March 27, 1928.

1,663,750

F. H. BEST

AUTOMATIC TRANSMISSION MEASURING SET

Filed May 9, 1925 2 Sheets-Sheet 1

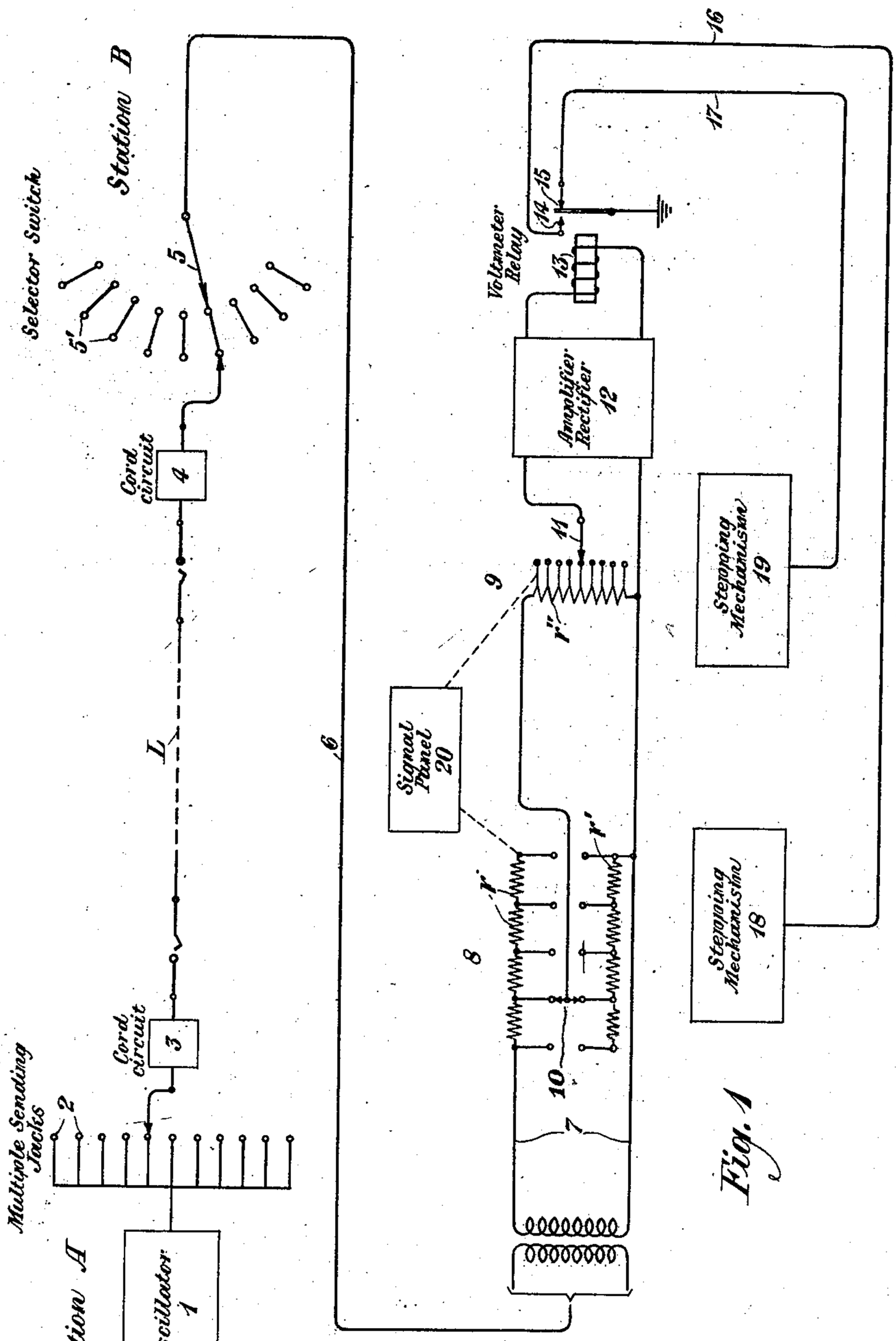

Fig. 1

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2 Sheets-Sheet 2

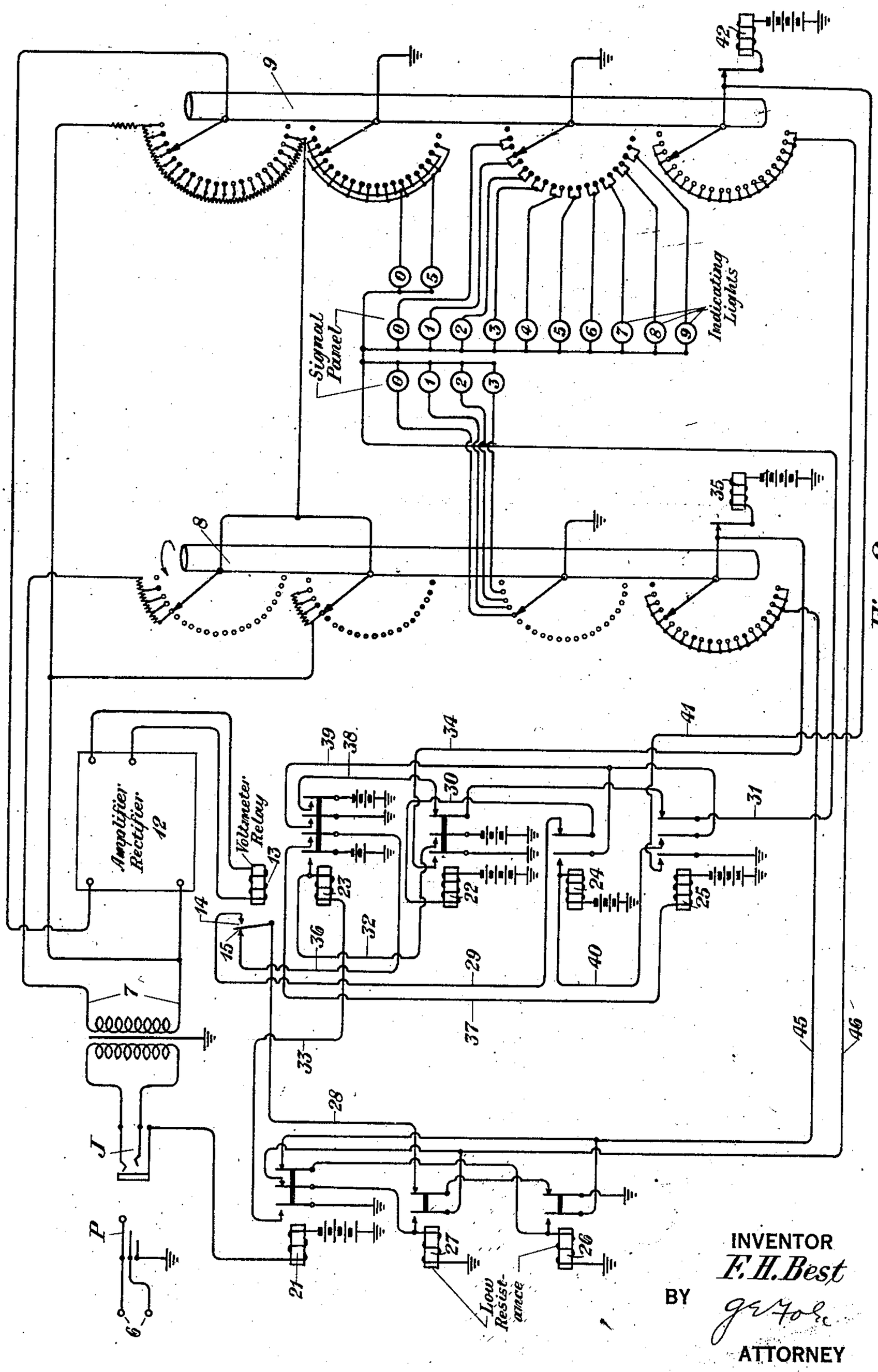

Fig. 2

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TRANSMISSION-MEASURING SET.

Application filed May 9, 1925. Serial No. 29,188.

This invention relates to improvements in devices for measuring or testing electrical currents.

The invention is particularly adapted for making measurements to obtain or test the transmission equivalent of telephone circuits, although it may be utilized for other purposes. One of the cardinal features of the device of the invention is that its operation is entirely automatic. It thus does away with all manually operated dial arrangements of former systems and allows measurements and tests to be made with far greater facility and speed than heretofore. Further features and purposes of the invention will appear more fully from the following detailed description thereof.

The invention may be more fully understood from the following description together with the accompanying drawing in the Figures 1 and 2 of which the invention is illustrated. Fig. 1 shows a schematic circuit arrangement of the invention, while in Fig. 2 is shown in detail circuit arrangements of a portion of the device.

