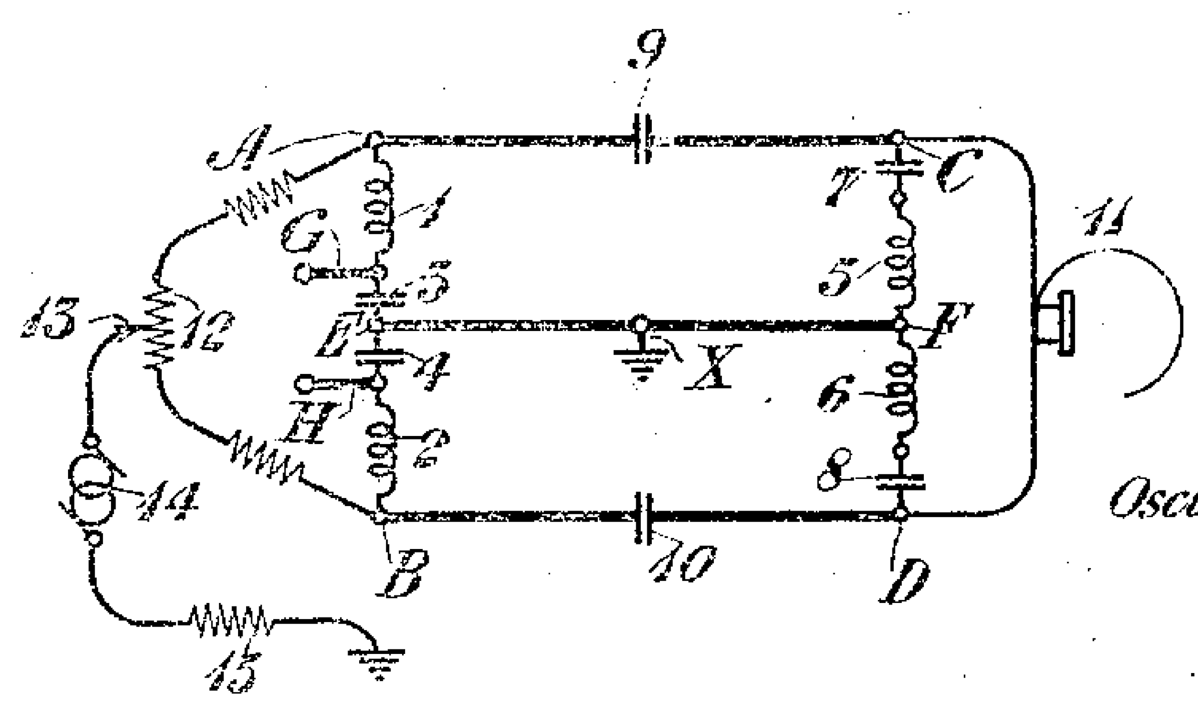
Dec. 8, 1925. 1,564,259

R. G. McCURDY

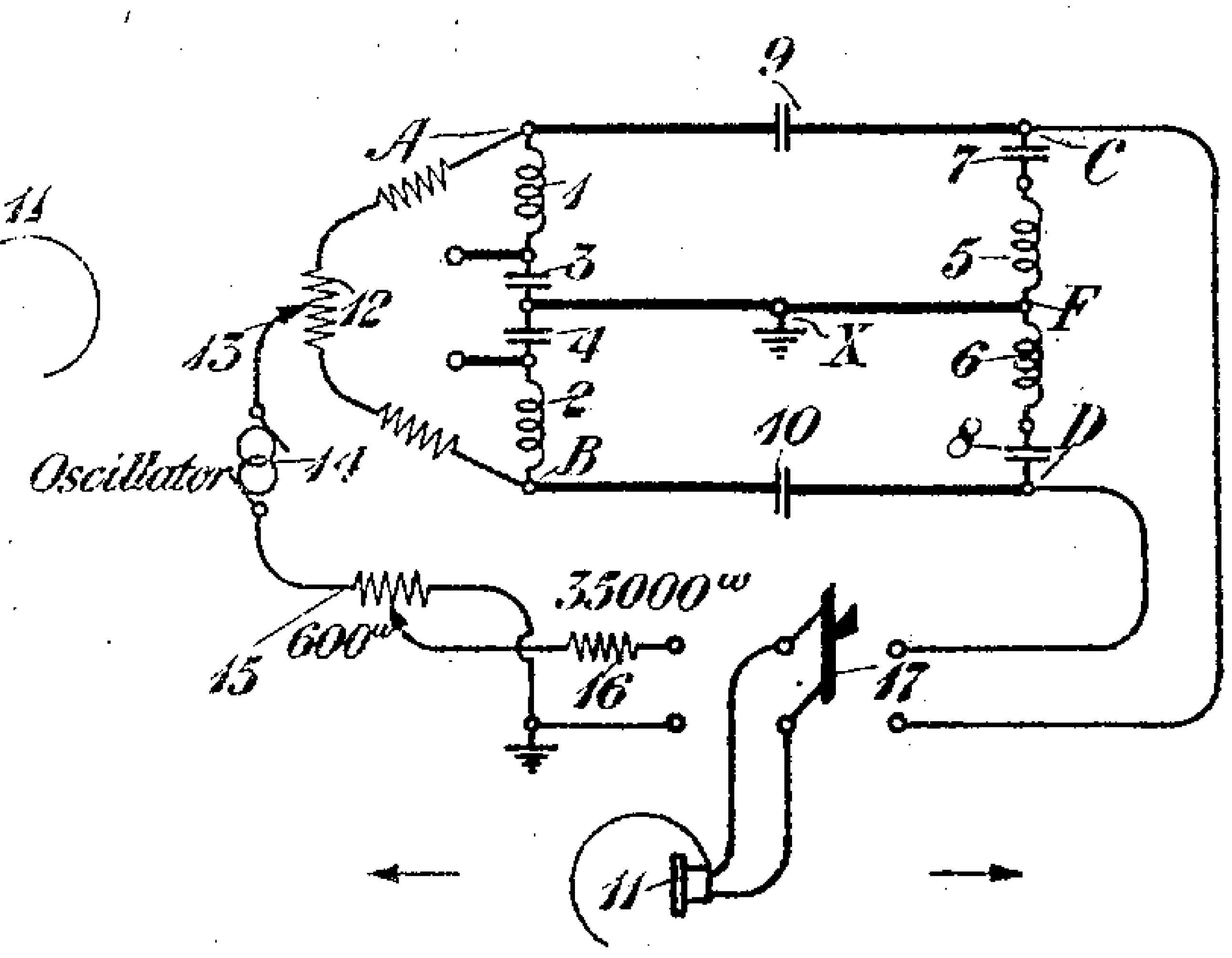
