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APPARATUS FOR TESTING AND REPAIRING TELEPHONE CIRCUITS

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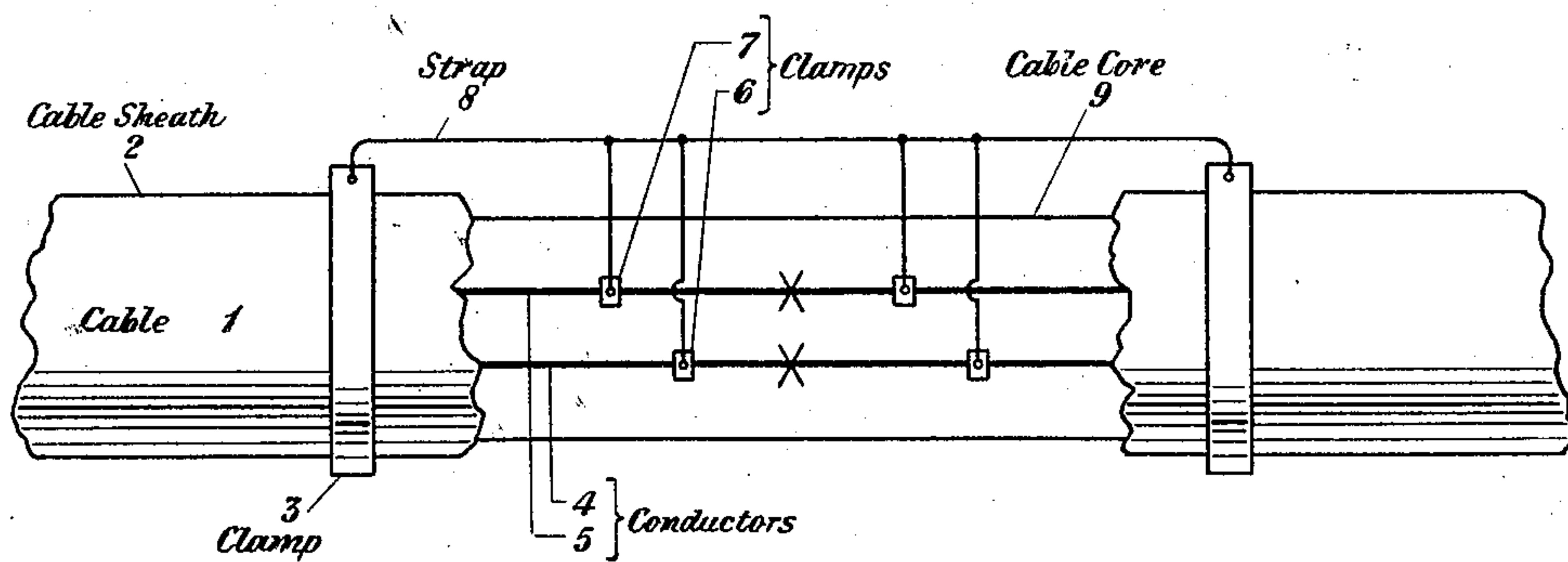


