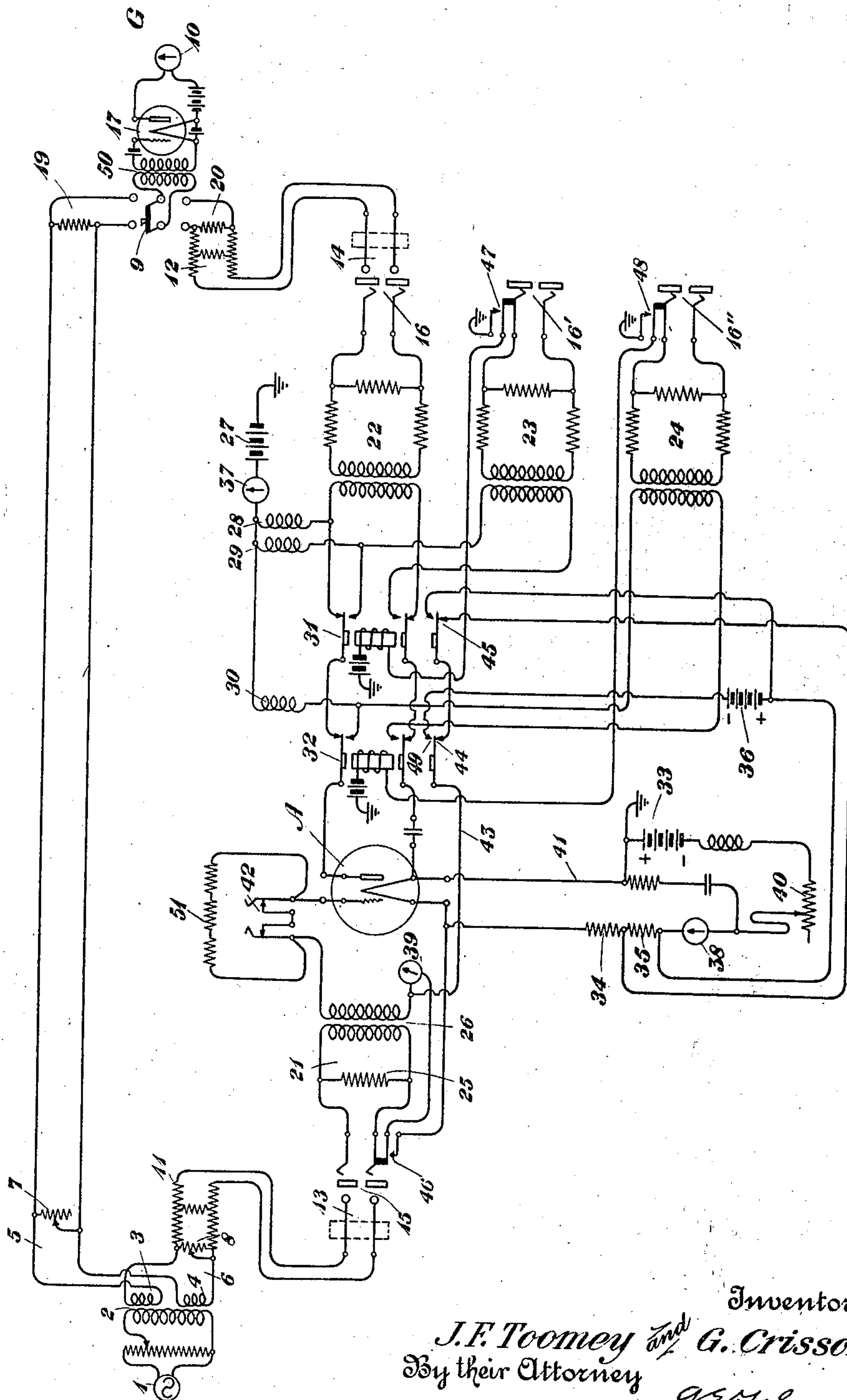


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J. F. TOOMEY ET AL
ELECTRICAL TESTING SYSTEM

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ELECTRICAL TESTING SYSTEM.

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To all whom it may concern:

Be it known that we, JOHN F. TOOMEY and GEORGE CRISSON, residing at New York and Hackensack, in the counties of New York and Bergen, and States of New York and New Jersey, respectively, have invented certain Improvements in Electrical Testing Systems, of which the following is a specification.

This invention relates to electrical testing systems, and particularly to an arrangement for readily determining the condition of vacuum tube amplifiers and the magnitude of the gain attainable from amplifiers of various types.