ELECTRICAL TESTING SYSTEM

Filed Dec. 30, 1921 2 Sheets-Sheet 1



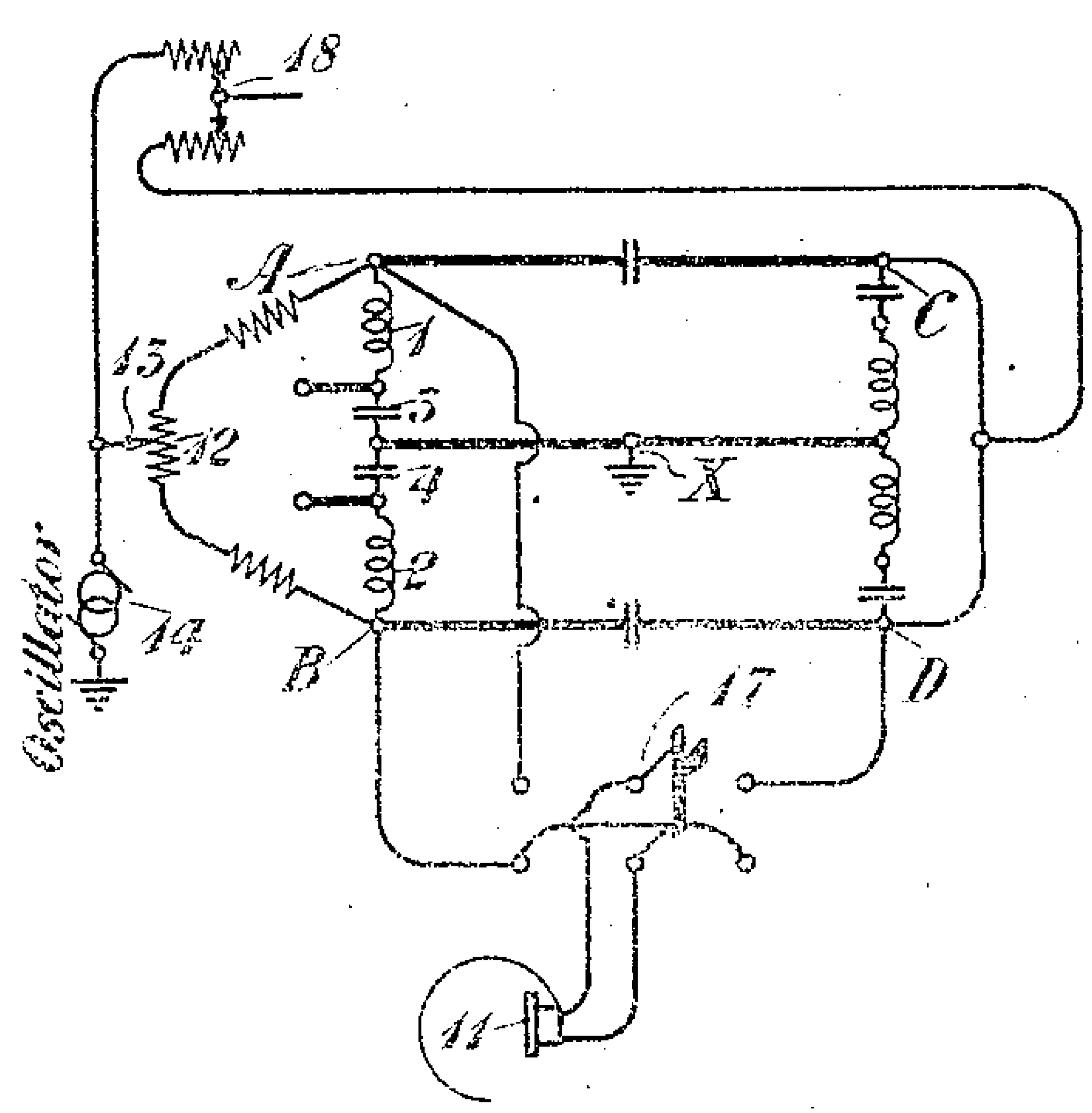
Whole Set - Null Method

Fig. 1.