Fig. 1

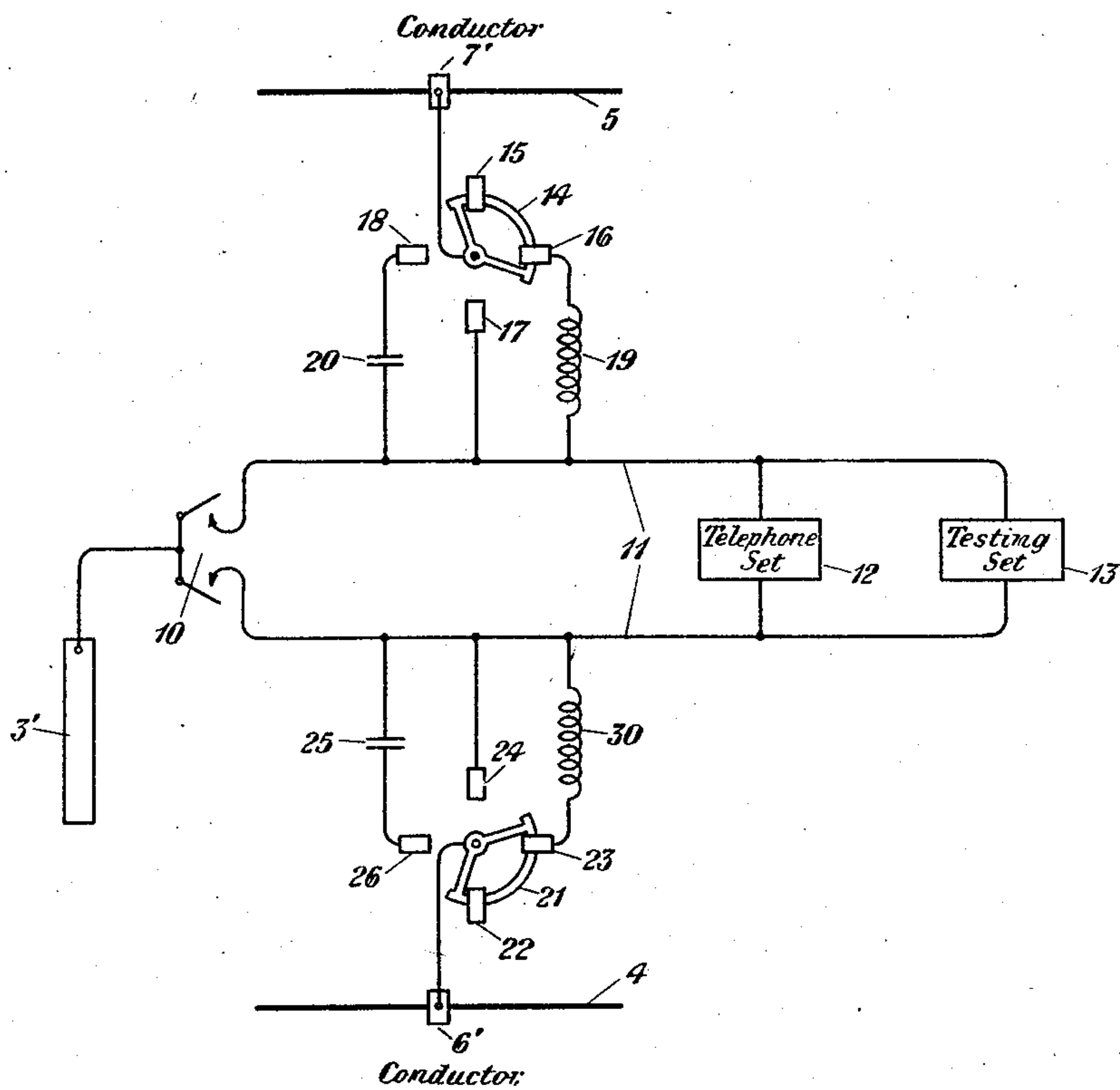


Fig. 2

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APPARATUS FOR TESTING AND REPAIRING TELEPHONE CIRCUITS

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This invention relates to a method and means for preventing inductive interferences from arising in circuits in a group, such, for example, as in a cable.

5 The arrangements of the invention are particularly advantageous for preventing the occurrence of interferences which might otherwise originate in the cable, or group, itself due to operations which have to be carried
10 out in the ordinary working on such circuits, such for example, as splicing or testing operations.

The problem of preventing the repairing or testing operations on one pair of conductors from causing interference on adjacent
15 pairs is particularly serious when the circuits are utilized for the transmission of high frequency carrier currents. This is due to the fact that the frequencies are so high and the
20 carrier levels are so low that work on one pair may very seriously disturb transmission on a number of adjacent pairs. Furthermore, the operations which must be performed in connection with loading ordinary
25 voice circuits are liable to cause serious interference on adjacent carrier circuits.

There are four elementary operations which may be performed on a pair of conductors which may cause interference in adjacent
30 carrier circuits. These operations are as follows: A conductor may be suddenly grounded when there is a potential difference between the conductor and ground; the conductor may be removed from ground at a
35 time when there is current flowing from the conductor to ground; the conductor carrying current may be suddenly interrupted; or a severed conductor may be connected at a time when the two portions are
40 at a different potential. In the case of the above listed operations there is a wave with a steep front originated which is very rich in high frequencies. Computations indicate that the interference due to these operations
45 may, under unfavorable conditions, be far in excess of any permissible interference and may constitute a major trouble. Accordingly it is one of the primary objects of the arrangements of the invention to provide ar-
50 rangements whereby the above operations and

others may be carried out without causing interference in adjacent circuits. Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

55 The invention may be more fully understood from the following description together with the accompanying drawing, in Figures 1 and 2 of which the invention is illustrated. Fig. 1 shows a method of preparing a pair
60 of cable conductors for repair or test work; Fig. 2 shows the method and apparatus of this invention whereby connections may be made to a pair of cable conductors for repair or test purposes without causing any interference in adjacent circuits. Similar reference characters have been utilized to denote like parts in both of the figures.

In Fig. 1 is shown a section of cable 1. Included in the cable would be a group of con-
70 ductors of which the pair of conductors 4 and 5 are shown. The clamps 6 and 7 are affixed to these conductors and are connected by the strap 8 to clamps, such as 3, whereby a ground connection may be established on the
75 cable sheath 2. Under these conditions no interference will be caused from touching the two conductors together, or to ground, or to testing apparatus, or from cutting them at the points marked XX. However, the estab-
80 lishment of the above described connections, or the connection and removal of the clamps, are just the operations, heretofore pointed out, which will cause inductive interference on adjacent circuits.