Various circuit arrangements have been devised and used for determining whether vacuum tubes used in signaling circuits such as telephone repeater circuits are operating properly, that is to say, whether they are producing the amount of transmission gain that they are designed to give. A gain-measuring circuit designed to perform this function is shown in the patent to D. F. Whiting, issued Jan. 16, 1923, No. 1,442,455. The arrangement therein shown has certain limitations, in that it is impracticable, in case a repeater embraces a plurality of tubes, to determine whether each tube is giving the gain that it is designed to give; and, in case these tubes are not giving their total predetermined gain, it is impracticable to determine which tube is below standard without replacing the various tubes with other tubes whose values are known.

It is the object of this invention to provide a circuit arrangement in which individual tubes of different types may be readily inserted and tested so as to determine whether they are giving the proper amount of amplification for which they were designed.

This invention will be better understood from the following description when read in connection with the attached drawing which shows one form of embodiment of the invention.

In the drawing, a source of oscillations 1 is connected with the primary winding of transformer 2 whereby currents of the proper testing frequency may be applied to the test circuit. The secondary winding of transformer 2, comprises two coils 3 and 4 which are connected in series between the

circuits 5 and 6. Bridged across each of the latter circuits are shunts 7 and 8 respectively for controlling the magnitude of the current applied to the testing apparatus associated with these circuits. Shunt 7 is designed to have initially relatively low resistance, so that by increasing its resistance the voltage across resistance 19 may be increased. On the other hand, shunt 8, which is initially open, serves to decrease the voltage across resistance 20 as the resistance of the shunt 8 is decreased. Circuit 5 forms a continuous path between the output side of transformer 2 and switch 9 by means of which circuit 5 may be connected to an indicating device such as a galvanometer G. The galvanometer circuit, extending from switch 9 to the instrument G, comprises a transformer 50 and an amplifier 17 whereby the oscillations may be amplified and detected.

Circuit 6, which constitutes a second path between the oscillator 1 and the galvanometer G is arranged to include the tube to be tested. Associated with circuit 6 are the networks 11 and 12 and the plugs 13 and 14, plug 13 being adapted for insertion in the jack 15 of the auxiliary gain testing circuit, and plug 14 being adapted for insertion in either of the jacks 16, 16' or 16'' of the said auxiliary circuit. Bridged across the output ends of circuits 5 and 6 are the resistances 19 and 20.

The auxiliary circuit, which forms part of circuit 6, comprises a common input circuit 21 and a plurality of output circuits 22, 23 and 24. The common input circuit embraces a resistance 25 and the transformer 26. The tube to be tested, shown in the drawing as permanently connected into the circuit, is inserted in a standard socket which is adapted to hold any type of tube, and to afford the proper connections for the grid, filament, and plate conductors. A source of plate current is applied from the battery 27 through either of the retardation coils 28, 29 or 30 (depending upon the type of tube), and the selection of the proper output circuit is determined by the insertion of plug 14 in the proper one of the terminal jacks 16, 16' or 16''. The filament heating current is supplied by the battery 33 which, in conjunction with the resistances 34 and 35, and in a certain case in conjunction with

the battery 36, supplies the proper potential between the grid and the filament. Ammeters 37 and 38 indicate respectively the plate current and the filament current, and a voltmeter 39, which is controlled by a local contact 46 of the jack 15, measures the grid-filament voltage.

Having in mind the foregoing description of the various parts of the circuit in which this invention is embodied, the invention will be made clear by the following description of the mode of operation of the circuit. Let it be assumed that it is desired to test a tube of a particular type which, for the purpose of illustration, will be called a V tube. The tube should be inserted in a socket of the auxiliary gain testing circuit as represented by A in the drawing. Plug 13 should be inserted in jack 15, and plug 14 in jack 16. The resistance 40 should be adjusted so as to provide the proper filament current from the battery 33. The plate-filament circuit extends from battery 27, through the ammeter 37 and retardation coil 28, the upper contacts of relays 31 and 32, to the plate of the vacuum tube thence through the electron path to the filament and over conductor 41 to ground. The grid-filament circuit extends from the grid through the inner contacts of key 42, the secondary winding of transformer 26, conductor 43, contacts 44 and 45 of relays 32 and 31 respectively, through resistance 34 to the filament of the tube. The potential applied to the grid is the drop in potential across the resistance 34 caused by the flow of filament current from the battery 33. This drop in potential is measured by the voltmeter 39 since the contact 46 of jack 15 has been closed by the insertion therein of plug 13.