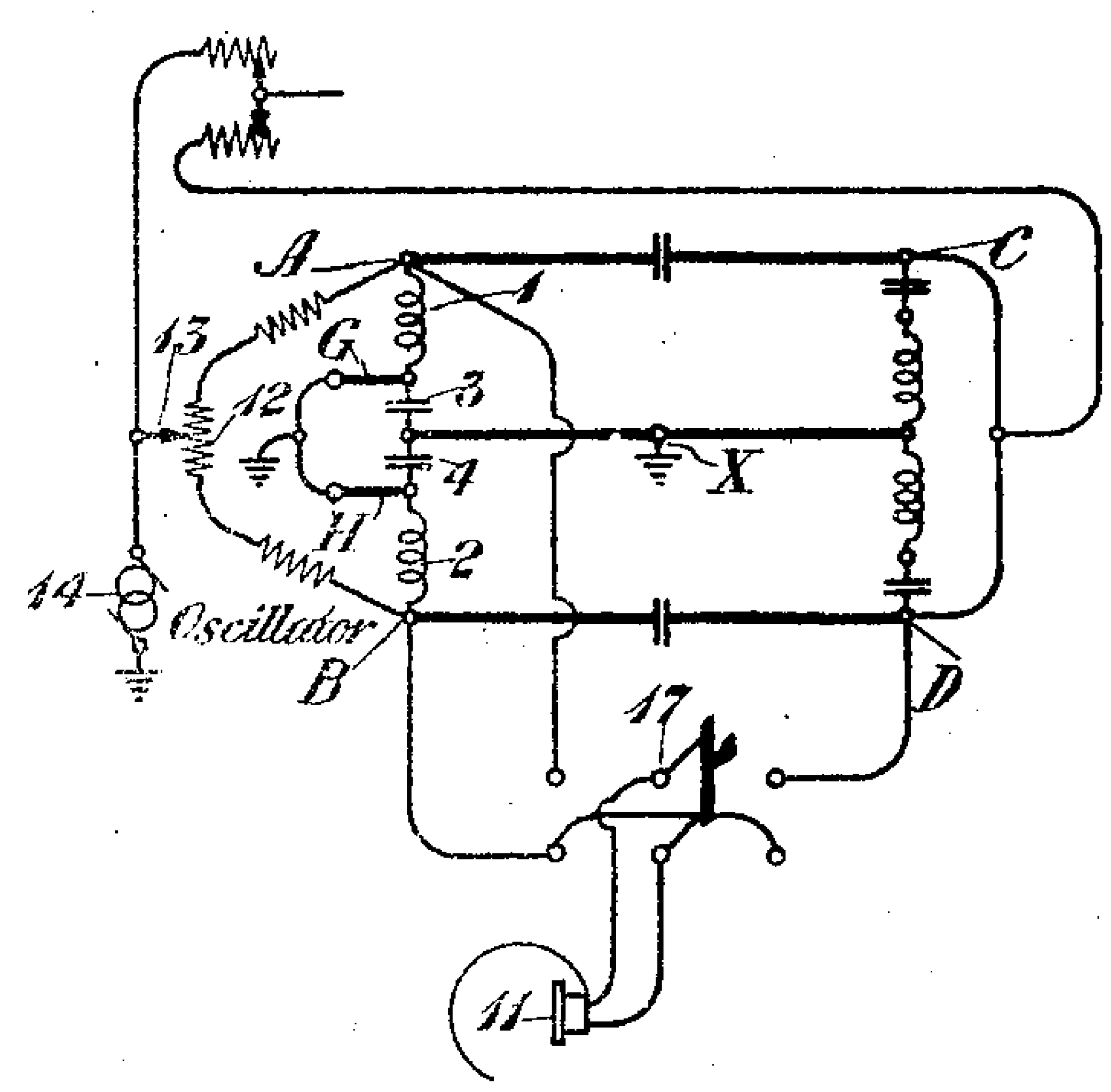
Whole Set - Comparison Method

Fig. 1a



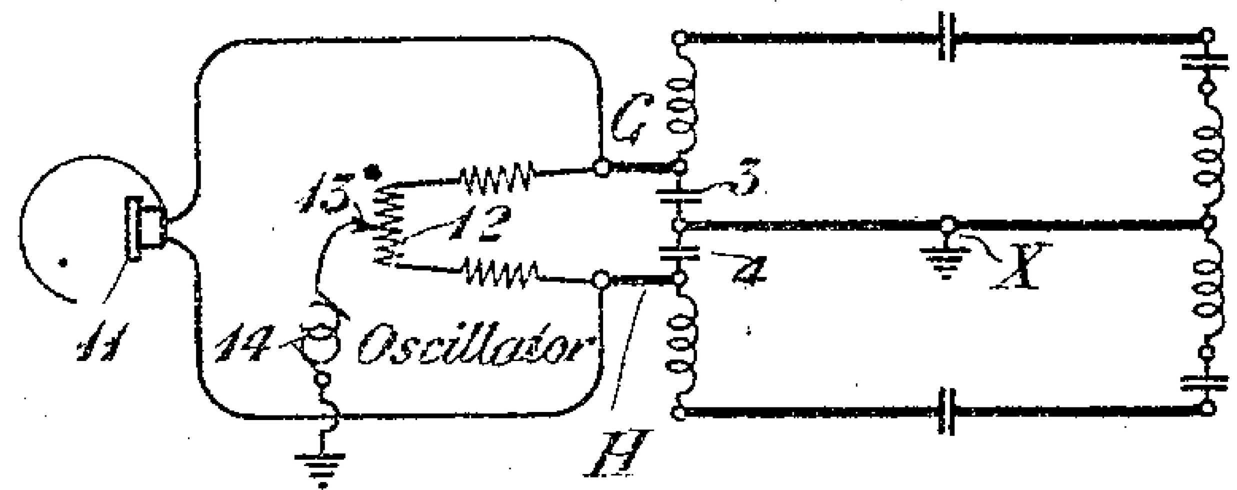
Balance of Telegraph Branches

Fig. 2



