C. S. DEMAREST.

TESTING SYSTEM FOR FOUR-WIRE CIRCUITS.

APPLICATION FILED JULY 24, 1920.

1,394,190.

Patented Oct. 18, 1921.

4 SHEETS—SHEET 1.

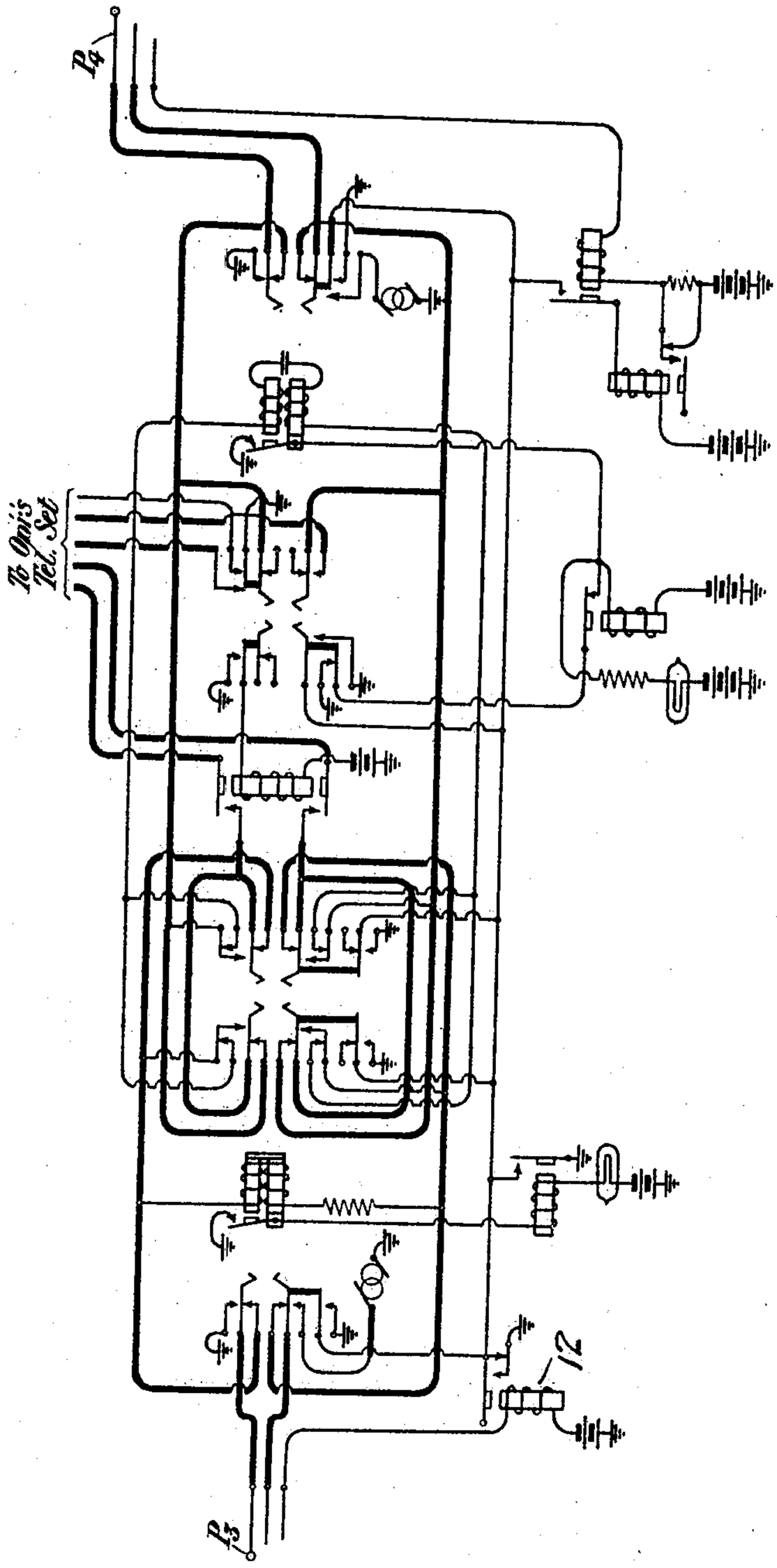

Fig. 1

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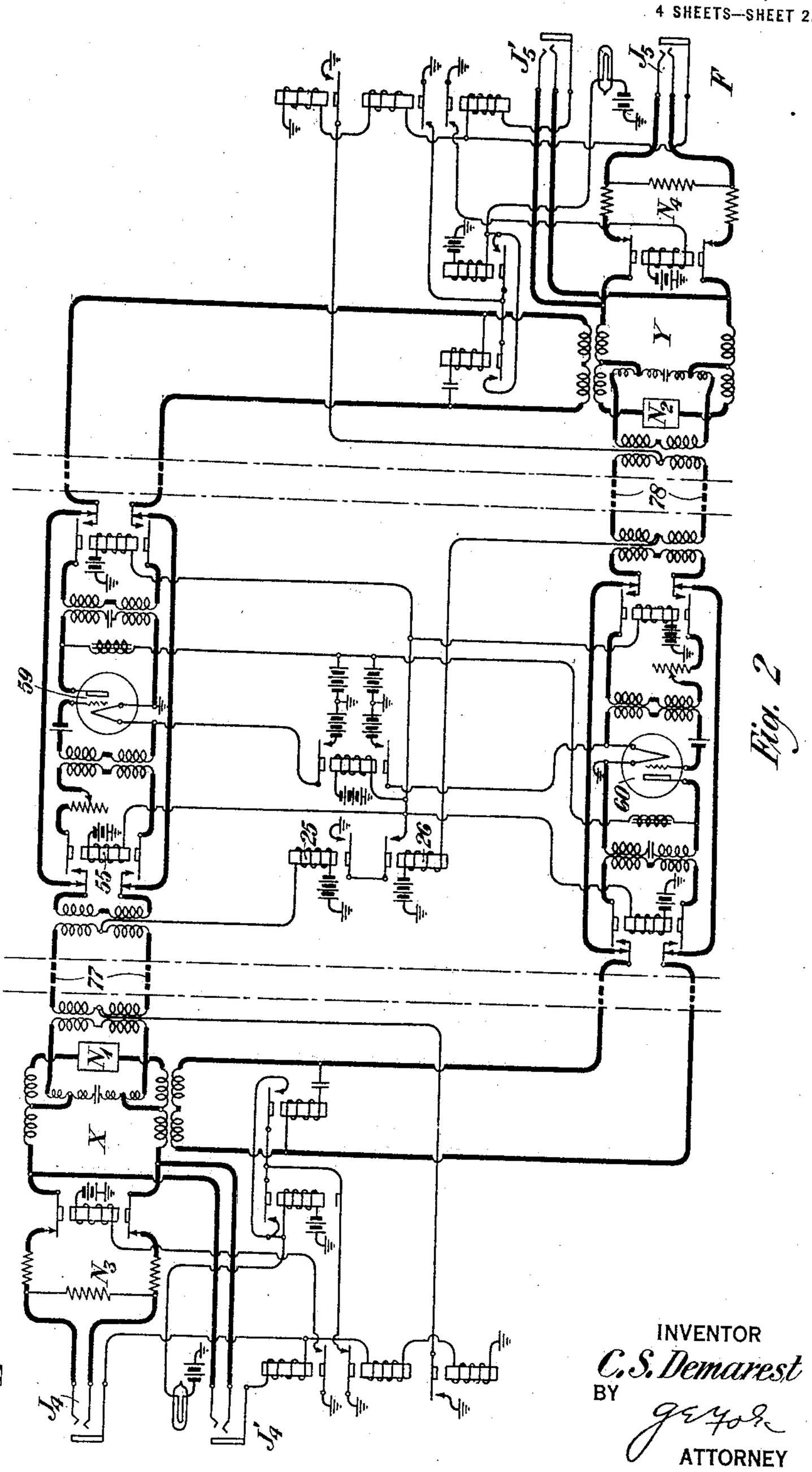