85 In Fig. 2 are shown the arrangements of this invention whereby the above type of connection may be established without such operations causing interference on adjacent circuits. In this arrangement are shown the
90 two conductors 4 and 5 with the clamps 6' and 7' affixed thereto. Each of these clamps is associated with the four-position switches 14 and 21. Switch 14 has four positions, position 15 being open, position 16 being connect-
95 ed to circuit 11 through an inductance 19, position 17 being directly connected to a circuit 11, and position 18 being connected to circuit 11 through a condenser 20. Switch 21 has four positions, position 22 being open, posi-
100

tion 23 being connected to circuit 11 through an inductance 30, position 24 being directly connected to circuit 11, and position 26 being connected to circuit 11 through a condenser 25. Circuit 11 may be completed by means of a switch 10 which is also connected to a clamp 3' which may be grounded on the cable sheath as heretofore. If desired the circuit 11 might be completed through a telephone set 12 or a testing set 13.

The procedure with the arrangements of this invention is to connect the clamps 6' and 7' to the conductors 4 and 5 while switches 14 and 21 are on the open positions 15 and 22, respectively. Switch 10, which is connected to clamp 3 grounded on the cable sheath, may then be closed. The next operation is to throw the switches 14 and 21 to the positions 16 and 23 which are connected to circuit 11 through the inductances 19 and 30. Under these conditions any potential difference which may exist between the conductors 4 and 5 themselves on the one hand and between the conductors and the cable sheath is equalized, but due to the inclusion of the inductances 19 and 30 in the connection, the process of equalization is not rapid enough to cause appreciable inductive interference in adjacent circuits. The next operation involves throwing the switches 14 and 21 to the positions 17 and 24 whereby the conductors are connected directly to circuit 11 and to ground. For this operation it is necessary that the switch be of a make-before-break type. As the conductors are at the same potential at this time, there will again be no interference or disturbance caused. Finally after the current in the inductances has died out, the switches may be removed altogether from the positions connected to the inductances. When this condition has been brought about, the clamps and apparatus, such as shown in Fig. 1, may, if desired, be affixed to the conductors and the apparatus of Fig. 2 may be removed.

If it is desired to remove the clamps and apparatus of Fig. 1, the apparatus shown in Fig. 2 is again connected to the conductors with the switches 14 and 21 on the positions 17 and 24 which are directly connected to circuit 11. The switch 10 is closed. After that the switches 14 and 21 are moved to positions 18 and 26, respectively, which are connected to circuit 11 through the condensers 20 and 25. This is again a make-before-break operation. After the operation, any current which flowed previously is interrupted but the interruption is brought about gradually by the condenser becoming charged so that there is no sudden interruption of the current. This operation will accordingly cause no interference. After the current has reached zero the switches are put in the open position and the clamps may be removed.

The application to the conductors of apparatus other than for repair or splicing op-

erations, such as telephone or testing sets, is also likely to result in interference of the same general type at the time that the apparatus is connected or disconnected. The arrangements of Fig. 2 are suitable for connecting any apparatus of this type to the conductors. Such apparatus would be connected to circuit 11 in a manner similar to that of the telephone set 12 or the testing set 13. The procedure of operation would be the same as heretofore described except that switch 10 would be left open.

While the switches 14 and 21 are shown with only four positions, it might be advantageous to utilize a greater number of positions and to utilize intermediate reactance steps. In that case the operation of switch 21, for example, would be from the open position 22 to the position connected to the larger inductance; from that position to one connected to a smaller inductance; and finally to the position 24. The operation for opening would be to go from position 24 to a position connected to a large capacity, thence to one connected to a smaller capacity, and thence to the open position 22.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. The method of preventing inductive interference from being caused in circuits in a group by the disconnection from a pair in such group of apparatus utilized for preparing such pair for testing or repair purposes, which comprises disconnecting such apparatus from the conductors of said pair gradually through a capacity.

2. The method of preventing inductive interference from being caused in circuits in a group by connection and disconnection from a pair in such group of apparatus for preparing such pair for testing or repair purposes, which comprises connecting such apparatus to the conductors of a pair through an inductance, eliminating such inductance from the connection, and disconnecting such apparatus from the conductors of the pair gradually through a capacity.

3. The method of preventing inductive interference from being caused in circuits in a group by the connection to a pair in such group of apparatus for preparing such pair for testing or repair purposes, which comprises grounding such apparatus, connecting such grounded apparatus to the conductors of a pair through an inductance, and eliminating the inductance from such connection.

4. A pair of conductors, clamping members connectible to said conductors, a circuit connected to said clamping members, means for

grounding said circuit, an inductance, and switching means for completing said circuit through said inductance.

5 5. A pair of conductors, clamping members connectible to said conductors, a circuit connected to said clamping members, means for grounding said circuit, a capacity, and switching means for including said capacity in said circuit.

10 6. A pair of conductors, clamping members connectible to said conductors, a circuit associated with said clamping members, means for grounding said circuit, and switching means whereby said circuit may be completed
15 between said clamping members either directly, or through an inductance, or through a capacity.

In testimony whereof, I have signed my
20 name to this specification this 16th day of July, 1929.

HARRY NYQUIST.

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