Balance of Coils of Telegraph Branch

Fig. 2a



Balance of Condensers of Telegraph Branches

Fig. 2b

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1,564,259

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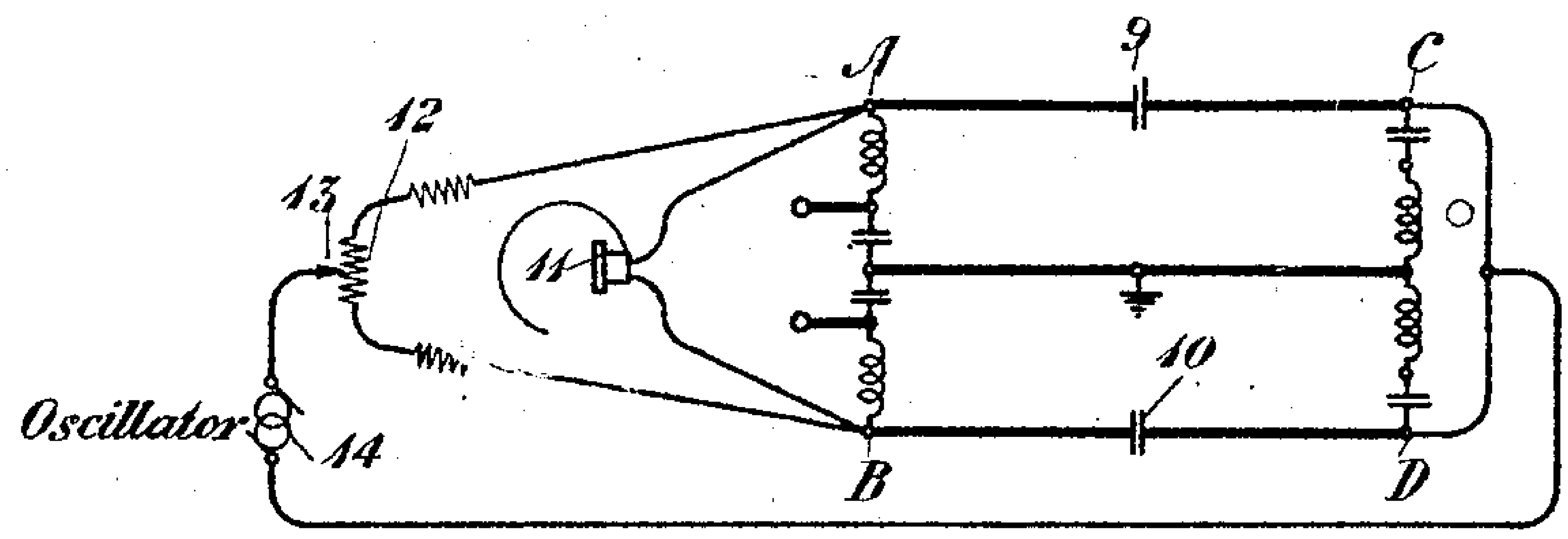
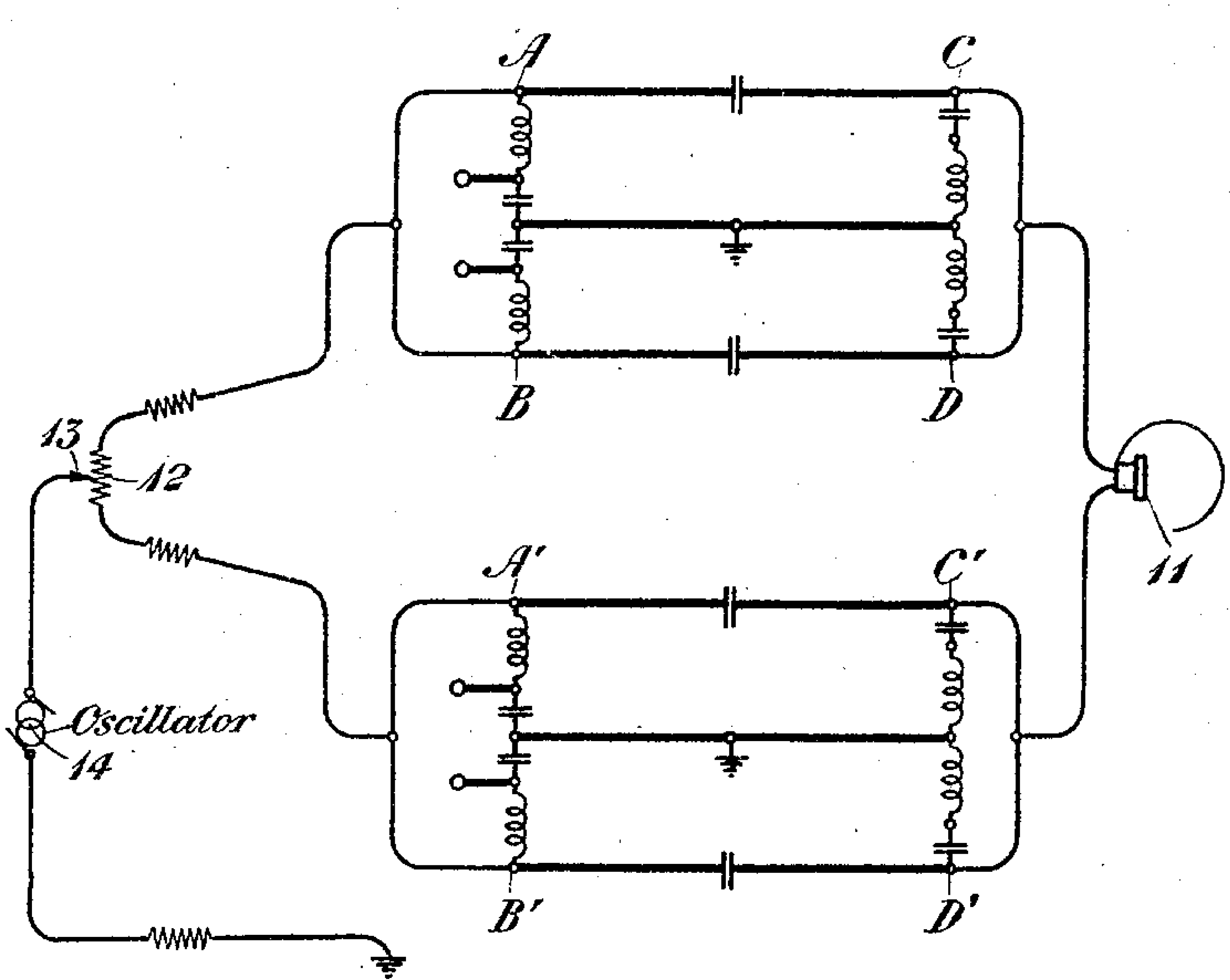
2 Sheets-Sheet 2



