responsive to alternating current, means in said first office for connecting said current responsive device to said secondly mentioned predetermined telephone line, and a circuit including said source of alternating current supply, said first and second mentioned predetermined telephone lines, said test line and said current responsive device.

15. In a telephone transmission measuring system, a source of alternating current supply, a calling device, a plurality of telephone lines forming a group, each line equipped with automatic switching apparatus responsive to said calling device, means for connecting said source of current supply and said calling device to any predetermined telephone line in said group, a test line multipled before and accessible to the last switch in the train of switching apparatus, a second predetermined telephone line in the group aforesaid, means for connecting said test line to said second predetermined telephone line, a device responsive to alternating current, means for connecting said second predetermined line to said current responsive device, and a circuit including said source of alternating current supply, said predetermined first, and second, telephone lines, said switching apparatus, said test line, and said current responsive device.

16. In a telephone transmission measuring system, a source of current supply, a transmission testing set, means for connecting the source of current supply to the testing set, a plurality of telephone lines forming a group, means for connecting said testing set to any predetermined telephone line in said group, a second predetermined telephone line in the group aforesaid, means for connecting said first mentioned predetermined telephone line to said secondly mentioned telephone line, means for connecting said secondly mentioned telephone line to the testing set, a circuit including the source of current supply, a variable resistance, the current responsive device, and a key of said testing set for obtaining a reading on said circuit by means of said current responsive device, a second circuit including the elements aforesaid, and said predetermined and last mentioned telephone lines, and means for varying said resistance to produce the reading first obtained.

17. In a multi-office transmission measuring system, a source of current supply, a transmission testing set, means for connecting the source of current supply to the testing set, a calling device, a first office, a second office, a plurality of telephone lines forming a group between said first and second offices, means for connecting said testing set and the calling device to a predetermined line in the group at the first office, a second predetermined line in said group, a test line in said second office having a distinguishing code number, means in said second office for connecting said secondly mentioned predetermined telephone line to said test line, automatic apparatus in the second office associative with said first mentioned predetermined telephone line responsive to said calling device for differentiating between said test line and any other line terminating in said second office, means in said first office for connecting the testing set to said secondly mentioned predetermined telephone line, a circuit including the source of current supply, a variable resistance, the current responsive device and a key of said testing set for obtaining a reading on said circuit by means of said current responsive device, a second circuit including the elements aforesaid, said first mentioned, said secondly mentioned predetermined telephone lines and said test line, and means for varying said resistance to produce the reading first obtained.

18. In a multi-office transmission measuring system, a source of alternating current supply, a transmission testing set, means for connecting the source of alternating current supply to the testing set, a calling device, a first office, a second office, a plurality of telephone lines forming a group between said first and second offices, means for connecting the testing set and the calling device to a predetermined telephone line in the group at the first office, a second predetermined line in said group, a test line in said second office having a distinguishing code number, means in said second office for connecting the second predetermined telephone line to said test line, automatic apparatus in the second office associative with said first mentioned predetermined telephone line, responsive to said calling device, for differentiating between said test line and any other line terminating in said second office, means in said first office for connecting the testing set to said secondly mentioned predetermined telephone line, a circuit including a variable resistance, the current responsive device and a key of said testing set, in inductive relation with a circuit including said source of alternating current supply, for obtaining a reading on the first mentioned circuit by means of said current responsive device, a third circuit, in inductive relation with the circuit including said source of alternating current supply, comprising the elements aforesaid, said first, and secondly mentioned predetermined telephone lines, and said test line, and means for varying said resistance to produce the reading first obtained.