Fig. 2

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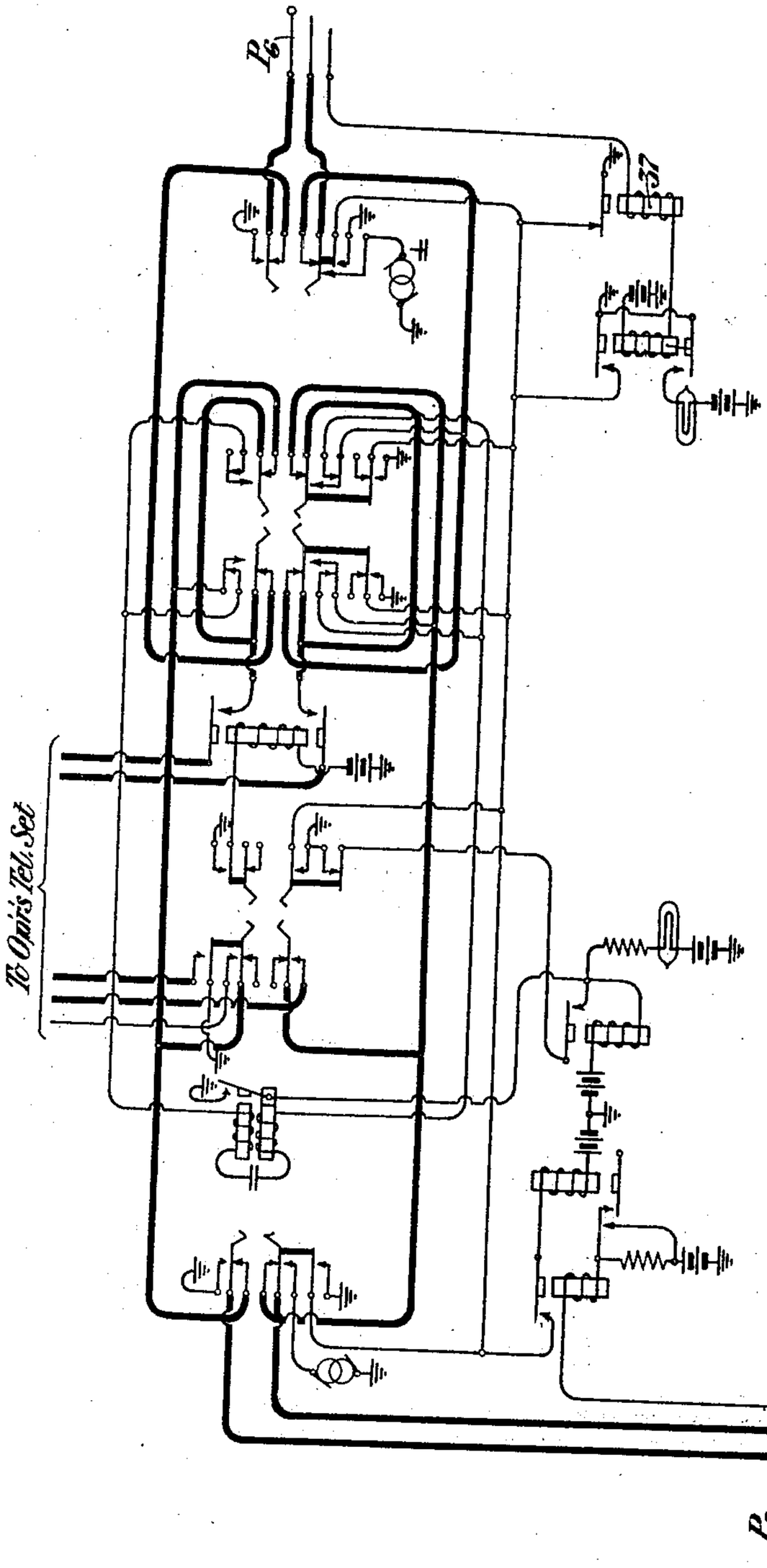