Balance of Series Condensers

Fig. 3



Comparison of 2 Composite Sets
Whole Set - Null Method

Fig. 4

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UNITED STATES PATENT OFFICE.

RALPH G. McCURDY, OF CRESSKILL, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

ELECTRICAL TESTING SYSTEM.

Application filed December 30, 1921. Serial No. 525,953.

To all whom it may concern:

Be it known that I, RALPH G. McCURDY, residing at Cresskill, in the county of Bergen and State of New Jersey, have invented certain Improvements in Electrical Testing Systems, of which the following is a specification.

This invention relates to electrical testing systems and especially to a method and means for determining the existence and magnitude of unbalance in telegraph composite sets and similar networks.

In signaling systems which are designed for the simultaneous transmission of telephone and telegraph signals it is necessary to insert at the terminals, for example, a network adapted to separate the telephone currents from the telegraph currents and to direct each of these currents into its individual terminal circuit. Networks intended to perform this function are usually designated composite sets. They consist usually of two branches bridged in parallel across the sides of the circuit with a condenser in each side of the circuit between the two junction points of the branches, with each side of the circuit. The branches bridged across the sides of the circuit consist usually of two inductances in series with two condensers. For the efficient operation of lines jointly used for telephone and telegraph signaling, it is necessary that substantially no unbalance should exist in these networks.

It is the object of this invention to provide a method and means for determining the existence of unbalance in composite sets and similar networks and to determine the magnitude of such unbalance.

This invention will be better understood from the following description when read in connection with the attached drawing, of which Figure 1 shows means for measuring the unbalance of the composite set as a whole, using the null method, and Fig. 1ª shows means for making the same measurement using the comparison method; Fig. 2 shows means for measuring the unbalance existing in the telegraph branches of the composite set and Figs. 2ª and 2ᵇ show means for measuring the unbalance existing between the elements of the telegraph branches; Fig. 3 shows a method for measuring the unbalance between the condensers in series with the sides of the line circuit and Fig. 4 shows an arrangement for measuring the unbalance between two composite sets using the null method.

The arrangments shown in Fig 1 comprise a composite set, a slide wire which constitutes the ratio arms of the Wheatstone bridge, a source of testing current and a current indicating instrument. The composite set comprises two circuits bridged in parallel across the sides of the signaling circuit, one extending from A to B, known as the telegraph branches, and the other extending from C to D, known as the grounded branches. Interposed in the sides of the signaling circuit between the two bridged circuits are two series condensers 9 and 10. The telegraph branches extending from A to B include 2 inductances 1 and 2 in series with two condensers 3 and 4. The junction point of the condensers is connected to ground. The grounded branches extending from C to D include two condensers 7 and 8 in series with the two inductances 5 and 6. The junction point of the inductances in this branch is grounded. One of the telegraph legs is connected to the composite set at the point G and the other leg is connected at the point H. Bridged across one end of the composite set between the points A and B is the circular slide wire resistance whose moveable contact point 13 is connected with one side of a source of oscillations 14, the other side of which is connected preferably through a resistance 15 to ground. Bridged across the other end of the composite set between the points C and D is a current indicating device, here represented by the telephone receiver 11. The source of oscillations 14 may be of a type adapted to give a single frequency or it may be of a type adapted to produce a complex wave form. When the oscillator 14 is in operation current will flow through the circular slide wire in opposite directions from the contact point 13 and thence through the various paths of the network to the ground X, which connects the midpoints of the two branches. If no unbalance exists, the points C and D will be at the same potential and consequently no current will flow through the receiver 11. If unbalance exists in the network it will be manifested by a tone in the said receiver, but the effect of this unbalance can be neutralized by proper adjustment of the variable slide wire ratio arms 12. If the slide wire is properly calibrated the percentage unbalance may be determined from the location of the contact point when balance is obtained.