In Fig. 1 is shown a transmission line L whose transmission efficiency it is desired to obtain by measuring the transmission characteristics thereof. The line L is shown interconnecting two stations A and B. To measure the transmission characteristics of the line L a cord circuit 3 at station A would be connected to the line and to one of a number of multiple jacks 2 which are connected to an oscillator 1. A desirable frequency for the oscillator might in practice be 1,000 cycles. At station B a cord circuit 4 would connect the line L to one of a number of contacts 5′ of a selector switch. The contact arm 5 would automatically find the contact and stop there. This arrangement is utilized so that only a single line may be connected to the measuring set at one time. Current from the oscillator 1 will then be transmitted from station A over the line L to station B and thence over conductor 6 to the measuring set. Current of the testing frequency will be impressed on a circuit 7 which includes the device 8 for introducing a loss step by step and the device 9 for decreasing the loss step by step. The current will then be transmitted to an amplifier rectifier device 12 and then transmitted through the voltmeter relay 13. With the devices 8 and 9 set at normal, that is, with the switch 10 on its farthest left-hand contacts and with the switch 11 on its lowest contacts, the current from the oscillator 1 transmitted over the line L will operate the voltmeter relay 13 so that it will close its contact 14. This will complete a circuit over conductor 16 to the stepping mechanism 18 and cause it to start operating to move the switch 10 successively over its contacts. This operation will in successive steps add in series in the circuit the individual resistance elements such as r and will decrease the number of resistance elements such as r' connected in shunt across the circuit. This will tend to introduce a loss step by step in the circuit and decrease the energy transmitted thereover. It is pointed out that each step of the device 8 has an arbitrary value, which in this instance, may be termed as a step of ten transmission units. In other words, the device 8 is arranged to increase the loss in steps of ten transmission units each. When the current has been decreased a certain amount by this method the voltmeter relay 13 will operate to open contact 14 and to close contact 15. This operation will stop the mechanism 18 and hold it in operated position. A circuit will now be closed over contact 15 and conductor 17 to the stepping mechanism 19, thus starting it in operation. The mechanism 19 will move the switch 11 upward step by step over its contacts, thus increasing the ratio of the resistance across the amplifier input to the total resistance controlled by the switch, thereby increasing the voltage across the amplifier input terminals. This will tend to decrease the loss step by step until the current again will be just strong enough to again operate relay 13. This will open the circuit 17 and stop the apparatus 19 from operating. It will also again close circuit 16. This will now operate to lock all of the apparatus up. It has been pointed out that the apparatus 8 consisted of a number of steps of ten transmission units each for increasing the loss. The apparatus 9 will, as a whole, equal or counteract one of these steps. Accordingly, it will be subdivided into a number of steps, such for example, as twenty steps each of one half a transmission unit. With such an arrangement an accurate measurement may be made of the transmission equivalent of the line. Associated with the devices 8 and 9 would be a signal panel, such as 20, which

would indicate to the test operator the exact number of transmission units and fraction thereof which had been cut into the line to obtain a condition of equality. By well known methods of comparison, this would be utilized to indicate the transmission equivalent of the line.