Fig. 3

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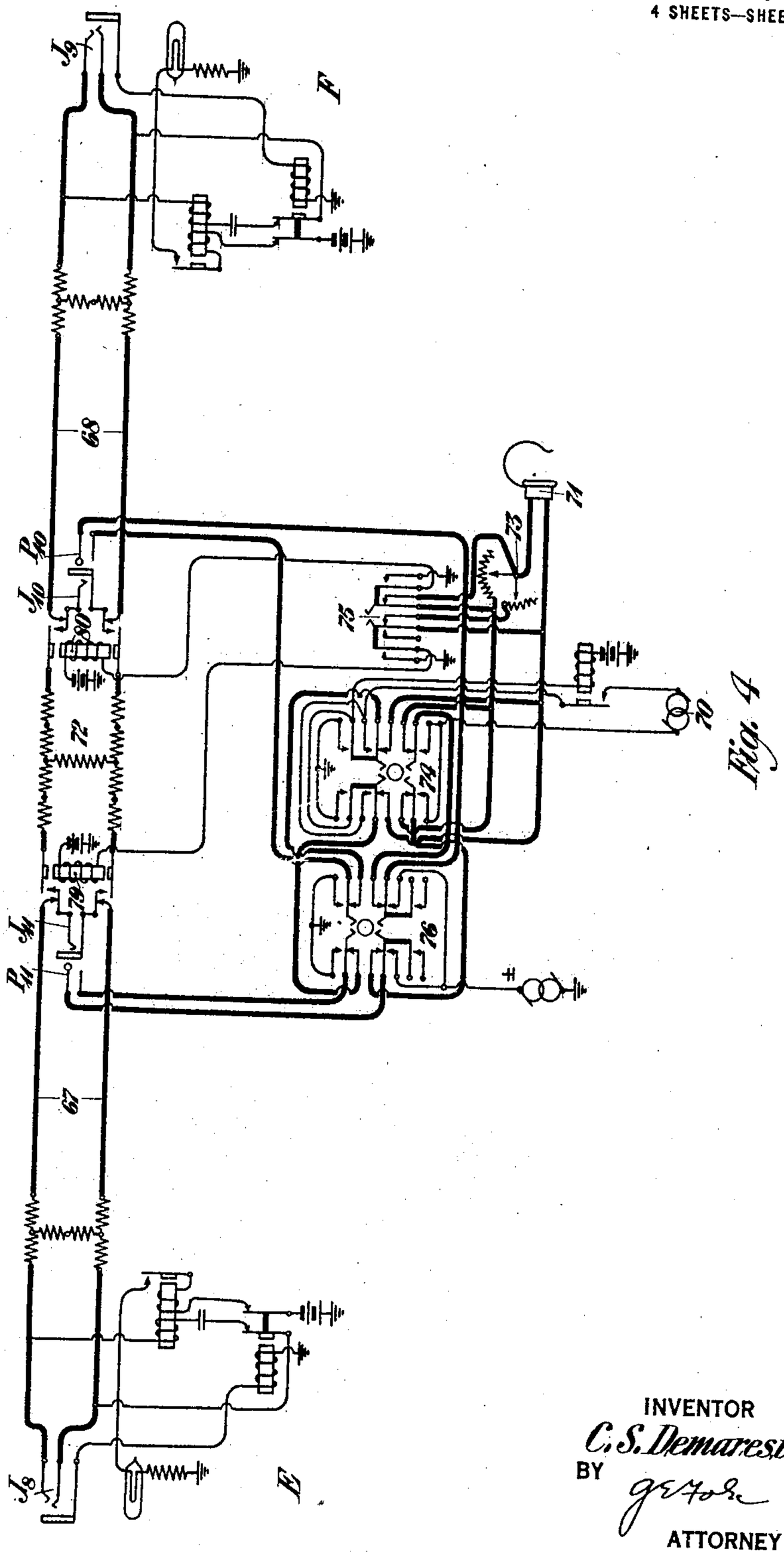

Fig. 4.