If the unbalance is fairly large it may be difficult to measure it by means of the null method described in connection with Fig. 1, due to the inability to obtain a sharply defined point of minimum tone in the receiver 11. If this situation exists a measurement may be made by the comparison method illustrated by Fig. 1ª. In this figure and in all subsequent figures, parts similar to those described in Fig. 1 have been given the same designating symbols. In Fig. 1ª the receiver 11 is connected with the swinging contacts of the double throw, double pole switch 17, the right-hand contacts of which are connected with the points C and D of the composite set, and the left-hand contacts of which are connected respectively with a high resistance 16 and with ground. This resistance is connected adjustably with the resistance 15 which acts as a potentiometer to vary the current through the receiver and the resistance 16 when they are connected to it. When the switch is operated toward the right the receiver 11 will be bridged across the points C and D and a tone will be produced in the receiver by current from the oscillator 14, the magnitude of which will depend upon the magnitude of the unbalance in the composite set. The switch is then operated toward the left, thereby connecting the receiver in series between the resistance 16 and ground. The variable resistance 15 is adjusted until the magnitude of the current flowing through the receiver 11, as indicated by the tone produced thereby, is the same as when the receiver is connected across the points C and D of the network. The magnitude of the unbalance may be determined by proper calibration of the potentiometer 15. In making this test the contact 13 of the slide wire resistance 12 should be positioned midway between the outer terminals of the slide wire resistance.

Fig. 2 shows a circuit arrangement for determining the magnitude of unbalance existing between the two telegraph branches of a composite set. By telegraph branch is meant that part of the set in which telegraph currents are intended to flow. Since it is desirable to measure the magnitude of the unbalance in this particular part of a composite set without disconnecting the other branches or elements of the set therefrom, the arrangement provides for protecting the branch to be tested from the effect of unbalance in the other parts of the composite set. In Fig. 2, one side of the grounded oscillator 14 is connected not only to the contact 13 of the slide wire resistance 12 but also to the variable resistance 18, which in turn is connected to the points C and D of the composite set. By means of the switch 17 the receiver 11 is adapted to be connected either between the points B and D or between the points A and B. To protect the branch to be tested from the effect of unbalance in the other parts of the set it is necessary to bring to the same potential the points A, B, C and D. This is done by the simultaneous adjustment of the variable resistance 12 and 18. With the switch 17 operated toward the right the receiver 11 is bridged across the points B and D. The resistance 18 should then be adjusted until the points B and D are the same potential, which would be indicated by silence in the receiver 11. The switch 17 is then operated toward the left, thereby bridging the receiver across the points A and B and the slide wire resistance 13 is then adjusted to produce the minimum tone in the receiver. The switch 17 should then be again operated toward the right in order to determine whether the points B and D are still at the same potential, because the adjustment of the resistance 13 may produce a slight unbalance which might cause a difference of potential across B and D. If such potential exists, the resistance 18 should be adjusted again until balance exists, and then the switch 17 should be operated to the left in order to determine whether the points A and B are still at the same potential. Complete balance of the network may be effected by successive adjustments of the two resistances. The setting of the dial of the resistance 12 indicates the percentage unbalance existing between that part of the telegraph branch, including the inductance 1 and condenser 3, and the part including the inductance 2 and condenser 4.

Fig. 2ª shows the arrangement of the apparatus for measuring the magnitude of the unbalance between the inductances alone of the telegraph branch. The circuit arrangement differs from that shown in Fig. 2 only in the shunting out of the condensers 3 and 4 by connecting the points G and H to ground. The method is similar to that described in connection with Fig. 2. The switch 17 is operated toward the right thereby connecting the receiver 11 across the points B and D, and the resistance 18 is adjusted until these points are at the same potential which would be indicated by silence in the receiver. The switch 17 is then operated toward the left and the variable slide wire 12 is adjusted to give minimum tone in the receiver 11. It is desirable to determine whether there is any potential across the points B and D after the adjustment of the slide wire 12 has been made. Successive adjustments of the two resistances should be made until complete balance of the network is effected. The setting of this slide wire is a measure of the percentage unbalance existing between the inductances 1 and 2 of the telegraph branch.

The means of measuring the unbalance between the condensers 3 and 4 in the telegraph branch is shown in 2^b. Since the impedance of the apparatus which is connected around the condensers of the telegraph branches is relatively high it is unnecessary to protect against unbalances in other parts of the composite set network when measuring the unbalance between these condensers. Accordingly, the outer ends of the variable resistance 12 are connected with the terminals G and H (which are the outer terminals of the condensers 3 and 4) and the receiver 11 is also bridged across these same terminals. Oscillations from the source 14 will be applied to the network and the variable resistance 12 will be adjusted until minimum tone is produced by the receiver 11. The setting of the slide wire is a measurement of the percentage unbalance of the two condensers.