In Fig. 2 there is shown in detail a circuit diagram of the measuring set heretofore illustrated schematically. Similar reference characters have been utilized to denote like parts in all of the figures of the drawing. The conductor 6 is shown in Fig. 2 as terminating in the plug P adapted to be connected to jack J of the measuring set. Accordingly, the voltage from circuit 6 will be applied to the circuit 7 of the measuring set and will then be transmitted to a receiver shunt device 8 and a potentiometer device 9 which are varied by their respective selectors, as will be pointed out hereinafter. The selector of the receiver shunt 8 normally rests so as to introduce no loss and acts to introduce loss (in the specific arrangements used for purposes of illustration) in steps of ten transmission units each. After passing through the receiver shunt and potentiometer, the voltage is applied to the amplifier rectifier 12 and thence to the voltmeter relay 13. It is pointed out that when plug P is inserted in jack J the sleeve circuit will cause relay 21 to operate for purposes to be pointed out hereinafter. The incoming voltage will be reduced by the potentiometer by a ten transmission unit ratio and then applied to the amplifier 12 and to the voltmeter relay 13. This applied voltage will cause the relay 13 to pull up and close contact 14. This will cause the following circuit to be closed: from ground contacts of relays 26 and 27, conductor 28, contact 14, conductor 29, contact to relay 24, conductor 30, winding of relay 22 to battery and ground, thereby operating relay 22. The operation of relay 22 will open at its right-hand contact, a circuit 31 common to all of the indicating lights in the signal panel. The operation of relay 22 also closes the following circuit: from ground contact of relay 21, conductor 33, winding of relay 23, conductor 32, middle contact and armature of relay 22 to battery and ground. This will cause relay 23 to operate and to lock up over its contact. The operation of relay 22 will also close the following circuit: from ground armature and contact of relay 22, conductor 34, contact and armature of relay 35 to battery and ground. This will cause relay 35 to operate intermittently to step the selector arms of mechanism 8 around step by step. The receiver shunt mechanism 8 accordingly will introduce into the circuit with each step a loss of ten transmission units. The mechanism continues to step until the loss introduced is such that the current through the voltmeter relay 13 falls below its marginal point, thus causing the armature of said relay to fall back and close the contact 15. This will cause the relay 22 to release and also cause a circuit to be closed from conductor 28, contact 15, conductor 36, armature and contact of relay 23, conductor 37, winding of relay 25 to battery and ground, thereby causing relay 25 to operate. It opens at its contact, the circuit 34 to the relay 35, thereby stopping the selector mechanism of the receiver shunt device 8 from further operation. The release of relay 22 again closes at its outer right-hand contact, the circuit 31 heretofore mentioned, common to all of the indicating lights at the signal panel. This last mentioned circuit, however, is now held open at the outer right-hand contact of relay 25. The operation of relay 25 also closes the following circuit: From ground armature and contact of relay 23, conductor 39, contact and armature of relay 25, conductor 40, winding of relay 24 to battery and ground. This will operate the relay 24 which will lock up over its left-hand contact and a contact of the relay 23. The operation of relay 25 also closes the circuit over conductor 41 to the relay 42 of the selector potentiometer mechanism 9. This relay will operate intermittently and move the selector arms around step by step. This operation of the potentiometer selector mechanism 9 will cut out loss by one-half transmission unit with each step until the current through the voltmeter relay 13 again passes the marginal point, thus causing relay 13 to operate and close its contact 14. Upon this operation of relay 13 it will be seen that the circuit previously traced over contact 14 and conductor 29 is now broken at the right-hand contact and armature of relay 24. The operation opens at contact 15 the previously traced circuit to relay 25, thereby causing relay 25 to release. The release of relay 25 breaks the circuit 41 leading to the selector mechanism 9, thereby stopping the operation of the potentiometer selector mechanism 9. The release of relay 25 at its outer right-hand contact completes again the circuit 31 which is common to all of the indicating lamps of the signal panel. The grounds to these lamps are completed over their respective selector mechanisms, and accordingly certain of these lights will light, and indicate the loss of the circuit or apparatus being measured in transmission units.

When the measurement has been obtained the plug P is withdrawn from the jack J, thus causing the relay 21 to release. This breaks the previously traced circuit to relay 23, allowing it to release, which in turn allows relay 24 to release. The release of relay 21 allows circuits to be completed over conductors 45 and 46 to the fourth bank of selector mechanism 8 and the fourth bank of

selector mechanism 9 through the windings of relays 26 and 27. As these two last mentioned relays are low resistance relays, the selectors step themselves around to normal. At the same time the relays 26 and 27 operate, breaking the previously traced circuit from the ground to the armature of the voltmeter relay 13, thus preventing another measurement from starting, even though the plug be reinserted into jack J until the outfit has been completely restored to normal. When this occurs, the contact through the fourth bank of each of the selectors 8 and 9 has been broken, the relays 26 and 27 then fall back and the circuit is ready for another measurement.

While the invention has been disclosed 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 in the appended claims.

What is claimed is:

1. A testing set for determining the transmission characteristics of a line comprising a circuit to which voltage from said line is to be applied, a responsive device in said circuit, means controlled thereby for automatically introducing steps of loss in said circuit and for subsequently introducing steps of gain in said circuit until the attenuation of said circuit counteracts the attenuation of said line, and means controlled by said last-mentioned means for indicating the amount of said steps of loss and gain introduced.

2. A testing set for determining the transmission characteristics of a line comprising a circuit to which voltage from said line is to be applied, a voltmeter relay in said circuit, a receiver shunt device for introducing a step by step loss in said circuit, a potentiometer device for decreasing step by step said loss introduced by said receiver shunt, automatic means for causing the operation of said receiver shunt and the successive operation of said potentiometer, said automatic means being controlled by said voltmeter relay, and means to indicate the degree of operation of said receiver shunt and said potentiometer.

3. A testing set for determining the transmission characteristics of a line comprising a circuit to which voltage from said line is to be applied, a voltmeter relay in said circuit, a receiver shunt device for introducing a step by step loss in said circuit, said receiver shunt loss for each step being an arbitrarily chosen unit, a potentiometer device for decreasing step by step said loss introduced by said receiver shunt, said potentiometer loss for each step being a fraction of said previously mentioned receiver shunt unit, automatic means for causing the operation of said receiver shunt and the successive operation of said potentiometer, said automatic means being controlled by said voltmeter relay, and means to indicate the degree of operation of said receiver shunt and said potentiometer.

In testimony whereof, I have signed my name to this specification this 8th day of May 1925.

FRED H. BEST.