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UNITED STATES PATENT OFFICE.

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TESTING SYSTEM FOR FOUR-WIRE CIRCUITS.

1,394,190. Specification of Letters Patent. Patented Oct. 18, 1921.

Original application filed February 24, 1919, Serial No. 278,945. Divided and this application filed July 24, 1920. Serial No. 398,657.

To all whom it may concern:

Be it known that I, CHARLES S. DEMAREST, residing at Ridgewood, in the county of Bergen and State of New Jersey, have invented certain Improvements in Testing Systems for Four-Wire Circuits, of which the following is a specification.

This invention relates to telephone transmission systems and more particularly to means for controlling the connection of telephone repeaters to a four-wire telephone transmission circuit, and for testing the efficiency of such type of circuit.

This application is a division of my copending application, Serial No. 278,945, filed February 24, 1919.

Heretofore it has been customary to connect the repeaters into the four-wire repeater circuit, and to maintain such connection permanently, regardless of the nature of the circuit that may be connected with each end of the said four-wire circuit. The telephone repeaters connected with a four-wire circuit are usually designed and operated to give an amplification that will compensate not only for the loss in the four-wire circuit itself, but also for the losses in the telephone trunk lines that may ordinarily be connected with the said four-wire circuit. When such a circuit is completely connected from subscriber to subscriber, the repeater is balanced and will operate satisfactorily, that is, without "singing." It has been found that whenever an operator connects her telephone set with such circuit for the purpose of supervising such connection, an unbalanced condition is created and the repeaters begin to "sing," thereby impairing the transmission over the circuit.

It is the object of this invention to provide a testing circuit the function of which is to determine whether the repeaters are operating properly so as to produce the desired transmission gain.

This invention will be better understood from the following description, when read in connection with the attached drawing of which Figure 1 shows a cord circuit at, for example, a toll office to connect the incoming trunk circuit with the four-wire repeater trunk shown in Fig. 2, which for purpose of description, is assumed to extend between two toll offices; Fig. 3 shows a cord circuit at the other of said toll offices to connect said repeater trunk with circuits of the type with which the repeater circuit is designed to cooperate. Fig. 4 shows a testing circuit by means of which the repeaters shown in Fig. 2 may be tested. The complete circuit may be clearly seen by arranging all the Figs. 1, 2 and 3 so that the bottom edge of Figs. 2 and 3 coincide respectively with the top edge of Figs. 1 and 2. Fig. 4 should be arranged symmetrically below Fig. 2.

Fig. 1 shows a cord circuit at the toll board E terminating in a plug P_3 adapted to be inserted in the jack J_8 of the testing circuit shown in Fig. 4 and also in a plug P_4 adapted for insertion in either jack J_4 or jack J_4' of the toll circuit shown in Fig. 2.

Fig. 2 shows a four-wire repeater trunk circuit extending between two toll offices, designated E and F, and terminating at each of these offices in two jacks. The four-wire circuit is of the usual type, having two two-wire branches which are electrically related by means of the hybrid repeating coils X and Y. Associated with coil X are two networks N_1 and N_3, the former being adapted to balance the circuit connected with jack J_4' and the latter being designed to control the transmission gain when the repeater is connected through the jack J_4 with a circuit having a lower transmission equivalent than that connected with the jack J_4'. When a circuit is connected with jack J_4, both networks are connected into the repeater circuit. In a similar manner coil Y has associated with it two networks N_2 and N_4; N_2 being adapted to balance the circuit connected with jack J_5' and N_4 functioning as a gain control network for a circuit connected with jack J_5. Each group of jacks at either end of the four-wire circuit has associated with it a group of relays controlled by the circuits connected with said jacks and adapted to control relays 25 and 26 of the repeater circuit which, in turn control the connection of the repeaters to the branches of the four-wire circuit, and the connection of the heater batteries with the filaments.