When the varying current from the source 1 is impressed upon the transformer 2, it will flow through the circuits 5 and 6 to the switch 9 setting up potential differences across resistances 19 and 20, respectively. If the switch is in its upper position, the voltage across resistance 19 will be impressed upon the indicating instrument 10 which is of very high impedance and will be measured accordingly. When the switch is in its lower position, the voltage across resistance 20 will likewise be impressed upon the indicating instrument 10 and measured. If the tube is operating properly, the current flowing through circuit 6 will be amplified accordingly. With the shunts set at values corresponding to zero gain of the amplifier, that is, with shunt 7 at the point of lowest resistance and with shunt 8 open, the voltage across resistance 20 will be greater in magnitude than that across resistance 19. By varying the shunt 8 and also, if necessary, the shunt 7, the amount of current flowing through circuits 5 and 6 may be adjusted to give equal voltages across resist-

ances 19 and 20. By proper calibration of the shunts 7 and 8, the gain in miles of transmission may be determined directly from the reading on the dial of the shunt, and accordingly the amount of amplification of any tube may be determined.

If a tube of another type is to be tested, which for purpose of illustration may be termed the L type, plug 14 should be inserted in jack 16' instead of in jack 16. By the operation of the local contact 47, relay 31 is operated, and the plate-filament circuit of the vacuum tube is connected with the output circuit 23 which is designed to have the proper impedance for L tubes. In consequence of the operation of relay 31 the plate current of a definite magnitude required for an L tube would be applied over a circuit extending from battery 27, through the retardation coil 29, over the inner contact of the upper armature of relay 31 to the plate of the vacuum tube thence through the electron path to the filament, and over conductor 41 to ground. Also the grid potential would be determined by the drop in potential across resistances 34 and 35 in series due to the flow of filament current through the said resistances. By applying to the tube, as thus connected, oscillations from the source 1, the amount of gain may be determined in the same manner in which the gain of the said V tube was measured.

If a third type of tube, which may be termed an O tube is to be tested, plug 14 should be inserted in jack 16'', which, by the operation of the local contact 48, energizes relay 32 and connects the plate-filament circuit of the tube with the output circuit 24, which has the proper impedance for this type of tube. The plate current would be supplied by the battery 27 through the retardation coil 30. The grid-filament circuit would, in this case extend from the grid, through the inner contacts of key 42, over conductor 43, contact 49 of relay 32, battery 36, resistances 35 and 34 to the filament of the tube; and it will be seen that the grid potential is the sum of the drop in potential across resistances 35 and 34 plus the voltage of battery 36.

The resistances shown in the output circuits 22, 23 and 24 are so proportioned that the impedance presented by the output transformer to the said V, L, or O tube respectively, is the same as that to which the tube would be connected when in service. They also introduce such losses into the circuit that the net gains measured by the dials associated with shunts 7 and 8 will be of convenient values.

The resistance 51, shown in connection with key 42 is intended for use in determining the presence of what is known as "grid leakage." If the tube under test is in perfect condition, the resistance of the

gap between the grid and the filament is practically infinity, and consequently the introduction into the grid circuit of a resistance such as 51 of the magnitude of several hundred thousand ohms would cause practically no variation in the normal output current. If, however, the tube is defective with respect to the grid-filament circuit, in that leakage exists between the grid and the filament, then the introduction of a resistance such as 51 into the circuit will appreciably affect the potential of the grid, and, in consequence the output current and gain, thus indicating "grid leakage."

It will be seen that the arrangement disclosed herein provides simple and effective means for quickly and accurately determining the magnitude of the gain to be obtained by a tube of any type. Although the arrangement as disclosed provides for the testing of only three types of tubes, the invention is not so limited, since a circuit embodying the principle of this invention may be designed to test any number of tubes.

Furthermore, the invention provides an auxiliary circuit having means for receiving and holding vacuum tubes of various types, a plurality of output circuits, an input circuit, all of these circuits being so proportioned that the impedance presented to the tube would be the same as that to which the tube would be connected in service, and having switching means which operate when the auxiliary circuit is connected with any well known type of gain-measuring circuit to automatically select the proper output circuit for a particular type of tube.

Although this invention has been described in a particular circuit arrangement, it is to be understood that it is capable of embodiment in other arrangements without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In an electrical testing system, the combination of a source of varying potential, an indicating instrument, a plurality of circuits for applying said potential to said instrument, one of said circuits being arranged to connect thereto an amplifier and to select the proper output network for said amplifier, the said circuit having means to shunt the current applicable to the said amplifier whereby the degree of amplification may be determined.