19. In a multi-office transmission measuring system, a source of alternating current supply, a transmission testing set, means for connecting the source of alternating current

supply to the testing set, a calling device, a first office, a second office, a plurality of telephone lines forming a group between said first and second offices, means for connecting the testing set and the calling device to a predetermined telephone line in the group at the first office, a second predetermined line in said group, a test line in the second office having a distinguishing code number, means in the second office for connecting said second predetermined telephone line to said test line, automatic apparatus in the second office associative with both said first and second mentioned predetermined telephone lines responsive to said calling device for differentiating between said test line and any other line terminating in said second office, means in said first office for connecting the testing set to said secondly mentioned predetermined line, a circuit including a variable resistance, the current responsive device and a key of said testing set, in inductive relation with a circuit including the source of alternating current supply for obtaining a reading on the first mentioned circuit by means of said current responsive device, a third circuit, in inductive relation with the circuit including said source of alternating current supply, comprising the elements aforesaid, said first and secondly mentioned predetermined telephone lines, and said test line, and means for varying said resistance to produce the reading first obtained.

20. In a telephone transmission measuring system, a source of alternating current supply, a transmission testing set, a calling device, a plurality of telephone lines forming a group, each line equipped with automatic switching apparatus responsive to said calling device, means for connecting said source of alternating current supply to the testing set, means for connecting the testing set and the calling device to any predetermined telephone line in said group, a test line multipled before and accessible to the last switch in the train of switching apparatus, a second predetermined telephone line in the group aforesaid, means for connecting said test line to said secondly mentioned predetermined telephone line, means for connecting said secondly mentioned predetermined telephone line to said testing set, a circuit including a variable resistance, current responsive device, and a key of said testing set, in inductive relation with a second circuit including said source of alternating current supply, for obtaining a reading on the first mentioned circuit by means of said current responsive device, a third circuit in inductive relation with the circuit including said source of alternating current supply, comprising the elements aforesaid, said first and secondly mentioned predetermined telephone lines, and said test line, and means for varying said resistance to produce the reading first obtained.

21. The method of testing the characteristics of transmission lines which consists in taking one of said lines and a line whose transmission loss is known, connecting the transmission measuring device to these lines, establishing a connection at a distant point over the line to be tested in accordance with its normal mode of operation to the line whose loss is known, manipulating the transmission testing device to determine the transmission loss of the combination, releasing the line tested, mathematically determining the transmission loss of the line tested, and deducing therefrom its transmission characteristics.

22. The method of testing the characteristics of transmission lines which consists in taking one of said lines and a line whose transmission loss is known, connecting the transmission measuring device to these lines, establishing a connection at a distant point over the line to be tested in accordance with its normal mode of operation to the line whose loss is known, manipulating the transmission testing device to determine the transmission loss of the combination, releasing the line tested, mathematically determining the transmission loss of the line tested, and of deducing therefrom its transmission characteristics, all steps in the method being conducted without interfering with the normal use of subscriber's lines.

23. The method of testing the characteristics of transmission lines which consists in taking one of said lines and a line whose transmission loss is known, of assigning a distinguishing designation to the line of known loss, connecting the transmission measuring device to these lines, establishing a connection at a distant point over the line to be tested in accordance with its normal mode of operation to the line whose loss is known, manipulating the transmission testing device to determine the transmission loss of the combination, releasing the line tested, mathematically determining the transmission loss of the line tested, and deducing therefrom its transmission characteristics, all steps in the method being conducted without interfering with the normal use of subscriber's lines.

24. The method of testing the characteristics of transmission lines which consists in taking one of said lines and a line whose transmission loss is known, of assigning a distinguishing designation to the line of known loss, connecting the transmission measuring device to these lines, transmitting signals corresponding to a distinguishing designation of the line of known loss over the line tested whereby a connection is established at the distant point with the line

whose loss is known, manipulating the transmission testing device to determine the transmission loss of the combination, releasing the line tested, mathematically determining the transmission loss of the line tested, and deducing therefrom its transmission characteristics, all steps in the method being conducted without interfering with the normal use of subscriber's lines.

In testimony whereof, we have signed our names to this specification this 23rd day of August, 1923.

WILLIAM H. HARDEN.
MICHAEL A. GRAEFENECKER.