Fig. 3 shows a cord circuit located at the toll office F terminating in two plugs P_5 and P_6, P_5 being adapted for insertion in jacks J_5 and J_5' of the four-wire trunk circuit and plug P_6 being adapted for insertion in jack J_9 of the testing circuit shown in Fig. 4.

Fig. 4 shows the repeater testing equipment which is preferably though not necessarily located in the same office in which the repeater shown in Fig. 2 is located and is connected by means of ring-down trunks 67 and 68 with the switchboards at the toll offices E and F terminating therein in jacks J_8 and J_9, respectively.

The central testing arrangement consists of an oscillator or vibrator 70 adapted to give an electromotive force of approximately telephonic frequency. A receiver 71 with which is associated a receiver shunt 73 is adapted to be connected across the end of the repeater circuit opposite to that end with which the oscillator 70 may be connected. The artificial line 72, which is of the well known type, has the same transmission equivalent as the four-wire circuit has when the repeaters are disconnected. A switch 74 is provided for connecting the oscillator 70 with either end of the repeater circuit or of the artificial line 72. A switch 75 is provided to connect the oscillator and the receiver alternately with the transmission circuit and with the artificial line.

In order to test the repeater, plug P_{10} is inserted in jack J_{10} and plug P_{11} in jack J_{11}. Plug P_3 is inserted in jack J_8 at toll office E, and plug P_6 is inserted in jack J_9 at toll office F and likewise plugs P_4 and P_5 are inserted in jacks J_4 and J_5 respectively. Relay 12 of the cord circuit at office E and relay 37 of the cord circuit at office F will be operated, and if the keys in both cord circuits are normal the repeaters 59 and 60 will be energized in the manner shown clearly in my copending application, Serial No. 278,945, filed February 24, 1919. If key 74 of the testing circuit is operated in the left hand direction an alternating electromotive force will be applied over contacts of keys 74 and 76, tip and ring contacts of plug P_{11} and jack J_{11}, trunk 67, over the tip and ring conductors of the cord circuit at office E, through branch 77 of the four-wire repeater circuit including the repeater 59, over the conductors of the cord circuit at office F and the conductors of trunk 68, tip and ring contacts of jack J_{10} and plug P_{10}, right hand normals contacts of switches 76 and 74, through receiver shunt 73 to the receiver 71. Switch 75 is now operated, thereby causing the operation of relays 79 and 80, which disconnects the source of tone 70 and the receiver 71 from the trunk circuits 67 and 68, respectively, and connects said source of tone to one end of the artificial line 72, and the receiver 71 to the other end of said artificial line.

The receiver shunt 73 is gradually varied until the volume of tone received in the receiver 71 when the receiver is connected across the artificial line is the same as when it is connected across the trunk leading to one end of the four-wire repeater circuit.

If the switch 74 is thrown in the right hand direction the source of alternating electromotive force 70 will be applied to the trunk 68 and the receiver 71 will be connected across the end of trunk 67, thus establishing the circuit from vibrator 70, right hand contacts of switch 74, tip and ring contacts of plug P_{10} and jack J_{10}, trunk 68, conductors of the cord circuit at office F, conductors 78 and repeater 60, forming one side of the four-wire circuit, conductors of the cord circuit at office E, trunk 67, contacts of jack J_{11} and plug P_{11}, left hand contacts of switches 76 and 74, receiver shunt 73 to receiver 71. By operating switch 75 in the manner heretofore described the vibrator 70 and the receiver and receiver shunt are alternately connected with the four-wire circuit and with the artificial line, and shunt 73 is varied until the volume of tone in the receiver 71 when the receiver is connected with the artificial line is the same as when connected with the four-wire repeater circuit. The reading upon the scale of the receiver shunt represents the transmission gain due to the presence of repeater 60 in the circuit.