2. In an electrical testing system, the combination of a source of varying potential, an indicating instrument, a plurality of circuits for applying said potential to said instrument, one of said circuits having means associated therewith for connecting an amplifier and its proper output net-

work to the said circuit, and means for measuring the gain attainable by the said amplifier.

3. In an electrical testing system, the combination of a source of varying potential, an indicating instrument, a plurality of circuits connecting said source and said instrument, one of said circuits having associated therewith a multi-electrode vacuum tube, a plurality of networks, and means for connecting the said vacuum tube with its proper output impedance network in said circuit and for varying the potential applied to the grid of the said vacuum tube.

4. In an electrical testing system, the combination of a source of varying potential, an indicating instrument, a circuit connecting said source and said instrument, a second circuit connected electrically in series with the said first circuit and comprising an auxiliary gain testing circuit having switching means for connecting the said auxiliary circuit with said second circuit.

5. In an electrical testing system, the combination with two serially connected circuits, of a source of oscillations, and an indicating instrument arranged for connection alternately with said circuits, one of said circuits having a thermionic vacuum tube connected therewith and means to shunt the energy applied to the input side of the said tube.

6. In an electrical testing system, the combination with two circuits, of a source of oscillations, common to both circuits and an indicating instrument arranged for connection alternately with each circuit, one of said circuits having associated therewith a thermionic tube and means to select an output circuit having the proper impedance for the said tube.

7. In an electrical testing system, the combination of a source of testing current, an indicating instrument, a circuit arranged to connect said source with said instrument, an amplifier circuit arranged to be connected with the said source and the said instrument, and means to shunt the current applied by the said source to the said amplifier circuit until the amount of current applied to the said instrument over each circuit is equalized.

8. In an electrical testing system, the combination of a source of current, an indicating instrument, a circuit arranged to connect said source with said instrument, a vacuum tube amplifier circuit having an input circuit connected with said source and a plurality of output circuits, and switching means to connect the said amplifier circuit with the proper type of output circuit when said amplifier is effectively connected with the circuit of the said indicating instrument.

9. In a vacuum tube testing circuit, the combination with a source of E. M. F. of an

- input circuit, a plurality of output circuits, a thermionic vacuum tube, switching means to connect the said vacuum tube with its proper output circuit, an indicating instrument and second switching means arranged to operate said first switching means whenever the said output circuit is connected with the circuit of the said indicating instrument.
10. In a vacuum tube testing circuit, the combination of an input circuit arranged for connection with a source of oscillations, a thermionic vacuum tube, a plurality of output circuits having various impedance values, a measuring circuit arranged for connection with said output circuits and switching means to control the selection of the proper output circuit for a particular type of vacuum tube whenever said measuring circuit is operatively connected with the said vacuum tube.
11. In a vacuum tube testing circuit, the combination of an input circuit consisting of a network of definite impedance, a source of oscillations arranged to be connected thereto, a thermionic vacuum tube, a plurality of output circuits one of which is normally connected with the said vacuum tube, a measuring circuit arranged to be connected with any of said output circuits, and switching means controlled by the connection of the said measuring circuit with any output circuit to connect the corresponding output circuit with the said vacuum tube.
12. In a vacuum tube testing circuit, the combination with an input circuit, a plurality of output circuits of different impedance values, a thermionic vacuum tube, switching means to connect said tube with its proper output circuits and a gain measuring circuit having means associated therewith to control the operation of the switching means for selecting the proper output circuits.
13. In a vacuum tube testing circuit, the combination with a gain measuring circuit of an auxiliary testing circuit embracing an input circuit, a plurality of output circuits, a thermionic vacuum tube, and switching means controlled by the connection of the auxiliary circuit with the gain testing circuit for connecting the said vacuum tube with an output circuit of correct impedance for the said tube.
14. In a vacuum tube testing circuit, the combination with a gain measuring circuit of an auxiliary testing circuit embracing an input circuit, a plurality of output circuits, a thermionic vacuum tube, and a plurality of switching means controlled by the connection of the auxiliary circuit with the gain testing circuit for connecting the vacuum tube with the input circuit and an output circuit having the proper impedance value for the particular type of tube connected with the auxiliary circuit.
- In testimony whereof, we have signed our names to this specification this 8th day of June, 1921.
- JOHN F. TOOMEY.
GEORGE CRISSON.