Fig. 3 shows an arrangement for measuring the unbalance between the series condensers 9 and 10 of the composite set. The outer ends of the variable resistance 12 are connected to the points A and B of the set, and the other ends C and D of the set are strapped together. The source of oscillations 14 is connected between the contact of the slide wire 12 and the strap connecting the points C and D. The receiver 11 is bridged across the points A and B. Since the impedance of the telegraph branches and the grounded branches of the composite set are relatively so great with respect to the series condensers their effect upon the network may be neglected. The variable resistance 12 is adjusted until the point of minimum tone is perceived in the receiver 11 and the setting of the said resistance is a measure of the percentage unbalance between the series condensers.

The method of measuring the percentage unbalance between the grounded branches of the composite set is similar to that for measuring the unbalance between the telegraph branches as described in connection with Fig. 2. In measuring the unbalance of the grounded branches the outer ends of the variable resistance 12 are connected across the points C and D and the points A and B are strapped together and connected with the variable resistance 18 in the same manner in which the points C and D of Fig. 2 are connected to the said resistance. The switch 17 is arranged to connect the receiver 11 either across the points B and D or across the points C and D. The manner of making this test is exactly the same as for measuring the unbalance of the telegraph branches and needs no further explanation.

Fig. 4 shows the circuit arrangement for measuring the percentage unbalance between two composite sets. In this arrangement the points A and B, C and D, A′ and B′, C′ and D′ of the two composite sets are strapped together as shown in the figure, and the variable resistance 12 and the receiver 11 are connected between the two sets in the manner there shown. Oscillations from grounded oscillator 14 will be impressed across the two networks between their respective outer terminals and ground. If the networks are balanced there will be no difference of potential across the receiver 11 and no tone will be produced thereby. If unbalance exists its effect may be neutralized by adjusting the variable resistance 12 until no tone or a minimum tone is produced by the receiver.

It will be seen that by means of the foregoing arrangements it is possible to determine the existence and the extent of unbalance existing in composite sets or similar networks as a whole, and also unbalance existing between correspondingly similar parts of such sets, which measurements may readily be made without physically separating the various branches or parts that constitute these networks. It will also be seen that the methods and means heretofore described are applicable for determining the magnitude of unbalance existing between two composite sets used in the side circuits of a phantom signaling circuit. By using these methods and arrangements the condition of a composite set or a similar network may, for example, be readily determined from the test-board of the signaling system without disturbing the connections of the circuit at the distributing frame or the composite rack in the office where the tests are being made.

Although this invention has been described as embodied in certain particular forms and arrangements of parts it is to be understood that it is not so limited but is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. The combination with a composite set having two similar grounded branches constituting two arms of a Wheatstone network of a variable resistance connected with one end of the said composite set, and constituting the two ratio arms of the network, a current indicating device connected with the other end of the composite set and a grounded source of varying potential connected with the contactor of the said variable resistance.

2. The combination with a composite set constituting two arms of a Wheatstone network of a variable resistance connected with one end of the said composite set constituting the two ratio arms of the Wheatstone

network, a grounded source of varying potential connected with the contactor of the said variable resistance, and having a potentiometer in the grounded side thereof, a current indicating device, and switching means to connect the said indicating device either across one end of the said composite set or in parallel with the potentiometer in the grounded side of the said source of potential.

3. The combination with a composite set having two similar branches constituting two arms of a Wheatstone network, of a source of alternating current connected therewith, and a current indicating device responsive to any unbalance currents through the said branches.

4. The combination with a composite set having two similar branches, of variable resistance ratio arms connected with the said branches constituting a Wheatstone network, a source of alternating current connected with the said network, and a current indicating device responsive to any unbalance currents flowing through the said branches.

5. The combination with a composite set comprising an impedance in series with each side of the said set, and an impedance in shunt therewith to ground of variable ratio arms connected with each side of said composite set, a source of alternating potential connected with the said ratio arms, and an indicating device bridged across the sides of the said set whereby unbalance between the said sides may be determined.

6. The combination with a composite set comprising impedance in series with each side of the said set and impedance in shunt therewith, of variable ratio arms bridged across the sides of the said set, a source of alternating potential effectively connected with the said variable ratio arms and the said impedances, and an indicating device connected across the said series impedances whereby unbalance between the sides of the said composite set may be determined.

7. The combination with a composite set comprising an impedance in series with each side of the said set and an impedance in shunt therewith to ground, variable ratio arms bridged across the sides of the said set, a source of alternating potential connected with the said arms and grounded through a potentiometer, an indicating device, and switching means to connect the said device either across the sides of the said set or across said potentiometer.

In testimony whereof, I have signed my name to this specification this 29th day of December 1921.

RALPH G. McCURDY.