By inserting the plug P_4 in the jack J_4 and the plug P_5 in the jack J_5, it will be noted that there has been included in the four-wire transmission circuit the networks N_3 and N_4, and consequently the artificial line 72 must have the same impedance as the four-wire circuit including the said networks but having the repeaters disconnected. If, however, the said plugs are inserted in jacks J_4' and J_5' respectively, the networks are not included in the said four-wire circuit (as has been shown in my copending application, Serial No. 278,945, filed February 24, 1919) and consequently the artificial line 72 must be adjusted so as to have the same characteristic impedance as the four-wire circuit without the networks N_3 and N_4, and with the repeaters disconnected.

From the foregoing description of the apparatus in which this invention is embodied and of its mode of operation, it will be seen that this invention provides a simple and efficient method for determining the improvement in transmission due to the connection of the repeaters in the four-wire transmission circuit. Although this invention is shown as embodied in the single form, it is apparent that it is capable of embodiment in other and varied forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a telephone system, the combination of a four-wire repeater trunk circuit, having telephonic repeaters associated therewith but normally disconnected therefrom, a testing

circuit comprising an artificial line having a transmission equivalent equal to that of the repeater trunk circuit when the said repeaters are disconnected, and link circuits for connecting said repeater circuit with said testing circuit, the said testing circuit being adapted to apply an alternating electromotive force of telephonic frequency alternately to one end of said circuit and to one end of said artificial line, a receiver and a measuring device adapted to be alternately connected with the other end of said repeater trunk circuit and with said artificial line, whereby the tones received in said receiver may be compared as to magnitude.

2. In a telephone system, the combination with a four-wire transmission circuit having repeaters associated therewith but normally disconnected therefrom, a testing circuit, link circuits having a plurality of keys associated therewith arranged to connect the said four-wire circuits with the said testing circuit, and switching means for effectively connecting the said repeaters with the said four-wire circuit when the said link circuits are connected with their respective associated circuits and all but one of said keys are in their unoperated positions.

3. In a telephone system, the combination with a four-wire repeater circuit of testing trunk circuits, link circuits for connecting each end of the said repeater circuit with its corresponding testing trunk circuit, an artificial line having the same transmission efficiency as the said four-wire circuit when the repeaters are disconnected therefrom, a source of testing potential, a measuring device and means to connect both the said source and the said device alternately with the said testing trunks and with the said artificial line.

4. In a telephone system, the combination with a four-wire repeater circuit having a plurality of repeaters associated therewith but normally disconnected therefrom, of a gain testing circuit and a plurality of link circuits for connecting the said repeater circuit with the said testing circuit, the link circuits having means associated therewith for controlling the connection of the said repeaters with the said four-wire circuit.

5. In a telephone system, the combination with a four-wire repeater circuit having line balancing networks and gain control networks associated with each end thereof, the said four-wire circuit terminating in a plurality of jacks at each end, of a testing circuit having an artificial line of adjustable impedance associated therewith, link circuits adapted to connect the said testing circuit with the said four-wire circuit, and to control the connection of the said gain control networks with the said four-wire circuit.

6. In a telephone system, the combination with a four-wire repeater circuit having a plurality of repeaters associated therewith but normally disconnected therefrom and also line balancing networks and gain control networks associated therewith, of a testing circuit having an artificial line whose impedance may be varied, and also a source of electromotive force and a gain measuring device associated therewith, and link circuits for connecting the said four-wire circuit with the said testing circuit and adapted to control the connection of the said repeaters and also of the said gain control networks with the said four-wire circuit.

In testimony whereof, I have signed my name to this specification this twenty-first day of July, 1920.

CHARLES S. DEMAREST.